Prepared for:

Cascade Corporation
2201 NE 201st Avenue
Fairview, Oregon 97024

The Boeing Company
P.O. Box 2207, M/S 7A-XA
Seattle, WA 98124

ANNUAL PERFORMANCE REPORT
1 JANUARY 2017 – 31 DECEMBER 2017

EAST MULTNOMAH COUNTY, TROUTDALE SANDSTONE AQUIFER REMEDY
ECSI 1479

Prepared by:

Geosyntec Consultants, Inc.
621 SW Morrison Street, Suite 600
Portland, OR 97205

Landau Associates, Inc.
130 2nd Avenue South
Edmonds, WA 98020

S.S. Papadopulos & Associates, Inc.
7944 Wisconsin Avenue
Bethesda, MD 20814

3 April 2018

Geosyntec consultants

TABLE OF CONTENTS

Page

TABLES

FIGURES

APPENDICES

TABLE OF CONTENTS (Continued)

Annual Performance Report
1 January 2017 – 31 December 2017

East Multnomah County Troutdale Sandstone Aquifer Remedy

Prepared by:

04/03/18

Cindy Bartlett, R.G. — Date
Geosyntec Consultants

Reviewed by:

04/03/18

Brent Miller, P.E. — Date
Geosyntec Consultants

Approved By:

04/03/18

Christine Kimmel, L.G. — Date
Landau Associates

Reviewed by:

04/03/18

Charles Andrews, Ph.D. — Date
S.S. Papadopulos & Associates, Inc.

Approved by:

04/03/18

Eric Weber, R.G. — Date
Landau Associates

1.0 INTRODUCTION

This 2017 Annual Performance Report is submitted on behalf of Cascade Corporation (Cascade) and The Boeing Company (Boeing) and summarizes performance and monitoring data for the East Multnomah County, Troutdale Sandstone Aquifer (TSA) remedy project. Data presented in this Annual Performance Report were collected during the period of 1 January 2017 through 31 December 2017 as part of the joint remedy being implemented under the Department of Environmental Quality's (DEQ's) Consent Order No. WMCSR-NWR-96-08 (DEQ, 1997).

1.1 Purpose of Report

The reporting period for the TSA remedy Annual Performance Report presents data through the calendar year 2017. This Annual Performance Report provides an evaluation of the TSA remedy performance, including:

- A summary of the remediation system operation, maintenance, and performance monitoring data;
- Operation of an additional remedial action, a soil vapor extraction (SVE) system;
- An assessment of aquifer restoration progress; and
- Recommendations and future planned activities.

In addition, a work plan for expansion of the SVE system is provided as an attachment for review.

TSA remedy data presented and evaluated in this report includes water level, groundwater extraction rate, discharge compliance, and water quality data for the operating remediation system, as well as data related to the SVE system. Laboratory reports for samples collected during this reporting period are contained on a compact disc provided with this report.

The project area and site are shown on Figure 1-1. The Lower TSA restoration zones (Zones A, B, C, and D), the TSA remedy network of extraction wells and monitoring wells, and the former and current TSA remedy extraction system layouts are shown on Figure 1-2.

Currently Sand and Gravel Aquifer (SGA) groundwater elevation data are collected monthly from one SGA well, BOP-44(usg), as part of the Portland Water Bureau (PWB) contingency plan (Landau Associates 2015). The location of this SGA well is included on Figure 1-2.

2.0 SIGNIFICANT ISSUES, EVENTS, AND ACTIONS

This section summarizes significant issues, events, and actions taken during the reporting period. The TSA remedy criteria for well and system decommissioning, monitoring well modifications, and changes in sampling frequency are summarized in Table 2-1. The current groundwater monitoring schedule is summarized in Table 2-2, and a summary of significant documents exchanged with DEQ during the period are presented in Table 2-3.

2.1 Monitoring Program and Schedule Modifications

Monitoring schedule modifications implemented during the reporting period were presented in the *2016 Annual Performance Report: 1 January 2016 through 31 December 2016, Troutdale Sandstone Aquifer Remedy* (Geosyntec, Landau Associates, and SSPA, 2017a) and the *EW-16 Monitoring Conversion and Eastside Conveyance Line Decommissioning Request* (Geosyntec, 2017b). These changes are described below:

- SGA well EMC-2(usg) was decommissioned in April 2017.

- The Oregon Water Resources Department (OWRD) provided approval of decommissioning methods for nine wells on 23 January 2018, following receipt of approval from DEQ (DEQ 2017a and 2016) for seven of the wells. The wells approved for decommissioning include groundwater monitoring wells: D-18(ds), D-16(ds), BOP-70(ds), BOP-71(ds), and RPW-1(ds) and soil vapor extraction wells VW-17D-75.0 and VW-17D-42.5. Two additional wells, D-18(dg) and D-16(dg), will be decommissioned following a field survey to confirm their presence and upon DEQ approval (Geosyntec, 2018). The decommissioning was recommended for wells that met the Remedy Well Network Criteria (Table 2-1) for one or more of the following reasons 1) concentrations of VOCs were below the MCL for 2 or more years; 2) the well locations were no longer needed for Portland Water Bureau (PWB) contingency monitoring during pumping events at the Columbia South Shore Well Field, or were redundant with other nearby well locations; or 3) operation of the SVE system at the vapor wells was completed and the wells were no longer necessary. OWRD approved special standards for backfilling the two SVE wells and five groundwater monitoring wells, and over-drilling methods of two wells, BOP-70(ds) and RPW-1(ds). A work plan describing the well decommissioning was submitted to DEQ for review and approval (Geosyntec, 2018). Access agreements and final coordination activities are being conducted for the wells, and decommissioning is planned for spring 2018.

- Reduced water quality monitoring at TSA wells from annual to biennial at EW-3 and from quarterly to semiannual at CMW-14R(ds).

- Reduced water level monitoring from semiannual to annual at TSA wells BOP-13(dg), BOP-21(ds), BOP-42(ds)/(dg), BOP-60(dg), BOP-62(ds), and EW-3.

- Extraction Well EW-16 was converted to monitoring use, and the eastside water conveyance and electrical lines were decommissioned.

- The computers operating the groundwater pump and treat system were upgraded with a new operating system and programmable logistics controller (PLC). The PLC was replaced in October 2017.

2.2 Portland Water Bureau Well Field Operations

The PWB operated the Columbia South Shore Well Field production wells (shown on Figure 1-1) for 31 days from 13 February to 15 March 2017 to provide 100% of the City of Portland water demand. During the pumping event, the PWB conducted the annual maintenance runs to test equipment and thereby eliminated the need for an additional pumping event. TSA remedy contingency monitoring was implemented pursuant to the PWB Contingency Monitoring Plan (Landau Associates, 2015). Water levels and groundwater quality samples were collected on 13 and 15 March 2017. PWB operated the well field for approximately seven hours on 7 September 2017 to augment the Bull Run supply during a temporary shortage of treatment chemicals. The two pumping events conducted in 2017 supplied approximately 2.4 billion gallons of groundwater from the well field to the City of Portland (PWB, 2018a).

In May 2017, PWB decommissioned well PWB-1(usg) and installed a replacement well [PWB-1(usg)B] in the direct vicinity of the former well. The well replacement was the result of a damaged well casing (PWB, 2018b). This replacement well is not part of the East Multnomah County TSA remedy project.

3.0 EXTRACTION AND TREATMENT SYSTEMS

This section summarizes the operation and performance of the groundwater extraction remedy. The Central Treatment System (CTS) is the only extraction and treatment system remaining in operation for the TSA remedy. The CTS operates to remove VOC mass from the saturated zone and maintain ongoing hydraulic plume control for the TSA. The location of the CTS compound and the currently operating four Lower TSA extraction wells are shown on Figure 1-2. Monitoring well construction details and location coordinates for monitoring and extraction wells are summarized in Table 3-1.

3.1 CTS Operational Summary

The CTS treats groundwater capture through the operation of four Lower TSA extraction wells (EW-1, EW-2, EW-14, and EW-23). The CTS and the extraction wells operated during the twelve-month reporting period. Planned shutdowns for system maintenance occurred as follows:

- 21 April: EW-2 shutdown for replacement of the flow meter.
- 13-15 July: EW-1 shutdown for sonar cleaning.
- 16-28 August: EW-2 shutdown for replacement of the variable frequency drive.
- 29 August to 1 September: EW-14 shutdown for replacement of the variable frequency drive.
- 1-13 November: The CTS and four extraction wells were shut down for replacement of the PLC system which was at the end of its life-cycle.

Unplanned temporary well shutdowns occurred during the reporting period, as follows:

- 19-24 January, 6-7 February, 9-14 February, and 23-25 October: EW-23 was off because the vault flooded during high precipitation events. The vault was pumped out and the pump restarted. The ground fault circuit interrupter (GFCI) in the vault was replaced in February and October.
- 30 June to 15 July: EW-23 pump not operating due to a power system outage. Power was off due to facility work and the EW-23 power had to be manually restarted.
- 29 March to 5 April: CTS and four wells down due to a system power outage from storms.

Decommissioning of the eastside conveyance lines and EW-16 conversion to monitoring status were approved by DEQ on 4 October 2017 (Geosyntec, 2017). The extent of the decommissioned eastside conveyance lines is shown on Figure 3-1. The wiring was removed (pulled out) and the electrical conduit and water conveyance lines were cut at two locations and the ends filled with a filled (capped) with an expandable plug and concrete grout. Following decommissioning, the lines were marked as “abandoned” in accordance with Oregon Administrative Rules (OAR 952-001-

0070). The pump and motor were removed from EW-16 on 31 October 2017, and EW-16 was incorporated into the quarterly groundwater monitoring schedule.

Upper TSA extraction wells EW-3 and Lower TSA extraction wells EW-5, EW-8, EW-11, EW-12, EW-13, and EW-15 remain in use as monitoring wells.

3.2 Groundwater Extraction Rates

Current operating extraction wells include: EW-1, EW-2, and EW-14, located in the mound area near the CTS; and EW-23 located on the Boeing property in the western treatment area. Extraction well construction data are presented in Table 3-1. Significant repairs were completed in 2017, largely due to an aging and outdated system. Repairs included replacement of the PLC, variable frequency drives at EW-2 and EW-14, and power system components at EW-23 where the vault floods regularly during high precipitation events.

Daily flow data from each well are recorded by the automated PLC system. Data from the PLC is downloaded weekly, and manual inspections and system field checks are also conducted weekly. Routine system inspections include manual collection of total flow meter readings, filter pressure monitoring, system inspection and maintenance, and collection of temperature and pH data. Target flow rates for the extraction wells have been established to maintain hydraulic capture of the dissolved VOC plume. The current target extraction rates are: EW-1 at 25 gpm, EW-2 at 25 gpm, EW-14 at 20 gpm, and EW-23 at 30 gpm.

During the reporting period, average extraction rates decreased steadily in EW-1 from about 94 gallons per minute (gpm) in January 2017 to 28 gpm at the end of June 2017. Hydraulic capture of the dissolved VOC plume was maintained near EW-1; however, to increase the extraction flow rates a sonar cleaning was conducted in July 2017. Following the sonar cleaning, EW-1 flow increased to 45 gpm in July 2017 and 67 gpm in August 2017, and flow has slowly decreased to approximately 42 gpm by the end of December 2017. Overall, the average annual flow rate for EW-1 was 43 gpm, well above the target flow rate of 25 gpm.

Flows at EW-2, EW-14, and EW-23 averaged 25, 19, and 27 gpm, respectively, and were either on target or very close to target flow rates. System and individual extraction well shutdowns (Section 3.1) resulted in lower flows at EW-2 (April, August, November), EW-14 (November), and EW-23 (February, July, and November). For the months when the system was fully operational, flow at EW-2 ranged from 21 to 34 gpm, at EW-14 from 17 to 21 gpm, and at EW-23 from 24 to 34 gpm. Flow rates were sufficient to maintain hydraulic capture.

Flow rate and water level data for extraction wells are provided in Appendix A. Average monthly extraction well flow rates over the most recent 5-year period are shown on Figures A-1 through A-4. The combined average monthly flow for all wells is shown on Figure A-5. Significant repair and cleaning events for the operating TSA extraction wells are also noted on Figures A-1 through

A-4. Average flow data for the 12-month reporting period for individual wells and the total combined system are summarized in Table A-1.

3.3 Treatment System Effluent Compliance

CTS performance data consist of weekly flow, pH, and temperature measurements. In addition, influent and effluent samples are collected from the CTS on a quarterly basis. Permits to discharge treated groundwater effluent from the CTS are presented in Attachment C to the TSA Remedy Consent Order (DEQ 1997).

CTS data for the reporting period are as follows:

- The average flow during the 12-month period, January through December 2017, was 114 gpm (Table A-1);
- Effluent pH ranged from 7.7 to 7.8 standard units (SU) and remained within the effluent limits of 6 to 9 SU;
- Effluent temperature ranged from 56 to 61 degrees Fahrenheit (F); and
- VOCs were not detected at the respective laboratory reporting limits in quarterly effluent samples.

Flow, pH, temperature, and influent and effluent VOC data for the reporting period, including compliance (or discharge) limits, are presented in Appendix A (Table A-2).

3.4 Well Decommissioning

SGA well EMC-2(usg) was initially recommended for well decommissioning, based on VOC concentrations being below the laboratory reporting limit since 1997, using over-drilling methods in a DEQ approved work plan (Landau Associates, 2016). However, based on issues raised by the property owner, OWRD approved a special standard variance for decommissioning by utilizing backfill methods. The revised well decommissioning was approved by DEQ (DEQ, 2016a) prior to commencing with the field activities. Well decommissioning activities were conducted by Oregon State licensed drillers and observed by representatives from Geosyntec. The original boring logs are provided in Appendix D.

Decontamination water and water removed from the well during decommissioning were placed in 55-gallon drums and transported to the Cascade property for transfer into the groundwater treatment system. No soil cuttings were generated. The well monument and vault were removed from the property and disposed of as non-hazardous solid waste.

3.5 Soil Vapor Extraction

The SVE system is an additional corrective measure that was implemented in the mound area where groundwater VOC concentrations have been slow to respond to treatment. The SVE system has removed approximately 47 pounds of VOCs mass from the unsaturated zone of the TSA mound area since the startup of the SVE Pilot Study in 2014 and continuation of the long term SVE extraction system in 2015 and 2016 (Geosyntec, Landau Associates, and SSPA, 2016; DEQ, 2014b, 2016b). Based on the mass removal rates, the system was expanded in November and December of 2016 with the addition of four new wells, VMW-A, VMW-B, VMW-C, and VMW-D (Figure 3-2). Extraction from shallow SVE wells VW-17d-45 and VW-17d-75 was discontinued in 2016 when the four new wells were brought online, due to negligible mass removed from these wells. DEQ approved decommissioning of these two wells (DEQ, 2017a), which is currently planned for Spring 2018.

3.5.1 SVE System Operation

The SVE system consists of a 15-horsepower, TurboTron regenerative blower and a knock-out tank situated on a concrete pad within the chain-link fence that surrounds the CTS. The system is connected to VW-17d-95.5 by aboveground PVC piping and to VMW-A through VMW-D by below ground PVC piping. A PVC exhaust stack directly discharges to the atmosphere at a height of approximately 8 feet.

The SVE system maintained an average flow rate of around 445 standard cubic feet per minute (scfm) in 2017 (Table E-1). SVE system operational data are provided in Appendix E. Flow rates, vapor concentrations (field and laboratory), and estimated mass extracted are summarized in Appendix E, Tables E-1 and E-2, and in Figures E-1, E-2, and E-3.

3.5.2 SVE System Monitoring

Routine SVE system monitoring consists of the following parameters for the five SVE wells (VMW-A, VMW-B, VMW-C, VMW-D, and VW-17d-95.5) and the system outlet, as follows:

- Weekly Sampling: collect field measurements of temperature, pressure, flow rates, and vapor data from the system and individual SVE wells,
- Monthly Sampling: collect vapor analytical samples from system effluent, and
- Quarterly Sampling: collect analytical vapor and groundwater samples from the individual SVE wells and D-17ds (groundwater only).

VOC results from PID measurements and laboratory testing are summarized in Tables E-1 and E-2 and the analytical results are shown on Figure E-1. Analytical laboratory reports and data validation memoranda are provided in Appendix F.

3.5.3 SVE System Mass Removal

Based on laboratory data, approximately 19 pounds of VOCs were removed in 2017, with a total of 47 pounds of VOCs removed since system startup in April 2015 (Figure E-3). The 2017 analytical results indicate the highest TCE vapor concentrations were observed at wells VMW-C (located west of CTS, ranging from 2,500 to 3,000 µg/m^3) and at well VMW-D (located east of the CTS, ranging from non-detect at the reporting limit to 6,600 µg/m^3). Groundwater samples collected from the SVE wells indicate the highest TCE concentrations in 2017 were also observed at wells VMW-C and VMW-D at concentrations ranging from 5.02 to 28.8 µg/L. Vapor and groundwater analytical results are shown on Figure 3-2.

In addition to the groundwater samples collected at the SVE wells, groundwater samples were also collected at CMW-17ds, which is located adjacent to the vapor wells and screened near the top of the lower TSA groundwater. Groundwater concentrations at this well are useful to evaluate the potential effect of SVE mass removal on groundwater concentrations. CMW-17ds is screened from elevation 14 to 24 feet mean sea level (MSL), or depths of 97.89 to 107.89 feet bgs, at a depth just below the deepest vapor monitoring well (VW-17D-95.5 is screened from elevation 44.5 to 24.5 feet MSL). VOC concentrations at CMW-17ds have significantly decreased in 2017 from 42.9 µg/l to 16.3 µg/L, indicating there is likely a correlation between the vapor mass removed and declining groundwater VOC concentrations. In addition, the data suggests that VOC mass removed from the vadose zone is no longer available to recontaminate groundwater. Groundwater elevations and TCE concentrations at CMW-17ds are shown on Figure C-1.

Operation of the SVE system is planned to continue through 2018 and possibly beyond, and a proposed expansion of the SVE system is provided in a Work Plan in Appendix G. The SVE system expansion proposes addition of three vapor monitoring wells along the eastern portion of the mound area to target treatment near groundwater monitoring well CMW-18(ds).

4.0 REMEDY PERFORMANCE SUMMARY

This section summarizes remedy performance data obtained during this reporting period, including groundwater levels and groundwater quality data. Groundwater elevation data are summarized in Appendix B, and groundwater quality data are summarized in Appendix C. Laboratory reports, along with data validation reports, are presented in Appendix F.

4.1 Groundwater Elevations

Groundwater elevations are measured monthly, quarterly, semi-annually, and annually based on the Performance Monitoring Schedule (Table 2-2). Water levels are measured monthly in the four operating Lower TSA extraction wells, and quarterly at eight Upper and Lower TSA former extraction wells that are currently utilized as monitoring wells. Currently, semiannual events are conducted at 28 TSA monitoring wells, and annual monitoring is conducted at an additional 14 TSA wells.

Depth to groundwater is measured using a portable electric tape meter in the monitoring wells, and with pressure transducers located in 11 wells (4 Upper TSA wells, 6 Lower TSA wells, and 1 SGA well). Pressure transducers are utilized in wells selected as part of the PWB contingency monitoring plan. Water level data are downloaded monthly from the pressure transducers. Groundwater depths and groundwater elevations are summarized in Table B-1. Water level hydrographs for the five wells with pressure transducers are also included in Appendix B on Figures B-1 and B-2 for the 12-month period from January through December 2017. Precipitation during the 12-month reporting period was approximately 46.10 inches (Appendix B, Figure B-3; NOAA, 2017). Normal annual precipitation at the Portland airport is about 36.0 inches.

4.2 Groundwater Flow and Hydraulic Capture

The objectives of the TSA dissolved VOC plume remedy are to: 1) maintain hydraulic capture; 2) prevent further vertical and horizontal spread of VOC contaminants: and 3) allow existing uses of groundwater resources in the eastern Multnomah County (DEQ, 1996). Groundwater elevations near the TSA mound area, located within Zone C, indicate that inward horizontal gradients towards the operating extraction wells continue due to ongoing remedy pumping. Groundwater contours for the semiannual water level measurement event (February 2017) and the annual event (August 2017) are provided in Figures 4-1a,b and 4-2a,b. Upper TSA groundwater flow direction is generally towards the north-northwest. Lower TSA inward hydraulic gradients toward the extraction wells are indicative of hydraulic capture and demonstrate the effectiveness of Lower TSA extraction wells EW-1, EW-2, EW-14, and EW-23 in achieving and maintaining capture. Groundwater flow directions in the Lower TSA do not vary significantly from wet to dry season and are strongly influenced by the operating extraction wells. These extraction wells capture groundwater within areas of the site where TCE concentrations remain above the cleanup level.

4.3 Water Quality

Groundwater quality monitoring was conducted in 2017 to meet the selected remedy requirements described in the ROD (DEQ, 1996). Groundwater samples are collected for analytical testing on a quarterly, semi-annually, annually, and biennial frequency based on the DEQ approved Performance Monitoring Schedule (Table 2-2). Biennial analytical monitoring is conducted during odd number calendar years (e.g., 2015 and 2017). The Performance Monitoring Schedule is reviewed annually to optimize the monitoring program to maintain compliance with the ROD. In 2017, groundwater analytical samples were collected at 18 TSA wells on a quarterly basis, 9 wells on a semiannual basis, 14 wells on an annual basis, and 10 wells on a biennial basis, as summarized in Table 2-2.

Analytical results for groundwater samples collected during the reporting period are summarized in Appendix C, Table C-1. Plots of time versus TCE concentrations for select monitoring wells in the mound area and the four operating extraction wells and EW-16 are presented in Figures C-1 through C-9. TCE concentration contours for the semiannual event (February 2017) and the annual event (August 2017) are shown on Figures 5-1a,b 5-2a,b for the Upper and Lower TSA wells. Laboratory reports for 2017 analytical testing are provided in Appendix F.

4.3.1 Upper TSA

TCE concentrations in the TSA mound area (located in Remedy Zone C) persist where the Cascade TGA plume historically discharged into the underlying TSA. TCE concentrations during the monitoring period (January through December 2017) ranged from 16.3 to 42.9 µg/L in well CMW-17(ds) (Figure C-1), 16 to 19.4 µg/ L at CMW-10(ds) (Figure C-6) and 18.1 to 87.1 µg/L at CMW-18(ds) (Figure C-7). Groundwater is captured by nearby Lower TSA extraction wells EW-2 and EW-14 within the vicinity of these three monitoring wells.

To further evaluate VOCs at CMW-18(ds), where the highest TCE concentrations were measured in 2017, a series of four passive diffusion bags were installed at 2.5 ft intervals across the 10-foot well screen. The TCE results from the top of the screen in descending order were: 18.1 µg/L, 32.9 µg/L, 36.7 µg/L, and 41.3 µg/L (Table C-1). The highest TCE concentration was in the deepest section of the screen, indicating this portion of the well screen (or aquifer) may be a target for additional groundwater treatment by increasing the flushing rates in this area of the remedy.

In the Upper TSA near the western remedy area and southern extent of the TSA mound area, TCE concentrations not only were below the MCL but also were not detected at concentrations above the laboratory reporting limits (Figures 5-1a and 5-2a), with the following exceptions:

- TCE concentrations at BOP-61(ds) were above the MCL at 5.6 µg/L for both the semiannual sampling events.

- A TCE concentration at BOP-66(ds) of 5.1 µg/L (above the MCL) was reported during the February event; however, the concentration decreased to 0.9 µg/L during the August event.

TCE concentrations at wells BOP-13(ds) and BOP-31(ds), located directly west and of the TSA mound area, continue to be below the MCL and the laboratory reporting limit [BOP-31(ds)]. TCE profiles for BOP-13(ds) are shown on Figure C-2 and for BOP-31(ds) on Figure C-3.

4.3.2 Lower TSA

TCE concentrations for the Lower TSA wells sampled in 2017 are shown on Figures 5-1b and 5-2b. In Lower TSA Zone B, the western portion of the remediation area, TCE concentrations were below the MCL during this reporting period. TCE concentrations at operating extraction well EW-23 were 3.31 and 1.48 µg/L during the semiannual events, respectively (Figure C-8).

In the Lower TSA Zone C, the central portion of the remedy, TCE concentrations were below the MCL at non-pumping extractions wells EW-5, EW-8, EW-11, EW-12, EW-15, and operating extraction well EW-1. TCE concentrations were above the MCL at extraction wells EW-2 (8.86 to 13.9 µg/L) and EW-14 (6.44 and 9.38 µg/L), see Figure C-9. The highest TCE concentration in the Lower TSA Zone C continued to occur in the mound area well D-17(ds) with concentrations ranging from 18.9 to 32.9 µg/L (Figure C-8). Monitoring well D-17(ds) is screened at the top of the Lower TSA across the water table. In monitoring well D-17(dg), screened in the lower portion of the Lower TSA, TCE concentrations ranged from below detection limits to 1.6 µg/L.

In Lower TSA Zone D, the eastern portion of the remediation area, TCE concentrations remained below the MCL in monitoring well CMW-26(dg) (2.02 to 4.44 µg/L) and at EW-16 (1.55 to 4.92 µg/L).

4.4 TSA Remedy Zone A

Currently, a total of seven TSA and one SGA monitoring wells remain in the Remedy Zone A, located north of Sandy Boulevard. In 2017, only well BOP-44(dg) was utilized for groundwater quality monitoring; the remaining Remedy Zone A wells were used to obtain water levels and/or PWB contingency monitoring. The locations of the wells are shown on Figure 1-2.

Wells PWB-1(uts) and PWB-2(lts) were scheduled for biennial sampling during August 2017; however, field crews inadvertently thought these wells had been decommissioned, and they were not sampled. The remaining four TSA Remedy Zone A and SGA monitoring wells are only used to obtain water levels and/or PWB contingency monitoring. TCE concentrations at Remedy Zone A wells are shown on Figures C-9 and C-10. VOCs have been below detection limits or the MCL since the late 1990s/2000, as follows:

- Upper TSA Well PWB-1(uts): TCE concentrations have been below the MCL since 2000 and below laboratory reporting limits (<0.5 or <1.0 µg/L) since 2004.

- Upper TSA Well PMX-167: TCE concentrations were below the laboratory reporting limits (<0.5 or <1.0 µg /L) the three times this well was sampled in 1992 and 1993.

- Upper TSA Well BOP-44(ds): TCE concentrations have been below the MCL since 2002, and below laboratory reporting limits (<0.5 or <1.0 µg /L) since 2009.

- Lower TSA Well PWB-1(lts): TCE concentrations have been below the MCL since 1998, and since then, TCE concentrations ranged from below the laboratory reporting limit (<0.2 µg/L) to 1.7 µg/L.

- Lower TSA Well PWB-2(lts): TCE concentrations were consistently below the laboratory reporting limits (<0.2 and <0.5 µg /L) for the time period this well was monitored (1994 to 2005).

- Lower TSA Well EMC-2(dg): TCE was detected only four times (0.68 to 1.1 µg/L) since monitoring began in 1993, otherwise TCE concentrations were not detected (<0.5 µg/L). TCE concentrations have consistently been below laboratory reporting limits (<0.5 µg/L) since 2003.

- Lower TSA Well BOP-44(dg): TCE concentrations have been below the MCL or below the laboratory reporting limits (<0.2 µg /L to <0.93 µg /L) over the entire time this well has been monitored

4.5 VOC Mass Removal in Saturated TSA

The mass removal estimates are based on groundwater influent VOC concentrations, and the average quarterly groundwater flow for the operating extraction wells, assuming that the VOCs are completely removed during groundwater treatment process. In 2017, approximately 2.5 pounds (lbs) of VOC mass were removed through the groundwater extraction system, a decrease from the 3.25 lbs removed in 2016. Since startup of the system in 1996, an estimated total of 493 lbs of VOC mass have been removed from the TSA and SGA. TCE annual mass removal estimates for the TSA remedy are summarized in Table C-2 and Figure C-11, and TCE mass removal estimates for each extraction well are summarized in Table C-3 and Figure C-12.

5.0 PERFORMANCE SUMMARY

Significant remedy performance findings are summarized below.

- Data suggest ROD remedy objectives for hydraulic capture continued to be achieved in 2017. Groundwater flow directions in the Upper and Lower TSA indicate ongoing inward and downward flow towards the operating extraction wells, and towards the north-northwest for Upper TSA wells located outside of the influence of the remedy pumping (Figures 4-1a,b and 4-2a,b). The 12-month average flow rate from the four operating extraction wells was 114 gpm, the same rate during the previous reporting period. Extraction rates at EW-1 declined (but did not decline below optimal levels) during the reporting period; the declining trends prompted sonar cleaning of the well in July 2017. Average flow rates at extraction wells EW-2, EW-14, and EW-23 were 25, 19, and 27 gpm, respectively, which are near the design target flow rates. Flow rates at these wells were slightly lower in 2017 due to significant system maintenance and repairs.

- In the Upper TSA, TCE concentrations remain above the MCL in the mound area (located in Remedy Zone C) wells CMW-10ds (16 and 16.7 µg/L), CMW-17ds (42.9 and 21.7 µg/L), and CMW-18ds (59.5 and 87.1 µg/L) during the February and August 2017 monitoring events, respectively. TCE concentrations in wells located outside of the mound area are below the MCL, except monitoring wells BOP-61(ds) (5.6 µg/L for both events) and BOP-66(ds) (5.1 and 0.9 µg/L), see Figures 5-1a and 5-2a.

- In the Lower TSA, the highest TCE concentrations remain within the vicinity of the mound area (located in Remedy Zone C) near wells D-17(ds) (18.9 and 27 µg/L), see Figures 5-1b and 5-2b. In Remedy Zones B and D, TCE concentrations were below the MCL during the reporting period. TCE concentrations for Lower TSA extraction wells remained generally stable and consistent with previous years. The highest TCE concentrations measured in the extraction wells during this reporting period were as follows: EW-1 (4.09 µg/L), EW-2 (13.9 µg/L), EW-14 (9.38 µg/L), and EW-23 (3.31 µg/L).

- In Remedy Zone A, north of Sandy Boulevard, and the SGA, entire remedy area, water quality has been restored as TCE concentrations have been below the MCL or the laboratory reporting limits since the late 1990s/early 2000s. Monitoring wells in this area have been used for water levels and PWB contingency monitoring, but these locations do not appear to provide data significantly different than wells located closer to the residual portions of the VOC plume. Data suggest ROD remedy objectives to restore groundwater quality to below the MCL has been achieved.

- The dissolved VOC plume continues to be hydraulically contained and captured by remedy operation in areas of the remedy where active pumping is conducted. Data suggest ROD remedy objectives for hydraulic capture was achieved in 2017.

- The SVE system has removed approximately 47 pounds of VOC mass from the unsaturated zone near the mound area (located in Remedy Zone C) from the April 2015 startup through December 2017. The system is anticipated to continue to operate during 2018, and expansion of the SVE system is recommended (see Section 6.0). Groundwater concentrations at adjacent monitoring well CMW-17(ds) steadily declined during 2017, likely demonstrating the effectiveness of the SVE system for groundwater treatment. Although the SVE system alone is not responsible for reduction of VOCs in groundwater, an additional benefit is vapor mass removal from the unsaturated zone thereby reducing the potential for future recontamination when groundwater levels rise to natural levels under non-pumping conditions (resaturation).

5.1 Restoration Progress

Approximately 2.5 lbs of VOC mass were removed from the remedy area groundwater extraction system in 2017. Performance data indicates that the existing pump and treat system continues to be effective in containing the groundwater dissolved VOC plume and for reducing VOC concentrations to below the MCL; however, progress toward restoration in the mound area (Remedy Zone C) is slower than other areas in the remedy. The design criterion for the remedy was a 20-year restoration time frame (completing in 2018). The ROD states that if restoration is not achieved within this time frame, that groundwater pump and treat will continue until restoration is complete. It is anticipated that operation of the pump and treat system within Remedy Zone C will continue beyond 2018 until restoration is complete.

Options are currently being reviewed to enhance restoration in the mound area with persistent VOC concentrations including:

1) optimization of extraction pumping to improve flushing rates and for reducing the closure timeline near CMW-18(ds);

2) pilot shutdown of EW-1 to provide more available water in the aquifer for increased pumping of EW-2 and EW-14, to improve flushing rates in the central and eastern edges of the mound area;

3) expansion of the SVE system to provide additional mass removal in the vadose zone near well CMW-18(ds) and to minimize the potential for groundwater recontamination from vadose zone mass in the mound area. The SVE system will operate in conjunction with the groundwater extraction system; and

4) optimization of flow at select extraction wells (EW-2 and EW-14) to enhance groundwater flow, including near CMW-18(ds) where VOC concentrations remain elevated.

6.0 RECOMMENDATIONS AND FUTURE PLANNED ACTIVITIES

Water-quality restoration has been achieved in the SGA, in the Upper and Lower TSA north of Sandy Boulevard (Zone A), and the majority of the western portion of the remedy (Remedy Zone B), as groundwater quality data indicates VOC concentrations are consistently below the MCL and thereby meet ROD remedial objectives. Residual TCE is detected above or near the MCL in small areas in the Upper TSA near the Zone B/C boundary and in the eastern portion of the remedy area in the Upper and Lower TSA (Remedy Zone D).

We are seeking DEQ concurrence for the following proposed changes, to optimize the monitoring programs and the remedy performance to support potential accelerated closure.

6.1 Recommended Changes for Groundwater Extraction Well Operations

Continued operation of the extraction wells to maintain hydraulic control of the dissolved VOC plume. Modification to the individual extraction wells are recommended to optimize flow rates and enhance flushing in areas of persistent VOC concentrations toward accelerating restoration.

- We recommend pilot shutdown of extraction well EW-1, located towards the western portion of the TSA mound area in Zone C. TCE concentrations have consistently been below the MCL since August 2013 and meet the Remedy Well Network Criteria (Table 2-1). The pilot shutdown of EW-1 is anticipated to improve flushing along the eastern portion of the mound area [EW-2, EW-14, and well CMW-18(ds)] based on preliminary model runs. Groundwater quality monitoring will continue on quarterly basis at EW-1 and nearby wells Upper TSA wells BOP-13(ds) and BOP-31(ds). Per the Remedy Well Network Criteria (Table 2-1), if VOC concentrations increase, then the resumed pumping of EW-1 will be evaluated. However, during EW-1 shutdown in 2014 (shutdown for two months due to electrical issues), we did not see an increase in TCE concentrations in these wells.

- We recommend increased pumping of extraction well EW-2 to improve flushing in the eastern portion of the mound area at EW-2, EW-14, and near well CMW-18(ds). Increased pumping at EW-2 is anticipated with the pilot shutdown of EW-1. Once increased flows stabilize, pumping rate trends will be evaluated to confirm the well capacity. We anticipate a sonar cleaning or other well rehabilitation activities may be necessary in 2018.

- We recommend increased pumping of extraction well EW-14 to improve flushing in the mound area (located in Remedy Zone C). Increased pumping at EW-14 is anticipated with the pilot shutdown of EW-1. Once increased flows stabilize, pumping rate trends will be evaluated to confirm the well capacity. A sonar cleaning event may be necessary in 2018.

- We recommend EW-23 continue to operate through 2018 and possibly beyond to capture impacted groundwater observed near wells BOP-61(ds) and BOP-66(ds). Pumping rates at EW-23 ranged were an average of 27 gpm during the last 12 months, slightly lower than the target flow rate for EW-23 of 30 gpm. The EW-23 flow is anticipated to be on target in 2018, following maintenance events that occurred in 2017.

6.2 Recommended Changes for SVE System Operation

The current SVE system has extracted 47 pounds of VOCs between system startup in April 2015 and December 2017. The removal of VOC mass from the vadose zone has likely eliminated a potential source for recontamination of groundwater. We recommend the continued operation of the SVE system and expansion of the system towards the eastern portion of the Remedy Zone C mound area A SVE expansion work plan is provided in Appendix G. Due to low mass removal rates, we recommend the cessation of extraction at existing SVE wells VW-17d-95.5, VMW-A, and VMW-B. Groundwater samples will continue to be collected at VMW-A and VMW-B per the Performance Monitoring Schedule (Table 2-2).

6.3 Recommend Changes to Monitoring Program and Schedule Modifications

The following monitoring program and schedule modifications are recommended:

- Decommission SGA well BOP-44(usg). This well meets remedy criteria (Table 2-1) for decommissioning because TCE concentrations have consistently been below the laboratory reporting limits since monitoring at the well began in 1997. TCE laboratory reporting limits have ranged from 0.2 µg/L (below the drinking water standard of 0.5 µg/L) to 1.0 µg/L. Currently the well is only being utilized for groundwater elevation monitoring during prolonged PWB well field pumping events as part of the PWB Contingency Plan. In addition, decommissioning of this well supports partial closure activities of the SGA (Section 6.4).

- Decommission or discontinue monitoring at TSA wells (three Upper TSA well and four Lower TSA wells) located north of Sandy Boulevard in TSA Zone A in support of Partial Closure activities for this area of the remedy. TCE concentrations at these seven wells were summarized in Section 4.3.3.

    - Decommission TSA wells BOP-44(dg), BOP-44(ds), and EMC-2(dg).

    - Discontinue water level monitoring at privately owned well PMX-167 and PWB-2(lts), owned by the Portland Water Bureau. Discontinue water quality monitoring at two other wells owned by the Portland Water Bureau: PWB-1(uts) and PWB-1(lts).

- Increase water quality monitoring frequency to a quarterly basis at Lower TSA wells BOP-13(dg), BOP-31(dg), and D-17(dg) to monitor potential changes in TCE concentration in support of the recommendation to pilot shutdown extraction well EW-1. If increases in TCE concentrations are consistently observed over two consecutive quarterly events, then resumed operation of EW-1 will be evaluated.

- Decrease water quality monitoring frequency from annual to biennial at Upper TSA monitoring wells BOP-21(ds), BOP-22R(ds), BOP-42(ds), and BOP-62(ds) due to distance of the well from the edge of the dissolved VOC plume and the continued use of other wells closer to the plume. TCE concentrations have consistently been below the MCL since monitoring started at the wells in 2017, and TCE concentrations have been below the laboratory reporting limit (0.2 µg/L, which is below the drinking water standard) historically at BOP-22R(ds), since 1997 at BOP-42(ds), and since 2015 at BOP-21(ds).

- Decrease water quality monitoring frequency from annual to biennial at Lower TSA monitoring wells BOP-20(dg), BOP-23(dg), BOP-42(dg), and BOP-60(dg) due to the wells' distance from the edge of the dissolved plume and stable TCE concentrations. VOC concentrations detected at these wells have been stable and below the MCL since 1989 at BOP-20(dg), since 2002 at BOP-23(dg), since 2004 at BOP-42(dg), and since 2009 at BOP-60(dg).

- Decrease water quality monitoring from semiannual to annual at non-pumping Lower TSA extraction well EW-8 due to the distance of the well from the dissolved VOC plume and the utilization of other wells closer to the plume. TCE concentrations at EW-8 have been less than the MCL since 2010.

- Discontinue water level measurements and decommission wells DEQ-1(dg), DEQ-5(ds), DEQ-5(dg), and CMW-3. These wells have been utilized only for groundwater elevations data only (no water quality) since 1990, 1993 [DEQ-5(dg/ds)], and 1988, respectively, and are located towards the south of the dissolved plume. Groundwater elevation data from these wells is considered redundant as there are remedy wells located closer to the plume that are utilized for groundwater elevation measurements.

- Decrease water quality monitoring at Lower TSA wells EW-16 and CMW-26(dg), which are located in Lower TSA Zone D from quarterly to semiannually. TCE concentrations have been below the MCL at CMW-26dg since 2013 and at EW-16 since the pump was pilot shutdown in November 2015.

- Eliminate upper and lower screen sampling at former extraction wells CMW-24dg/EW-5, EW-8, EW-11, EW-12, and EW-15. Currently, two passive diffusion bags are deployed in each well to evaluate the upper and lower portions of the screens. The data from these samples are not significantly different relative to each other (see Table C-1, and

Appendix F for the historical data set). One passive diffusion bag will be left in the lower portion of the screen.

These above recommendations support Partial Closure of select areas of the remedy where restoration goals have been achieved, which is discussed in the next section.

6.4 Partial Closure by Select Areas of the Remedy

We recommend that remedy areas that have met cleanup criteria in accordance with the ROD be approved by DEQ for partial closure as a precursor to eventual site closure activities. The partial closure (or partial No Further Action [NFA]) will help unencumber land development on parcels owned by other individuals or corporations (other than Cascade or Boeing) by removing controls established for the remedy area in the DEQ approved *Institutional Control Plan* (Landau Associates, Prowell Environmental, 1999). Remedy activities and monitoring will continue in areas that exhibit VOC concentrations above the MCL or areas that provide spatial coverage of the dissolved VOC plume. Currently, we are requesting a partial closure (partial NFA) for the SGA and the TSA remedy area located to the north of Sandy Boulevard (Remedy Zone A).

6.4.1 SGA Partial Closure Request

Restoration has been achieved for the SGA, which is currently monitored only at well BOP-44(usg) for PWB contingency monitoring. The SGA groundwater quality monitoring was removed from the remedy program in 2014 year due to VOC concentrations being consistently below the MCLs and or the laboratory reporting limits. Remedy objectives stated in the ROD have been achieved for the SGA; therefore, we are recommending partial closure of this area of the remedy.

The only remaining SGA well, BOP-44(usg), is monitored to coincide with long period PWB wellfield pumping events, per the current PWB Contingency Plan (Landau, 2015). Water levels at BOP-44(usg) were influenced (drawn down) by high volume and long duration pumping by PWB (111 days in 2015); however, post pumping TCE concentrations did not increase in this or wells located closer the residual VOC plume. Similarly, during 100% augmentation pumping event by PWB in February and March 2017 (31 days), VOC concentrations did not increase.

TCE concentrations at BOP-44(usg) have consistently been below the laboratory reporting limits, which have ranged from 0.2 µg/L (below the drinking water standard of 0.5 µg/L) to 1.0 µg/L. BOP-44(usg), along with PWB-1(usg) and EMC-2(usg), were approved by DEQ for cessation of groundwater quality sampling in 2014. PWB-1(usg) and EMC-2(usg) were decommissioned in 2017 (PWB-1(usg) was decommissioned by PWB). TCE concentrations in all three of these wells were below the laboratory reporting limits since monitoring began in 1997 at EMC-2(usg) and BOP-44(usg), and in 1994 at PWB-2(usg).

In addition, historical SGA analytical results (from the time period when the VOC plume was at its maximum lateral extent) indicate that groundwater restoration in the SGA was successful. The

maximum historical TCE concentrations (60 µg/L) was reported at DEQ-3(usg), located east of BOP-44(usg). TCE concentrations at DEQ-3 decreased to below the MCL in 2001 and remained below the laboratory reporting limits (0.2 µg/L, which is below the drinking water standard) until the well was removed from the monitoring program in 2006. The TSA groundwater pump and treat systems were started in late 1998, including the North Treatment System which included SGA extraction well EW-20. The North Treatment System was shut down in 2006 due to consistent VOC concentrations below the MCL.

6.4.2 Zone A Partial Closure Request

Restoration has been achieved in the remedy area located north of Sandy Boulevard (Remedy Zone A) for the Upper TSA and Lower TSA because VOC concentrations are consistently below the MCL and/or the laboratory reporting limits. Remedy objectives stated in the ROD have been achieved for the Upper TSA and the Lower TSA in Remedy Zone A; therefore, we are recommending partial closure of this area of the remedy.

Currently groundwater quality and/or groundwater elevations are monitored at three Upper TSA wells [BOP-44(ds), PWB-1(uts), and PMX-167-groundwater elevation data only] and at four Lower TSA wells [BOP-44(dg), PWB-1(lts), PWB-2(lts), and EMC-2(dg)]. Groundwater quality data continue to indicate that TCE concentrations in this area of the remedy are below the MCLs. In addition, TCE concentrations have been below the laboratory reporting limits, which range from 0.2 µg/L to 1.0 µg/L in all seven of these wells since late 1990s to early 2000s, with BOP-44(ds) the last well to have TCE concentrations decrease to below the laboratory reporting limit in 2009.

In 2015, wells selected for monitoring water levels and groundwater quality as part of the PWB contingency monitoring plan were repositioned to wells closer to the leading edge of the dissolved TSA VOC plume, including BOP-44(ds) and BOP-44(dg). If this partial closure request is approved, wells BOP-31(ds) and BOP-31(dg) may be candidates to replace the above well pair. The PWB Contingency Monitoring Plan will be revised and submitted for DEQ consideration in a future document.

6.4.3 Restoration Progress Towards Closure in Other Zones

- Restoration in the western remedy area (also referenced as Remedy Zone B) is complete except for a small area near wells BOP-61(ds) and BOP-66(ds), which are located near the Zone B/C boundary. TCE concentrations at these two wells have been stable for the past several years at or slightly higher than the MCL. Monitoring wells in the western most portion of this remedy area exhibit TCE concentrations below the laboratory reporting limit (0.2 µg/L). We recommend continued operation of EW-23 to restore groundwater quality to below the MCL.

- Restoration in the central portion of the remedy area (also referenced as Remedy Zone C) continues, as this area of the site (mound area) that contains the highest TCE

concentrations. TCE concentrations in the mound area continue to decrease; however, this portion of the remedy area has been slower to respond to remedial actions. The addition of SVE operating in conjunction with the pump and treat system has provided additional mass removal (in the unsaturated zone). The SVE system was expanded in the central portion of Restoration Zone C in 2016, and further expansion of the SVE system is being proposed for 2018 to expedite mass removal. In addition, pilot shutdown of EW-1 is recommended to potentially enhance groundwater flow at the other two mound area extraction wells, EW-2 and EW-14.

- Restoration in the eastern remedy area (also referenced as Remedy Zone D) is almost complete as current TCE concentrations are below the MCL. Currently, monitoring wells CMW-26dg, EW-16 (converted to monitoring status in 2017), and EW-11 (converted to monitoring status in 2009) are monitored in Zone D. Additional monitoring to evaluate if TCE concentrations are stable is warranted following EW-16 monitoring conversion, in accordance with the procedures outlined in Table 2-1. If VOC concentrations continue to decline in this remedy area (Remedy Zone D), partial closure will be recommended.

7.0 REFERENCES

Geosyntec Consultants, Landau Associates, and SSPA, 2017. Annual Performance Report: 1 January 2016 through 31 December 2016, Troutdale Sandstone Aquifer Remedy. 15 March 2017.

Geosyntec Consultants, 2017. EW-16 Monitoring Conversion and Eastside Conveyance Line Decommissioning Request, Troutdale Sandstone Aquifer Remedy. 12 September 2017.

Geosyntec Consultants, 2018. Revised Well Decommissioning Work Plan, East Multnomah County Troutdale Sandstone Aquifer Remedy. 2 April 2018.

Landau Associates, 2015. Technical Memorandum: 2015 Monitoring and Contingency Plan for PWB Pumping Events. 21 July 2015.

Landau Associates, 2016. Work Plan for decommissioning wells BOP-22(dg), BOP-70(ds), BOP-71(ds), and EMC-2(usg). 14 September 2016.

Landau Associates and Prowell Environmental, 1999. Institutional Controls Plan, Troutdale Sandstone Aquifer. 21 September 1999.

NOAA, 2017. National Oceanic and Atmospheric Administration, www.nws.noaa.gov, website accessed January 2018.

Oregon Department of Environmental Quality (DEQ), 1996. Remedial Action Record of Decision for the East Multnomah county Groundwater Contamination Site, Troutdale Sandstone Aquifer. 31 December 1996.

Oregon Department of Environmental Quality (DEQ), 1997. TSA Remedy Order on Consent, WMCSR-NWR-96-08, 14 February 1997.

Oregon Department of Environmental Quality (DEQ), 2016. Email from B. Williams, Approval of Work Plan for decommissioning wells BOP-22(dg), BOP-70(ds), BOP-71(ds), and EMC-2(usg). 28 September 2016.

Oregon Department of Environmental Quality (DEQ), 2017a. Email from B. Williams, Approval of 2016 TSA Annual Report. 16 June 2017.

Oregon Department of Environmental Quality (DEQ), 2017b. Email from K. Thiessen, Approval of EW-16 Monitoring Conversion and Eastside Conveyance Line Decommissioning Request 4 October 2017.

PWB, 2018a. 2017 Summer Water Supply Season-Retrospective. 5 February 2017.

PWB, 2018b. Telephone conversation with Chris Kimmel, Landau Associates, and Doug Wise, PWB on well decommissioning activities. February 13.

TABLES

Table 2-1
Remedy Well Network Criteria
TSA Remedy - East Multnomah County

This table summarizes TSA remedy criteria for extraction well pilot shutdown, well and system decommissioning, monitoring well network modifications, and changes in sampling frequency. These criteria were presented in Section 5 of the eighth TSA annual performance report[1] and are summarized below for ongoing reference.

1. PILOT SHUTDOWN CRITERIA

The following criteria are for TSA extraction well(s) currently in pilot shutdown mode:

- *If TCE concentrations in these pilot shutdown wells increase to levels equal to or above the MCL for two consecutive quarters, extraction at individual wells shall resume.*
- *If TCE remains below the MCL cleanup level for 2 years, DEQ will evaluate potential decommissioning of these wells.*

2. MONITORING WELL NETWORK MODIFICATION

Wells may be removed from the monitoring program if a well meets one or more of the following criteria:

- *TCE concentrations have been consistently below detection limits for 2 or more years.*
- *The well is located outside the limits of the plume and is no longer needed to monitor hydraulic plume control or restoration progress.*
- *The location of a well duplicates another well better suited to evaluate hydraulic control and restoration progress.*

3. SAMPLING FREQUENCY MODIFICATIONS

The following criteria serve to standardize current and future monitoring adjustments as restoration progresses over the coming years:

Criteria for Increasing Sampling Frequency:

- *The sampling frequency will be increased at a well if TCE concentrations increase to detected levels for two consecutive sampling events where they have been below detection limits for 2 or more years.*
- *The sampling frequency will be increased at a well if TCE concentrations increase above the MCL for two consecutive sampling events where they have been below the MCL for 2 or more years.*

Criteria for Reducing Sampling Frequency:

- *If TCE has been consistently below detection limits for the prior 2 years, the sampling frequency may be reduced.*
- *If TCE has been stable to declining for the prior 2 years, the sampling frequency may be reduced.*

4. CRITERIA FOR WELL DECOMMISSIONINGS

Extraction and monitoring well decommissionings will be proposed to DEQ if the following criteria are met:

- *Extraction well decommissioning may be proposed to DEQ if TCE concentrations remain consistently below the MCL in that well for 2 years following pilot shutdown; two consecutive TCE detections at or above the MCL may prompt resumed operation.*
- *Monitoring well decommissioning will be proposed to DEQ if TCE concentrations remain below the MCL during the confirmation sampling round that will be performed 2 years after a well has been removed from the remedy monitoring schedule; if TCE is detected at or above the MCL during the confirmation sampling round, additional monitoring may be required.*

[1]Landau Associates, Prowell Environmental, Pegasus Geoscience, 2006. Troutdale Sandstone Aquifer Remedial Action Annual Performance Evaluation, 04/01/05 through 03/31/06. 30 June 2006.

Table 2-2
Performance Monitoring Schedule - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

Well	Aquifer	Water Level Measurements	Water Quality Sampling	Responsibility
Groundwater Systems				
CTS Influent	—	—	Quarterly	Cascade
CTS Effluent	—	—	Quarterly	Cascade
TSA Extraction Wells				
EW-1 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-2 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-14 (on)	Lower TSA	Monthly	Quarterly	Cascade
EW-23 (on)	Lower TSA	Monthly	Semiannually	Cascade
TSA Monitoring Wells				
BOP-13(ds)	Upper TSA	Quarterly	Quarterly	Boeing
BOP-13(dg)	Lower TSA	Annually to Quarterly	Annually to Quarterly	Boeing
BOP-20(ds)	Upper TSA	Semiannually PWB Monitoring	Annually PWB Monitoring	Boeing
BOP-20(dg)	Lower TSA	Semiannually to Annually PWB Monitoring	Annually to Biennial PWB Monitoring	Boeing
BOP-21(ds)	Upper TSA	Annually PWB Monitoring	Annually to Biennial PWB Monitoring	Boeing
BOP-22R(ds)	Upper TSA	Annually PWB Monitoring	Annually to Biennial PWB Monitoring	Boeing
BOP-23(dg)	Lower TSA	Semiannually to Annually PWB Monitoring	Annually to Biennial PWB Monitoring	Boeing
BOP-31(ds)	Upper TSA	Quarterly	Quarterly	Boeing
BOP-31(dg)	Lower TSA	Semiannually to Quarterly	Semiannually to Quarterly	Boeing
BOP-42(ds)	Upper TSA	Annually	Annually to Biennial	Boeing
BOP-42(dg)	Lower TSA	Annually	Annually to Biennial	Boeing
BOP-44(ds)	Upper TSA	Annually to Decommission	Biennially to Decommission	Cascade
BOP-44(dg)	Lower TSA	Annually to Decommission	Biennially to Decommission	Cascade
BOP-60R(ds)	Upper TSA	Annually	Biennial	Boeing
BOP-60(dg)	Lower TSA	Annually	Annually to Biennial	Boeing
BOP-61(ds)	Upper TSA	Semiannually	Semiannually	Boeing
BOP-61(dg)	Lower TSA	Semiannually	Semiannually	Boeing
BOP-62(ds)	Upper TSA	Annually	Annually to Biennial	Boeing
BOP-65(ds)	Upper TSA	Semiannually	Annually	Boeing
BOP-66(ds)	Upper TSA	Semiannually	Semiannually	Boeing
D-17(ds)	Lower TSA	Quarterly	Quarterly	Cascade
D-17(dg)	Lower TSA	Semiannually to Quarterly	Semiannually to Quarterly	Cascade
DEQ-1(dg)	Lower TSA	Semiannually to Decommission	—	Cascade
DEQ-5(ds)	Upper TSA	Semiannually to Decommission	—	Cascade
DEQ-5(dg)	Lower TSA	Semiannually to Decommission	—	Cascade
EMC-2(dg)	Lower TSA	PWB Monitoring to Decommission	—	Cascade
EW-3 (monitoring only)	Upper TSA	Annually	Biennially	Boeing
EW-8 (monitoring only)	Lower TSA	Semiannually	Semiannually to Annually	Cascade
EW-11 (monitoring only)	Lower TSA	Annually	Biennial	Cascade
EW-12 (monitoring only)	Lower TSA	Semiannually	Quarterly	Cascade
EW-13 (monitoring only)	Lower TSA	Semiannually	Annually	Boeing
EW-15 (monitoring only)	Lower TSA	Annually	Biennial	Cascade
EW-16 (monitoring)	Lower TSA	Monthly to Semiannually	Quarterly to Semiannually	Cascade
CMW-3	TSA	Semiannually to Decommission	—	Cascade
CMW-8(dg)	Lower TSA	Semiannually	Biennial	Cascade
CMW-10(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-10(dg)	Lower TSA	Semiannually	Annually	Cascade

Table 2-2
Performance Monitoring Schedule - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

Well	Aquifer	Water Level Measurements	Water Quality Sampling	Responsibility
CMW-14R(ds)	Lower TSA	Semiannually	SemiAnnually	Cascade
CMW-17(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-18(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-19(ds)	Upper TSA	Quarterly	Quarterly	Cascade
CMW-20(ds)	Upper TSA	Semiannually	Annually	Cascade
CMW-22(dg)	Lower TSA	Semiannually	Biennial	Cascade
CMW-24(dg)/EW-5	Lower TSA	Semiannually	Semiannually	Cascade
CMW-25(dg)	Lower TSA	Semiannually	Semiannually	Cascade
CMW-26(dg)	Lower TSA	Semiannually	Quarterly to Semiannually	Cascade
CMW-36(dg)	Lower TSA	PWB Monitoring	PWB Monitoring	Cascade
PMX-167 [W. Interlachen]	Upper TSA	Semiannually to Discontinue	—	Cascade
PMX-208(dg) [Simpson]	Lower TSA	Semiannually to Discontinue	—	Cascade
PWB-1(uts)	Upper TSA	Semiannually to Discontinue	Biennial to Discontinue	Cascade
PWB-1(lts)	Lower TSA	Annually to Discontinue	Biennial to Discontinue	Cascade
PWB-2(lts)	Lower TSA	Semiannually to Discontinue	—	Cascade
SGA Monitoring Wells				
BOP-44(usg)	Upper SGA	PWB Monitoring to Decommission	--	Cascade
Vapor Monitoring Wells				
VMW-17d-95.5	Upper TSA	--	--	Cascade
VMW-A	Upper TSA	Quarterly	Quarterly	Cascade
VMW-B	Upper TSA	Quarterly	Quarterly	Cascade
VMW-C	Upper TSA	Quarterly	Quarterly	Cascade
VMW-D	Upper TSA	Quarterly	Quarterly	Cascade

NOTES:

[a]Annual monitoring performed in August; semiannual in February and August; quarterly in February, May, August, and November. Two-year monitoring was performed in August 2017 and will be conducted in August 2019.

Recommendations for modifications to the Monitoring Schedules are indicated in red text, and wells recommended for decommissioning are also in red text and shaded green.

PMX-208dg: monitoring as PMX-208dg was discontinued in 2017 as part of the Eastside Decommissioning Activities.

Table 2-3
Significant Remedy Documents – 1 January 2017 through 31 December 2017
TSA Remedy – East Multnomah County Oregon

Date	Document Type	Author	Title	Comments
3/15/17	Report	Geosyntec Consultants, Landau Associates, and SSPA	Cascade Boeing TSA 2016 Annual Report, East Multnomah County TSA Remedy, ECSI 1479, Fairview, Oregon	2016 Annual Performance Report, 1 January 2017 – 31 December 2017. Recommendations included: • Decommission monitoring wells D-16ds, D-18ds, and RPW-1ds and vapor extraction wells VW-17d-42.5 and VW-17d-75.5. • Reduce/change monitoring at BOP-13(dg), BOP-21(ds), BOP-42(ds), BOP-42(dg), BOP-62(ds), BOP-60(dg), EW-3, and CMW-14R(ds).
9/12/17	Technical Memorandum	Geosyntec Consultants	EW-16 Monitoring Conversion; Eastside Conveyance Line Decommissioning Request, East Multnomah County TSA Remedy, ECSI 1479, Fairview, Oregon	Request for DEQ approval to decommission the Eastside Conveyance Lines, discontinue monitoring at private well PMX-208(dg), and cease pilot shutdown and convert EW-16 to monitoring use.
11/8/17	Presentation (PowerPoint)	Landau Associates and Geosyntec Consultants	DEQ East Multnomah County (TSA Remedy) Meeting	Remedy overview introduction for new DEQ project manager (K. Thiessen)
6/6/17 and 9/26/17	Technical Memorandum and Email	Geosyntec Consultants	E. Multnomah Co. TSA Remedy (ECSI 1479) - Proposal for CMW-36(dg) decommissioning. Retraction of Proposal (Email).	Request to decommission CMW-36(dg) and change PWB contingency monitoring location from CMW-36(dg) to PMX-208(dg). Email request to retract and cancel the decommissioning request. CMW-36(dg) will remain a PWB contingency monitoring location.

Table 2-3
Significant Remedy Documents – 1 January 2017 through 31 December 2017
TSA Remedy – East Multnomah County Oregon

Date	Document Type	Author	Title	Comments
06/16/17	Email	DEQ	RE: East Multnomah Co, TSA project	DEQ approval of 2016 Annual Report for the East Multnomah Co, TSA project
10/04/17	Letter	DEQ	RE: EW-16 Monitoring Conversion; Eastside Conveyance Line Decommissioning Request	DEQ approval of EW-16 conversion to monitoring status and the eastside decommissioning request

Table 3-1
Well Construction Data - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

Well	Aquifer Screened	NAD 1983 State Plane Oregon (ft)		Elevations (ft MSL)				Depth of Boring (ft bgs)
		X Coordinate	Y Coordinate	Ground Surface	Measuring Point	Top of Screen	Bottom of Screen	
Extraction Wells								
EW-1	Lower TSA	7699560.1	689504.6	124.1	124.04	-27.8	-57.8	183
EW-2	Lower TSA	7700692.2	689205.9	126.2	126.01	-6.8	-46.8	179
EW-14	Lower TSA	7699952.7	689329.7	128.4	127.63	-21.9	-51.9	230
EW-23	Lower TSA	7698806.9	690524.7	83.8	83.93	-26.2	-66.2	157
Monitoring Wells & Former Extraction Wells Approved for Monitoring Use								
BOP-13(ds)	Upper TSA	7699461.3	689388.4	126.7	128.94	9.0	-1.0	132
BOP-13(dg)	Lower TSA	7699465.9	689375.4	127.5	128.71	-41.0	-61.0	193
BOP-20(ds)	Upper TSA	7698395.4	691041.6	78.2	77.45	9.0	-11.0	97
BOP-20(dg)	Lower TSA	7698381.4	691042.6	78.1	77.32	-105.0	-125.0	209
BOP-21(ds)	Upper TSA	7697591.5	691105.0	77.1	78.02	-88.0	-108.0	192
BOP-22R(ds)	Upper TSA	7697050.5	691019.5	84.2	82.91	-158.8	-178.8	310
BOP-23(dg)	Lower TSA	7699526.6	690832.2	75.2	76.96	-26.0	-46.0	125
BOP-31(ds)	Upper TSA	7699322.2	690090.6	97.1	99.04	17.0	7.0	91
BOP-31(dg)	Lower TSA	7699323.6	690105.1	96.5	98.51	-34.0	-54.0	154
BOP-42(ds)	Upper TSA	7698251.0	689588.3	129.3	130.74	-8.0	-28.0	159
BOP-42(dg)	Lower TSA	7698236.8	689588.9	129.5	130.71	-92.0	-112.0	243
BOP-44(ds)	Upper TSA	7698995.4	691938.6	32.5	35.24	-23.0	-43.0	76
BOP-44(dg)	Lower TSA	7699014.1	691938.6	32.6	35.15	-104.0	-124.0	166
BOP-60R(ds)	Upper TSA	7697726.6	690503.5	83.2	82.80	-71.8	-81.8	165
BOP-60(dg)	Lower TSA	7697704.8	690369.9	93.8	93.59	-165.0	-185.0	280
BOP-61(ds)	Upper TSA	7698640.8	690240.7	96.3	94.64	6.0	-4.0	100
BOP-61(dg)	Lower TSA	7698632.5	690246.1	96.2	94.43	-60.0	-70.0	171
BOP-62(ds)	Upper TSA	7697855.5	689987.2	112.1	112.29	-42.0	-51.9	166
BOP-65(ds)	Upper TSA	7698234.0	690115.0	104.4	104.22	2.0	-8.0	113
BOP-66(ds)	Upper TSA	7698670.7	690111.4	103.3	102.97	13.0	3.0	102
D-17(ds)	Lower TSA	7699886.2	689530.7	121.9	123.28	12.0	2.0	121
D-17(dg)	Lower TSA	7699869.5	689532.2	121.8	124.61	-30.0	-50.0	178
DEQ-1(dg)	Lower TSA	7701973.4	688195.6	151.0	150.58	-53.0	-73.0	235
DEQ-5(ds)	Upper TSA	7698660.3	688786.4	155.9	155.68	19.9	0.0	160
DEQ-5(dg)	Lower TSA	7698650.5	688787.3	155.9	155.95	-58.0	-78.0	240
EMC-2(dg)	Lower TSA	7701014.5	692008.0	44.8	43.51	-75.0	-85.0	140
EW-3	Upper TSA	7697737.4	690313.3	97.1	94.26	-77.9	-102.9	205
EW-8	Lower TSA	7699521.9	690435.9	77.3	77.16	6.8	-33.2	163
EW-11	Lower TSA	7702091.6	689192.5	115.4	114.73	-22.8	-62.8	235
EW-12	Lower TSA	7699532.9	689992.8	94.4	94.14	-16.1	-46.1	197
EW-13	Lower TSA	7698486.3	690082.6	104.5	103.59	-33.5	-73.5	234
EW-15	Lower TSA	7701759.5	689205.3	116.7	116.21	-27.3	-57.3	186
EW-16	Lower TSA	7702424.1	689665.5	84.2	83.71	-40.3	-80.3	198
CMW-3	Upper & Lower TSA	7700342.3	688415.4	148.1	147.69	25.0	-53.0	209
CMW-8(dg)	Lower TSA	7700075.7	689028.3	137.0	136.21	-41.0	-56.0	199
CMW-10(ds)	Upper TSA	7700599.9	688922.1	135.2	134.54	21.0	6.0	135
CMW-10(dg)	Lower TSA	7700589.4	688923.9	135.3	135.05	-53.0	-68.0	210
CMW-14R(ds)	Lower TSA	7700852.9	689866.6	83.9	83.48	29.0	9.0	76
CMW-17(ds)	Upper TSA	7700547.4	689425.5	120.0	121.89	24.0	14.0	110
CMW-18(ds)	Upper TSA	7700889.2	689267.3	118.2	117.66	16.0	6.0	118
CMW-19(ds)	Upper TSA	7700297.2	688642.8	144.3	144.08	10.0	0.0	170
CMW-20(ds)	Upper TSA	7699683.6	688990.1	150.5	152.72	6.0	-4.0	158
CMW-22(dg)	Lower TSA	7701545.4	689850.7	82.1	81.65	-42.0	-52.0	142
CMW-24(dg)/EW-5	Lower TSA	7700192.8	689918.9	80.5	77.74	8.0	-42.1	127
CMW-25(dg)	Lower TSA	7699797.3	690022.8	75.7	75.28	-34.0	-44.0	131
CMW-26(dg)	Lower TSA	7703189.8	689303.5	106.3	108.98	-59.0	-69.0	238
CMW-36(dg)	Lower TSA	7701389.7	690792.4	79.1	78.84	-31.0	-41.0	162
PMX-167 [W. Interlachen]	Upper TSA	7701730.1	693573.0	45.0	44.84	----- Not Available -----		50
PMX-208(dg) [Simpson]	Lower TSA	7701239.6	690330.0	80.2	81.14	-15.0	-35.0	115
PWB-1(lts)	Lower TSA	7700352.3	692604.8	14.0	16.48	-98.0	-118.0	134
PWB-1(uts)	Upper TSA	7700344.1	692612.1	13.9	15.98	-51.0	-71.0	86
PWB-2(lts)	Lower TSA	7701771.0	693589.1	45.1	44.32	-20.0	-40.0	90
BOP-44(usg)	SGA	7698996.3	691888.8	24.6	34.25	-181.0	-191.0	219

Table 3-1
Well Construction Data - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

		NAD 1983 State Plane Oregon (ft)		Elevations (ft MSL)				
Well	**Aquifer Screened**	**X Coordinate**	**Y Coordinate**	**Ground Surface**	**Measuring Point**	**Top of Screen**	**Bottom of Screen**	**Depth of Boring (ft bgs)**
Vapor Extraction/Vapor Monitoring Wells								
VW-75d-95.5	Upper TSA - Vapor	7700536.9	689410.4	120.0	-------	*44.5*	*24.5*	130
VMW-A	Upper TSA - Vapor	7700436.7	689423.9	121.0	-------	34.5	14.5	114
VMW-B	Upper TSA - Vapor	7700630.8	689380.7	120.7	-------	36.2	16.2	111
VMW-C	Upper TSA - Vapor	7700339.8	689398.9	122.0	-------	34.5	14.5	110
VMW-D	Upper TSA - Vapor	7700693.2	689302.0	120.6	-------	33.1	13.1	110

NOTES:

1. Monitoring wells indicated in red text were recommended for sampling frequency modifications (Table 2-2). Wells indicated in red text and green shading are recommended for decommissioning.

2. EW-16 was converted to monitoring in October 2017; approved by DEQ 10.04.17.

ft = feet
MSL = mean sea level
bgs = below ground surface

FIGURES

PWB-15
PWB-7
PWB-14
PWB-19
PWB-13
PWB-18
PWB-12
PWB-8

N

Legend

- PWB BLA Production Well
- PWB SGA Production Well
- PWB TSA Production Well
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Note
The southern boundary of the Columbia South Shore Well Field - Wellhead Protection Area runs along I-84 in the vicinity of this Site.

0 1,000 2,000 Feet

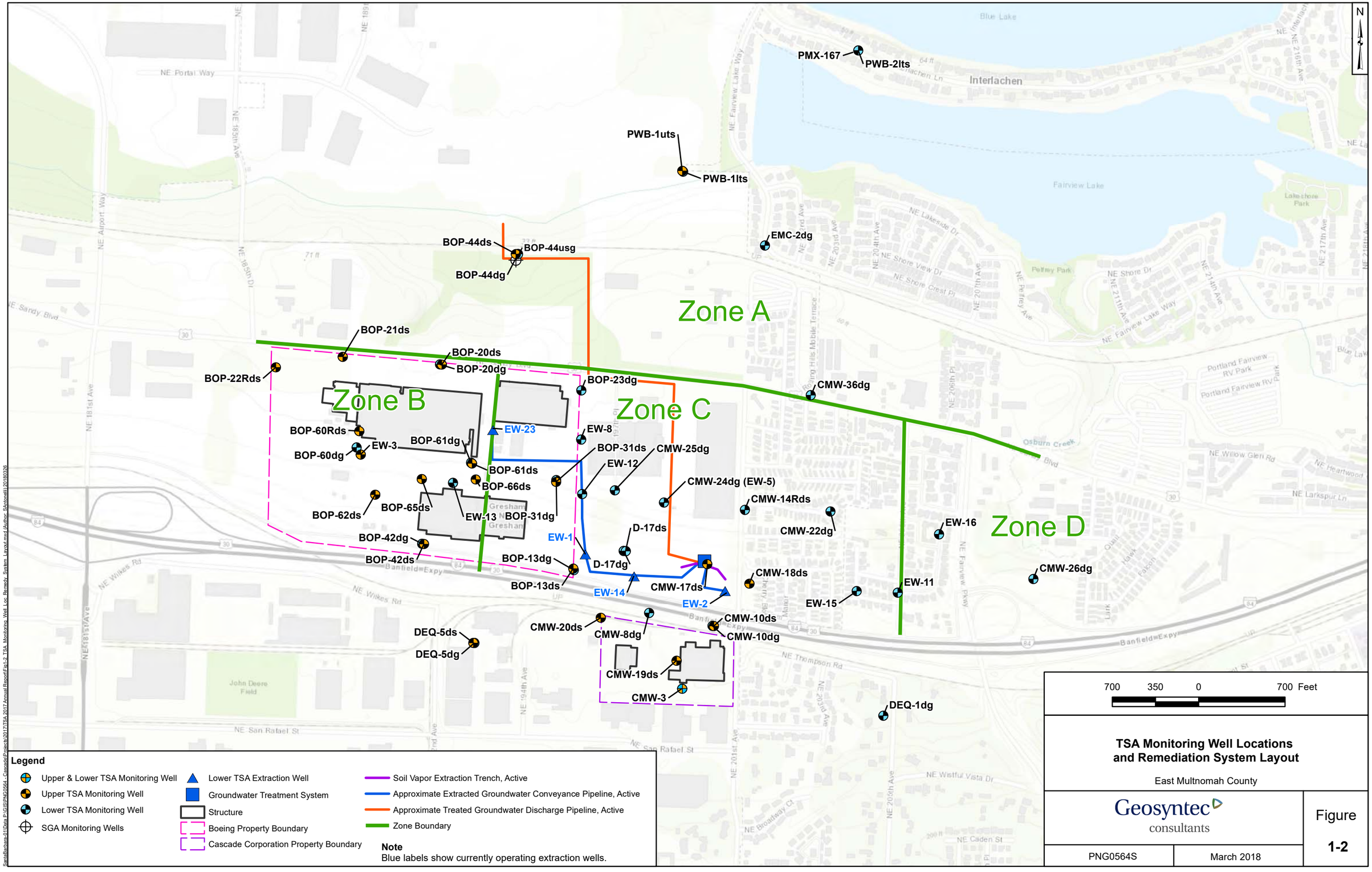
Project Location
TSA Remedy
East Multnomah County

Geosyntec consultants

PNG0564S | March 2018

Figure **1-1**

SantaBarbara-01\Data P:\GIS\PNG\0564 - Cascade\eProjects\2017\TSA 2017 Annual Report\Fig1-1 Project Location.mxd (Author: SAnton\ll) 20180315



Legend

- Upper & Lower TSA Monitoring Well
- Upper TSA Monitoring Well
- Lower TSA Monitoring Well
- SGA Monitoring Wells
- Lower TSA Extraction Well
- Groundwater Treatment System
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary
- Soil Vapor Extraction Trench, Active
- Approximate Extracted Groundwater Conveyance Pipeline, Active
- Approximate Treated Groundwater Discharge Pipeline, Active
- Zone Boundary

Note
Blue labels show currently operating extraction wells.

700 350 0 700 Feet

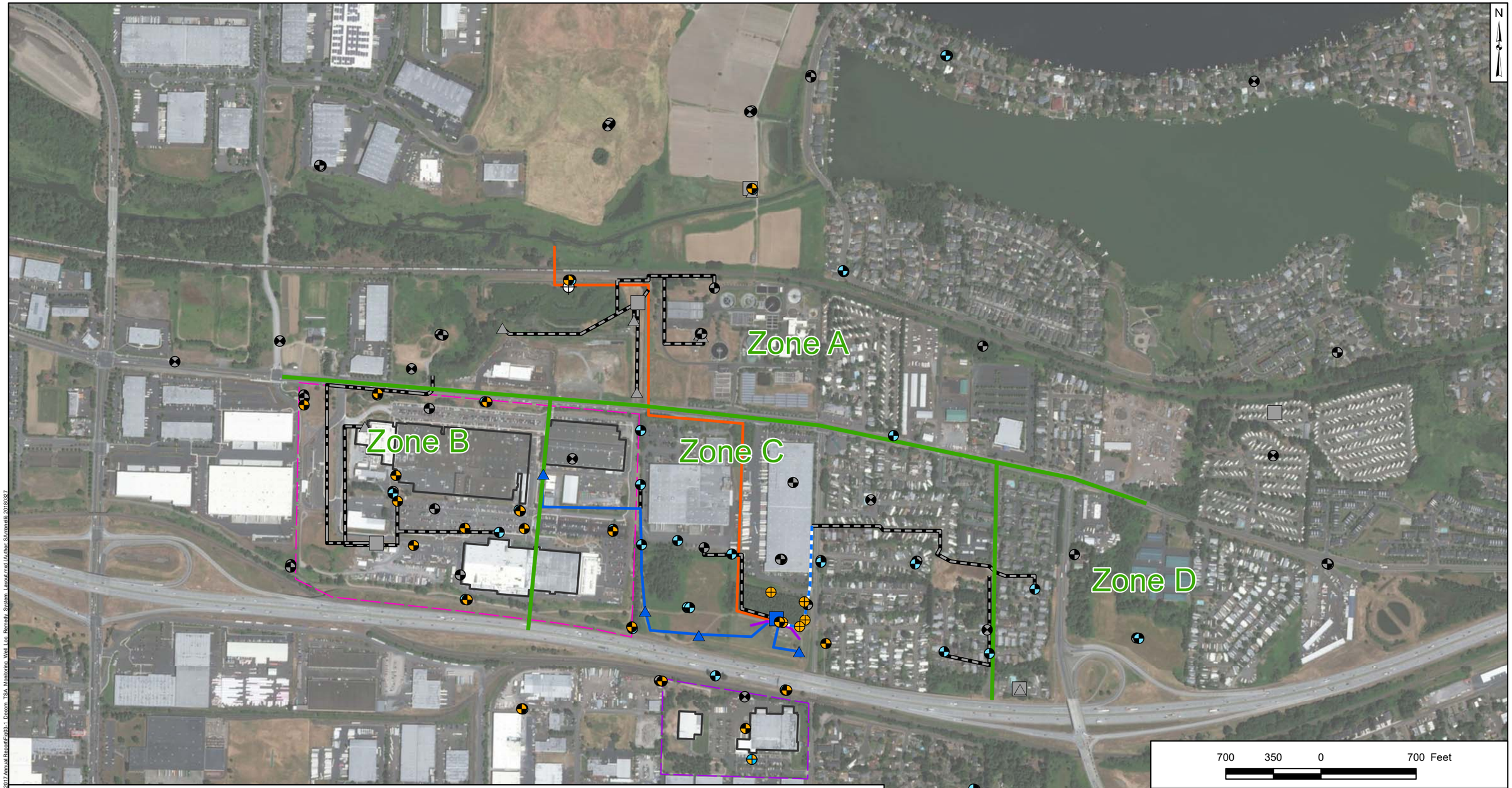
TSA Monitoring Well Locations and Remediation System Layout

East Multnomah County

Geosyntec consultants

PNG0564S | March 2018

Figure **1-2**



Legend

- Upper & Lower TSA Monitoring Well
- Upper TSA Monitoring Well
- Lower TSA Monitoring Well
- SGA Monitoring Well
- CU1 Monitoring Well
- Decommissioned Upper TSA Monitoring Well
- Decommissioned Lower TSA Monitoring Well
- Decommissioned or No Longer Monitored Monitoring Well
- Lower TSA Extraction Well
- Decommissioned Extraction Well
- Groundwater Treatment System
- Decommissioned Groundwater Treatment System
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary
- Approximate Soil Vapor Extraction Trench, Active
- Approximate Extracted Groundwater Conveyance Pipeline, Active
- Approximate Extracted Groundwater Conveyance Pipeline, No Longer in Use
- Approximate Treated Groundwater Discharge Pipeline, Active
- Approximate Extracted Groundwater Conveyance Pipeline, Decommissioned
- Approximate Treated Groundwater Discharge Pipeline, Decommissioned
- Zone Boundary

Note: Well EMC-2(usg) and the eastside conveyance lines were decommissioned during this reporting period.

700 350 0 700 Feet

Decommissioned TSA Monitoring Wells and Remediation System Components

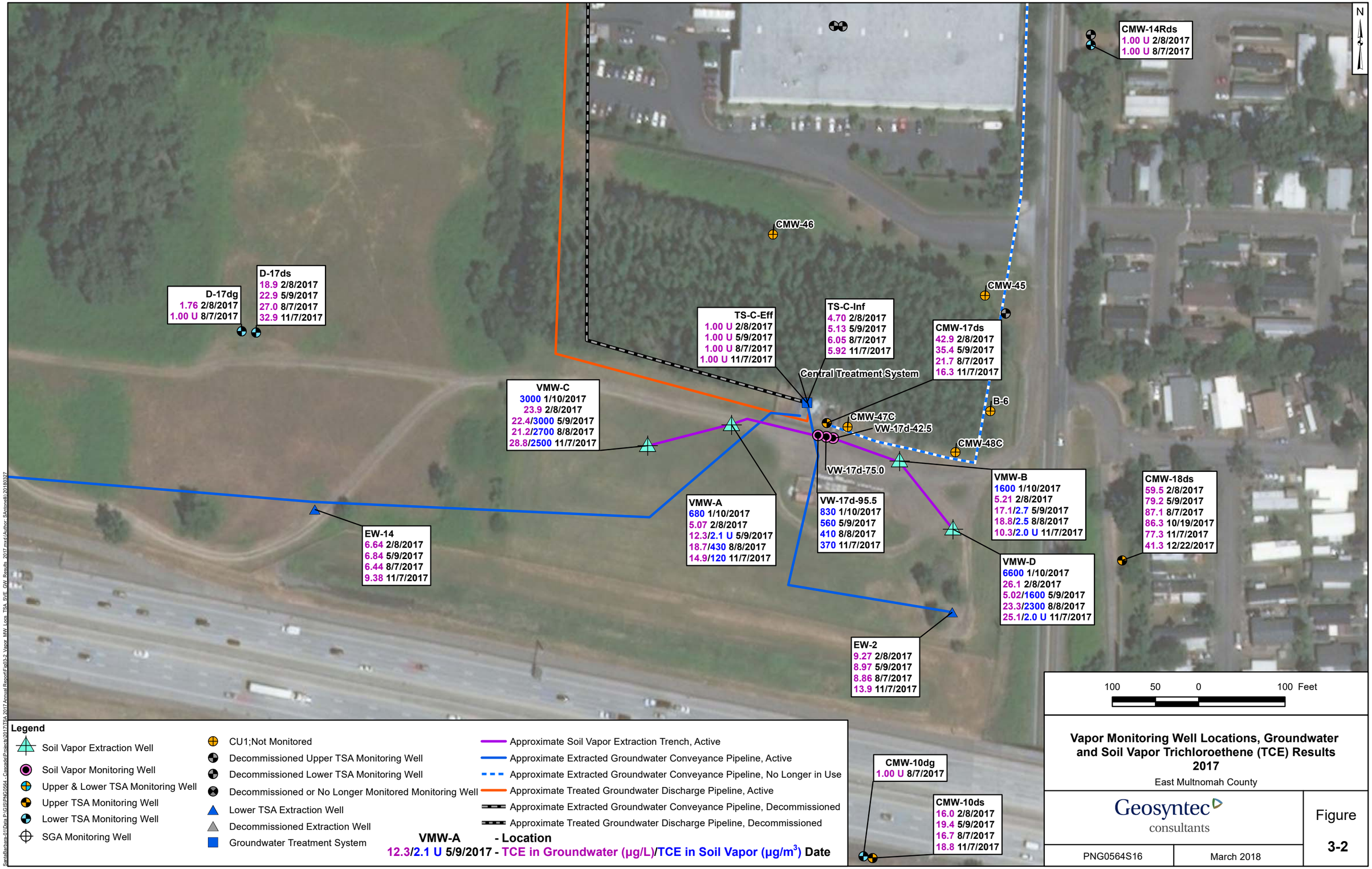
East Multnomah County

Geosyntec consultants

PNG0564S | March 2018

Figure **3-1**

SantaBarbara-01\Data P:\GIS\PNG\0564 - Cascade\Projects\2017\TSA 2017 Annual Report\Fig03-1 Decom TSA Monitoring Well Loc Remedy System Layout.mxd (Author: SA.rbonelli) 20180327



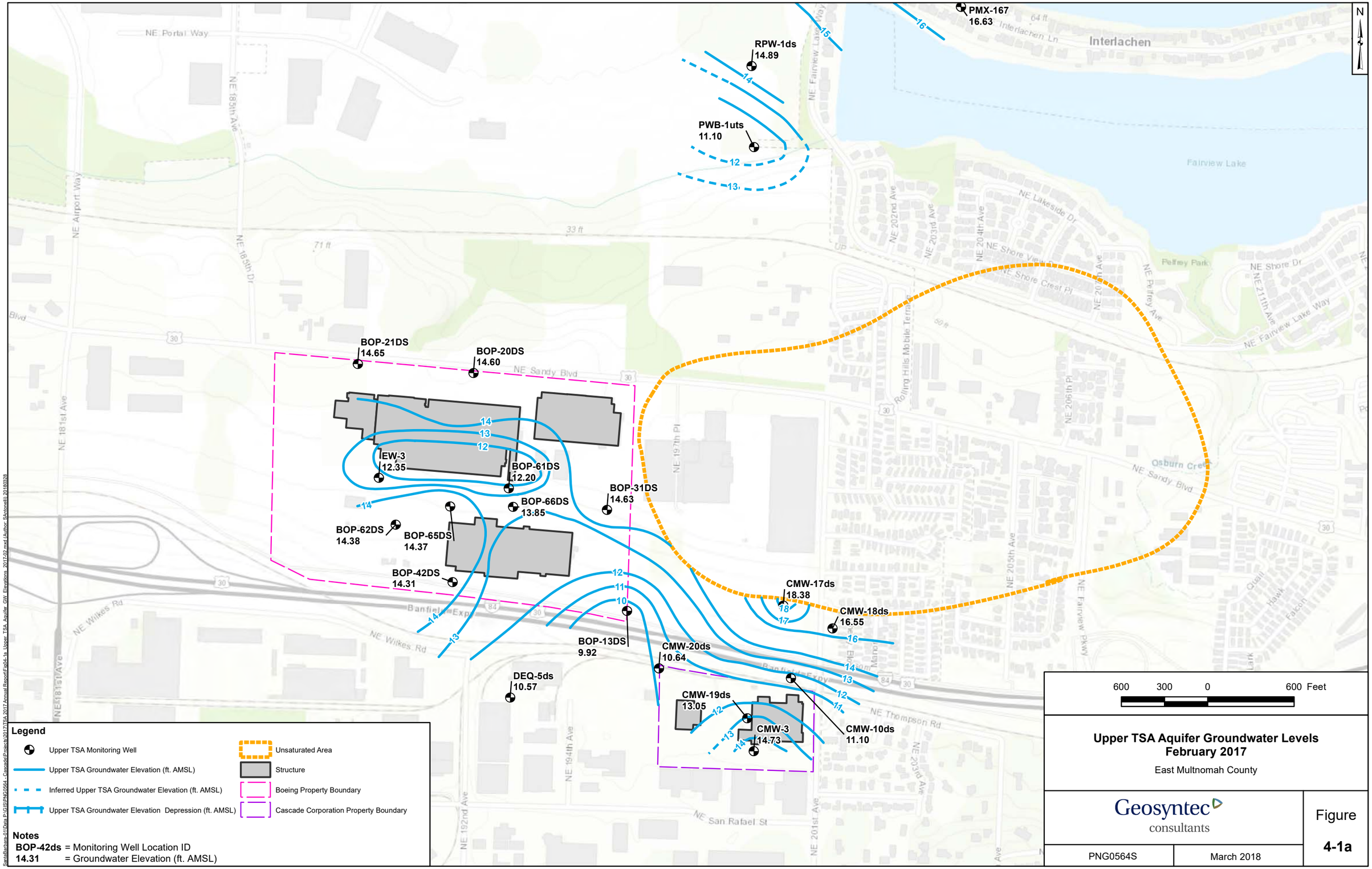
Vapor Monitoring Well Locations, Groundwater and Soil Vapor Trichloroethene (TCE) Results 2017

East Multnomah County

Geosyntec consultants

PNG0564S16 | March 2018

Figure 3-2



Legend

- Upper TSA Monitoring Well
- Upper TSA Groundwater Elevation (ft. AMSL)
- Inferred Upper TSA Groundwater Elevation (ft. AMSL)
- Upper TSA Groundwater Elevation Depression (ft. AMSL)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

BOP-42ds = Monitoring Well Location ID
14.31 = Groundwater Elevation (ft. AMSL)

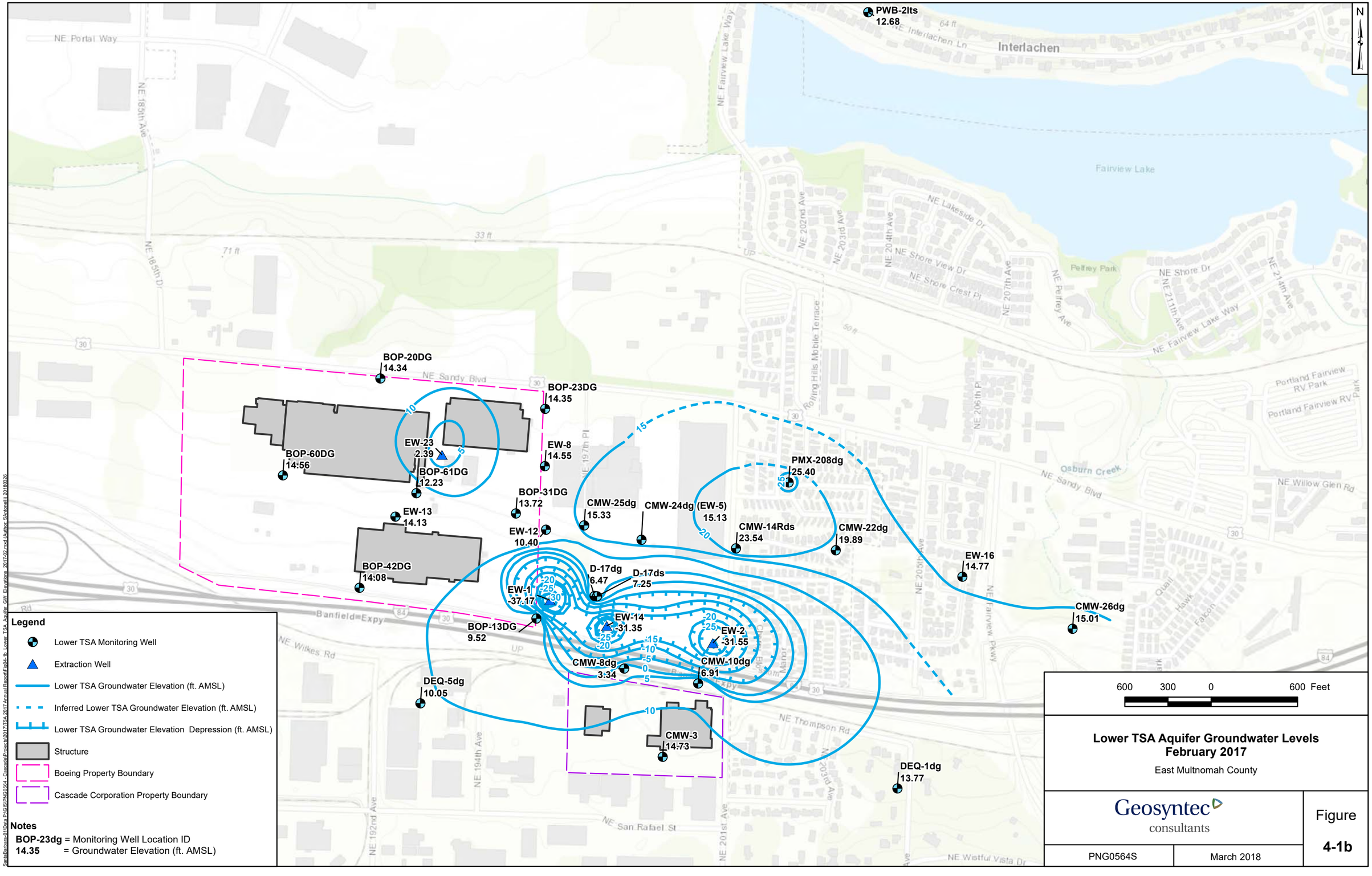
Upper TSA Aquifer Groundwater Levels February 2017

East Multnomah County

Geosyntec consultants

PNG0564S | March 2018

Figure **4-1a**



Legend

- Lower TSA Monitoring Well
- Extraction Well
- Lower TSA Groundwater Elevation (ft. AMSL)
- Inferred Lower TSA Groundwater Elevation (ft. AMSL)
- Lower TSA Groundwater Elevation Depression (ft. AMSL)
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

BOP-23dg = Monitoring Well Location ID
14.35 = Groundwater Elevation (ft. AMSL)

Lower TSA Aquifer Groundwater Levels February 2017

East Multnomah County

Geosyntec consultants

PNG0564S	March 2018	Figure 4-1b

SantaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\2017\TSA 2017 Annual Report\Fig04-1b Lower TSA Aquifer GW Elevations 2017-02.mxd (Author: SAntonelli) 20180326

PMX-167
12.49

BOP-44ds
12.39

BOP-21ds
12.96

BOP-22Rds
13.19

BOP-20ds
12.75

BOP-60Rds
12.99

BOP-61ds
11.31

BOP-65ds
13.14

EW-3
10.74

BOP-62ds
12.98

BOP-66ds
13.09

BOP-42ds
13.91

BOP-31ds
13.07

BOP-13ds
9.19

CMW-17ds
23.14

CMW-18ds
17.87

DEQ-5ds
14.89

CMW-20ds
15.06

CMW-10ds
14.85

CMW-19ds
16.76

CMW-3
17.73

Legend

- Upper TSA Monitoring Well
- Upper TSA Groundwater Elevation (ft. AMSL)
- Inferred Upper TSA Groundwater Elevation (ft. AMSL)
- Upper TSA Groundwater Elevation Depression (ft. AMSL)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

BOP-42ds = Monitoring Well Location ID
13.91 = Groundwater Elevation (ft. AMSL)

600 300 0 600 Feet

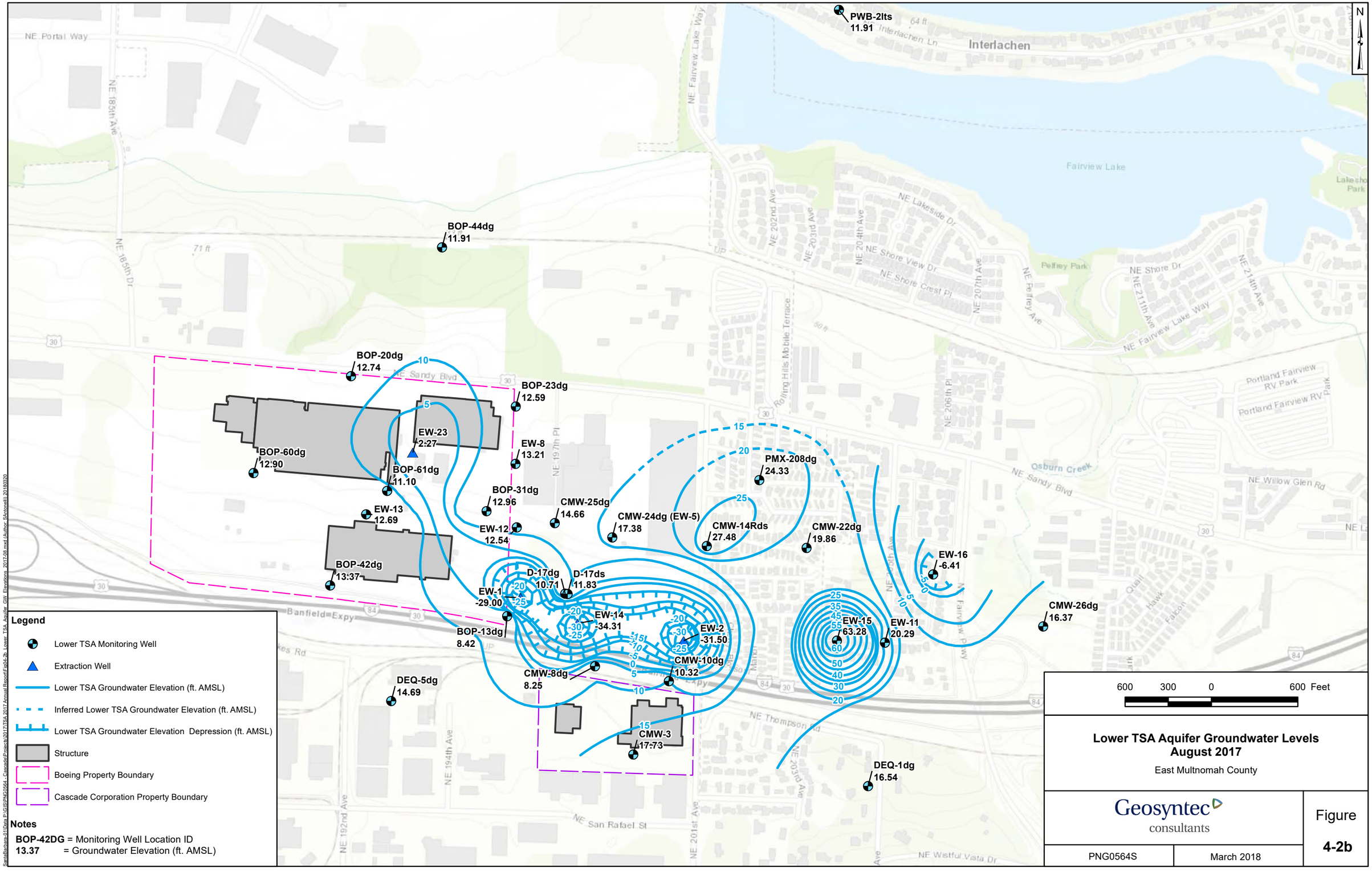
Upper TSA Aquifer Groundwater Levels August 2017

East Multnomah County

Geosyntec consultants

PNG0564S | March 2018

Figure 4-2a



BOP-61ds
5.6

5

BOP-66ds
5.1

BOP-31ds
< 0.20

BOP-13ds
1.6

CMW-17ds
42.9

CMW-18ds
59.5

55

45

35

25

CMW-10ds
16.0

15

5

CMW-19ds
< 1.00

N

Legend

- Upper TSA Monitoring Well
- Upper TSA Trichloroethene Contour (µg/L)
- Inferred Upper TSA Trichloroethene Contour (µg/L)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

CMW-10ds = Monitoring Well Location ID
16.0 = TCE Concentration (µg/L)

Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.

500 250 0 500 Feet

Upper TSA Aquifer Trichloroethene Concentrations
February 2017
East Multnomah County

Geosyntec consultants

PNG0564S | February 2018

Figure **5-1a**

SantaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\2017\TSA 2017 Annual Report\Fig5-1a Upper TSA Aquifer TCE Contours 2017-02.mxd (Author: SAntonelli) 20180202

N

EW-23
3:31

EW-8
< 1.00(U)/1.17(L)

BOP-61dg
0.80

BOP-31dg
4.6

CMW-25dg
< 1.00

CMW-24dg (EW-5)
< 1.00(U)/< 1.00(L)

CMW-14Rds
< 1.00

EW-12
1.86(U)/2.75(L)

EW-16
3.90

D-17dg
1.76

D-17ds
18.9

EW-1
3.33

EW-14
6.64

EW-2
9.27

CMW-26dg
2.60

5'

Legend

- Lower TSA Monitoring Well
- Extraction Well
- Lower TSA Trichloroethene Contour (µg/L)
- Inferred Lower TSA Trichloroethene Contour (µg/L)
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

D-17dg = Monitoring Well Location ID
1.76 = TCE Concentration (µg/L)
(U) = Upper interval at long screened well location
(L) = Lower interval at long screened well location

Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.

500 250 0 500 Feet

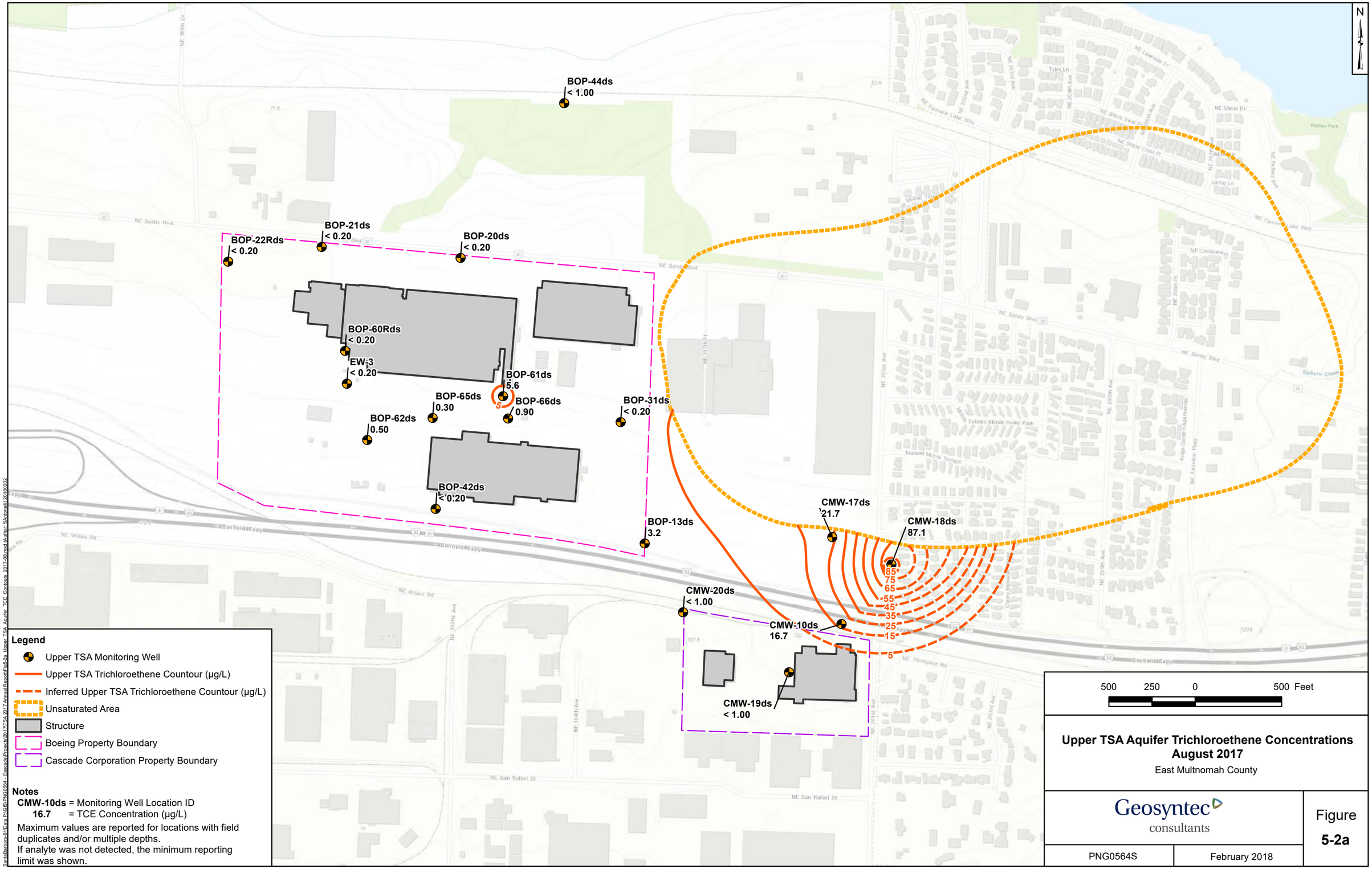
Lower TSA Aquifer Trichloroethene Concentrations February 2017

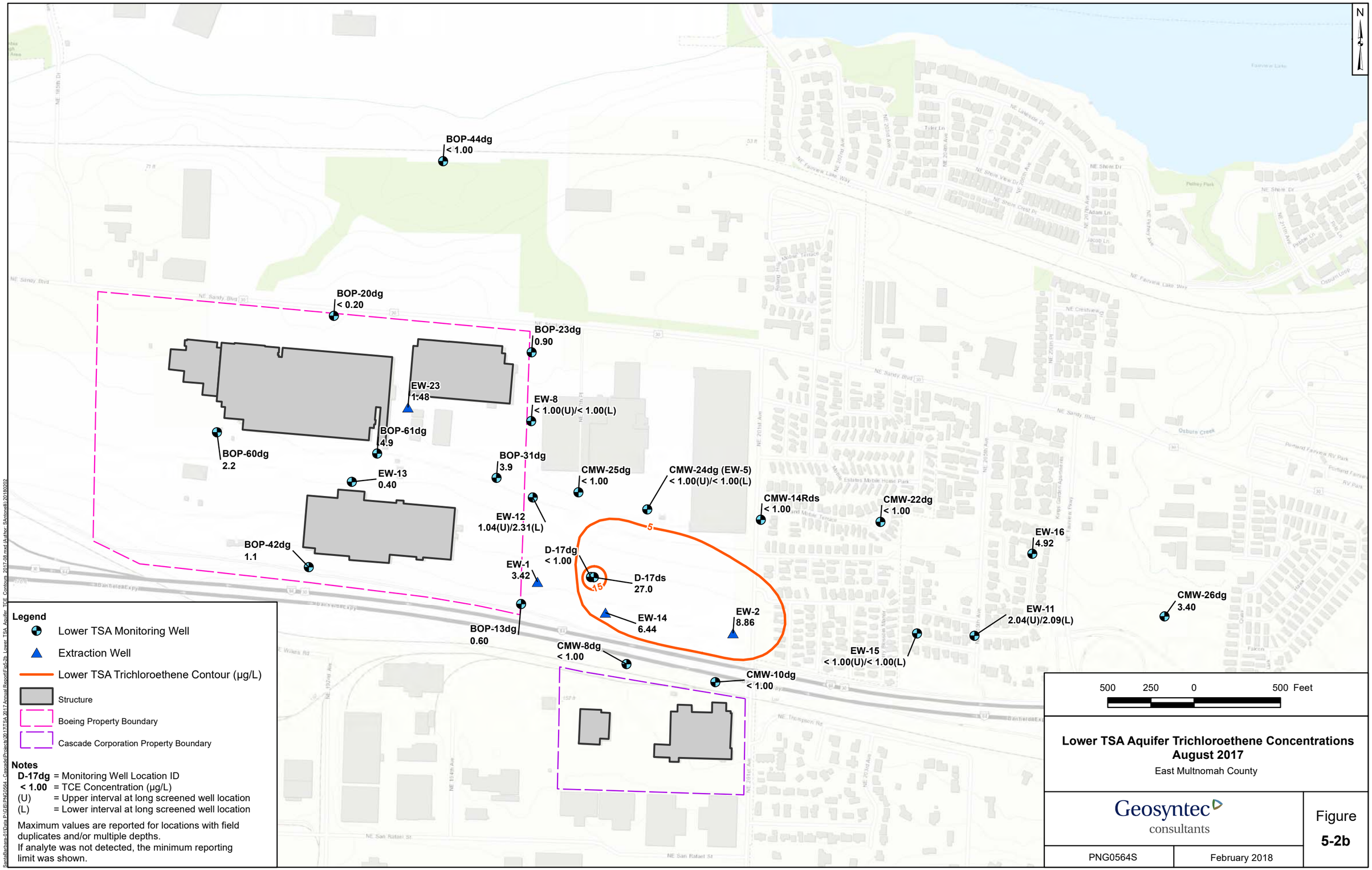
East Multnomah County

Geosyntec consultants

PNG0564S | February 2018

Figure **5-1b**


N
BOP-44ds
< 1.00
BOP-21ds
< 0.20
BOP-22Rds
< 0.20
BOP-20ds
< 0.20
BOP-60Rds
< 0.20
EW-3
< 0.20
BOP-61ds
5.6
BOP-65ds
0.30
BOP-66ds
0.90
BOP-31ds
< 0.20
BOP-62ds
0.50
BOP-42ds
< 0.20
BOP-13ds
3.2
CMW-17ds
21.7
CMW-18ds
87.1
85
75
65
55
45
35
25
15
5
CMW-20ds
< 1.00
CMW-10ds
16.7
CMW-19ds
< 1.00
NE Sandy Blvd
NE Wilkes Rd
NE San Rafael St
NE Thompson Rd
Banfield Expy
NE Fairview Lake Way
NE Shore Dr
NE Lakeside Dr
Tyler Ln
NE Shore View Pl
NE Shore Crest Pl
Jacob Ln
Pathley Park
NE Crestview Dr
NE 20th Pl
Osburn Creek
Mobile Estates Mobile Home Park
Tenant Mobile Terrace
Cherry Blossom Apartments
Kings Garden Apartments
NE 19th Pl
NE 192nd Ave
NE 194th Ave
NE 201st Ave
NE 203rd Ave
NE 205th Ave
NE 207th Ave
NE 30th Dr
Legend
Upper TSA Monitoring Well
Upper TSA Trichloroethene Countour (µg/L)
Inferred Upper TSA Trichloroethene Countour (µg/L)
Unsaturated Area
Structure
Boeing Property Boundary
Cascade Corporation Property Boundary
Notes
CMW-10ds = Monitoring Well Location ID
16.7 = TCE Concentration (µg/L)
Maximum values are reported for locations with field duplicates and/or multiple depths.
If analyte was not detected, the minimum reporting limit was shown.
500 250 0 500 Feet
Upper TSA Aquifer Trichloroethene Concentrations
August 2017
East Multnomah County
Geosyntec consultants
Figure
5-2a
PNG0564S
February 2018
S:\antaBarbara-01\Data P\GIS\PNG0564 - Cascade\Projects\2017\TSA 2017 Annual Report\Fig5-2a_Upper_TSA_Aquifer_TCE_Contours_2017-08.mxd (Author: SAntonelli) 20180202



SantaBarbara-01\Data P:\GIS\PNG0564 - Cascade\Projects\2017\TSA 2017 Annual Report\Fig5-2b_Lower_TSA_Aquifer_TCE_Contours_2017-08.mxd (Author: SAntonelli) 20180202

APPENDIX A

Extraction Rate Profiles

Table A-1
TSA Extraction Rates 1 January 2017 through 31 December 2017 and
12-Month Averages through 31 December 2017
TSA Remedy - East Multnomah County

Zone	12-Mo. Avg.	01/2017	02/2017	03/2017	04/2017	05/2017	06/2017	07/2017	08/2017	09/2017	10/2017	11/2017	12/2017
Zone B	**27**	**24**	**22**	**30**	**26**	**30**	**29**	**22**	**34**	**32**	**29**	**16**	**27**
EW-23	*27*	*24*	*22*	*30*	*26*	*30*	*29*	*22*	*34*	*32*	*29*	*16*	*27*
Zone C	**87**	**94**	**81**	**79**	**50**	**90**	**81**	**97**	**104**	**114**	**103**	**66**	**80**
EW-1	*43*	*47*	*39*	*37*	*32*	*34*	*28*	*45*	*67*	*59*	*50*	*34*	*42*
EW-2	*25*	*25*	*22*	*21*	*0*	*34*	*33*	*31*	*16*	*37*	*34*	*18*	*21*
EW-14	*19*	*21*	*21*	*21*	*18*	*22*	*20*	*21*	*21*	*18*	*19*	*14*	*17*
Zone D	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
EW-16	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total Avg Flow TSA	**114**	**118**	**103**	**109**	**77**	**120**	**111**	**119**	**137**	**146**	**133**	**82**	**107**

NOTES:

Monthly average flow rates are shown in gallons per minute for each well.

Wells that have not operated during the last 12 months are not shown.

The PLC was replaced in November 2017, so average flows for November are lower than normal.

EW-16 pilot shutdown began in November 2014, and EW-16 was converted to monitoring in October 2017.

Table A-2
Discharge Monitoring Summary - Cental Treatment System
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

Parameter	Discharge Limitations[a]	Unit	Sample Date	System Discharge			Number of Exceedances	Sample Frequency
				Min	Avg	Max		
January 2017								
pH	6.0 – 9.0	su	—	7.70	7.73	7.80	0	Weekly
Temperature	—	ºF	—	59	60	61	—	Weekly
Flow[#]	—	gpm	—	--	47	--	—	Daily
February 2017								
Trichloroethene	5.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	2/2/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	ºF	—	59	59	60	—	Weekly
Flow[#]	—	gpm	—	--	39	--	—	Daily
March 2017								
pH	6.0 – 9.0	su	—	7.70	7.75	7.80	0	Weekly
Temperature	—	ºF	—	60	60	61	—	Weekly
Flow[#]	—	gpm	—	--	37	--	—	Daily
April 2017								
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	ºF	—	60	60	61	—	Weekly
Flow[#]	—	gpm	—	--	32	--	—	Daily
May 2017								
Trichloroethene	5.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	5/3/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.70	7.76	7.80	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow[#]	—	gpm	—	--	34	--	—	Daily

Table A-2
Discharge Monitoring Summary - Cental Treatment System
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

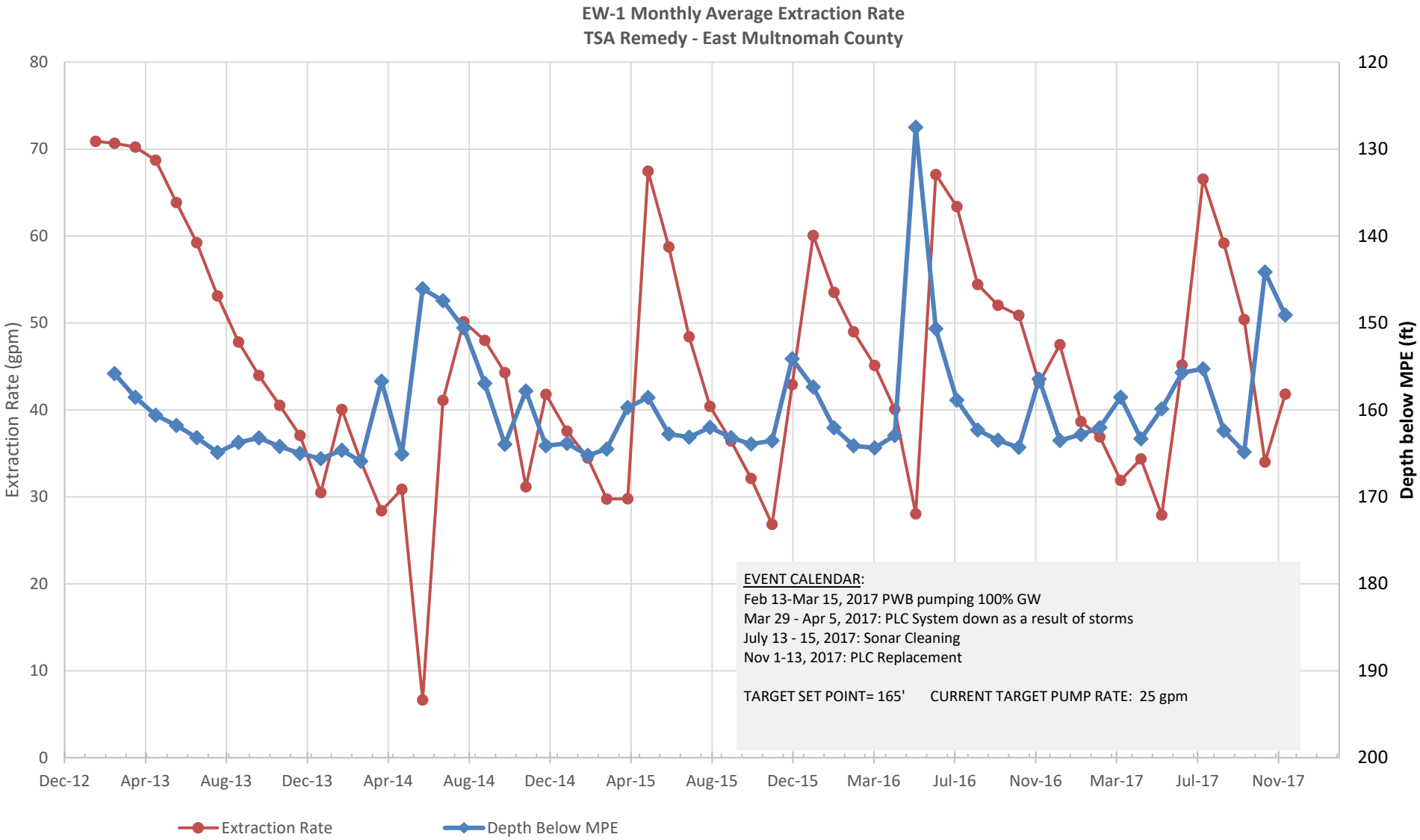
Parameter	Discharge Limitations[a]	Unit	Sample Date	System Discharge			Number of Exceedances	Sample Frequency
				Min	Avg	Max		
June 2017								
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	ºF	—	60	60	61	—	Weekly
Flow[#]	—	gpm	—	--	33	--	—	Daily
July 2017								
pH	6.0 – 9.0	su	—	7.70	7.76	7.80	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow[#]	—	gpm	—	--	45	--	—	Daily
August 2017								
Trichloroethene	5.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	8/4/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow[#]	—	gpm	—	--	67	--	—	Daily
September 2017								
pH	6.0 – 9.0	su	—	7.70	7.73	7.80	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow	—	gpm	—	--	59	--	—	Daily
October 2017								
pH	6.0 – 9.0	su	—	7.70	7.70	7.70	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow[#]	—	gpm	—	--	50	--	—	Daily
November 2017								
Trichloroethene	5.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
1,1-Dichloroethene	7.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
cis-1,2-Dichloroethene	70	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Tetrachloroethene	5.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
Vinyl Chloride	2.0	µg/L	11/1/2016	< 1.0	< 1.0	< 1.0	0	Quarterly
pH	6.0 – 9.0	su	—	7.80	7.80	7.80	0	Weekly
Temperature	—	ºF	—	60	60	60	—	Weekly
Flow[#]	—	gpm	—	--	34	--	—	Daily
December 2017								
pH	6.0 – 9.0	su	—	7.70	7.78	7.80	0	Weekly
Temperature	—	ºF	—	56	58	60	—	Weekly
Flow[#]	—	gpm	—	--	42	--	—	Daily

NOTES:

[a]Discharge limitations for the CTS are per Attachment C to DEQ Consent Order No. WMCSR-NWR-96-08 dated 2/14/97. Analysis for VOCs includes TS-C-Eff.

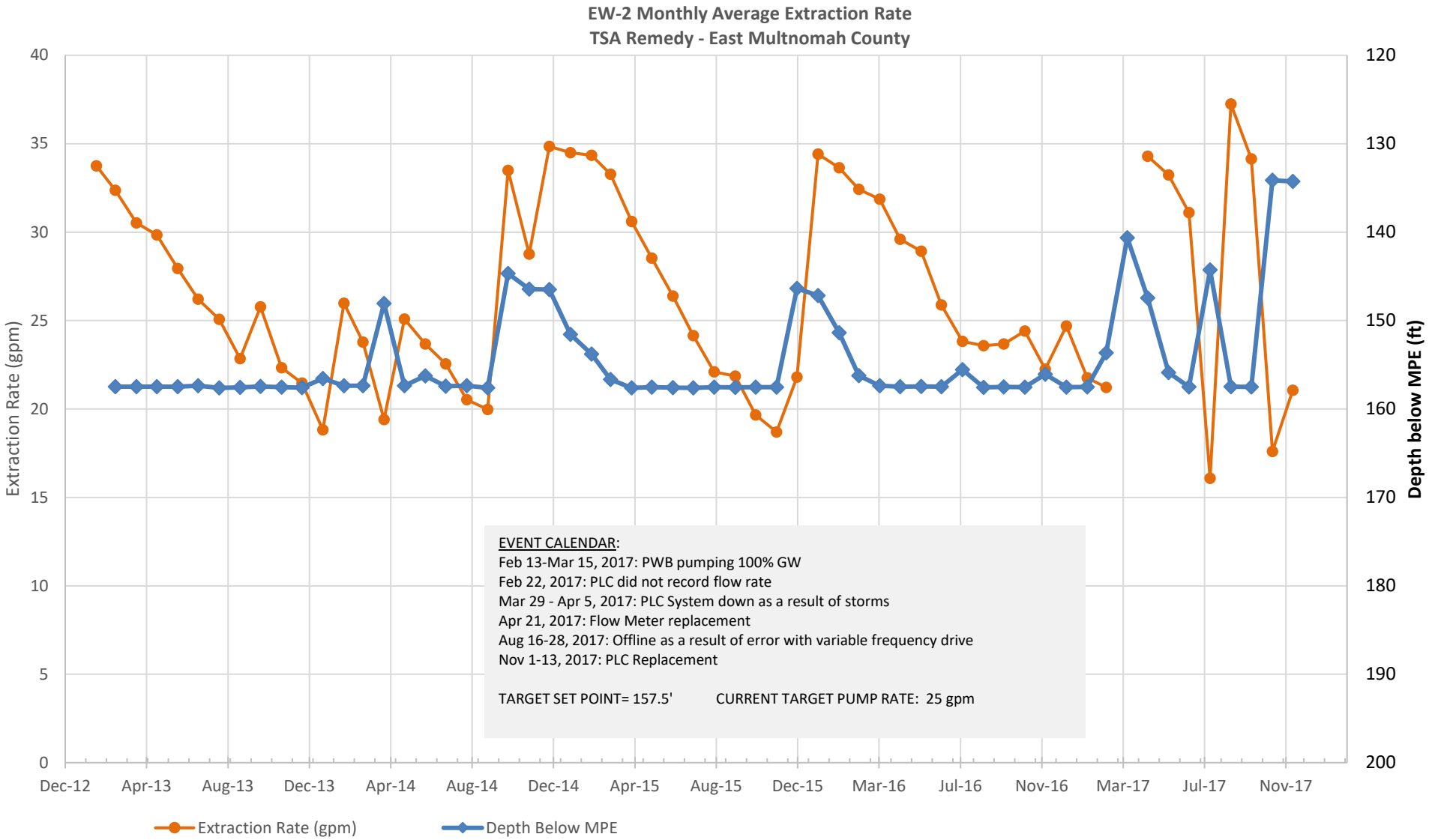
[#]Flow includes EW-1, EW-2, EW-14, and EW-23.

µg/L = micrograms/liter; ºF = degrees Fahrenheit; gpm = gallons per minute; su = standard units.



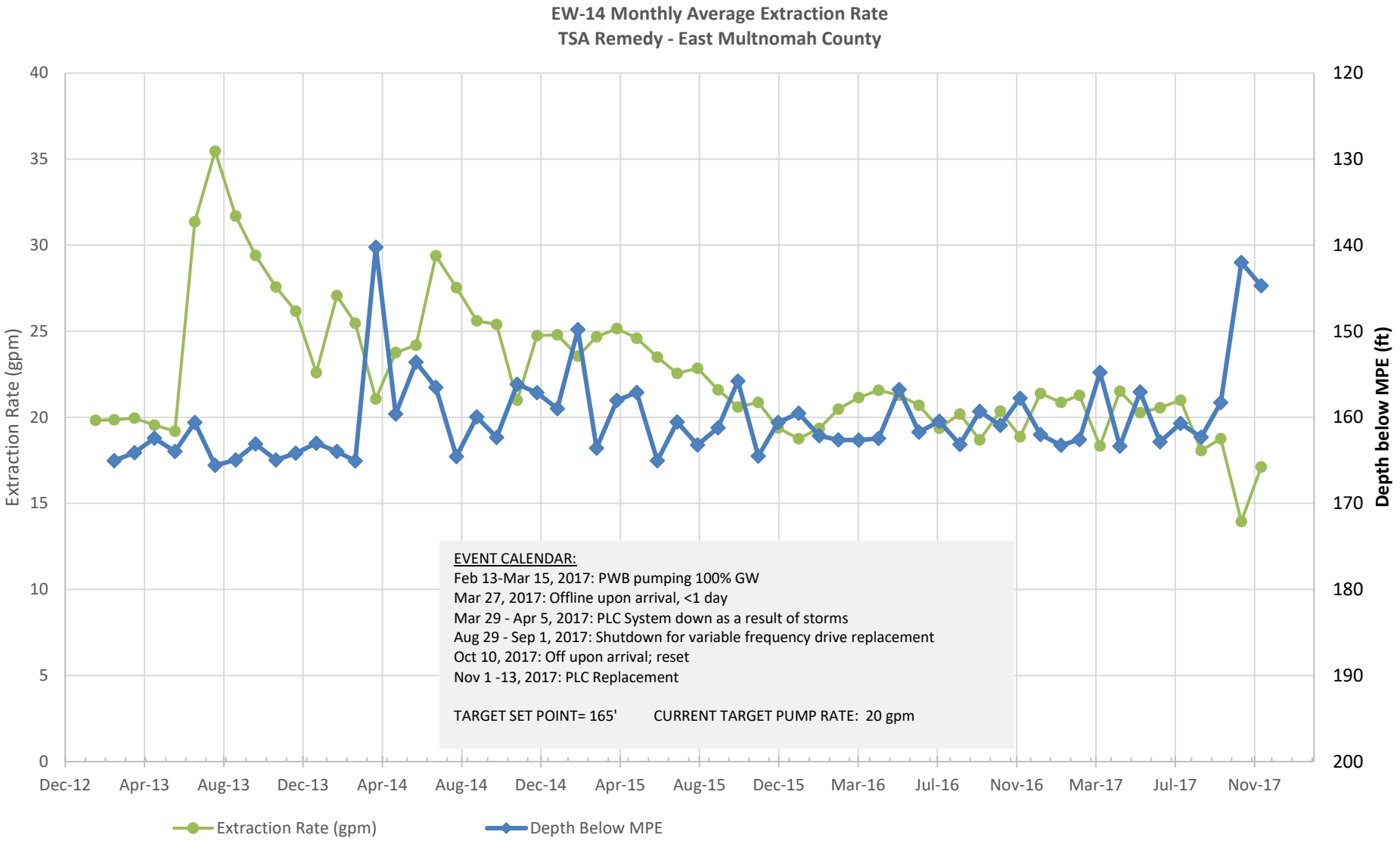
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-1 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-1



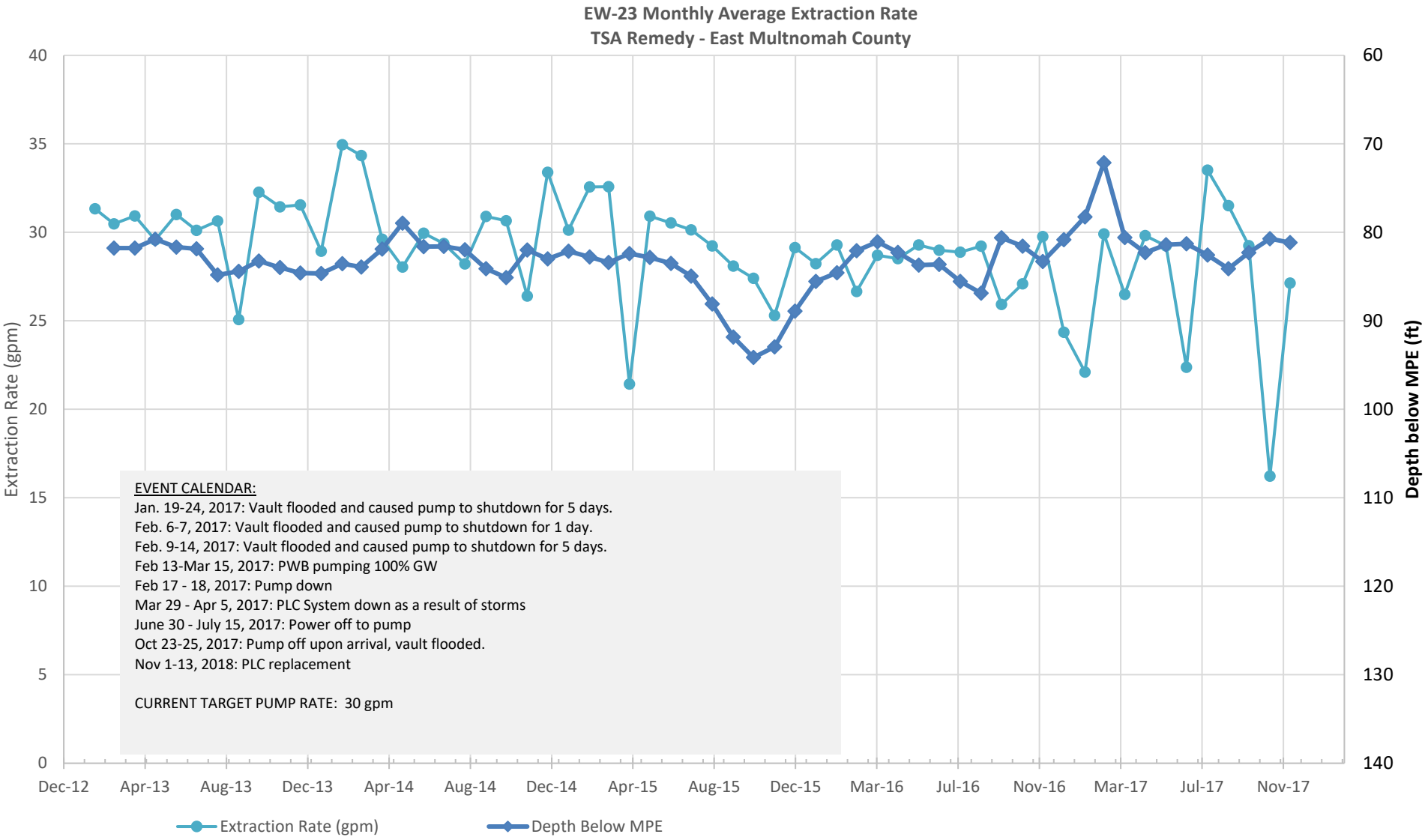
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-2 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-2



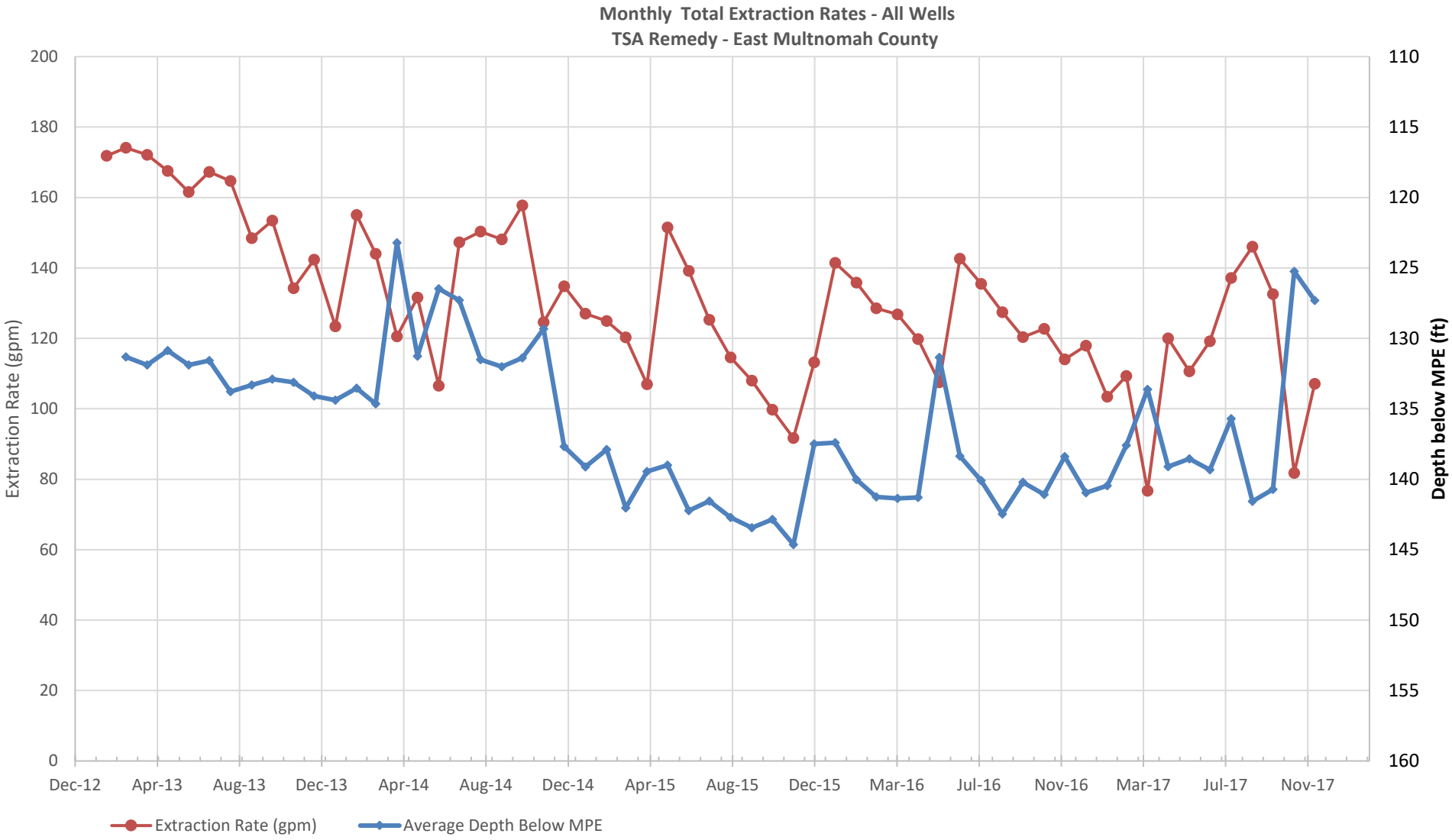
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-14 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-3



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**EW-23 Monthly Average Extraction Rate** **TSA Remedy**	Figure A-4



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Total Extraction Rate for Remedy Wells** **TSA Remedy**	Figure A-5

APPENDIX B

Groundwater Elevation Data

Table B-1
Groundwater Elevations - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Extraction Wells						
Lower	EW-1	2/8/2017	9:30	124.04	161.21	-37.17
Lower	EW-1	5/9/2017	11:30	124.04	163.11	-39.07
Lower	EW-1	8/7/2017	11:47	124.04	153.04	-29.00
Lower	EW-1	11/7/2017	9:15	124.04	137.50	-13.46
Lower	EW-14	2/8/2017	9:50	127.63	158.98	-31.35
Lower	EW-14	5/9/2017	11:40	127.63	163.84	-36.21
Lower	EW-14	8/7/2017	11:58	127.63	161.94	-34.31
Lower	EW-14	11/7/2017	9:35	127.63	140.61	-12.98
Lower	EW-16	2/8/2017	11:35	83.71	68.94	14.77
Lower	EW-16	5/9/2017	15:30	83.71	64.21	19.50
Lower	EW-16	8/7/2017	14:45	83.71	90.12	-6.41
Lower	EW-16	11/7/2017		83.71	69.71	14.00
Lower	EW-2	2/8/2017	9:40	126.01	157.56	-31.55
Lower	EW-2	5/9/2017	11:20	126.01	144.71	-18.70
Lower	EW-2	8/7/2017	10:39	126.01	157.51	-31.50
Lower	EW-2	11/7/2017	9:25	126.01	137.10	-11.09
Lower	EW-23	2/8/2017	10:00	83.93	81.54	2.39
Lower	EW-23	5/8/2017	11:22	83.93	82.88	1.05
Lower	EW-23	8/7/2017	15:10	83.93	81.66	2.27
Lower	EW-23	11/7/2017	9:45	83.93	83.84	0.09
Monitoring Wells						
Upper	BOP-13ds	2/6/2017	8:44	128.94	119.02	9.92
Upper	BOP-13ds	8/1/2017	8:30	128.94	119.75	9.19
Upper	BOP-20ds	2/6/2017	10:29	77.45	62.85	14.6
Upper	BOP-20ds	8/1/2017	10:22	77.45	64.70	12.75
Upper	BOP-21ds	2/6/2017	10:21	78.02	63.37	14.65
Upper	BOP-21ds	8/1/2017	11:00	78.02	65.06	12.96
Upper	BOP-22Rds	8/1/2017	10:05	82.91	69.72	13.19
Upper	BOP-31ds	2/6/2017	9:39	99.04	84.41	14.63
Upper	BOP-31ds	8/1/2017	9:32	99.04	85.97	13.07
Upper	BOP-42ds	2/6/2017	8:33	130.74	116.43	14.31
Upper	BOP-42ds	8/1/2017	8:11	130.74	116.83	13.91
Upper	BOP-44ds	8/7/2017	15:56	35.24	22.85	12.39
Upper	BOP-60Rds	8/1/2017	12:18	82.80	69.81	12.99
Upper	BOP-61ds	2/6/2017	12:18	94.64	82.44	12.20
Upper	BOP-61ds	8/1/2017	13:28	94.64	83.33	11.31
Upper	BOP-62ds	2/6/2017	10:52	112.29	97.91	14.38
Upper	BOP-62ds	8/1/2017	9:13	112.29	99.31	12.98
Upper	BOP-65ds	2/6/2017	11:11	104.22	89.85	14.37
Upper	BOP-65ds	8/1/2017	15:05	104.22	91.08	13.14
Upper	BOP-66ds	2/6/2017	11:02	102.97	89.12	13.85
Upper	BOP-66ds	8/1/2017	14:11	102.97	89.88	13.09
Upper	CMW-10ds	2/8/2017	12:50	134.54	123.44	11.10
Upper	CMW-10ds	5/9/2017	14:00	134.54	120.71	13.83
Upper	CMW-10ds	8/7/2017	18:17	134.54	119.69	14.85
Upper	CMW-10ds	11/7/2017	14:05	134.54	120.09	14.45
Upper	CMW-17ds	2/8/2017	10:35	121.89	103.51	18.38
Upper	CMW-17ds	5/9/2017	10:50	121.89	99.61	22.28
Upper	CMW-17ds	8/7/2017	12:25	121.89	98.75	23.14
Upper	CMW-17ds	11/7/2017	10:30	121.89	99.68	22.21

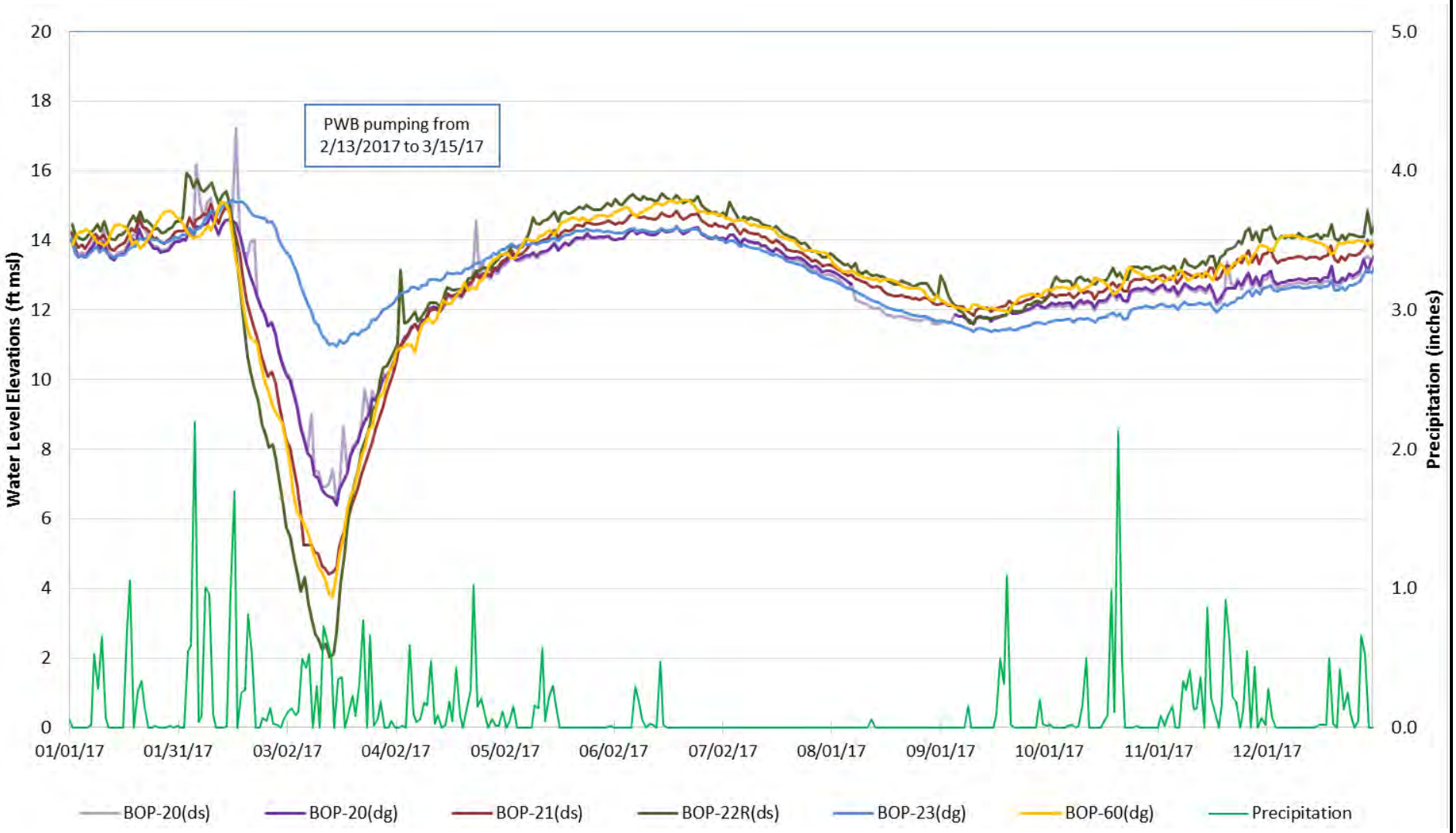
Table B-1
Groundwater Elevations - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Upper	CMW-18ds	2/8/2017	12:20	117.66	101.11	16.55
Upper	CMW-18ds	5/9/2017	13:30	117.66	100.28	17.38
Upper	CMW-18ds	8/7/2017	10:20	117.66	99.79	17.87
Upper	CMW-18ds	11/7/2017	12:40	117.66	100.22	17.44
Upper	CMW-18ds	12/22/2017	11:40	117.66	100.20	17.46
Upper	CMW-19ds	2/8/2017	13:20	144.08	131.03	13.05
Upper	CMW-19ds	5/9/2017	14:33	144.08	128.17	15.91
Upper	CMW-19ds	8/7/2017	14:24	144.08	127.32	16.76
Upper	CMW-19ds	11/7/2017	12:10	144.08	127.68	16.40
Upper	CMW-20ds	2/8/2017	13:09	152.72	142.08	10.64
Upper	CMW-20ds	8/7/2017	14:00	152.72	137.66	15.06
Upper	DEQ-5ds	2/8/2017	13:03	155.68	145.11	10.57
Upper	DEQ-5ds	8/7/2017	13:38	155.68	140.79	14.89
Upper	EW-3	2/6/2017	10:41	94.26	81.91	12.35
Upper	EW-3	8/1/2017	13:05	94.26	83.52	10.74
Upper	PMX-167	2/8/2017	8:25	44.84	28.21	16.63
Upper	PMX-167	8/7/2017	13:17	44.84	32.35	12.49
Upper	PWB-1uts	2/8/2017	8:53	15.98	4.88	11.10
Upper	RPW-1ds	2/8/2017	8:39	15.9	1.01	14.89
Upper and Lower	CMW-3	2/8/2017	12:41	147.69	132.96	14.73
Upper and Lower	CMW-3	8/7/2017	14:10	147.69	129.96	17.73
Lower	BOP-13dg	2/6/2017	8:47	128.71	119.19	9.52
Lower	BOP-13dg	8/1/2017	8:31	128.71	120.29	8.42
Lower	BOP-20dg	2/6/2017	10:27	77.32	62.98	14.34
Lower	BOP-20dg	8/1/2017	10:23	77.32	64.58	12.74
Lower	BOP-23dg	2/6/2017	10:12	76.96	62.61	14.35
Lower	BOP-23dg	8/1/2017	10:05	76.96	64.37	12.59
Lower	BOP-31dg	2/6/2017	9:38	98.51	84.79	13.72
Lower	BOP-31dg	8/1/2017	9:30	98.51	85.55	12.96
Lower	BOP-42dg	2/6/2017	8:31	130.71	116.63	14.08
Lower	BOP-42dg	8/1/2017	8:08	130.71	117.34	13.37
Lower	BOP-44dg	8/7/2017	17:11	35.15	23.24	11.91
Lower	BOP-60dg	2/6/2017	10:39	93.59	79.03	14.56
Lower	BOP-60dg	8/1/2017	11:15	93.59	80.69	12.90
Lower	BOP-61dg	2/6/2017	12:48	94.43	82.20	12.23
Lower	BOP-61dg	8/1/2017	13:54	94.43	83.33	11.10
Lower	CMW-10dg	2/8/2017	12:53	135.05	128.14	6.91
Lower	CMW-10dg	8/7/2017	18:22	135.05	124.73	10.32
Lower	CMW-14Rds	2/8/2017	11:40	83.48	59.94	23.54
Lower	CMW-14Rds	8/7/2017	10:30	83.48	56.00	27.48
Lower	CMW-22dg	2/8/2017	11:43	81.65	61.76	19.89
Lower	CMW-22dg	8/7/2017	10:45	81.65	61.79	19.86
Lower	CMW-24dg (EW-5)	2/8/2017	14:40	77.74	62.61	15.13
Lower	CMW-24dg (EW-5)	8/7/2017	11:25	77.74	60.36	17.38
Lower	CMW-25dg	2/8/2017	11:10	75.28	59.95	15.33
Lower	CMW-25dg	8/7/2017	16:52	75.28	60.62	14.66
Lower	CMW-26dg	2/8/2017	13:55	108.98	93.97	15.01
Lower	CMW-26dg	5/9/2017	15:05	108.98	91.10	17.88
Lower	CMW-26dg	8/7/2017	15:12	108.98	92.61	16.37
Lower	CMW-26dg	11/7/2017	13:30	108.98	93.19	15.79
Lower	CMW-8dg	2/8/2017	12:57	136.21	132.87	3.34

Table B-1
Groundwater Elevations - 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

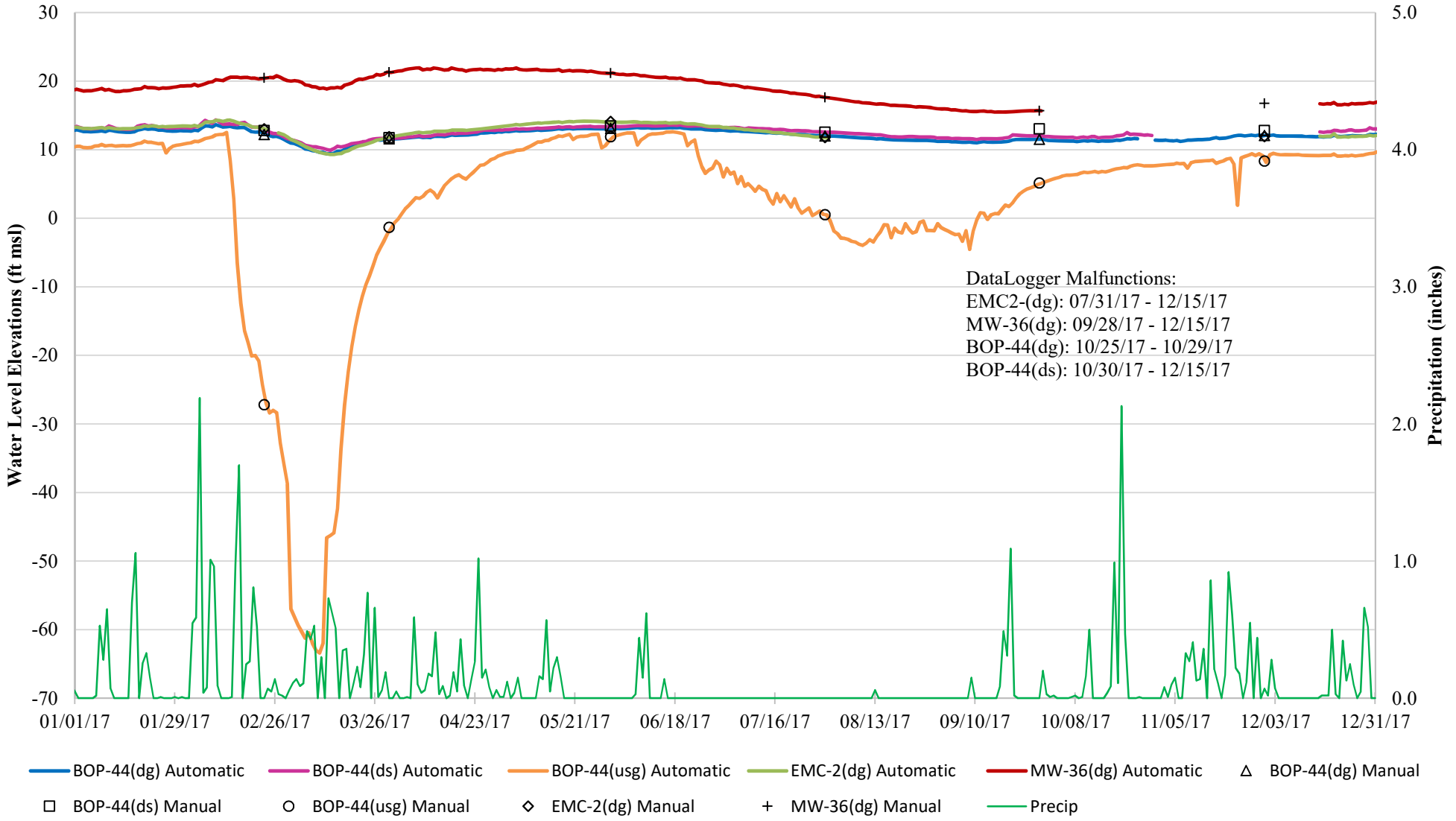
TSA Zone	Well ID	Date	Time	Top of Casing Elevation (ft MSL)	Depth to Water (ft below TOC)	Groundwater Elevation (ft MSL)
Lower	CMW-8dg	8/7/2017	18:03	136.21	127.96	8.25
Lower	D-17dg	2/8/2017	15:40	124.61	118.14	6.47
Lower	D-17dg	8/7/2017	14:25	124.61	113.90	10.71
Lower	D-17ds	2/8/2017	16:00	123.28	116.03	7.25
Lower	D-17ds	5/9/2017	12:10	123.28	111.38	11.90
Lower	D-17ds	8/7/2017	13:53	123.28	111.45	11.83
Lower	D-17ds	11/7/2017	11:40	123.28	111.04	12.24
Lower	DEQ-1dg	2/8/2017	8:04	150.58	136.81	13.77
Lower	DEQ-1dg	8/7/2017	12:30	150.58	134.04	16.54
Lower	DEQ-5dg	2/8/2017	13:00	155.95	145.90	10.05
Lower	DEQ-5dg	8/7/2017	13:44	155.95	141.26	14.69
Lower	EW-11	8/7/2017	8:49	114.73	94.44	20.29
Lower	EW-12	2/8/2017	15:15	94.14	83.74	10.40
Lower	EW-12	5/9/2017	12:40	94.14	80.78	13.36
Lower	EW-12	8/7/2017	16:06	94.14	81.60	12.54
Lower	EW-12	11/7/2017	11:00	94.14	81.85	12.29
Lower	EW-13	2/6/2017	11:06	103.59	89.46	14.13
Lower	EW-13	8/1/2017	14:52	103.59	90.9	12.69
Lower	EW-15	8/7/2017	15:28	116.21	52.93	63.28
Lower	EW-8	2/8/2017	10:57	77.16	62.61	14.55
Lower	EW-8	8/7/2017	11:10	77.16	63.95	13.21
Lower	PMX-208dg	2/8/2017	8:11	81.14	55.74	25.40
Lower	PMX-208dg	8/7/2017	10:02	81.14	56.81	24.33
Lower	PWB-2lts	2/8/2017	8:28	44.32	31.64	12.68
Lower	PWB-2lts	8/7/2017	13:23	44.32	32.41	11.91
Vapor Monitoring Wells						
Upper	VMW-A	2/8/2017	16:40	123.34	102.89	20.45
Upper	VMW-A	5/9/2017	12:10	123.34	101.06	22.28
Upper	VMW-A	8/7/2017	12:56	123.34	99.90	23.44
Upper	VMW-A	11/7/2017	15:00	123.34	100.15	23.19
Upper	VMW-B	2/8/2017	16:50	123.25	99.91	23.34
Upper	VMW-B	5/9/2017	13:15	123.25	98.09	25.16
Upper	VMW-B	8/7/2017	13:56	123.25	98.88	24.37
Upper	VMW-B	11/7/2017	15:20	123.25	97.83	25.42
Upper	VMW-C	2/8/2017	16:20	124.17	101.03	23.14
Upper	VMW-C	5/9/2017	12:40	124.17	99.22	24.95
Upper	VMW-C	8/7/2017	13:22	124.17	98.75	25.42
Upper	VMW-C	11/7/2017	15:40	124.17	98.59	25.58
Upper	VMW-D	2/8/2017	17:00	122.67	98.98	23.69
Upper	VMW-D	5/9/2017	13:43	122.67	98.32	24.35
Upper	VMW-D	8/7/2017	14:29	122.67	98.00	24.67
Upper	VMW-D	11/7/2017	16:00	122.67	98.64	24.03

Notes:
ft MSL = feet above mean sea level
TOC = top of casing



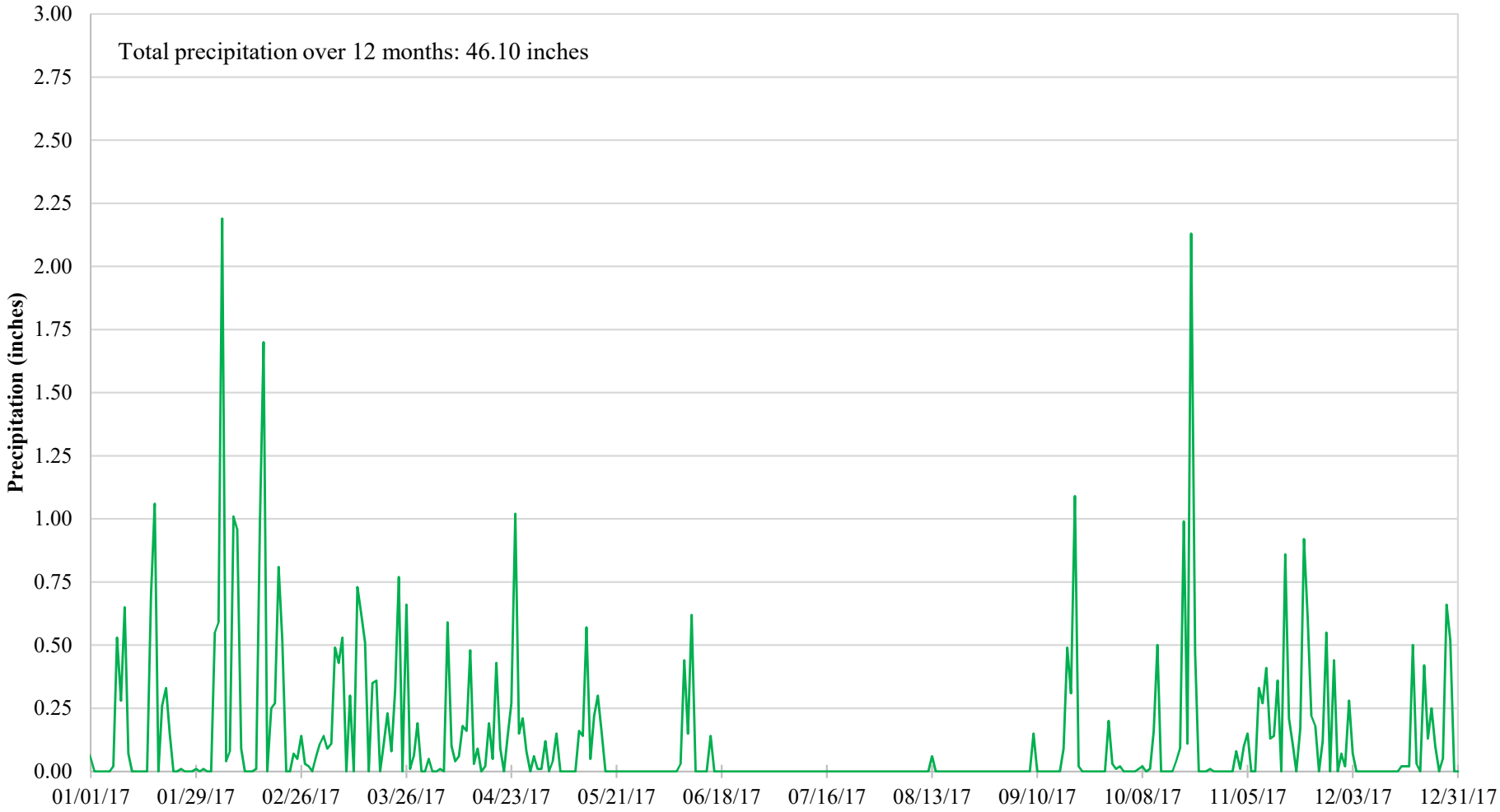
LANDAU ASSOCIATES

Boeing Portland Gresham, Oregon	**Hydrographs for Boeing TSA Wells**	Figure B-1



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Hydrograph for TSA Wells** **1 January 2017 through 31 December 2017**	Figure B-2



Note: Data from NOAA National Weather Service Preliminary Local Climatological Data (WS Form: F-6); Portland International Airport

Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Precipitation** **1 January 2017 through 31 December 2017**	Figure B-3

APPENDIX C

Groundwater Quality Data

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
System Influent/Effluent								
Lower	TS-C-Inf	TS-C-INF-020817	2/8/2017	**4.7**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Inf	TS-C-INF-050917	5/9/2017	**5.13**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Inf	TS-C-INF-080717	8/7/2017	**6.05**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Inf	TS-C-INF-110717	11/7/2017	**5.92**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-020817	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-020817-DUP	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-050917	5/9/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-050917-DUP	5/9/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-080717-DUP	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-110717	11/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	TS-C-Eff	TS-C-EFF-110717 DUP	11/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Extraction Wells								
Lower	EW-1	EW1-020817	2/8/2017	**3.33**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-1	EW1-050917	5/9/2017	**3.41**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-1	EW1-080708	8/7/2017	**3.42**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-1	EW1-110717	11/7/2017	**4.09**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-2	EW2-020817	2/8/2017	**9.27**	< 1.00	**1.02**	< 1.00	< 1.00
Lower	EW-2	EW2-050917	5/9/2017	**8.97**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-2	EW2-080708	8/7/2017	**8.86**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-2	EW2-110717	11/7/2017	**13.9**	**1.12**	**1.19**	< 1.00	< 1.00
Lower	EW-14	EW14-020817	2/8/2017	**6.64**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-14	EW14-050917	5/9/2017	**6.84**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-14	EW14-080708	8/7/2017	**6.44**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-14	EW14-110717	11/7/2017	**9.38**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-16	EW16-020817	2/8/2017	**3.9**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-16	EW16-050917	5/9/2017	**4.53**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-16	EW16-080708	8/7/2017	**4.92**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-16	EW16-111617	11/16/2017	**1.55**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-23	EW23-020817	2/8/2017	**3.31**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-23	EW23-080708	8/7/2017	**1.48**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-23	EW23-110717	11/7/2017	**1.98**	< 1.00	< 1.00	< 1.00	< 1.00

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Monitoring Wells								
Lower	BOP-13dg	BOP-13DG-0817	8/7/2017	**0.6**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-20dg	BOP-20DG-0317	3/13/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-20dg	BOP-20DG-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-23dg	BOP-23DG-0317	3/13/2017	**0.5**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-23dg	BOP-23DG-0817	8/7/2017	**0.9**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-31dg	BOP-31DG-0217	2/6/2017	**4.6**	**0.40**	**0.50**	< 0.20	< 0.20
Lower	BOP-31dg	BOP-31DG-0817	8/7/2017	**3.9**	**0.40**	**0.40**	< 0.20	< 0.20
Lower	BOP-42dg	BOP-42DG-0817	8/7/2017	**1.1**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-44dg	BOP44DG-080708	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	BOP-60dg	BOP-60DG-0317	3/13/2017	**1.8**	< 0.20	**0.20**	< 0.20	< 0.20
Lower	BOP-60dg	BOP-60DG-0817	8/7/2017	**2.2**	< 0.20	**0.20**	< 0.20	< 0.20
Lower	BOP-61dg	BOP-61DG-0217	2/6/2017	**0.8**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	BOP-61dg	BOP-61DG-0817	8/7/2017	**4.9**	< 0.20	**0.50**	< 0.20	< 0.20
Lower	CMW-10dg	CMW10DG-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-14Rds	CMW14RDS-020817	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-14Rds	CMW14RDS-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-22dg	CMW22DG-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-24dg (EW-5)	CMW24DG-020817-L	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-24dg (EW-5)	CMW24DG-020817-U	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-24dg (EW-5)	CMW24DG-080817-L	8/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-24dg (EW-5)	CMW24DG-080817-U	8/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-25dg	CMW25DG-020817	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-25dg	CMW25DG-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-26dg	CMW26DG-020817	2/8/2017	**2.6**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-26dg	CMW26DG-050917	5/9/2017	**2.02**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-26dg	CMW26DG-080717	8/7/2017	**3.4**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-26dg	CMW26DG-110717	11/7/2017	**4.44**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-36dg	MW-36DG-031517	3/15/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	CMW-8dg	CMW8DG-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	D-17dg	D17DG-020817	2/8/2017	**1.76**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	D-17dg	D17DG-080708	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	D-17ds	D17DS-020817	2/8/2017	**18.9**	< 1.00	**5.02**	< 1.00	< 1.00
Lower	D-17ds	D17DS-050917	5/9/2017	**22.9**	< 1.00	**5.49**	< 1.00	< 1.00
Lower	D-17ds	D17DS-080708	8/7/2017	**27**	**1.09**	**6.60**	< 1.00	< 1.00
Lower	D-17ds	D17DS-110717	11/7/2017	**32.9**	**1.24**	**6.58**	< 1.00	< 1.00
Lower	EW-8	EW8-020817-L	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-8	EW8-020817-U	2/8/2017	**1.17**	< 1.00	< 1.00	< 1.00	< 1.00

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Lower	EW-8	EW8-080717-L	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-8	EW8-080717-U	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-11	EW11-080817-L	8/8/2017	**2.09**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-11	EW11-080817-U	8/8/2017	**2.04**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-020817-L	2/8/2017	**2.75**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-020817-U	2/8/2017	**1.86**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-050917-L	5/9/2017	**2.23**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-050917-U	5/9/2017	**1**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-080717-L	8/7/2017	**2.31**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-080717-U	8/7/2017	**1.04**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-110717-L	11/7/2017	**1.26**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-12	EW12-110717-U	11/7/2017	**2.66**	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-13	EW-13-0817	8/7/2017	**0.4**	< 0.20	< 0.20	< 0.20	< 0.20
Lower	EW-15	EW15-080717-L	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lower	EW-15	EW15-080717-U	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	BOP-13ds	BOP-13DS-0217	2/6/2017	**1.6**	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-13ds	BOP-Z-0217	2/6/2017	**1.4**	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13DS-0517	5/8/2017	**1.9**	< 0.20	**0.20**	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13DS-0817	8/7/2017	**3.2**	< 0.20	**0.40**	< 0.20	< 0.20
Upper	BOP-13ds	BOP-13DS-1117	11/3/2017	**2.4**	< 0.20	**0.30**	<0.20	< 0.20
Upper	BOP-20ds	BOP-20DS-0317	3/13/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-20ds	BOP-20DS-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-20ds	BOP-Z-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-21ds	BOP-21DS-0317	3/13/2017	< 0.20	< 0.20	**0.60**	< 0.20	< 0.20
Upper	BOP-21ds	BOP-21DS-0817	8/7/2017	< 0.20	< 0.20	**0.40**	< 0.20	**2.9**
Upper	BOP-21ds	BOP-21DS-0917	9/5/2017	< 0.20	< 0.20	**0.40**	< 0.20	**1.0**
Upper	BOP-22Rds	BOP-22RDS-0317	3/13/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-22Rds	BOP-22RDS-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31DS-0217	2/6/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31DS-0517	5/8/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31DS-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-31ds	BOP-31DS-1117	11/3/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-42ds	BOP-42DS-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-44ds	BOP44DS-080817	8/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	BOP-60Rds	BOP-60RDS-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-60Rds	BOP-Y-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-61ds	BOP-61DS-0217	2/6/2017	**5.6**	**0.30**	**0.80**	< 0.20	< 0.20
Upper	BOP-61ds	BOP-61DS-0817	8/7/2017	**5.6**	**0.30**	**0.50**	< 0.20	< 0.20

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Upper	BOP-62ds	BOP-62DS-0817	8/8/2017	**0.5**	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-65ds	BOP-65DS-0817	8/7/2017	**0.3**	< 0.20	< 0.20	< 0.20	< 0.20
Upper	BOP-66ds	BOP-66DS-0217	2/6/2017	**5.1**	**0.30**	**0.20**	< 0.20	< 0.20
Upper	BOP-66ds	BOP-66DS-0817	8/7/2017	**0.9**	< 0.20	< 0.20	< 0.20	< 0.20
Upper	CMW-10ds	CMW10DS-020817	2/8/2017	**16**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-10ds	CMW10DS-050917	5/9/2017	**19.4**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-10ds	CMW10DS-080717	8/7/2017	**16.7**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-10ds	CMW10DS-110717	11/7/2017	**18.8**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-020817	2/8/2017	**42.6**	**2.10**	**5.83**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-020817-DUP	2/8/2017	**42.9**	**2.13**	**5.78**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-050917	5/9/2017	**35.4**	< 1.00	**5.00**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-050917-DUP	5/9/2017	**35.2**	< 1.00	**5.25**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-080717	8/7/2017	**21.7**	**1.46**	**2.81**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-080717-DUP	8/7/2017	**18.3**	**1.12**	**2.58**	< 1.00	< 1.00
Upper	CMW-17ds	CMW17DS-110717	11/7/2017	**16.3**	< 1.00	**2.09**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-020817	2/8/2017	**59.5**	**1.62**	**7.43**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-050917	5/9/2017	**79.2**	< 1.00	**11.0**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-080717	8/7/2017	**83.3**	**3.02**	**9.90**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-080717-DUP	8/7/2017	**87.1**	**2.89**	**10.3**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-101917	10/19/2017	**86.3**	**3.09**	**12.7**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-110717	11/7/2017	**77.3**	**1.56**	**10.4**	< 1.00	< 1.00
Upper	CMW-18ds	CMW18DS-110717-D	11/7/2017	**72.3**	**1.46**	**9.63**	< 1.00	< 1.00
Upper	CMW-18ds	MW18DS-122217-102.5	12/22/2017	**18.1**	< 1.00	**3.17**	< 1.00	< 1.00
Upper	CMW-18ds	MW18DS-122217-105	12/22/2017	**32.9**	< 1.00	**6.68**	< 1.00	< 1.00
Upper	CMW-18ds	MW18DS-122217-107.5	12/22/2017	**36.7**	< 1.00	**7.68**	< 1.00	< 1.00
Upper	CMW-18ds	MW18DS-122217-109	12/22/2017	**41.3**	< 1.00	**8.14**	< 1.00	< 1.00
Upper	CMW-19ds	CMW19DS-020817	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-19ds	CMW19DS-020817-DUP	2/8/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-19ds	CMW19DS-050917	5/9/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-19ds	CMW19DS-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-19ds	CMW19DS-110717	11/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	CMW-20ds	CMW20DS-080717	8/7/2017	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Upper	EW-3	EW-3-0817	8/7/2017	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20

Table C-1
Groundwater Analytical Results - (µg/L)
1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County

TSA Zone	Monitoring Well ID	Sample ID	Sample Date	Trichloroethene (TCE)	Tetrachloroethene (PCE)	cis-1,2-Dichloroethene	1,1-Dichloroethene	Vinyl Chloride
Vapor Monitoring Wells								
Upper	VMW-A	VMWA-020817	2/8/2017	**5.07**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	VMW-A	VMWA-050917	5/9/2017	**12.3**	< 1.00	**1.58**	< 1.00	< 1.00
Upper	VMW-A	VMWA-080817	8/8/2017	**18.7**	< 1.00	**2.18**	< 1.00	< 1.00
Upper	VMW-A	VMWA-110717	11/7/2017	**14.9**	< 1.00	**1.34**	< 1.00	< 1.00
Upper	VMW-B	VMWB-020817	2/8/2017	**5.21**	< 1.00	**1.97**	< 1.00	< 1.00
Upper	VMW-B	VMWB-050917	5/9/2017	**17.1**	< 1.00	**1.85**	< 1.00	< 1.00
Upper	VMW-B	VMWB-080817	8/8/2017	**18.8**	< 1.00	**2.54**	< 1.00	< 1.00
Upper	VMW-B	VMWB-110717	11/7/2017	**10.3**	< 1.00	**1.30**	< 1.00	< 1.00
Upper	VMW-C	VMWC-020817	2/8/2017	**23.9**	< 1.00	**4.18**	< 1.00	< 1.00
Upper	VMW-C	VMWC-050917	5/9/2017	**22.4**	< 1.00	**2.88**	< 1.00	< 1.00
Upper	VMW-C	VMWC-080817	8/8/2017	**21.2**	**1.47**	**3.42**	< 1.00	< 1.00
Upper	VMW-C	VMWC-110717	11/7/2017	**28.8**	**1.86**	**1.83**	< 1.00	< 1.00
Upper	VMW-D	VMWD-020817	2/8/2017	**26.1**	< 1.00	**3.36**	< 1.00	< 1.00
Upper	VMW-D	VMWD-050917	5/9/2017	**5.02**	< 1.00	< 1.00	< 1.00	< 1.00
Upper	VMW-D	VMWD-080817	8/8/2017	**23.3**	< 1.00	**3.02**	< 1.00	< 1.00
Upper	VMW-D	VMWD-110717	11/7/2017	**25.1**	**1.03**	**2.39**	< 1.00	< 1.00

Notes:

Results are presented in micrograms per liter (µg/L)

BOP = wells installed by and /or on Boeing Corporation Property

CMW = monitoring wells installed by and/or on Cascade Corporation property.

< = compound not detected above the reporting limit shown.

Bold value indicates detection above method detection limit.

Sample ID with "DUP" indicates duplicate sample.

Sample ID with "U" indicates sample collected from the upper portion of the screened interval.

Sample ID with "L" indicates sample collected from the lower portion of the screened interval.

Samples analyzed using EPA Method 8260 and results shown above have been validated with applicable qualifiers shown.

Laboratory and validation reports for above listed samples are presented on a disc in Appendix F.

N/A = not applicable

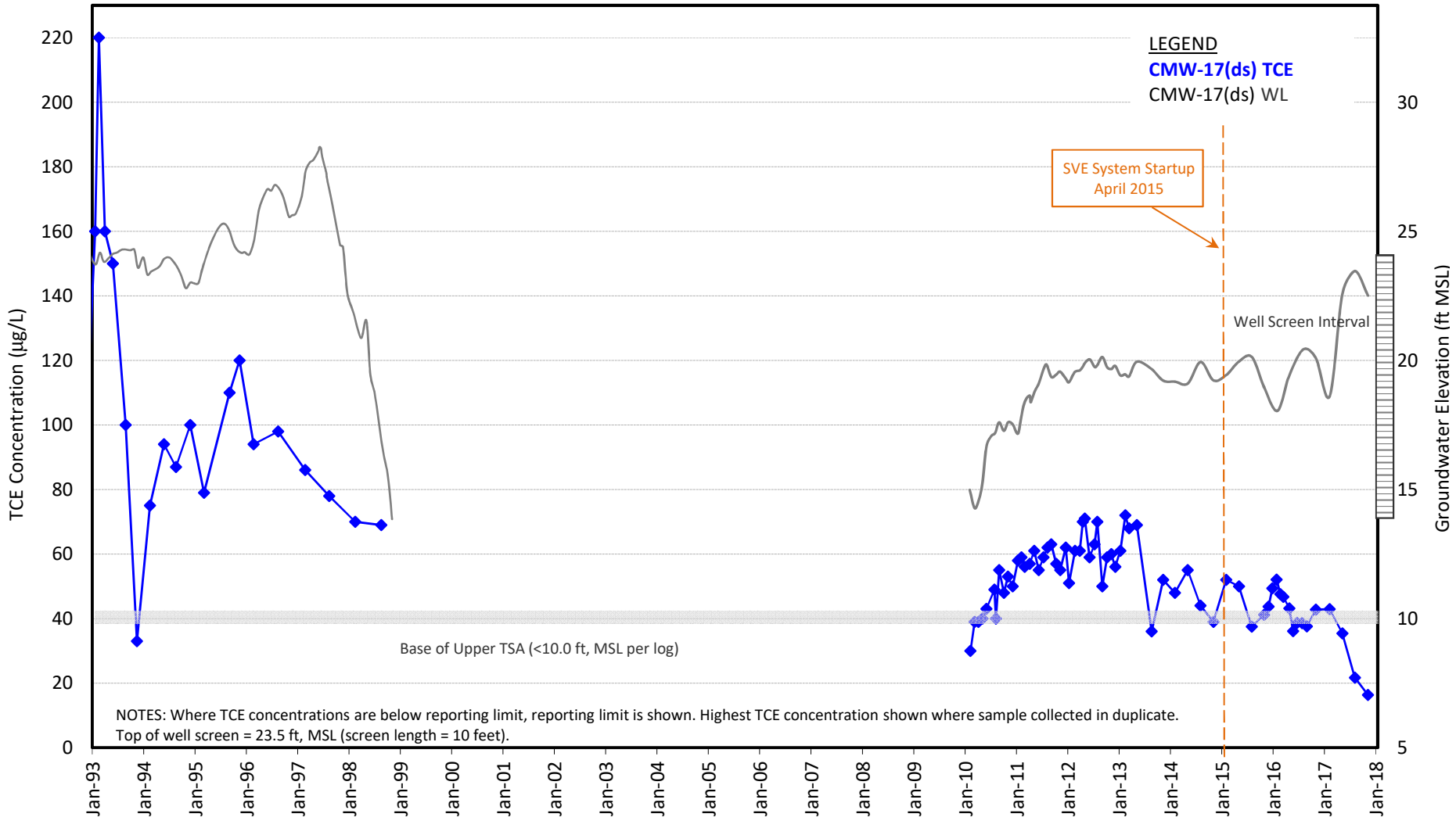
Table C-2
TCE Mass Removal - January 1998 through December 2017
TSA Remedy - East Multnomah County

Date	Pounds of TCE Removed Per Year	Cumulative Pounds of TCE Removed
Jan-98	0.00	0.00
Aug-98	116.00	116.00
Feb-00	110.00	226.00
Feb-01	55.00	281.00
Feb-02	51.20	332.20
Feb-03	32.30	364.50
Feb-08	81.00	445.50
Feb-09	8.10	453.60
Feb-10	6.11	459.71
Feb-11	4.59	464.30
Feb-12	5.48	469.79
Feb-13	7.17	476.96
Dec-13	3.39	480.35
Dec-14	3.46	483.81
Dec-15	2.98	486.80
Dec-16	3.25	490.04
Dec-17	2.53	492.58

Table C-3
TCE Mass Removal Per Extraction Well
TSA Remedy - East Multnomah County

Date	Pounds of TCE Removed Per Well										
	EW-1	EW-2	EW-3	EW-13	EW-14	EW-15	EW-16	EW-18	EW-22	EW-23	Total
Mar 2008-Feb 2009	1.02	2.03	1.54	0.47	1.69	0.60	0.08	0.13	0.12	0.43	8.10
Mar 2009-Feb 2010	0.68	1.93	1.07	0.20	1.52	0.21	0.04	0.08	0.00	0.38	6.11
Mar 2010-Feb 2011	0.79	1.70			1.41	0.03	0.05			0.61	4.59
Mar 2011-Feb 2012	1.86	1.60			1.58		0.00			0.46	5.48
Mar 2012-Feb 2013	1.72	3.10			1.36		0.22			0.77	7.17
Mar 2013-Dec 2013	0.80	1.34			0.83		0.05			0.37	3.39
2014	0.68	1.41			0.82		0.10			0.44	3.46
2015	0.60	1.22			0.74		0.00			0.43	2.98
2016	0.87	1.42			0.70		0.00			0.26	3.25
2017	0.67	0.98			0.60		0.00			0.28	2.53

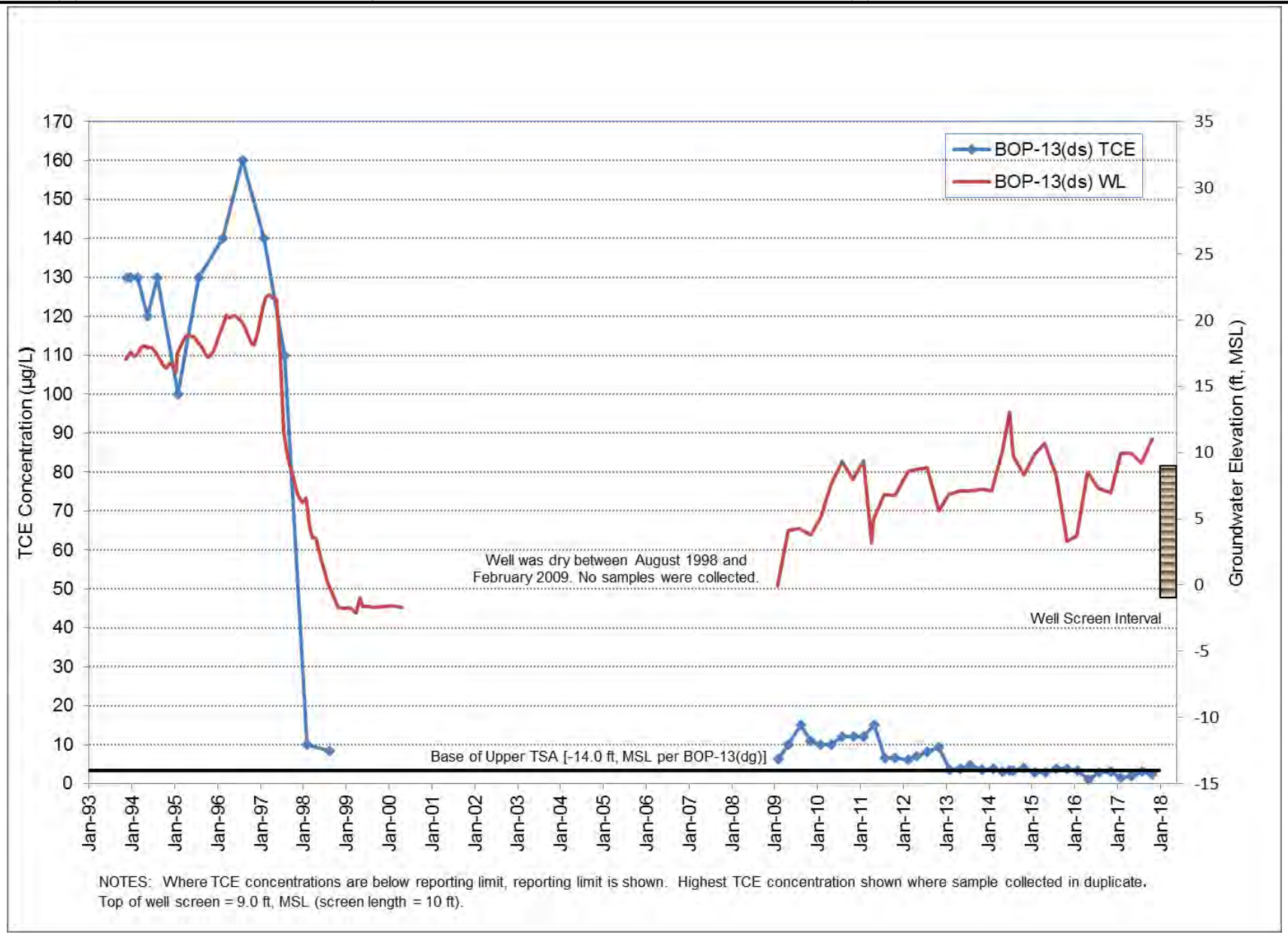
Notes
The amount of TCE removed by the extraction wells in the remedial systems was calculated by multiplying average monthly flow rates at each extraction well by estimated



NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.
Top of well screen = 23.5 ft, MSL (screen length = 10 feet).

Geosyntec consultants

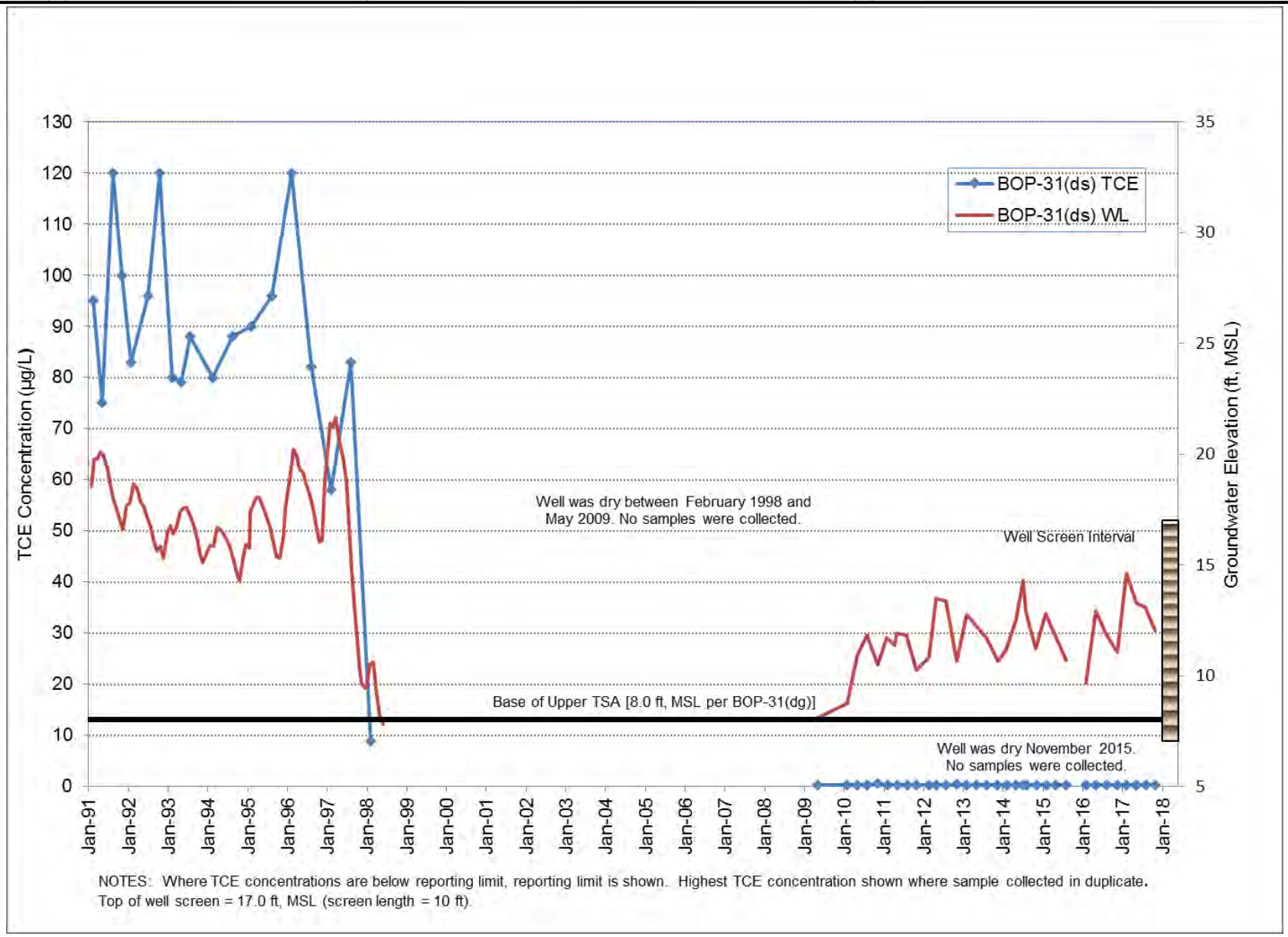
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-17(ds) TSA Remedy**	Figure C-1



NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.
Top of well screen = 9.0 ft, MSL (screen length = 10 ft).

Boeing Portland Gresham, Oregon	**BOP-13(ds) TCE Concentration Profile TSA Remedy – East Multnomah County**	Figure C-2

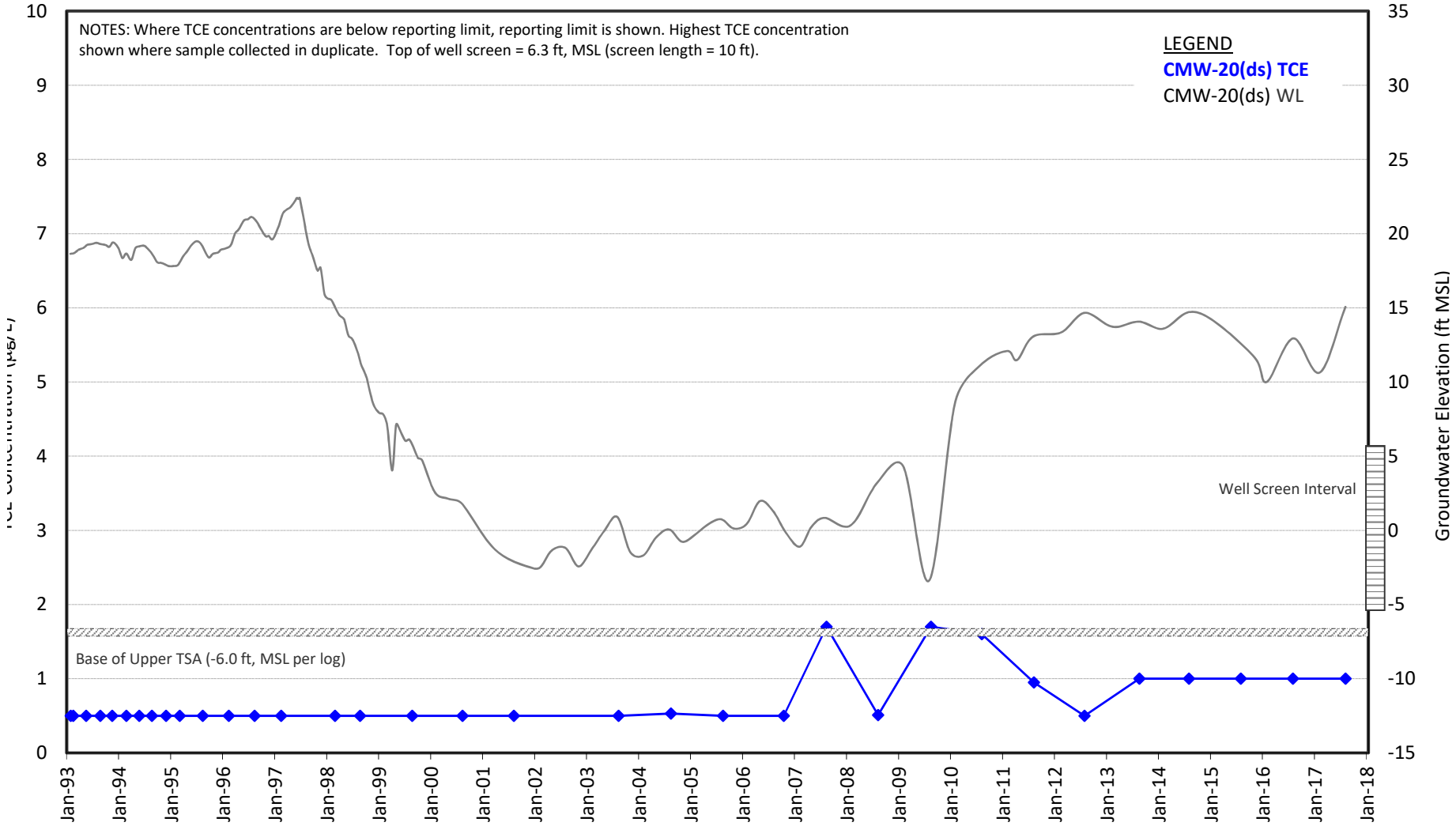
LANDAU ASSOCIATES



NOTES: Where TCE concentrations are below reporting limit, reporting limit is shown. Highest TCE concentration shown where sample collected in duplicate.
Top of well screen = 17.0 ft, MSL (screen length = 10 ft).

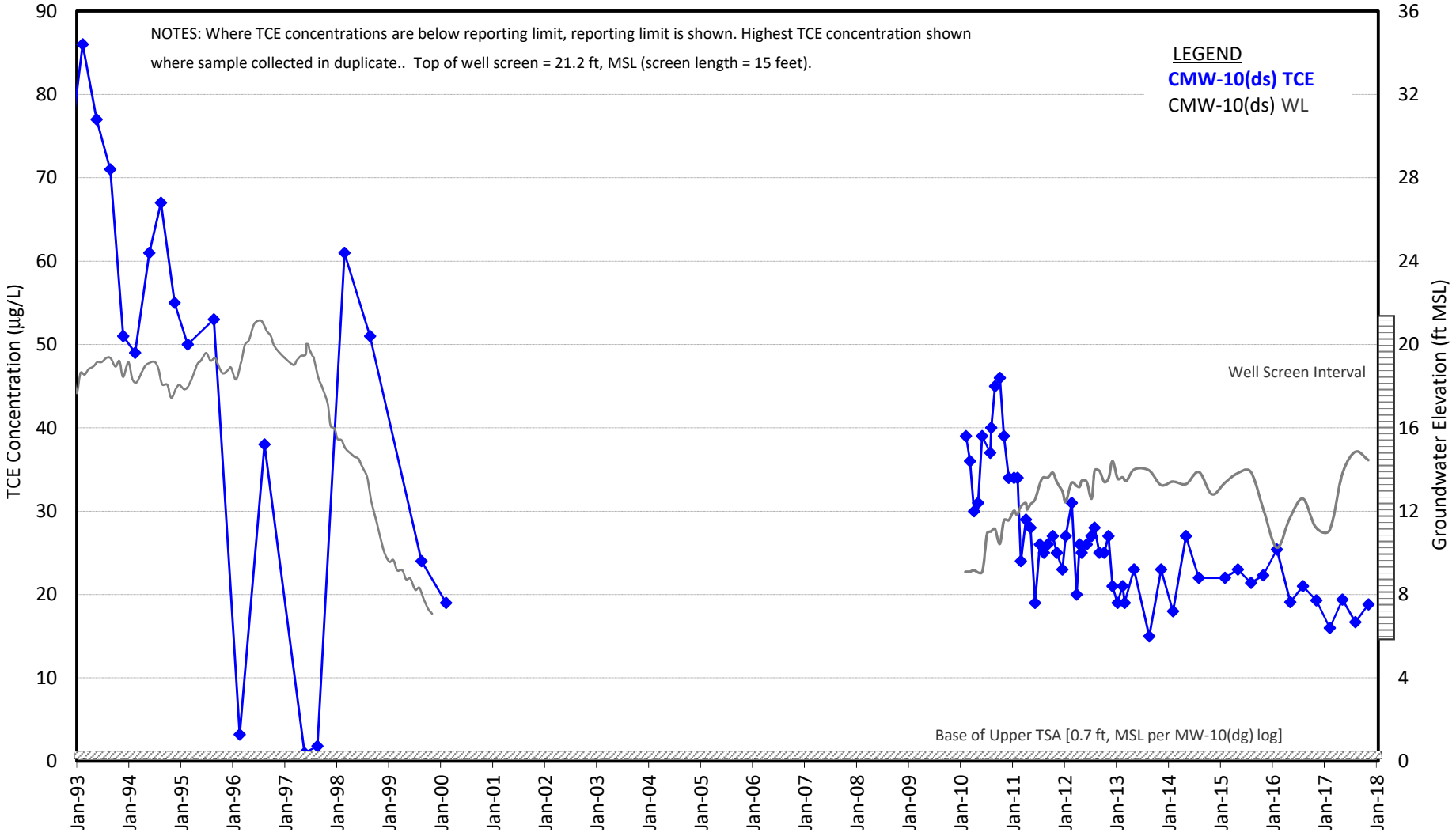
Boeing Portland Gresham, Oregon	**BOP-31(ds) TCE Concentration Profile TSA Remedy – East Multnomah County**	Figure C-3

LANDAU ASSOCIATES



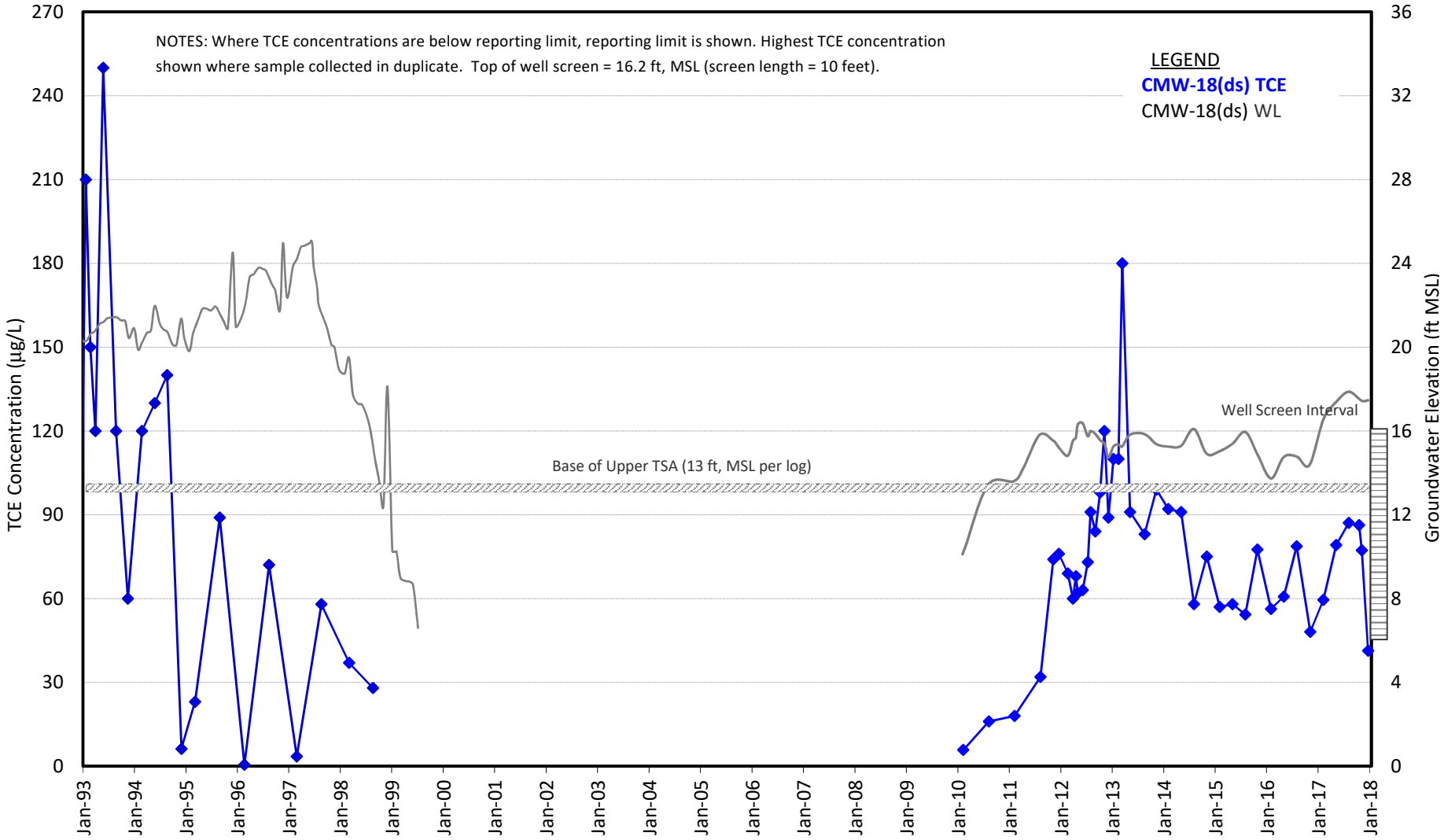
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-20(ds)** **TSA Remedy**	Figure C-4



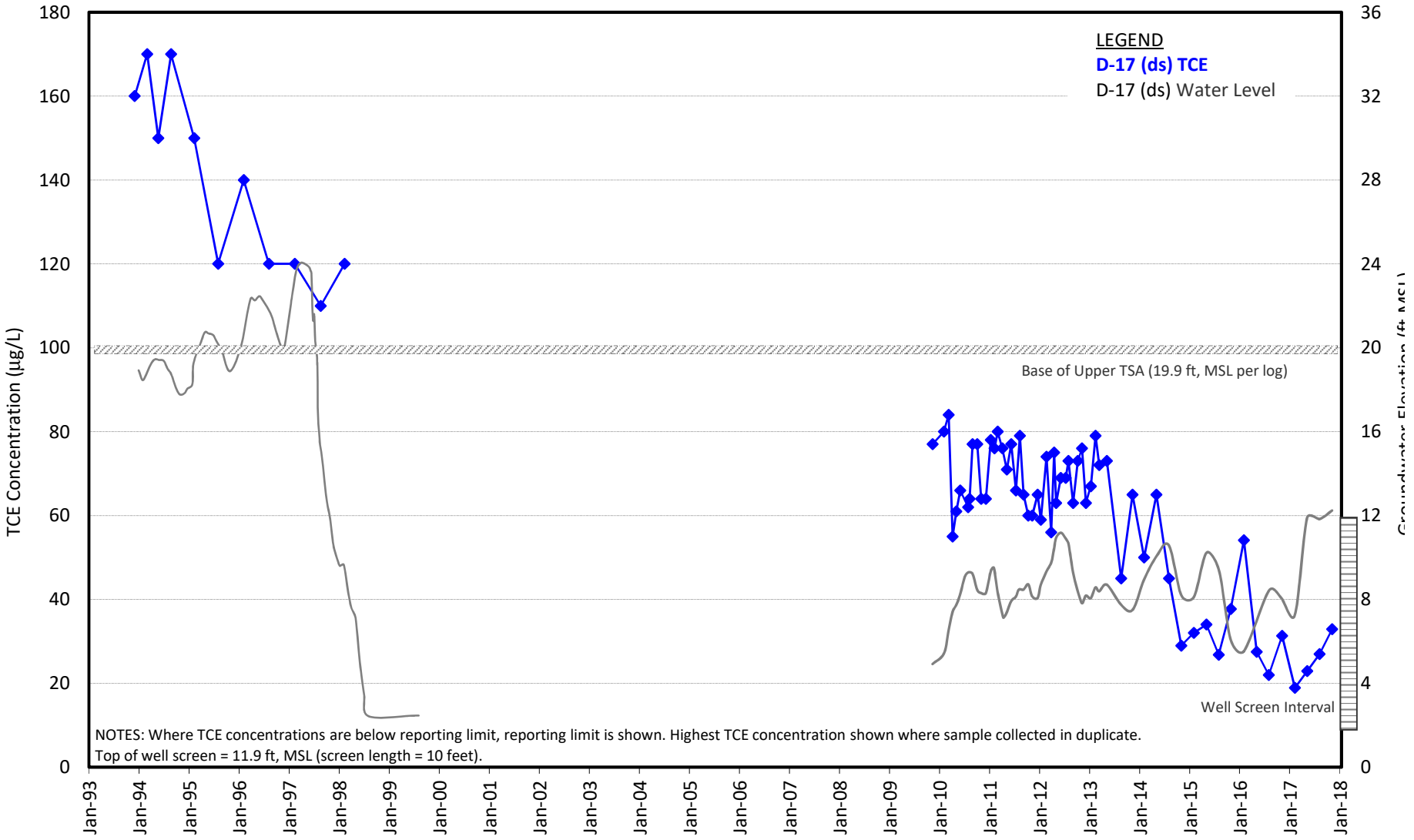
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-10(ds)** **TSA Remedy**	Figure C-5



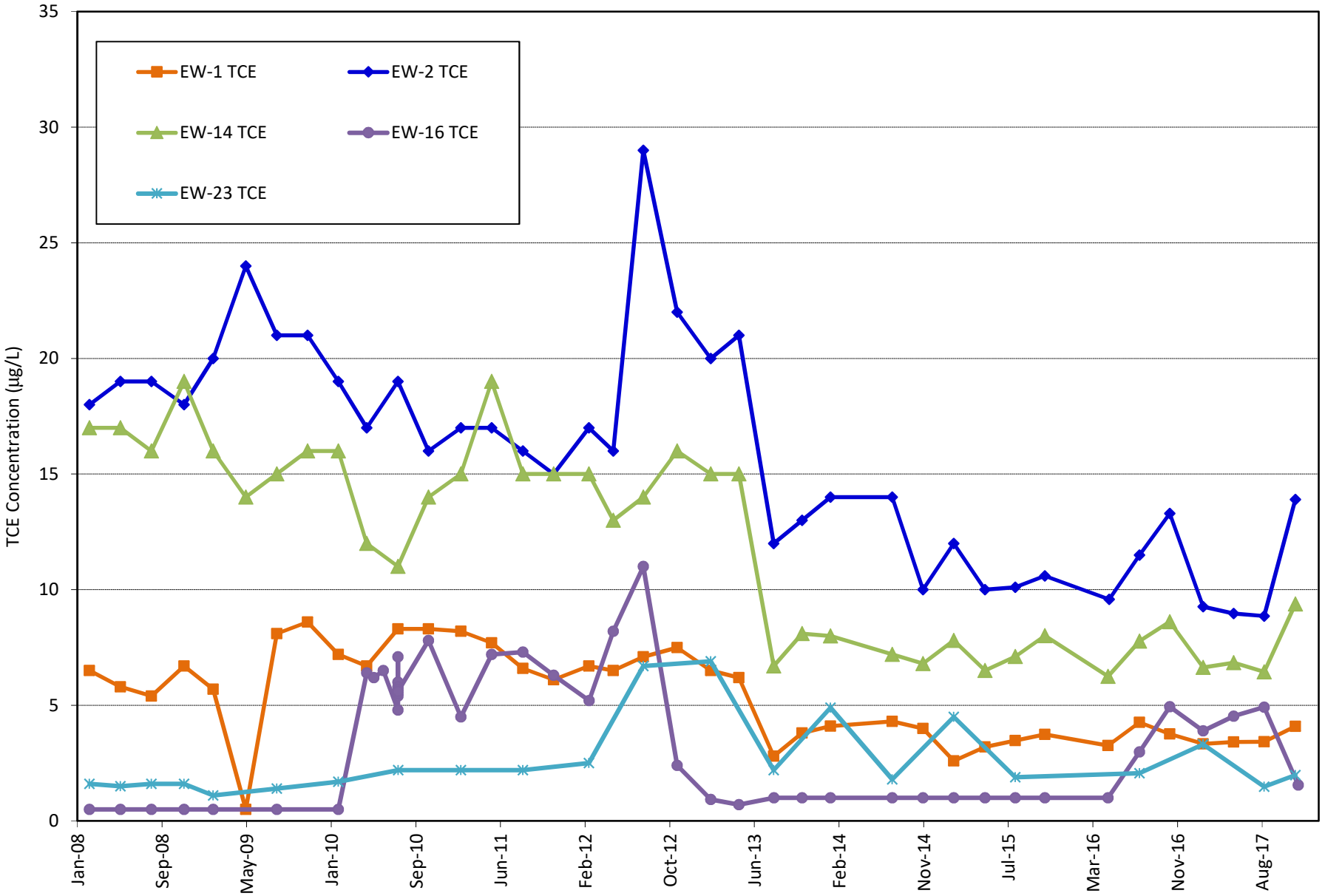
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**TCE Concentration Profile CMW-18(ds)** **TSA Remedy**	Figure C-6



Geosyntec consultants

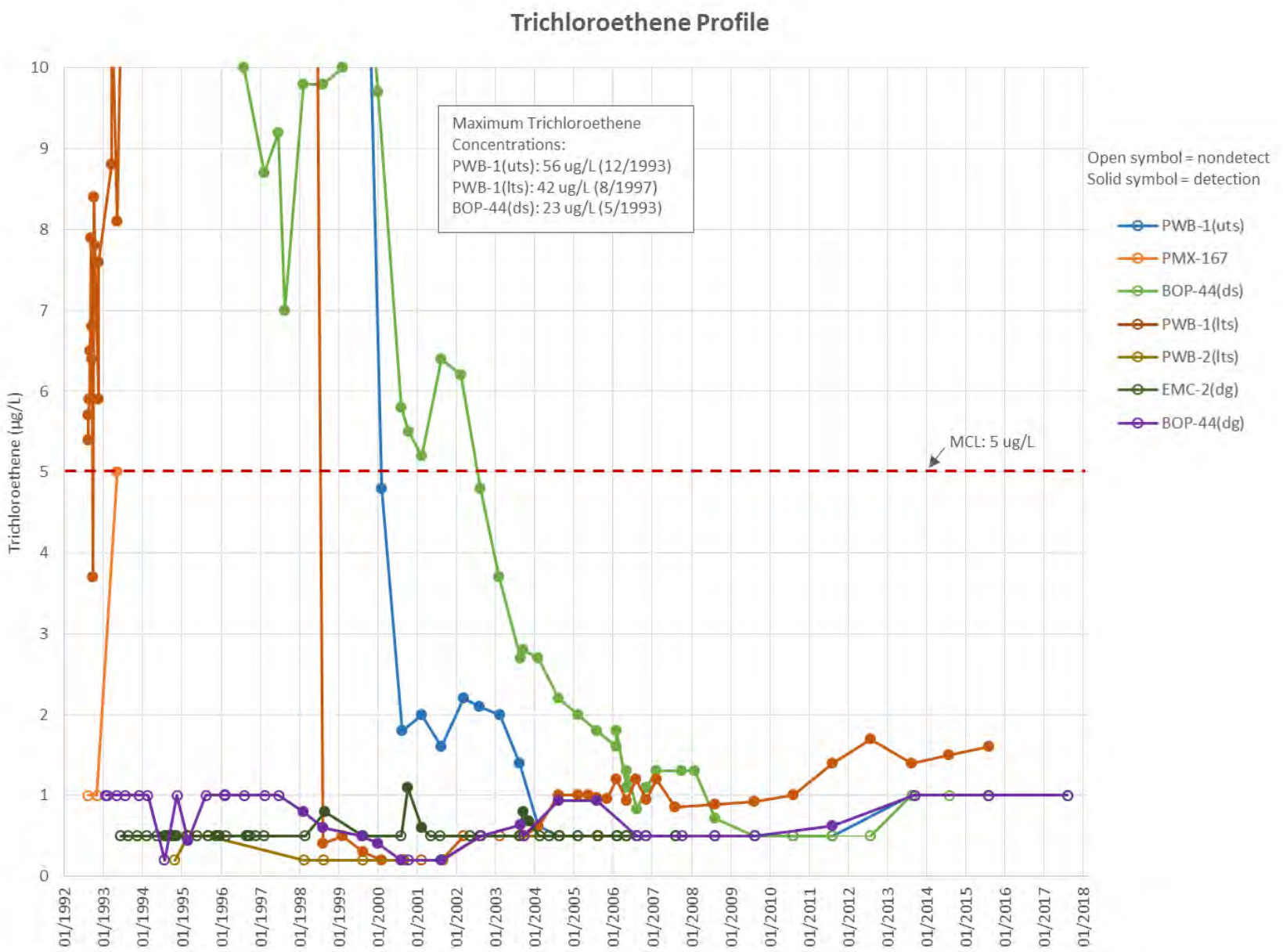
Cascade Corporation Gresham, Oregon	**TCE Concentration Profile D-17(ds)** **TSA Remedy**	Figure C-7



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**Operating Extraction Wells TCE Concentration Profiles TSA Remedy**	Figure C-8

VOC charts_ FigsC1 and C4toC8-12312017

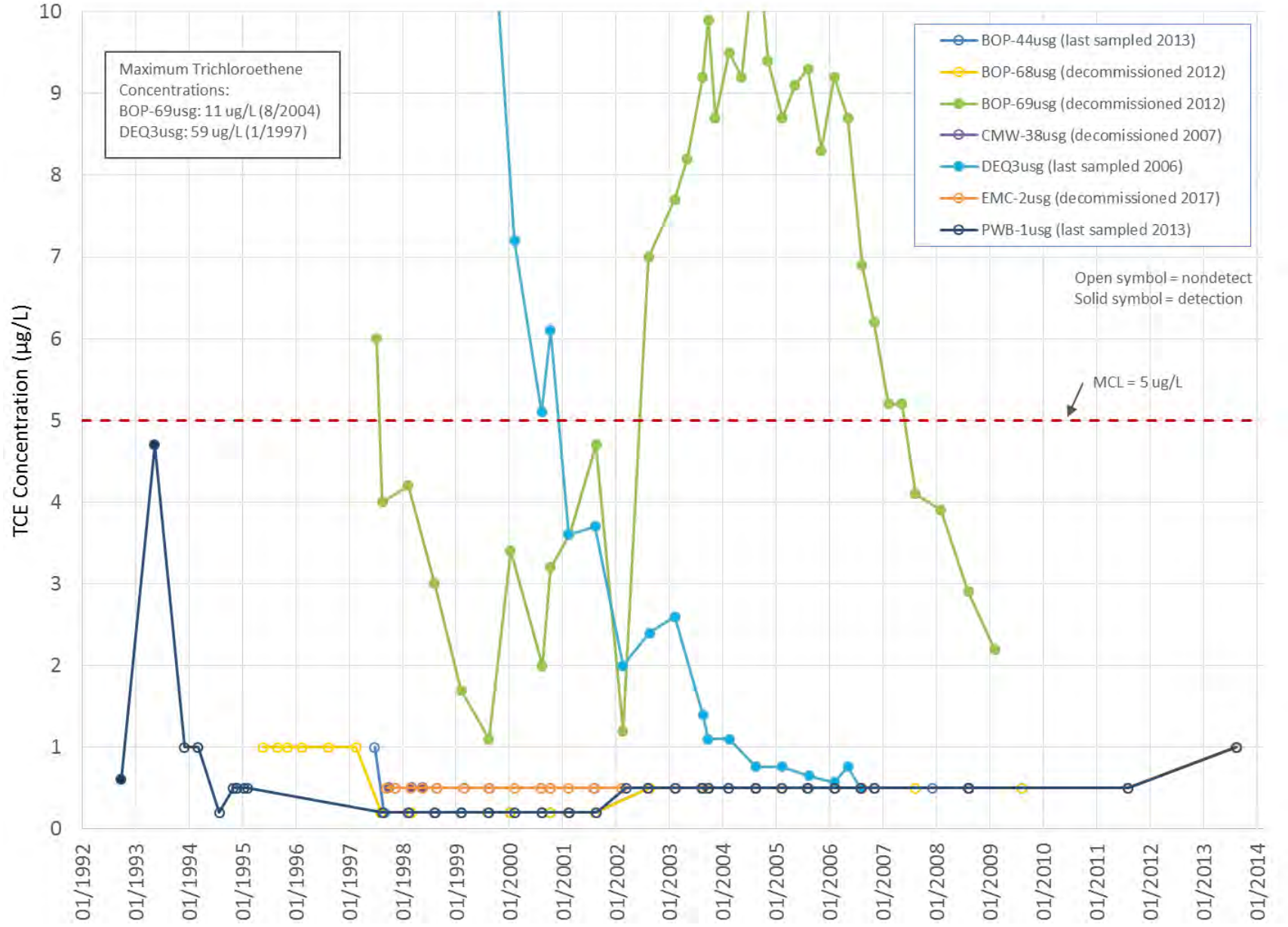


LANDAU ASSOCIATES

East Multnomah County Remedy

Zone A TCE Profiles

Figure
C-9

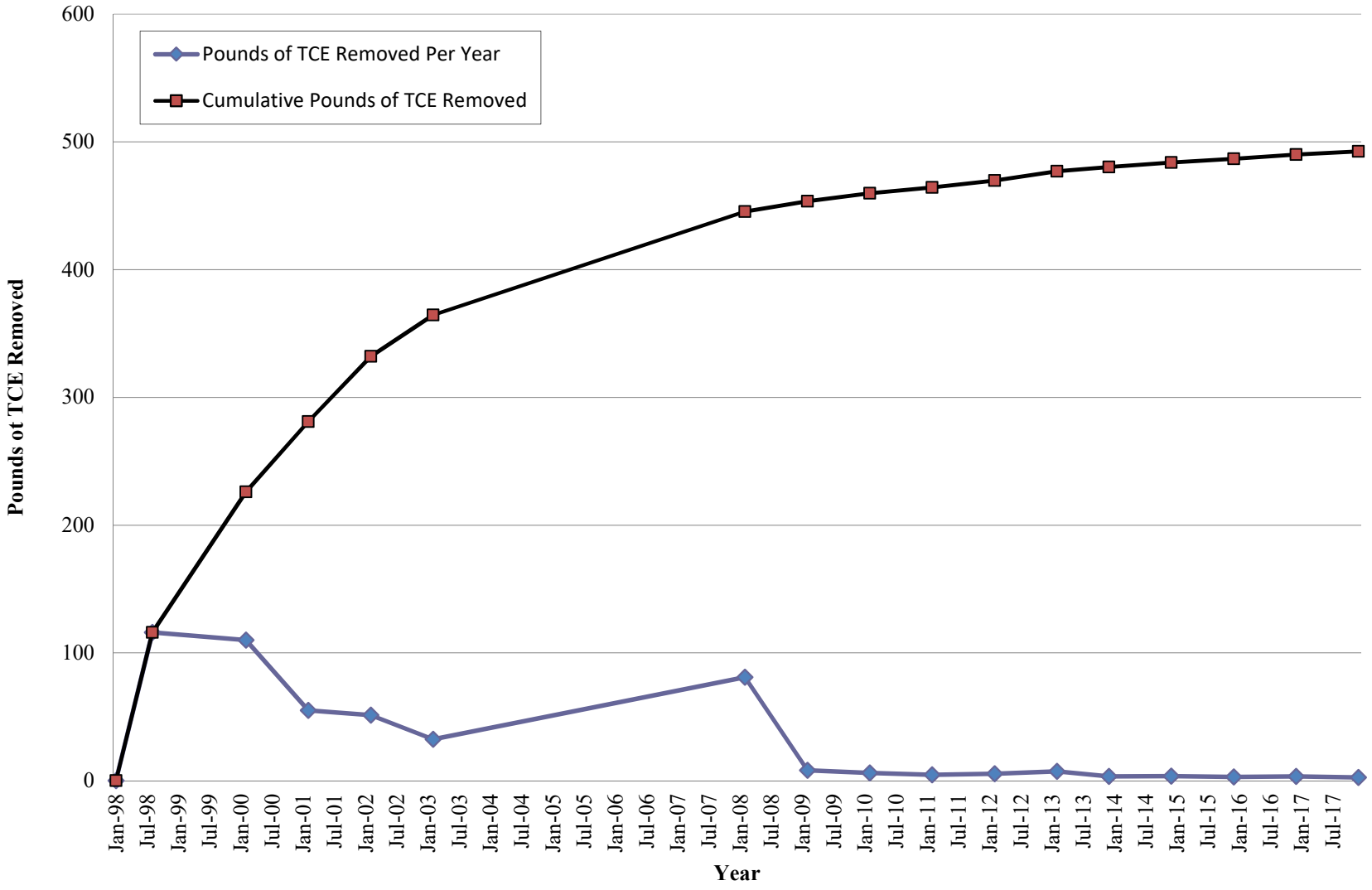


LANDAU ASSOCIATES

East Multnomah County Remedy

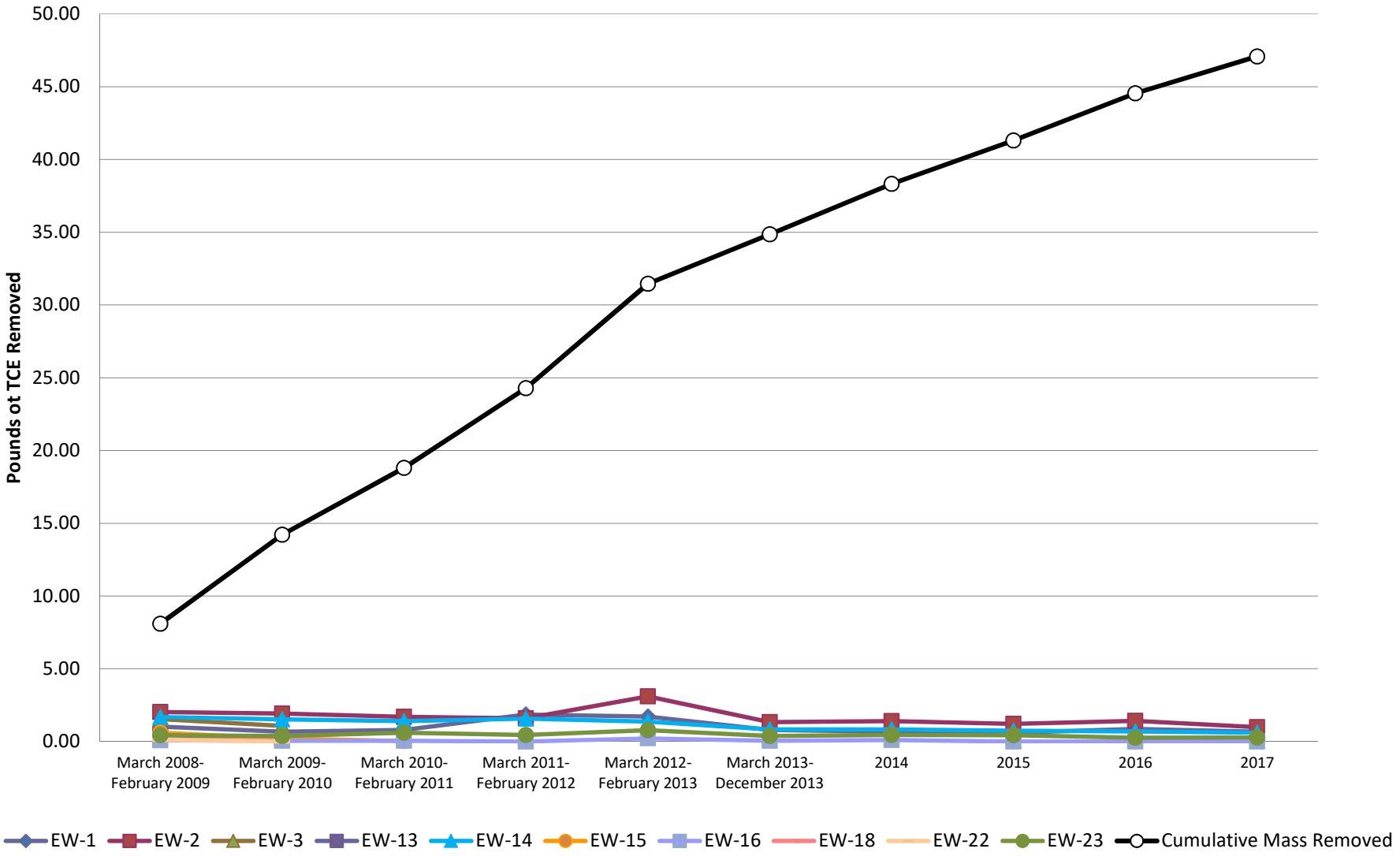
TCE Profiles for SGA Wells

Figure
C-10



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**TCE Mass Removal** **TSA Remedy**	Figure C-11



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**TCE Mass Removal per Extraction Well TSA Remedy**	Figure C-12

APPENDIX D

Well Decommissioning

LOG OF EXPLORATORY BORING

PROJECT NAME	Cascade Corporation	BORING NO.	EMC-2(usg)
LOCATION	Troutdale, Oregon	PAGE	1 OF 5
DRILLED BY	Staco Well Services	GROUND ELEV.	52.9'
DRILL METHOD	Air Rotary	TOTAL DEPTH	175.00'
LOGGED BY	Bob Williams	DATE COMPLETED	09/11/97

SAMPLE NUMBER	SAMPLE TYPE	GROUND WATER LEVELS	DEPTH IN FEET	SAMPLES	WELL DETAILS	LITHOLOGIC COLUMN	LITHOLOGIC DESCRIPTION
1	C						**0 to 19.0 feet: SILT (ML),** light brown with orange mottling, nonplastic, micaceous, trace rounded, medium to coarse, well-graded basaltic sand, damp. (ALLUVIUM)
2	C		5				
3	C		10				
			15				
4	C		20				**19.0 to 49.0 feet: SAND (SW),** black, basaltic clasts, fine to coarse, well graded, rounded grains with quartz and red basalt clasts, poorly to well cemented with light brown to yellow-green palagonitic cement; moist to wet. (TROUTDALE SANDSTONE AQUIFER - SANDSTONE)
5	C		25				@ 25.0 feet: becomes well cemented.
6	C		30				@ 30.0 feet: becomes poorly cemented.
							@ 34.0 feet: becomes well cemented.
7	C	▽ 8/29/97	35				
			40				

REMARKS

(1) C = cutting sample collected with fine-mesh sieve. (2) Water samples collected at 157 feet and 175 feet. (3) Open triangle = approximate depth at which water was encountered during drilling. Black triangle = water level in completed well. (4) Borehole was drilled with an air rotary rig; 10-inch bit, threaded casing to 155 feet, open hole to 175 feet.

LOG OF EXPLORATORY BORING

PROJECT NAME	Cascade Corporation	BORING NO.	EMC-2(usg)
LOCATION	Troutdale, Oregon	PAGE	2 OF 5
DRILLED BY	Staco Well Services	GROUND ELEV.	52.9'
DRILL METHOD	Air Rotary	TOTAL DEPTH	175.00'
LOGGED BY	Bob Williams	DATE COMPLETED	09/11/97

SAMPLE NUMBER	SAMPLE TYPE	GROUND WATER LEVELS	DEPTH IN FEET	SAMPLES	WELL DETAILS	LITHOLOGIC COLUMN	LITHOLOGIC DESCRIPTION
8	C	▼ 9/11/97					19.0 to 49.0 feet: **SAND (SW)**, continued.
9	C		45				
10	C		50				**49.0 to 130.0 feet; SANDY GRAVEL (GW)**, black, basaltic, white to light yellowish brown and red quartzitic, fine to coarse, well graded, rounded, some vesicular clasts with black, basaltic sand and light yellowish brown quartzitic, and micaceous sand, fine to coarse, subrounded to rounded, moderately to well cemented with palagonite cement, trace silt; wet. (TROUTDALE SANDSTONE AQUIFER - CONGLOMERATE)
11	C		55				@ 55.0 feet: sandstone decreasing.
12	C		60				
13	C		65				@ 65.0 feet: borehole stays open - formation well cemented.
14	C		70				@ 68.0 feet: increasing brown silt content.
15	C		75				@ 70.0 to 75.0 feet: becomes moderately cemented, increased black, fine to coarse sand and brown silt.
			80				

REMARKS

(1) C = cutting sample collected with fine-mesh sieve. (2) Water samples collected at 157 feet and 175 feet. (3) Open triangle = approximate depth at which water was encountered during drilling. Black triangle = water level in completed well. (4) Borehole was drilled with an air rotary rig; 10-inch bit, threaded casing to 155 feet, open hole to 175 feet.

LOG OF EXPLORATORY BORING

PROJECT NAME	Cascade Corporation	BORING NO.	EMC-2(usg)
LOCATION	Troutdale, Oregon	PAGE	3 OF 5
DRILLED BY	Staco Well Services	GROUND ELEV.	52.9'
DRILL METHOD	Air Rotary	TOTAL DEPTH	175.00'
LOGGED BY	Bob Williams	DATE COMPLETED	09/11/97

SAMPLE NUMBER	SAMPLE TYPE	DEPTH IN FEET	LITHOLOGIC DESCRIPTION
16	C		**49.0 to 130.0 feet; SANDY GRAVEL (GW)**, continued.
			@ 80.0 feet: becomes well cemented.
17	C	85	
18	C	90	@ 90.0 feet: becomes moderately cemented.
			@ 93.0 feet: water production is approximately 10 gpm.
19	C	95	
20	C	100	
21	C	105	
22	C	110	
			@ 113.0 to 130.0 feet: increasing black, basaltic, and light yellowish brown quartzitic sand, fine to coarse, well graded.
23	C	115	
		120	

REMARKS

(1) C = cutting sample collected with fine-mesh sieve. (2) Water samples collected at 157 feet and 175 feet. (3) Open triangle = approximate depth at which water was encountered during drilling. Black triangle = water level in completed well. (4) Borehole was drilled with an air rotary rig; 10-inch bit, threaded casing to 155 feet, open hole to 175 feet.

LOG OF EXPLORATORY BORING

PROJECT NAME	Cascade Corporation	BORING NO.	EMC-2(usg)
LOCATION	Troutdale, Oregon	PAGE	4 OF 5
DRILLED BY	Staco Well Services	GROUND ELEV.	52.9'
DRILL METHOD	Air Rotary	TOTAL DEPTH	175.00'
LOGGED BY	Bob Williams	DATE COMPLETED	09/11/97

SAMPLE NUMBER	SAMPLE TYPE	DEPTH IN FEET	LITHOLOGIC DESCRIPTION
24	C		**49.0 to 130.0 feet; SANDY GRAVEL (GW),** continued.
25	C	125	
26	C	130	**130.0 to 148.5 feet: INTERBEDDED SILTSTONE, SANDSTONE, and CONGLOMERATE (ML/SW/GW),** clayey siltstone is light brown to gray; black basaltic to yellowish-white quartzitic, micaceous sand, very fine to coarse-grained, subangular to rounded grains; gravel has clasts of dark basalt and white to yellow quartz, subrounded to rounded. (CONFINING UNIT 2 EQUIVALENT)
27	C		
28	C	135	
29	C		@ 130.0 feet: primarily light brown siltstone (80 percent fines, 10 percent sand, 10 percent gravel).
30	C	140	@ 132.0 feet: conglomerate and sand increase as siltstone decreases; siltstone changes color from light brown to light gray (5 percent fines, 40 percent sand, 50 percent gravel).
31	C		@ 135.0 feet: increase in percentage of light gray siltstone and clayey, silty, very fine-grained and micaceous sandstone (10 percent fines, 20 percent sand, 70 percent gravel).
32	C	145	
33	C		@ 137.5 feet: decrease in very fine sandstone and increase in coarse sand; primarily gravel; water production at 50 gpm (10 percent fines, 20 percent sand, 70 percent gravel).
34	C		
35	C	150	@ 140.0 to 143.0 feet: primarily gravel and fine to coarse sand with trace fine grained silty sandstone (50 percent sand, 50 percent gravel).
36	C		@ 144.0 feet: percentage of fine sandstone increases; light gray (10 percent fines, 40 percent sand, 50 percent gravel).
		155	
37	C		@ 147.0 feet: fine sandstone becomes more indurated, light brown to yellowish green (50 percent sand, 50 percent gravel).
		160	@ 148.0 feet: thin zone of light gray siltstone; increased amount of cemented sandstone on gravel clasts

GROUND WATER LEVELS | SAMPLES | WELL DETAILS | LITHOLOGIC COLUMN

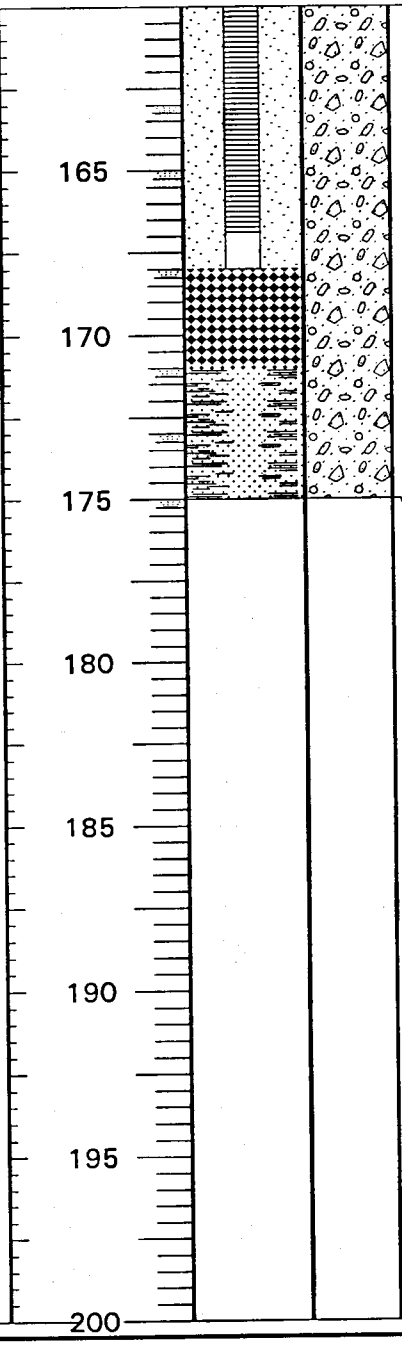
REMARKS

(1) C = cutting sample collected with fine-mesh sieve. (2) Water samples collected at 157 feet and 175 feet. (3) Open triangle = approximate depth at which water was encountered during drilling. Black triangle = water level in completed well. (4) Borehole was drilled with an air rotary rig; 10-inch bit, threaded casing to 155 feet, open hole to 175 feet.

LOG OF EXPLORATORY BORING

PROJECT NAME	Cascade Corporation	BORING NO.	EMC-2(usg)
LOCATION	Troutdale, Oregon	PAGE	5 OF 5
DRILLED BY	Staco Well Services	GROUND ELEV.	52.9'
DRILL METHOD	Air Rotary	TOTAL DEPTH	175.00'
LOGGED BY	Bob Williams	DATE COMPLETED	09/11/97

SAMPLE NUMBER	SAMPLE TYPE
38	C
39	C
40	C
41	C
42	C
43	C



(10 percent fines, 40 percent sand, 50 percent gravel).

148.5 to 175.0 feet: SANDY GRAVEL (GW), black basaltic and light yellowish brown quartzitic gravel, fine to coarse, well graded, subangular to rounded with black to light brown-yellow basaltic and quartzitic sand, subangular to rounded, fine to medium, well graded, moderate to well cemented, trace brown silt. (SAND AND GRAVEL AQUIFER)

@ 157.0 feet: increased percentage of sand.

@ 165.0 feet: increased percentage of sand.

@ 172.0 feet: decreasing cementation.

@ 175.0 feet: water production up to 75 gpm with 20 feet of open hole.

Total depth drilled = 175.0 feet.
Total depth sampled = 175.0 feet.

WELL COMPLETION DETAILS:

0 to 157.0 feet: 4-inch-diameter, flush-threaded, Schedule 40 PVC blank riser pipe.
157.0 to 167.0 feet: 4-inch-diameter, flush-threaded, Schedule 40 PVC well screen with 0.040-inch, machine-cut, slots.
167.0 to 168.0 feet: 4-inch-diameter, Schedule 40 PVC sump.

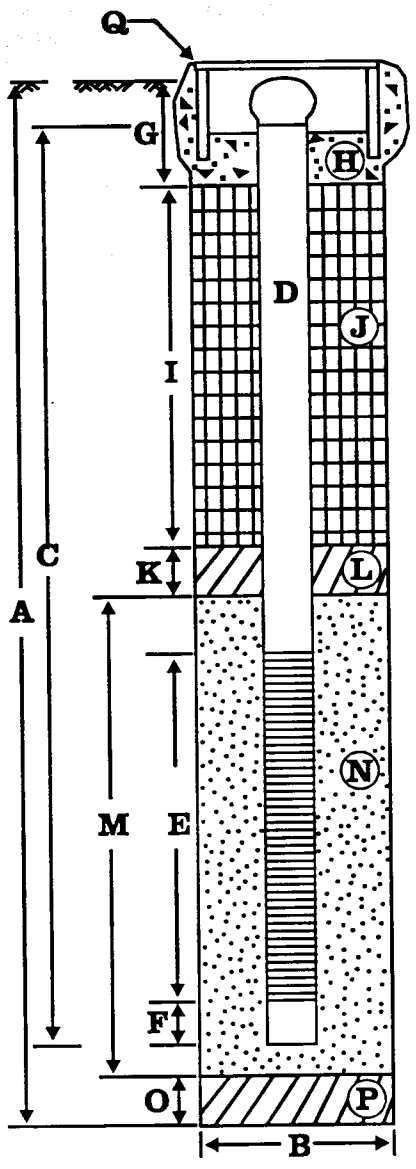
0 to 3.0 feet: 3/8-inch bentonite chips hydrated with potable water.
3.0 to 153.0 feet: Bentonite grout.
153.0 to 155.0 feet: 20 mesh sand.
155.0 to 168.0 feet: 8 - 12 mesh silica sand.
168.0 to 171.0 feet: 3/8-inch bentonite chips.
171.0 to 175.0 feet: Slough (native material).

REMARKS

(1) C = cutting sample collected with fine-mesh sieve. (2) Water samples collected at 157 feet and 175 feet. (3) Open triangle = approximate depth at which water was encountered during drilling. Black triangle = water level in completed well. (4) Borehole was drilled with an air rotary rig; 10-inch bit, threaded casing to 155 feet, open hole to 175 feet.

WELL DETAILS

Project Number:	40683-008.027 Task 6	Boring/Well No.:	EMC-2(usg)
Client Name:	Cascade Corporation	Top of Casing Elev.:	54.93
Project Name:	TSA Remedy	Ground Surface Elev.:	52.9
Location:	Troutdale, Oregon	Installation Date:	9/11/97
Driller:	Staco Well Services	Permit/Start Card No.:	104252



	Depth (ft, bgs)	Elev. (ft, msl)
	0.0	52.9
	3.0	49.9
	153.0	-100.1
	155.0	-102.1
	157.0	-104.1
	167.0	-114.1
	168.0	-115.1
	168.0	-115.1
	175.0	-122.1

Installed by: Bob Williams

Reviewed by: Eric Tuppan

Date: 10/10/1997

EXPLORATORY BORING

A. Total depth:	175 ft.
B. Diameter:	10 in.
Drilling method:	Air Rotary

WELL CONSTRUCTION

C. Well casing length:	168 ft.
Well casing material:	Schedule 80 PVC
D. Well casing diameter:	4 in.
E. Well screen length:	10 ft.
Well screen type:	MS PVC
Well screen slot size:	0.040 in.
F. Well sump/end cap length:	1.0 ft.
G. Surface seal thickness:	3 ft.
H. Surface seal material:	Bentonite chips
I. Annular seal thickness:	153 ft.
J. Annular seal material:	Bentonite grout
K. Filter pack seal thickness:	2 ft.
L. Filter pack seal material:	#20 Silica sand
M. Sand pack thickness:	13 ft.
N. Sand pack material:	8-12 Silica sand
O. Bottom material thickness:	3 ft.
P. Bottom material:	Bentonite+slough
Q. Vault box type:	Flush mount
Well centralizer depths:	37 ft.
	77 ft.
	117 ft.
	157 ft.
	167 ft.

NOTES: MS PVC = machine slotted polyvinyl chloride.
Bottom material includes bentonite chips from 168.0 to 171.0 and native material slough from 171.0 to 175.0 ft.

PJ:\GEOLOGY\CASCADE\0683-008.027\EMC2DTAL.DOC\RKW

APPENDIX E

SVE Data

Table E-1
Soil Vapor Extraction 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County Oregon

Well ID	Date	Time (hrs)	Temperature (degrees F)	Flow Rate (scfm)	PID Measurement (ppm)	Calculated VOC Concentrations (µg/L)
Soil Vapor Extraction Outlet Well						
SVE System Outlet	01/03/17	7:40	105	475.0	1.9	11.11
SVE System Outlet	01/10/17	11:00	100.3	462.8	1.3	7.60
SVE System Outlet	01/16/17			440.0	0.7	4.09
SVE System Outlet	01/25/17	10:40	115	495.0		
SVE System Outlet	01/31/17	15:00	110	460.0	1.1	6.43
SVE System Outlet	02/07/17	10:15	120	480.0	1.2	7.01
SVE System Outlet	02/15/17	9:30	110	450.0	2.1	12.28
SVE System Outlet	02/21/17	8:10	118	470.5	1.2	7.01
SVE System Outlet	02/27/17	11:40	112	475.3	1.1	6.43
SVE System Outlet	03/07/17	14:30	118	465.0	1.0	5.85
SVE System Outlet	03/13/17	14:30	118	460.0		
SVE System Outlet	03/21/17	8:20	115	445.0	0.7	4.09
SVE System Outlet	03/28/17	8:30	130	440.0	0.9	5.26
SVE System Outlet	04/04/17	14:00	110	430.7	0.9	5.26
SVE System Outlet	04/11/17	12:20	112	435.0	0.8	4.68
SVE System Outlet	04/17/17		110	425.2	0.8	4.68
SVE System Outlet	04/25/17	13:50	115	430.6	0.7	4.09
SVE System Outlet	05/02/17	15:50	120	427.0	0.8	4.68
SVE System Outlet	05/08/17	12:00	130	430.2	0.7	4.09
SVE System Outlet	05/15/17	11:20	120	423.5	0.6	3.51
SVE System Outlet	05/22/17	9:45	120	430.6	0.7	4.09
SVE System Outlet	05/30/17	8:45	115	437.7	0.6	3.51
SVE System Outlet	06/06/17	7:45	124	434.4	0.7	4.09
SVE System Outlet	06/12/17	9:30	122	440.9	0.8	4.68
SVE System Outlet	06/18/17	15:00	138	438.5	0.7	4.09
SVE System Outlet	06/27/17	16:10	145	440.7	0.6	3.51
SVE System Outlet	07/04/17		135	436.4	0.8	4.68
SVE System Outlet	07/11/17	9:10	125	442.5	1.1	6.43
SVE System Outlet	07/18/17	8:10	130	440.9	0.7	4.09
SVE System Outlet	07/25/17	9:10	128	444.5	0.8	4.68
SVE System Outlet	07/30/17	13:00	136	432.7	0.7	4.09
SVE System Outlet	08/08/17	7:40	130	444.3	0.7	4.09
SVE System Outlet	08/14/17	10:30	125	441.8	0.7	4.09
SVE System Outlet	08/22/17	12:50	130	450.4	0.7	4.09
SVE System Outlet	08/29/17	14:00	144	448.6	0.8	4.68
SVE System Outlet	09/05/17	8:10	140	441.6	0.9	5.26
SVE System Outlet	09/12/17	12:20	138	444.8	0.6	3.51
SVE System Outlet	09/19/17	13:20	128	438.6	0.6	3.51
SVE System Outlet	09/25/17	12:00	128	451.6	0.6	3.51
SVE System Outlet	10/03/17	15:00	125	440.3	0.7	4.09
SVE System Outlet	10/10/17	13:50	128	438.6	0.7	4.09
SVE System Outlet	10/16/17	9:35	122	444.6	0.8	4.68

Table E-1
Soil Vapor Extraction 1 January 2017 through 31 December 2017
TSA Remedy - East Multnomah County Oregon

Well ID	Date	Time (hrs)	Temperature (degrees F)	Flow Rate (scfm)	PID Measurement (ppm)	Calculated VOC Concentrations (µg/L)
Soil Vapor Extraction Outlet Well						
SVE System Outlet	10/23/17	12:20	125	448.1	0.8	4.68
SVE System Outlet	10/31/17	7:10	119	441.2	0.8	4.68
SVE System Outlet	11/06/17	9:00	128	436.1	0.7	4.09
SVE System Outlet	11/14/17	15:50	125	440.8	0.7	4.09
SVE System Outlet	11/20/17	13:30	124	436.1	0.7	4.09
SVE System Outlet	11/27/17	15:30	125	442.5	0.7	4.09
SVE System Outlet	12/04/17	13:20	128	444.1	0.7	4.09
SVE System Outlet	12/12/17	13:20	128	428.1	0.7	4.09
SVE System Outlet	12/18/17	13:25	125	436.8	0.7	4.09
SVE System Outlet	12/26/17	11:20	90	428.6	0.6	3.51

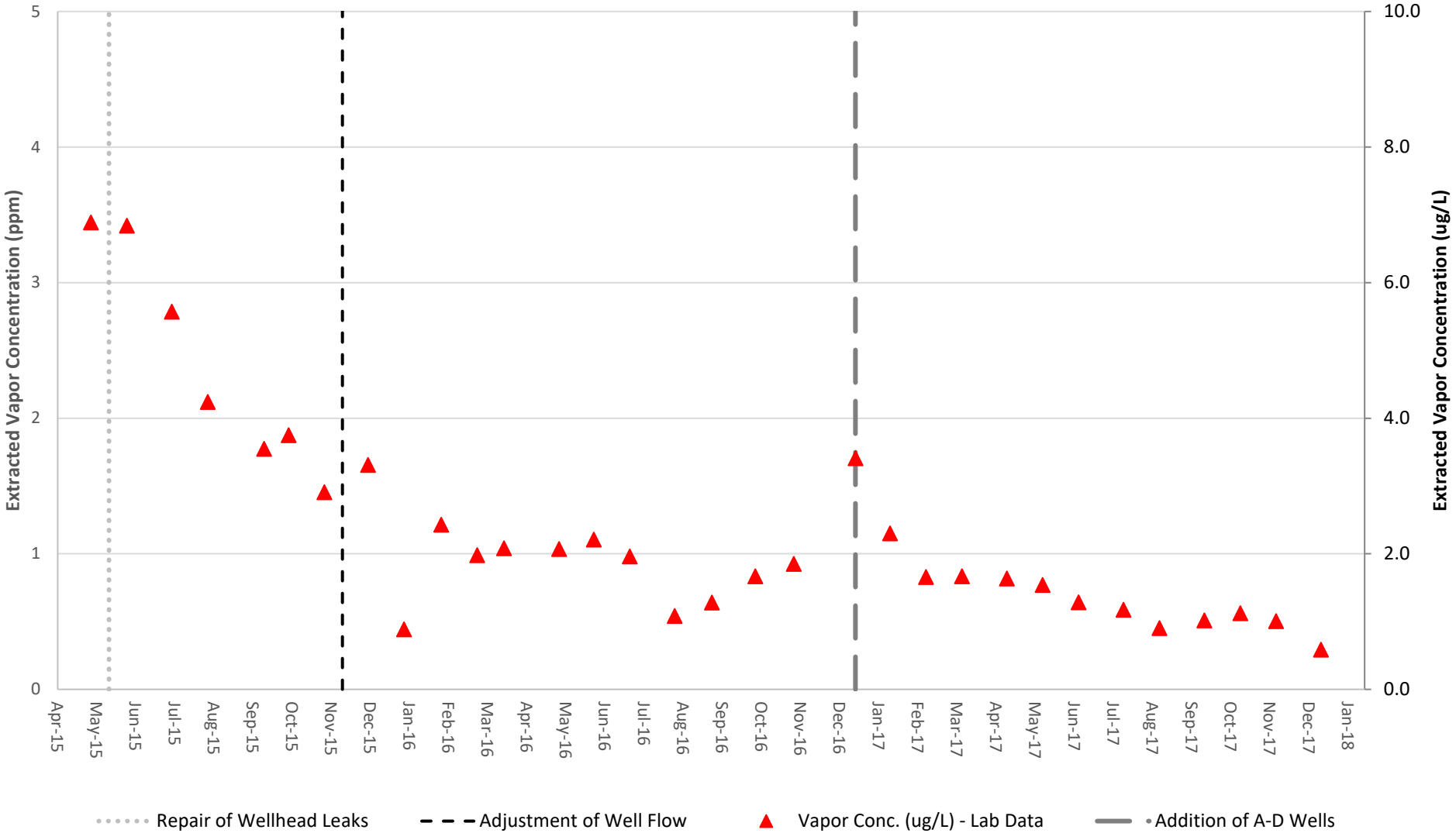
Notes:

ID = identification
hrs = hours
F = Fahrenheit
scfm = standard cubic feet per minute
ppm = parts per million
µg/L = micrograms per Liter
VOC = volatile organic compounds
Bold text indicates sampling dates for data shown on Table E-2
Calculated VOC concentrations are based on PID readings
Flow rates increased on 12/14/16 due to new wells online

Table E-2
Soil Vapor Extraction - Laboratory VOC Results
TSA Remedy - East Multnomah County Oregon

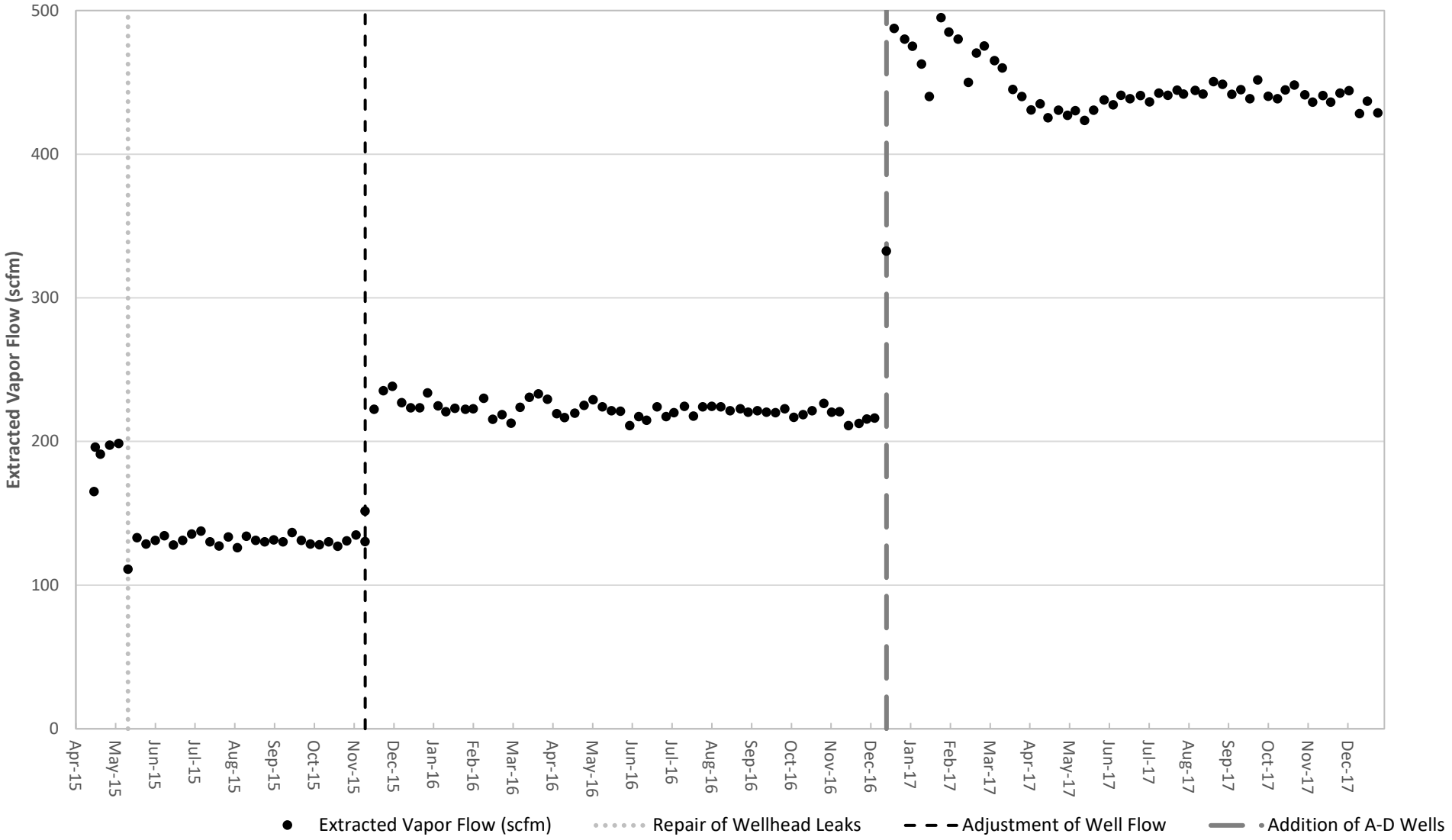
Well ID	Date	cis-1,2-dichloroethene (µg/m^3)	Trichloro-ethene (µg/m3)	Tetrachloro-ethene (µg/m3)	Total VOCs (µg/m3)	Flow Rate (scfm)
System Outlet	01/10/17	160	2,000	140	2,300	462.8
	02/07/17	110	1,400	120	1,630	480.0
	03/07/17	99	1,400	160	1,659	465.0
	04/11/17	130	1,400	140	1,670	435.0
	05/08/17	96	1,400	140	1,636	430.2
	06/06/17	100	1,300	140	1,540	434.4
	07/11/17	76	1,100	110	1,286	442.5
	08/08/17	65	1,000	110	1,175	444.3
	09/12/17	60	770	73	903	444.8
	10/10/17	61	870	88	1,019	438.6
	11/06/17	68	970	84	1,122	436.1
	12/12/17	60	860	88	1,008	444.1
Well VW17D-95.5	01/10/17	110	830	54	994	112.2
	05/08/17	76	560	35	671	101.6
	08/08/17	54	410	26	490	100.3
	11/06/17	65	370	25	460	99.5
Well VMW-A	01/10/17	67	680	54	801	114.1
	05/08/17	< 2.1	< 2.1	< 2.1	0	127.9
	08/08/17	15	430	64	509	123.8
	11/06/17	9.7	120	17	146.7	121.6
Well VMW-B	01/10/17	140	1,600	110	1,850	118.2
	05/08/17	< 2.3	2.7	< 2.3	2.7	122.6
	08/08/17	< 2.1	2.5	< 2.1	2.5	124.6
	11/06/17	< 2.0	< 2.0	< 2.0	0	122.3
Well VMW-C	01/10/17	260	3,000	200	3,460	123
	05/08/17	200	3,000	390	3,590	125.1
	08/08/17	140	2,700	320	3,160	125.1
	11/06/17	140	2,500	210	2,850	124.4
Well VMW-D	01/10/17	290	6,600	430	7,320	120.7
	05/08/17	110	1,600	160	1,870	121.6
	08/08/17	140	2,300	190	2,630	124.6
	11/06/17	< 2.0	< 2.0	< 2.0	0	123.2

Notes:
ID = identification
scfm = standard cubic feet per minute
µg/m^3 = micrograms per cubic meter
VOC = volatile organic compounds
Total VOCs are the calculated sum of the three VOCs shown
Flow rates increased on 12/14/16 due to the four new wells online



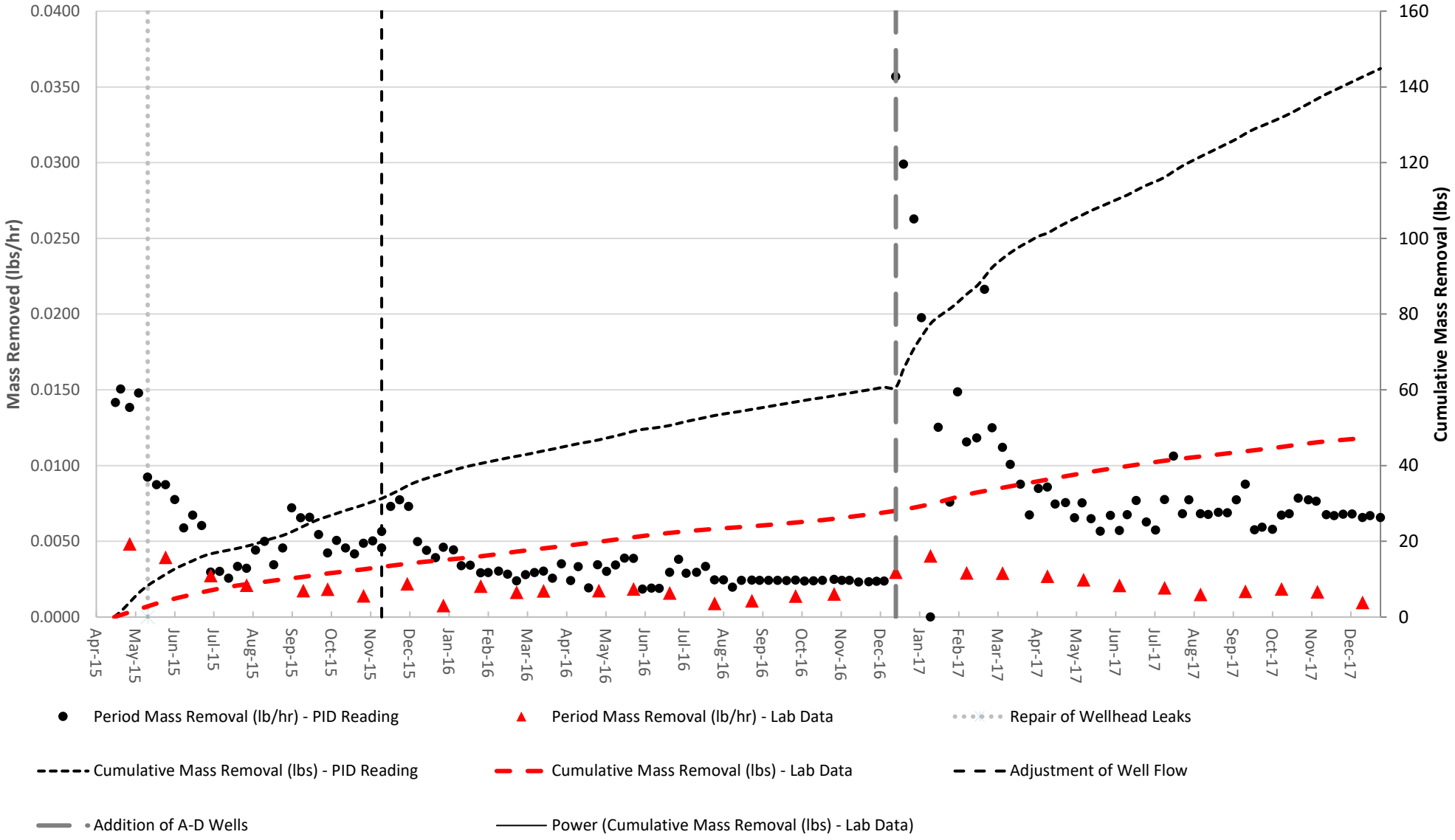
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Effluent cVOC Vapor Concentration** **TSA Remedy**	Figure E-1



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Extracted Vapor Flow (Weekly Average)** **TSA Remedy**	Figure E-2



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE System Mass Removal** **TSA Remedy**	Figure E-3

APPENDIX F

Data Validation Memoranda
Annual Reporting Period
Laboratory Reports (CD)
Historical Data Summary Tables – VOCs and
Groundwater Elevations (CD)

Technical Memorandum

TO: Chris Kimmel, Project Manager

FROM: Kristi Schultz and Danille Jorgensen

DATE: March 17, 2017

RE: **Boeing Portland (TSA)**
First Quarter 2017 Groundwater Quality Sampling
Laboratory Data Quality Evaluation

This technical memorandum provides the results of a focused data validation associated with 7 groundwater samples and 1 trip blank collected during the first quarter 2017 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1762970. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 2016). Landau Associates performed an EPA-equivalent Level II verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. Data validation qualifiers are summarized in Table 1.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of ≤6°C. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spikes were analyzed with this sample batch. No qualification of the data was determined necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and RPDs for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicate Results

As specified in the QAPP, blind field duplicate samples were collected at a rate of one blind field duplicate sample per 20 samples, but not less than one blind field duplicate per sampling round. One

pair of blind field duplicate water samples (BOP-Z-0217/BOP-13ds-0217) was submitted for analysis with data package 1762970.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate samples except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pairs submitted for analysis were within the project-specified control limits. No qualification of the data was necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recovery was low for 1,1,2,2-tetrachloroethane. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.

Kristi Schultz
Data Specialist

Danille Jorgensen
Environmental Data Manager

DRJ/kes
[\\EDMDATA01\PROJECTS\025\116\FILERM\T\TSA\DATA\DV MEMOS TSA\2017\1Q17\TSA 1Q17 TM.DOCX]

References

EPA. 2016. National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, DC: US Environmental Protection Agency.

Table 1
Summary of Data Qualifiers
Boeing Portland TSA Phase I

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-13ds-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-Z-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-31dg-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-31ds-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-61dg-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-61ds-0217	Low continuing calibration recovery
1762970	1,1,2,2-Tetrachloroethane	0.2 U	UJ	BOP-66ds-0217	Low continuing calibration recovery

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Geosyntec consultants

180A Marketplace Blvd
Knoxville, TN 37922
PH 865.330.0037
www.geosyntec.com

Memorandum

Date:	22 March 2017
To:	Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From:	Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject:	**Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L889482 and L889484 and ALS Environmental Service Request Number P1700125**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of twenty-six groundwater samples, six air samples, three field duplicates and one trip blank, collected from January 10 – February 23, 2017, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected VOCs (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data are usable for meeting project objectives.

The data were reviewed based on the pertinent methods referenced in the data package, professional and technical judgment and the following documents

- USEPA National Functional Guidelines for Organic Superfund Method Data Review, January 2017 (USEPA-540-R-2017-002

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L889482-01	TS-C-EFF-020817
L889482-02	TS-C-EFF-020817-DUP
L889482-03	TS-C-INF-020817
L889484-01	EW1-020817
L889484-02	EW2-020817
L889484-03	EW14-020817
L889484-04	EW16-020817
L889484-05	EW23-020817
L889484-06	VMWA-020817
L889484-07	VMWB-020817
L889484-08	VMWC-020817
L889484-09	VMWD-020817
L889484-10	EW8-020817-L
L889484-11	EW8-020817-U
L889484-12	EW12-020817-L
L889484-13	EW12-020817-U
L889484-14	D17DG-020817
L889484-15	D17DS-020817

Laboratory ID	Client ID
L889484-16	CMW10DS-020817
L889484-17	CMW14RDS-020817
L889484-18	CMW17DS-020817
L889484-19	CMW17DS-020817-DUP
L889484-20	CMW18DS-020817
L889484-21	CMW19DS-020817
L889484-22	CMW19DS-020817-DUP
L889484-23	CMW24DG-020817-L
L889484-24	CMW24DG-020817-U
L889484-25	CMW25DG-020817
L889484-26	CMW26DG-020817
L889484-27	TRIP BLANK LOT#345
P1700125-001	SVE EFF-011017
P1700125-002	VW-17d-95.5-011017
P1700125-003	VMW-A-011017
P1700125-004	VMW-C-011017
P1700125-005	VMW-B-011017
P1700125-006	VMW-D-011017

The water samples were received at the laboratory at 3.1ºC, within the criteria 0-6ºC.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

✓ Overall Assessment (Completeness)
✓ Holding Time
✓ Method Blank
✓ Matrix Spike/Matrix Spike Duplicate
✓ Laboratory Control Sample

- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four method blanks were reported (batches WG951684, WG951685, WG951686 and WG952791). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were not reported with the data set.

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

Work Orders L889482 and L889484: The recoveries of acrolein in the LCS/LCSD pairs in batches WG951684, WG951685, WG951686 andWG952791 were high, outside the laboratory specified acceptance criteria. Since acrolein was not detected in the associated samples, no qualifications were applied to the acrolein data.

Work Order L889484: The recovery of acetone in the LCSD in batch WG951686 was high, outside the laboratory specified acceptance criteria. Since acetone was not detected in the associated sample, no qualifications were applied to the acetone data.

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Three field duplicates were collected with the sample sets, TS-C-EFF-020817-DUP, CMW17DS-020817-DUP and CMW19DS-020817-DUP. Acceptable precision (RPD ≤ 30%) was demonstrated between the field duplicates and the original samples, TS-C-EFF-020817, CMW17DS-020817 and CMW19DS-020817, respectively.

1.8 Trip Blank

One trip blank, TRIP BLANK LOT#345, accompanied the sample shipments. VOCs were not detected in the trip blank above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the RDLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in the units parts per million (ppm) in the EDDs, while the sample data were reported in the units parts per billion (µg/L). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues

were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a SUMMA Canister sample is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported (batch P170113). VOCs were not detected in the method blank above the method reporting limits (MRLs).

2.4 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One LCS was reported. The recovery results were within the laboratory specified acceptance criteria.

2.5 Laboratory Duplicate

Laboratory duplicates were not reported with the data set.

2.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.7 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.8 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.9 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for the samples due to the sample dilutions analyzed.

2.10 Electronic Data Deliverable Review

Results and sample IDs in the EDD were reviewed against the information provided by the associated level II report at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory report; both the MRLs and the MDLs were listed in the EDD. It was also noted that the data were reported in micrograms per cubic meter ($\mu g/m^3$) in the EDD, while the sample data were reported in both micrograms per cubic meter ($\mu g/m^3$) and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II report and the EDD.

---

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

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.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Geosyntec consultants

180A Marketplace Blvd
Knoxville, TN 37922
PH 865.330.0037
www.geosyntec.com

Memorandum

Date: 6 June 2017

To: Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon

From: Geosyntec Quality Assurance Group, Knoxville, Tennessee

Subject: Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Order L896424, L908834 and L908840 and ALS Environmental Service Request Numbers PP1701164, P1701788 and P1702259

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S17

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of twenty groundwater samples, two field duplicate samples, three trip blanks and eight air samples, collected March 7 and 15, 2017, April 11, 2017 and May 9 and 10, 2017, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected VOCs

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives. The qualified data should be used within the limitations of the qualifications.

The data were reviewed based on the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, January 2017 (EPA-540-R-2017-002), the pertinent methods referenced in the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L896424-01	MW-36DG-031517
L896424-02	TRIP BLANK LOT #373
L908834-01	CMW17DS-050917
L908834-02	CMW17DS-050917-DUP
L908834-03	EW2-050917
L908834-04	EW1-050917
L908834-05	EW14-050917
L908834-06	D17DS-050917
L908834-07	EW12-050917-U
L908834-08	EW12-050917-L
L908834-09	CMW18DS-050917
L908834-10	CMW19DS-050917
L908834-11	CMW26DG-050917
L908834-12	EW16-050917
L908834-13	VMWA-050917
L908834-14	VMWB-050917

Laboratory ID	Client ID
L908834-15	VMWC-050917
L908834-16	VMWD-050917
L908834-17	TRIPBLANK LOT #375
L908834-18	CMW10DS-050917
L908840-01	TS-C-EFF-050917
L908840-02	TS-C-EFF-050917-DUP
L908840-03	TS-C-INF-050917
L908840-04	TRIP BLANK LOT #375
P1701164-001	SVE EFF-030717
P1701788-001	EFF-041117
P1702259-001	VMWEFF-050917
P1702259-002	VMW95.5-050917
P1702259-003	VMWA-050917
P1702259-004	VMWB-050917
P1702259-005	VMWD-050917
P1702259-006	VMWC-050917

The water samples were received at the laboratory at 2.8ºC, within the criteria 0-6ºC.

The following issues were noted with the chain of custody (COC) forms:

- Incorrect error corrections were observed on the COC forms instead of the proper procedure of a single strike through, correction, and initials and date of person making the correction.
- There was no date or time of sample relinquishing on the COC in ESC report L896424. In addition, no analysis was listed on the COC for the trip blank. The trip blank was analyzed for VOCs.
- The relinquishing times on the COC forms in ESC reports L908834 and L908840 were not documented correctly. The sampler entered "NA" on the COCs as the relinquishing time.
- Sample CMW10DS-050917 was reported in report L908834, but was not listed on the COC. The client was contacted and notified the laboratory to analyze the sample. The issue was documented on a nonconformance form in the laboratory report.

- The relinquishing times on the COC forms in ALS reports ALS PP1701164, P1701788 and P1702259 were not documented correctly. The sampler entered "NA" on two of the COCs and "approx. 15:00" on the other COC for the relinquishing times.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples, field duplicate samples and trip blanks were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

✓ Overall Assessment
✓ Holding Time
✓ Method Blank
✓ Matrix Spike/Matrix Spike Duplicate
⊗ Laboratory Control Sample
✓ Surrogates
✓ Field Duplicate
✓ Trip Blank
✓ Sensitivity
✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Five method blanks were reported (batches WG961982,

WG979442, WG980061, WG979739 and WG980420). VOCs were not detected in the method blank above the reported detection limits (RDLs).

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Two batch MS/MSD pairs were reported. Since these were batch QC, there was no impact on the samples and no qualifications were applied to the data

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Five LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

L896424: The acetone and 2-butanone RPDs in batch WG961982 were high, outside the laboratory specified acceptance criteria. Since acetone and 2-butanone were not detected in the associated samples, no qualifications were applied to the data.

L908834: The bromomethane RPD in batch WG979442 and the naphthalene and 1,2,3-trichlorobenzene RPDs in batch WG980061 were high, outside the laboratory specified acceptance criteria. Since bromomethane, naphthalene and 1,2,3-trichlorobenzene were not detected in the associated samples, no qualifications were applied to the data. In addition, the recoveries of 1,2-dibromo-3-chloropropane were low and outside the laboratory specified acceptance criteria in batch WG979442. Therefore, the nondetect results of 1,2-dibromo-3-chloropropane in the associated samples were UJ qualified as estimated less than the RDL. The bromomethane LCSD result in batch WG980061 was flagged with E, indicating the LCSD concentration was above the calibration range. No qualifications were applied to the data, based on professional and technical judgment.

L908840: The LCS recovery of 1,2-dibromo-3-chloropropane was low and outside the laboratory specified acceptance criteria in batch WG979739. Therefore, the nondetect results of 1,2-dibromo-3-chloropropane in the associated samples were UJ qualified as estimated less than the RDL.

Sample	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
CMW18DS-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
CMW17DS-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5

Sample	Compound	Laboratory Result (mg/L)	Laboratory Flag	Validation Result (mg/L)	Validation Qualifier*	Reason Code**
CMW17DS-050917-DUP	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
CMW19DS-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
CMW26DG-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
D17DS-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW1-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW12-050917-L	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW12-050917-U	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW14-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW16-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
EW2-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
VMWA-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
VMWB-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
VMWC-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
VMWD-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
TRIPBLANK LOT #375	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
TS-C-EFF-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
TS-C-EFF-050917-DUP	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5
TS-C-INF-050917	1,2-Dibromo-3-Chloropropane	0.0050	U,J4	0.0050	UJ	5

mg/L-milligrams per liter
U-not detected at or above the RDL
J4-laborator flag indicating the associated batch QC was outside the laboratory limits for accuracy
*Validation qualifiers are defined in Attachment 1 at the end of this report
** Reason codes are defined in Attachment 2 at the end of this report

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Two field duplicate samples were collected with the sample sets, CMW17DS-050917-DUP and TS-C-EFF-050917-DUP. Acceptable precision (RPD ≤30%) was demonstrated between the field duplicates and the original samples, CMW17DS-050917 and TS-C-EFF-050917.

1.8 Trip Blank

Three trip blanks, TRIP BLANK LOT #373, TRIPBLANK LOT #375 and TRIP BLANK LOT #375, accompanied the sample shipments. VOCs were not detected in the trip blanks above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect results were reported.

1.10 Electronic Data Deliverable (EDD) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the hardcopy laboratory reports; both the RDLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in the units milligram per liter (mg/L) in the EDDs, while the data in the hardcopy reports were reported in the units microgram per liter (µg/L). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for selected VOCs per EPA method TO-15 (1,1-dichloroethene, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene and vinyl chloride).

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample

- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a sample collected in a Summa canister is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four method blanks were reported [(batches P170314, P170418 (2 method blanks), P170522 and P170523). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Matrix Spike/Matrix Spike Duplicate

MS/MSD pairs were not reported.

2.5 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.6 Laboratory Duplicate

One sample set specific laboratory duplicate was reported, using sample VMWD-051917. The RPD results were within the laboratory specified acceptance criteria.

2.7 Surrogates

Acceptable surrogate recoveries were reported.

2.8 Field Duplicate

Field duplicates were not collected with the air sample sets.

2.9 Trip Blank

Trip blanks were not shipped with the air sample sets.

2.10 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for samples due to the dilutions analyzed.

2.11 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the hardcopy laboratory report; both the MRLs and the MDLs were listed in the EDD. It was also noted that the data were reported in micrograms per cubic meter ($\mu g/m^3$) in the EDD, while the sample data were reported in both $\mu g/m^3$ and parts per billion by volume (ppbv). This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

---

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

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.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Technical Memorandum

TO: Chris Kimmel, Project Manager

FROM: Kristi Schultz and Danille Jorgensen

DATE: June 30, 2017

RE: **Boeing Portland (TSA)**
Second Quarter 2017 Groundwater Quality Sampling
Laboratory Data Quality Evaluation

This technical memorandum provides the results of a focused data validation associated with 2 groundwater samples and 1 trip blank collected during the second quarter 2017 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1799280. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 2016). Landau Associates performed an EPA-equivalent Level II verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. Data validation qualifiers are summarized in Table 1.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of ≤6°C. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks. No qualification of the data was necessary. No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spikes were analyzed with this sample batch. No qualification of the data was determined necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and RPDs for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicate Results

No blind field duplicates were submitted with this sample batch. No qualification of the data was determined necessary.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recovery was low for 2-hexanone. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.

Kristi Schultz
Data Specialist

Danille Jorgensen
Environmental Data Manager

DRJ/kes
[P:\025\116\FILERM\T\TSA\DATA\DV MEMOS TSA\2017\2Q17\TSA 2Q17 TM.DOCX]

References

EPA. 2016. National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, DC: US Environmental Protection Agency.

Table 1
Summary of Data Qualifiers
Boeing Portland TSA Phase I

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
1799280	2-Hexanone	5.0 U	UJ	BOP-13ds-0517	Low continuing calibration recovery
1799280	2-Hexanone	5.0 U	UJ	BOP-31ds-0517	Low continuing calibration recovery

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Geosyntec consultants

180A Marketplace Blvd
Knoxville, TN 37922
PH 865.330.0037
www.geosyntec.com

Memorandum

Date:	28 August 2017
To:	Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From:	Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject:	**Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Order L928636 and ALS Environmental Service Request Numbers P1703349 and P1703894**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of thirty-six groundwater samples, three field duplicates, one trip blank and seven air samples, collected July 11, 2017 and August 7-8, 2017, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and ALS Environmental, Simi Valley, California provided the analytical services.

The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected VOCs (1,1-Dichloroethene, cis-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, and Vinyl Chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data are usable for meeting project objectives.

The data were reviewed based on the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, January 2017 (EPA-540-R-2017-002), the pertinent methods referenced in the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L928636-01	EW1-080708
L928636-02	EW2-080708
L928636-03	EW14-080708
L928636-04	EW16-080708
L928636-05	EW23-080708
L928636-06	BOP44DG-080708
L928636-07	BOP44DS-080817
L928636-08	D17DG-080708
L928636-09	D17DS-080708
L928636-10	EW8-080717-U
L928636-11	EW8-080717-L
L928636-12	EW12-080717-L
L928636-13	EW12-080717-U
L928636-14	EW15-080717-L
L928636-15	EW15-080717-U
L928636-16	CMW8DG-080717
L928636-17	CMW10DG-080717
L928636-18	CMW10DS-080717
L928636-19	CMW14RDS-080717
L928636-20	CMW17DS-080717
L928636-21	CMW17DS-080717-DUP
L928636-22	CMW18DS-080717
L928636-23	CMW18DS-080717-DUP
L928636-24	CMW19DS-080717

Laboratory ID	Client ID
L928636-25	CMW20DS-080717
L928636-26	CMW22DG-080717
L928636-27	CMW25DG-080717
L928636-28	CMW26DG-080717
L928636-29	CMW24DG-080817-L
L928636-30	CMW24DG-080817-U
L928636-31	EW11-080817-U
L928636-32	EW11-080817-L
L928636-33	VMWA-080817
L928636-34	VMWB-080817
L928636-35	VMWC-080817
L928636-36	VMWD-080817
L928636-37	TS-C-INF-080717
L928636-38	TS-C-EFF-080717
L928636-39	TS-C-EFF-080717-DUP
L928636-40	TRIP BLANK LOT #382
P1703349-001	VMWEFF-071117
P1703894-001	VMWEFF-080817
P1703894-002	VMW95.5-080817
P1703894-003	VMWA-080817-SV
P1703894-004	VMWB-080817-SV
P1703894-005	VMWC-080817-SV
P1703894-006	VMWD-080817-SV

The water samples were received at the laboratory at 2.7ºC, within the validation criteria of 0-6ºC.

Incorrect error corrections were observed on the chain of custody (COC) in laboratory report L928636, instead of the proper procedure of a single strike through, correction and initials and date of person making the correction.

No time of collection was listed on the COC for the trip blank; the laboratory assigned a collection time of 00:00.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The groundwater samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Sample
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

1.1 Overall Assessment (Completeness)

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three method blanks were reported (batches WG1008855, WG1009065 and WG1009067). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

One batch MS/MSD pair was reported. Since this is batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data.

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

The LCS/LCSD recoveries of acrolein in batches WG1008855, WG1009065 and WG1009067 were high and outside the laboratory specified acceptance criteria. In addition, the chloroethane and bromomethane RPDs in batches WG1008855 and WG1009067, respectively, were high and outside the laboratory specified acceptance criteria. Since acrolein, chloroethane and bromomethane were not detected in the associated samples, no qualifications were applied to the data.

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Three field duplicates, CMW17DS-080717-DUP CMW18DS-080717-DUP and TS-C-EFF-080717-DUP, were collected with the sample set. Acceptable precision (RPD <30%) was demonstrated between the field duplicates and the original samples, CMW17DS-080717, CMW18DS-080717 and TS-C-EFF-080717, respectively.

1.8 Trip Blank

One trip blank, TRIP BLANK LOT #382, accompanied the sample shipment. VOCs were not detected in the trip blank above the RDLs.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverable (EDD) Review

Results and sample IDs in the EDD were reviewed against the information provided by the associated level II report at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the level II report; both the RDLs and the method detection limits (MDLs) were listed in the EDD. It was also noted that the data were reported in units of parts per million (ppm) in the EDD, while the sample data were reported in units of parts

per billion (or microgram per liter, µg/L) in the level II report. This did not affect the quality of the data. No other discrepancies were identified between the level II report and the EDD.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment (Completeness)
- ✓ Holding Time
- ✓ Method Blank
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment (Completeness)

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a sample collected in a SUMMA canister is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two method blanks were reported (batches P170714 and P170815). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Two LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.5 Laboratory Duplicate

One laboratory duplicate was reported using sample VMWEFF-080817. The RPD results were within the laboratory specified acceptance criteria.

2.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.7 Field Duplicate

A field duplicate was not collected with the air samples.

2.8 Trip Blank

A trip blank was not shipped with the air sample sets.

2.9 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for the samples due to the sample dilutions analyzed.

2.10 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the level II reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu g/m^3$) in the EDDs, while the sample data were reported in both $\mu g/m^3$ and parts per billion by volume (ppbv) in the level II reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

---

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

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.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

Technical Memorandum

TO: Chris Kimmel, Project Manager

FROM: Kristi Schultz and Danille Jorgensen

DATE: September 30, 2017

RE: **Boeing Portland (TSA)**
Third Quarter 2017 Groundwater Quality Sampling
Laboratory Data Quality Evaluation

This technical memorandum provides the results of a focused data validation associated with 24 groundwater samples and 3 trip blanks collected during the third quarter 2017 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data packages 1836045 and 1846612. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 2016). Landau Associates performed an EPA-equivalent Level IIa verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. Data validation qualifiers are summarized in Table 1.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of ≤6°C. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks with the following exception:

- Toluene was detected at a concentration greater than the reporting limit in the trip blank associated with data package 1846612. Toluene was not detected above the reporting limit in the associated samples; no qualification of the data was necessary.

No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spikes were analyzed with this sample batch. No qualification of the data was determined necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and Relative Percent Differences (RPDs) for the laboratory control samples and associated duplicates were within the current laboratory-specified control limits with the following exceptions:

- Several LCS and/or LCSD recoveries were high for vinyl acetate or 1,2-dichloropropane in laboratory data package 1836045. Vinyl acetate and 1,2-dichloropropane were not detected at concentrations greater than the reporting limits in the associated samples. No qualification of the data was necessary.
- The LCS recovery was high for vinyl acetate in laboratory data package 1846612. Vinyl acetate was not detected at concentrations greater than the reporting limit in the associated samples. No qualification of the data was necessary.

Blind Field Duplicate Results

As specified in the QAPP, blind field duplicate samples were collected at a rate of one blind field duplicate sample per 20 samples, but not less than one blind field duplicate per sampling round. Two pairs of blind field duplicate water samples (BOP-Y-00817/BOP-60Rds-0817 and BOP-Z-0817/BOP-20ds-0817) were submitted for analysis with data package 1836045.

A project-specified control limit of 20 percent was used to evaluate the RPDs between the duplicate samples except when the sample results were within five times the reporting limit. In these cases, a project-specified control limit of plus or minus the reporting limit was used. RPDs for the duplicate sample pairs submitted for analysis were within the project-specified control limits, with the following exceptions:

- The RPDs for acetone associated with field duplicate pairs BOP-Y-00817/BOP-60Rds-0817 and BOP-Z-0817/BOP-20ds-0817 in data package 1836045 exceeded the project-specified control limit. The associated sample results were qualified as estimated (J), as indicated in Table 1.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recovery was low for multiple compounds in data package 1836045. Associated sample results were qualified as estimated (J, UJ), as indicated in Table 1.

- The CCV recovery was high for multiple compounds in data package 1836045. The affected compounds were not detected at concentrations greater than the reporting limits in the associated samples. No qualification of the data was necessary.

The reported concentration of vinyl chloride in sample BOP-21ds in data package 1836045 was unusually high and inconsistent with historical data. The well location was re-sampled and reanalyzed in lab data package 1846612, with results closer to historical norms. The reanalysis result will be reported.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.

Kristi Schultz
Data Specialist

Danille Jorgensen
Environmental Data Manager

DRJ/kes
[P:\025\116\FILERM\T\TSA\DATA\DV MEMOS TSA\2017\3Q17\TSA 3Q17 TM.DOCX]

References

EPA. 2016. National Functional Guidelines for Superfund Organic Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, DC: US Environmental Protection Agency.

Table 1
Summary of Data Qualifiers
Boeing Portland TSA Phase I

Data Package	Analyte	Result	Qualifier	Sample Number	Reason
1836045	Bromomethane	0.5 U	UJ	BOP-13ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-13dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-20ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-20dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-21ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-22Rds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-23dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-31ds-0807	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-31dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-42ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-42dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-60Rds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-60dg-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-60dg-0817	Low continuing calibration recovery
1836045	Trichlorofluoromethane	0.5 U	UJ	BOP-60dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-61ds-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-61dg-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-61dg-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-61dg-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-61dg-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-62ds-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-62ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-62ds-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-62ds-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-65ds-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-65ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-65ds-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-65ds-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-66ds-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-66ds-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-66ds-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-66ds-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	EW-3-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	EW-3-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	EW-3-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	EW-3-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	EW-3-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	EW-13-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	EW-13-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	EW-13-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	EW-13-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-Y-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-Y-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-Y-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-Y-0817	Low continuing calibration recovery
1836045	Chloromethane	0.5 U	UJ	BOP-Z-0817	Low continuing calibration recovery
1836045	Vinyl Chloride	0.2 U	UJ	BOP-Z-0817	Low continuing calibration recovery
1836045	Bromomethane	0.5 U	UJ	BOP-Z-0817	Low continuing calibration recovery
1836045	Chloroethane	0.5 U	UJ	BOP-Z-0817	Low continuing calibration recovery
1836045	Acetone	32	J	BOP-60Rds-0817	High field duplicate RPD
1836045	Acetone	40	J	BOP-Y-0817	High field duplicate RPD
1836045	Acetone	9.8	J	BOP-20ds-0817	High field duplicate RPD
1836045	Acetone	15	J	BOP-Z-0817	High field duplicate RPD

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ = The analyte was not detected in the sample; the reported sample reporting limit is an estimate.

Technical Memorandum

TO: Chris Kimmel, Project Manager

FROM: Kristi Schultz and Danille Jorgensen

DATE: December 22, 2017

RE: **Boeing Portland (TSA)**
Fourth Quarter 2017 Groundwater Quality Sampling
Laboratory Data Quality Evaluation

This technical memorandum provides the results of a focused data validation associated with 2 groundwater samples and 1 trip blank collected during the fourth quarter 2017 TSA water quality sampling event at Boeing Portland. Samples were analyzed by Eurofins Lancaster Laboratories Environmental LLC (LLI), located in Lancaster, Pennsylvania. This data quality evaluation covers LLI data package 1872152. Samples submitted to LLI were analyzed for volatile organic compounds ([VOCs]; US Environmental Protection Agency [EPA] Method SW8260C).

The verification and validation check was conducted with guidance from applicable portions of EPA's *National Functional Guidelines for Organic Data Review* (EPA 2016). Landau Associates performed an EPA-equivalent Level IIa verification and validation check on each laboratory data package, which included the following:

- Verification that the laboratory data package contained all necessary documentation (including chain-of-custody records; identification of samples received by the laboratory; date and time of receipt of the samples at the laboratory; sample conditions upon receipt at the laboratory; date and time of sample analysis; explanation of any significant corrective actions taken by the laboratory during the analytical process; and, if applicable, date of extraction, definition of laboratory data qualifiers, all sample-related quality control data, and quality control acceptance criteria).
- Verification that all requested analyses, special cleanups, and special handling methods were performed.
- Evaluation of sample holding times.
- Evaluation of quality control data compared to acceptance criteria, including method blanks, surrogate recoveries, matrix spike results, laboratory duplicate and/or replicate results, and laboratory control sample results.
- Evaluation of overall data quality and completeness of analytical data.

Data validation qualifiers are added to the sample results, as appropriate, based on the verification and validation check. The absence of a data qualifier indicates that the reported result is acceptable without qualification. The data quality evaluation is summarized below. All data was found to be acceptable with no qualifications.

Chain-of-Custody Records

A signed chain-of-custody (COC) record was attached to the data packages. The laboratory received all samples in good condition. All analyses were performed as requested. No special cleanups or handling methods were requested.

Upon receipt by LLI, the sample container information was compared to the associated chain-of-custody and the cooler temperatures were recorded. The coolers were received with temperatures within the EPA-recommended limit of ≤6°C. No qualification of the data was necessary.

Holding Times

For all analyses and all samples, the time between sample collection, extraction (if applicable), and analysis was determined to be within EPA- and project-specified holding times. No qualification of the data was necessary.

Blank Results

Laboratory Method Blanks

At least one method blank was analyzed with each batch of samples for VOCs analysis. Target analytes were not detected at concentrations greater than the reporting limits in the associated method blanks. No qualification of the data was necessary.

Field Trip Blanks and Field Equipment Blanks

One trip blank was submitted to the laboratory for VOC analysis with each sample batch. Target analytes were not detected at concentrations greater than the reporting limits in the associated trip blanks. No qualification of the data was necessary.

No field equipment blanks were submitted for analysis with this sample batch.

Surrogate Recoveries

Appropriate compounds were used as surrogate spikes for the VOCs analysis. Recovery values for the surrogate spikes were within the current laboratory-specified control limits. No qualification of the data was necessary.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) and Laboratory Replicate Results

No matrix spikes were analyzed with this sample batch. No qualification of the data was determined necessary.

Laboratory Control Sample and Laboratory Control Sample Duplicate (LCS/LCSD) Results

At least one laboratory control sample and/or laboratory control sample duplicate (LCS/LCSD) was analyzed with each batch of samples for VOCs analysis. Recoveries and RPDs for the laboratory control

samples and associated duplicates were within the current laboratory-specified control limits. No qualification of the data was necessary.

Blind Field Duplicate Results

No blind field duplicate pairs were submitted with this sample batch.

Quantitation Limits

Project-specified quantitation limits were met for all samples except for instances where high concentrations required dilution of the sample extracts.

Audit/Corrective Action Records

No audits were performed or required. No corrective action records were generated for this sample batch. Based on the laboratory's case narratives, continuing calibration verification (CCV) recovery results were within laboratory-specified control limits, with the following exceptions:

- The CCV recovery was high for acetone in data package 1872152. Acetone was not detected at concentrations greater than the reporting limit in the associated samples. No qualification of the data was necessary.

Completeness and Overall Data Quality

The completeness for this data set is 100 percent, which meets the project-specified goal of 90 percent minimum.

Data precision was evaluated through laboratory control sample duplicates. Data accuracy was evaluated through laboratory control samples and surrogate spikes. No data were rejected.

LANDAU ASSOCIATES, INC.

Kristi Schultz
Data Specialist

Danille Jorgensen
Environmental Data Manager

DRJ/kes
[P:\025\116\FILERM\T\TSA\DATA\DV MEMOS TSA\2017\4Q17\TSA 4Q17 TM.DOCX]

References

EPA. 2016. National Functional Guidelines for Organic Superfund Methods Data Review. edited by Office of Superfund Remediation and Technology Innovation (OSRTI). Washington, DC: US Environmental Protection Agency.

Geosyntec consultants

180A Marketplace Blvd
Knoxville, TN 37922
PH 865.330.0037
www.geosyntec.com

Memorandum

Date:	9 January 2018
To:	Cindy Bartlett, RG, LG, Geosyntec Consultants, Portland, Oregon
From:	Geosyntec Quality Assurance Group, Knoxville, Tennessee
Subject:	**Stage 2A Data Validation - Level II Data Deliverables – ESC Lab Sciences Work Orders L945318, L949531, L949550, L951871 and L959754 and ALS Environmental Service Request Numbers P1704515, P1705054 and P1705669**

SITE: Cascade Corp, Fairview Oregon; Job No: PNG0564S16

INTRODUCTION

This report summarizes the findings of the Stage 2A data validation of twenty-four groundwater samples, two field duplicate samples, four trip blanks, collected October 19, 2017, November 7, 2017, November 16, 2017 and December 22, 2017, and eight air samples, collected September 12, 2017, October 10, 2017 and November 7, 2017, as part of the site investigation activities for the Cascade Corp, Fairview Oregon project. The samples were analyzed by EPA method 8260B at ESC Lab Sciences (ESC), Mt. Juliet, Tennessee and by EPA method TO-15 at ALS Environmental, Simi Valley, California. The samples were analyzed for the following tests:

- EPA Method 8260B - Volatile Organic Compounds (VOCs)
- EPA Method TO-15 – Selected VOCs (1,1-Dichloroethene, cis-1,2-dichloroethene, trichloroethene, tetrachloroethene, and vinyl chloride)

EXECUTIVE SUMMARY

The samples were handled, prepared, and measured in the same manner under similar prescribed conditions.

Overall, based on this Stage 2A data validation covering the quality control (QC) parameters listed below, the data as qualified are usable for meeting project objectives. Qualified data should be used within the limitations of the qualifications.

The data were reviewed based on the USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, January 2017 (EPA-540-R-2017-002), the pertinent methods referenced in the data package and professional and technical judgment.

The following samples were analyzed in the data set:

Laboratory ID	Client ID
L945318-01	CMW18DS-101917
L945318-02	TRIP BLANK
L949531-01	CMW26DG-110717
L949531-02	CMW19DS-110717
L949531-03	CMW18DS-110717
L949531-04	CMW18DS-110717-D
L949531-05	CMW17DS-110717
L949531-06	CMW10DS-110717
L949531-07	EW12-110717-L
L949531-08	EW12-110717-U
L949531-09	D17DS-110717
L949531-10	EW14-110717
L949531-11	EW2-110717
L949531-12	EW1-110717
L949531-13	EW23-110717
L949531-14	VMWA-110717
L949531-15	VMWB-110717
L949531-16	VMWC-110717
L949531-17	VMWD-110717

Laboratory ID	Client ID
L949531-18	TRIP BLANK LOT #387
L949550-01	TS-C-INF-110717
L949550-02	TS-C-EFF-110717
L949550-03	TS-C-EFF-110717 DUP
L951871-01	EW16-111617
L951871-02	TRIP BLANK #1549
L959754-01	MW18DS-122217-102.5
L959754-02	MW18DS-122217-105
L959754-03	MW18DS-122217-107.5
L959754-04	MW18DS-122217-109
L959754-05	TRIP BLANK
P1704515-001	SVE EFF-091217
P1705054-001	SVE EFF - 101017
P1705669-001	VMWA-110717-SV
P1705669-002	VMWC-110717-SV
P1705669-003	VMWB-110717-SV
P1705669-004	VMWD-110717-SV
P1705669-005	VMW-95.5-110717
P1705669-006	SVEEFF-110717

The water samples were received at the laboratory at 0.7ºC, 0.9ºC, 2.1ºC and 1.2ºC, within the validation criteria of 0-6ºC.

Incorrect error corrections were observed on the chain of custody (COC) forms in laboratory reports L949531, L951871, L959754 and P1705569, instead of the proper procedure of a single strike through, correction and initials and date of person making the correction.

No time of collection was listed on the COCs for the trip blanks reported in L945318 and L951871; the laboratory assigned a collection time of 07:30 and 00:00, respectively. No date or time of collection were listed on the COC for the trip blank reported in L949531; the laboratory assigned a collection date the same as the associated samples and a collection time of 00:00. There was a trip blank listed on the COC in report L949550, but it was not received by the laboratory. No qualifications were applied to the data, but the discrepancy should be noted by the data user.

1.0 VOLATILE ORGANIC COMPOUNDS BY EPA METHOD 8260B

The water samples were analyzed for VOCs per EPA Method 8260B.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

✓ Overall Assessment
✓ Holding Time
✓ Method Blank
✓ Matrix Spike/Matrix Spike Duplicate
⊗ Laboratory Control Sample
✓ Surrogates
✓ Field Duplicate
✓ Trip Blank
✓ Sensitivity
✓ Electronic Data Deliverables Review

1.1 Overall Assessment

The VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

1.2 Holding Time

The holding time for the VOC analysis of a preserved water sample is 14 days from collection to analysis. The holding times were met for the sample analyses.

1.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Six method blanks were reported (batches WG1034014, WG1041173, WG1041175, WG104499, WG1057179 and WG1057676). VOCs were not detected in the method blanks above the reported detection limits (RDLs).

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were not reported in reports L945318, L949531, L951871 and L959754. One batch MS/MSD pair was reported in report L949550. Since this is batch QC, the results do not affect the samples in this data set and qualifications were not applied to the data.

1.5 Laboratory Control Sample (LCS)

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Four LCSs and two LCS/LCS duplicate (LCSD) pairs were reported. The recovery and relative percent difference (RPD) results were within the laboratory specified acceptance criteria, with the following exceptions.

The LCS recoveries of acrolein in batches WG1041175, WG104499 and WG1057179 were high and outside the laboratory specified acceptance criteria. In addition, the acetone and n-propylbenzene recoveries in batches WG1057179 and WG1057676, respectively, were high and outside the laboratory specified acceptance criteria. Since acrolein, acetone and n-propylbenzene were not detected in the associated samples, no qualifications were applied to the data.

The LCS recoveries of 1,1,2-trichlorotrifluoroethane (Freon 113) and chloromethane in batches WG1057179 and WG1057676, respectively, were low and outside the laboratory specified acceptance criteria. Therefore, the nondetect results of 1,1,2-trichlorotrifluoroethane and chloromethane in the associated samples were UJ qualified as estimated less than the RDLs.

Sample ID	Compound	Laboratory Concentration (mg/L)	Laboratory Flag	Validation Concentration (mg/L)	Validation Qualifier*	Reason Code**
MW18DS-122217-102.5	Freon 113	0.0010	U,J4	0.0010	UJ	5
MW18DS-122217-105	Freon 113	0.0010	U,J4	0.0010	UJ	5
MW18DS-122217-107.5	Freon 113	0.0010	U,J4	0.0010	UJ	5
MW18DS-122217-109	Freon 113	0.0010	U,J4	0.0010	UJ	5
TRIP BLANK	Chloromethane	0.0025	U,J4	0.0025	UJ	5

mg/L- milligram per liter
U-not detected at or above the stated RDL
J4-laboratory flag indicating that the associated batch QC was outside the established QC range for accuracy
* Validation qualifiers are defined in Attachment 1 at the end of this memo
** Reason codes are defined in Attachment 2 at the end of this memo

1.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

1.7 Field Duplicate

Two field duplicates, CMW18DS-110717-D and TS-C-EFF-110717 DUP, were collected with the sample sets. Acceptable precision (RPD <30%) was demonstrated between the field duplicates and the original sample CMW18DS-110717 and TS-C-EFF-110717, respectively.

1.8 Trip Blank

The following trip blanks accompanied the sample shipments: TRIP BLANK accompanied the samples in L945318; TRIP BLANK LOT #387 accompanied the samples in L949531; TRIP BLANK #1549 accompanied the samples in L951871; TRIP BLANK, accompanied the samples in L959754. VOCs were not detected in the trip blank above the RDLs.

As noted above, there was a trip blank listed on the COC in report L949550, but it was not received by the laboratory. No qualifications were applied to the data, but the discrepancy should be noted by the data user.

1.9 Sensitivity

The sample results were reported to the RDLs. No elevated non-detect values were reported.

1.10 Electronic Data Deliverables (EDDs) Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II report at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the RDLs in the level II reports; both the RDLs and the method detection limits (MDLs) were listed in the EDDs. It was also noted that the data were reported in units of parts per million (ppm) in the EDDs, while the sample data were reported in units of parts per billion (or microgram per liter, µg/L) in the level II reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

2.0 SELECTED VOLATILE ORGANIC COMPOUNDS BY EPA METHOD TO-15

The air samples were analyzed for VOCs per EPA Method TO-15.

The areas of data review are listed below. A leading check mark (✓) indicates an area of review in which the data were acceptable. A preceding crossed circle (⊗) signifies areas where issues

were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Time
- ✓ Method Blank
- ✓ Laboratory Control Sample
- ✓ Laboratory Duplicate
- ✓ Surrogates
- ✓ Field Duplicate
- ✓ Trip Blank
- ✓ Sensitivity
- ✓ Electronic Data Deliverables Review

2.1 Overall Assessment

The selected VOC data reported in this package are considered usable for meeting project objectives. The analytical completeness, defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding Time

The holding time for the VOC analysis of a sample collected in a SUMMA canister is 30 days from collection to analysis. The holding times were met for the sample analyses.

2.3 Method Blank

Method blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three method blanks were reported (batches P170920, P171021 and P171117). VOCs were not detected in the method blanks above the method reporting limits (MRLs).

2.4 Laboratory Control Sample

LCSs were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). Three LCSs were reported. The recovery results were within the laboratory specified acceptance criteria.

2.5 Laboratory Duplicate

Laboratory duplicates were not reported.

2.6 Surrogates

Acceptable surrogate recoveries were reported for the sample analyses.

2.7 Field Duplicate

A field duplicate was not collected with the air samples.

2.8 Trip Blank

A trip blank was not shipped with the air sample sets.

2.9 Sensitivity

The sample results were reported to the MRLs. Elevated non-detect values were reported for the samples due to the sample dilutions analyzed.

2.10 Electronic Data Deliverables Review

Results and sample IDs in the EDDs were reviewed against the information provided by the associated level II reports at a minimum of 20% as part of the data validation process. It was noted that the samples were reported to the MRLs in the level II reports; both the MRLs and the MDLs were listed in the EDDs. It was also noted that the data were reported in micrograms per cubic meter ($\mu g/m^3$) in the EDDs, while the sample data were reported in both $\mu g/m^3$ and parts per billion by volume (ppbv) in the level II reports. This did not affect the quality of the data. No other discrepancies were identified between the level II reports and the EDDs.

---

* * * * *

ATTACHMENT 1
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by Geosyntec's Data Validation Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

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.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA VALIDATION REASON CODES
Assigned by Geosyntec's Data Validation Team

Valid Value	Description
1	Preservation requirement not met
2	Analysis holding time exceeded
3	Blank contamination (i.e., method, trip, equipment, etc.)
4	Matrix spike/matrix spike duplicate recovery or RPD outside limits
5	LCS recovery outside limits and RPD outside limits (LCS/LCSD)
6	Surrogate recovery outside limits
7	Field Duplicate RPD exceeded
8	Serial dilution percent difference exceeded
9	Calibration criteria not met
10	Linear range exceeded
11	Internal standard criteria not met
12	Lab duplicates RPD exceeded
13	Other

RPD-relative percent difference

APPENDIX G
Expanded SVE Work Plan

Geosyntec consultants

621 SW Morrison St., Suite 600
Portland, OR 97205
PH 503.222.9518
www.geosyntec.com

February 19, 2018

Mr. Kenneth Thiessen
Oregon Department of Environmental Quality
700 NE Multnomah St., Suite #600
Portland, Oregon 97232

Subject: Work Plan for Soil Vapor Extraction System Expansion
East Multnomah County Troutdale Sandstone Aquifer Remedy
Fairview, Oregon (ECSI #1479)

Dear Ken:

Geosyntec Consultants (Geosyntec) has prepared this Work Plan on behalf of Cascade Corporation (Cascade) and The Boeing Company (Boeing) to describe the operation and performance of the current soil vapor extraction (SVE) system and recommend additional three wells (VMW-E, VMW-F, and VMW-G) be installed and added to the system. The SVE system is part of the East Multnomah County Troutdale Sandstone Aquifer (TSA) remedy being conducted jointly by Cascade and Boeing under the Department of Environmental Quality's (DEQ's) Consent Order No. WMCSR-NWR-96-08 (DEQ, 1997). Previously DEQ approved the December 2014 SVE system installation work plan (Geosyntec, 2014) and the November 2016 system expansion work plan (Geosyntec 2016). The SVE system has effectively removed approximately 50 pounds of volatile organic compounds (VOCs) from the unsaturated zone of the TSA.

CURRENT SVE SYSTEM

The current SVE system was installed in March/April 2015 and utilized 3 existing vapor monitoring wells (VW-17) with screens at depths of 42.5, 75, and 95.5 feet below ground surface (bgs). The shallow well (VW-17-42.5) was constructed with a 5-foot screen, while the two deep wells (VW-17-75 and VW-17-95.5) were constructed with 20-foot screens. The three wells were installed near the Central Treatment System (CTS) in the vicinity of groundwater monitoring well CMW-17ds.

In 2017, VW-17d-42.5 and VW-17d-75 were shut down with approval from DEQ (DEQ, 2017) based on declining VOC vapor concentrations. Four new SVE wells (VMW-A, VMW-B, VMW-C, and VMW-D) were installed in November 2016 to increase VOC mass removal in the unsaturated zone above the TSA groundwater and to expand the aerial coverage of the SVE system in the direct vicinity of the mound area. The five active SVE wells, CMW-17ds, and the CTS are shown on Figure 1.

The SVE system contains a blower rated for 900 standard cubic feet per minute (scfm), a moisture separator prior to the blower, and an exhaust stack that discharges 10 feet above ground surface. Aboveground polyvinyl chloride (PVC) piping to VW-17d-95 and underground PVC piping to VMW-A through VMW-D connects the vapor wells to the blower.

EXISTING SVE SYSTEM PERFORMANCE

Through January 2018, the SVE system has operated greater than 98% of the time and currently extracts an average of approximately 430 scfm of soil vapor at a vacuum of 4 inches of mercury (in Hg). The initial target extraction rate of approximately 160 scfm was increased in November 2015 and then again in November 2016 to the present flow (Figure 2) in order to optimize VOC mass removal and vary subsurface flow patterns. System process data is collected weekly for vacuums, flowrates, temperatures, and field VOC measurements using a photoionization detector [PID] of the SVE effluent. Process data readings are provided in Attachment A.

Vapor samples from the five SVE wells are collected on a quarterly basis (Table 1), and SVE system effluent samples are collected on a monthly basis (Table 1) for laboratory analysis. Field and laboratory VOC concentrations over time are shown for the SVE effluent in Figure 3 and for the vapor wells in Figure 4. VOC concentrations have decreased significantly in three of the operating SVE wells (VW17D-95.5, VMW-A, and VMW-B) since their respective startups. Based on the decreased VOC concentrations observed in these wells, it is recommended that these three wells be shut down.

Based on monthly laboratory results[1], nearly 50 pounds of VOCs have been removed through January 2018 (Figure 5). The removal efficiency is consistent with the removal efficiency of 10 to 20 pounds per year estimated in the original Work Plan (Geosyntec, 2014). The system effluent discharge rates have been below the DEQ's de minimis threshold for treatment of VOCs in air discharge effluent of one ton per year for total VOCs as hazardous air pollutants [OAR 340-200-0020]. As a result, treatment is not required, and vapor is discharged directly to the atmosphere via the stack.

Groundwater analytical results indicate VOC concentrations in CMW-17ds have shown a decreasing trend since February 2017 (Figure 6) with TCE concentrations decreasing from 42 to 16 µg/L. The combined treatment of the CTS (groundwater VOC mass removal) and the SVE (unsaturated VOC mass removal) are thought to be expediting the cleanup in the vicinity of the well by removing VOC mass from the unsaturated zone (formerly saturated prior to groundwater

[1] Monthly laboratory data is used rather than weekly PID field measurements to estimate mass removal rates, since laboratory data is believed to be more accurate and reliable. Field PID removal rates are included for reference.

drawdown from the remedy pumping), the capillary fringe, and VOCs that are potentially diffusing from the groundwater.

PROPOSED SVE SYSTEM EXPANSION

Installation of three new SVE wells (VMW-E, VMW-F, and VMW-G) is proposed to increase VOC mass removal in the unsaturated zone above the TSA groundwater near CMW-18ds with reported TCE concentrations ranging from 59.5 to 87.1 µg/L in 2017. Due to the limited number of existing extraction and observation wells around existing SVE wells, radius of influence (ROI) data is not available. A 50-foot ROI (100-foot spacing) is assumed for proposed well placement. Existing SVE wells VW-17d-95.5, VMW-A, and VMW-B will be shut down and utilized as groundwater and vacuum monitoring (or observation) wells, if possible, following installation of the new wells. Proposed SVE well locations are shown on Figure 1.

Vapor Well Locations

CMW-18ds is located on ODOT property and in the direct vicinity of residential housing, which limits drilling access; therefore, the SVE wells are proposed at locations on Cascade property. The wells will be directionally-drilled eastward beneath NE 201st Ave such that the SVE well screens terminate near the east side of NE 201st Ave in the vicinity of CMW-18ds. The boreholes will be advanced at an approximate 45-degree angle for a total estimated drilled length of 150 feet. The boreholes will be beneath the underground utilities located in NE 201st Ave, where the maximum invert depth is approximately 15 feet bgs in the west side of the roadway. Drilling operations and equipment will be staged on Cascade property to utilize existing SVE infrastructure and electricity, minimize noise disturbance to the neighborhood, avoid above- and below-ground utilities along/beneath NE 201st Avenue, and to eliminate the need for additional access agreements. A right-of-way permit will be needed to drill beneath NE 201st Ave, and the existing access agreement with ODOT will be amended to acknowledge these well locations beneath these properties. A cross section of the proposed drilling area is included in Figure 7.

Well Installation and Construction

The three well borings will be drilled using a sonic drill rig. Telescoping drilling methods (i.e. a stepdown) will be used at the contact between the Troutdale Gravel Aquifer (TGA) and underlying Confining Unit 1 (CU1). The boring will be drilled using 8-inch casing and a 6-inch diameter core barrel, stepped down to 6-inch casing with a 4-inch core barrel. Prior to advancing the 6-inch casing, the borehole will be backfilled with bentonite and allowed to set to minimize downward migrations of possible contaminants from one aquifer to another. Soil will be cored continuously and will be field screened for VOCs during drilling using a PID. Target depths for the borings will be approximately five feet beneath first encountered groundwater in the TSA, which is estimated to occur at 100 to 105 feet bgs (based on well CMW-18ds). The depth to groundwater

during the February 2018 monitoring event was 100 feet bgs at CMW-18ds. If groundwater is not encountered, the borings will be extended to a maximum depth of 110 feet bgs (or 165 feet total drilled length), and field observations and field screening results (i.e. PID measurements) will be used to evaluate well screen placement depths.

The wells will be installed with a 30-foot screen to a depth of approximately 110 feet bgs spanning the water table to allow for groundwater sampling as well as vapor extraction. Based on the estimated 45-degree drilling angles, the boring will be advanced approximately 150 lineal feet, with the screen located between approximately 120 to 150 lineal feet or 90 to 110 vertical feet bgs. At this time, a packer system is not anticipated to be necessary to separate the vapor and groundwater well screens, since the proposed vacuum is not strong enough to pull water into the SVE system. The applied vacuum will be monitored and adjusted to prevent groundwater rise above the top of the vapor screen. The wells will be constructed of 2-inch diameter, schedule 40 PVC, with a 0.01-inch (10-slot) screen and 10/20 silica sand filter pack.

Investigation derived waste (IDW) will consist of soil cuttings and water generated during drilling and well development. Soil cuttings will be stored on-site in 55-gallon drums or roll-off boxes to be dewatered as necessary, pending characterization and off-site permitted disposal. Water will be stored on-site in totes or a larger water storage container and solids will be settled out. Water will be treated through the on-site water treatment system (CTS) and ultimately discharged under the existing National Pollutant Discharge Elimination System permit. Remaining solids will be added to a soil roll off box prior to characterization and off-site disposal.

Vapor Well Startup

The new SVE wells will be connected to the existing SVE manifold with PVC piping buried approximately one-foot bgs (Figure 8). Valving and gauging will be installed to allow for vapor transfer and process data collection. Although significant water production is not expected, entrained water will be separated from the vapor with the current in-line moisture separator, and the collected liquids will be transferred to the CTS for treatment and disposal.

The SVE system will remain within the site chain-link fence to prevent unauthorized access. Process data and PID SVE effluent concentrations will continue to be recorded in the field on a weekly basis. Monthly SVE effluent and quarterly well vapor samples will be collected in evacuated 1.0-liter summa canisters for laboratory analysis. The summa canister samples will be analyzed for cVOCs by EPA Method TO-15. Groundwater samples will be collected every other month from the new wells to evaluate initial and post-startup groundwater VOC concentrations. After six months of monthly sampling, the sampling frequency will be evaluated and possibly reduced to quarterly monitoring.

EXPECTED EXPANDED SVE SYSTEM PERFORMANCE

The modified SVE system is expected to be operated for approximately 24 months, at a flow rate of approximately 625 scfm (125 scfm for each of the 5 wells) and an applied vacuum of 4 in Hg. Based on the long-term VOC concentrations observed in VW-17d-95.5, VMW-C, and VMW-D, VOC concentration are expected to stabilize around 1,000 micrograms per cubic meter. An additional 40 to 50 pounds of VOC mass is expected to be removed with the SVE system during the first 24 months of operation, based on the expected flows and concentrations. These discharge rates are estimated to remain below DEQ's de minimis treatment threshold of one ton per year for total VOCs and, as a result, effluent treatment is not planned.

DATA EVALUATION AND REPORTING

Field data collected from the SVE system will be evaluated on a weekly basis to track and optimize system performance and to estimate VOC mass removal. The extracted VOC concentration and mass removal levels over time will be used to assess system performance. Operation of the system will be modified or discontinued once mass removal rates reach asymptotic levels.

System performance data, along with recommendations for system modifications, continued operation of the system, and/or termination of system operation, will be included in the 2018 TSA annual report. Bimonthly/quarterly groundwater sample results will also be included in the 2018 TSA annual report.

CLOSURE

We look forward to your review and approval of this Work Plan. Please contact us at (503) 222-9518 with any questions regarding this Work Plan or if you need additional information.

Sincerely,

Geosyntec Consultants, Inc.

Cindy Bartlett, R.G.
Senior Geologist/Project Manager

Brent A. Miller, P.E.
Senior Principal

Cc: Jason Hegdahl, Cascade Corporation
Nick Garson, The Boeing Company
Chris Kimmel, Landau Associates

References:

Geosyntec, 2014. Work Plan for Soil Vapor Extraction System Installation and Operation, East Multnomah County Troutdale Sandstone Aquifer Remediation, Fairview, Oregon, 3 December 2014.

Geosyntec, 2016. Work Plan for Soil Vapor Extraction System Expansion, East Multnomah County Troutdale Sandstone Aquifer Remediation, Fairview, Oregon, 9 September 2016.

Oregon Department of Environmental Quality (DEQ), 2017. Email from B. Williams, Approval of 2016 TSA Annual Report. 16 June 2017.

Attachments:

Table 1	SVE Well cVOC Vapor Concentrations
Figure 1	Site and Well Locations
Figure 2	SVE Extracted Vapor Flow
Figure 3	SVE Effluent cVOC Vapor Concentration
Figure 4	SVE Well cVOC Vapor Concentrations
Figure 5	SVE System Mass Removal
Figure 6	TCE Concentration Profile CMW-17(ds)
Figure 7	Well Cross Section
Figure 8	Expanded SVE Equipment Diagram
Attachment A	SVE Process Data

Tables

Table 1. SVE System Vapor Sampling Results (Cascade Corporation, Fairview, OR)

	System Outlet																
Compound	4/28/15	5/26/15	6/30/15	7/28/15	9/10/15	9/29/15	10/27/15	11/30/15	12/28/15	1/26/16	2/23/16	3/15/16	4/27/16	5/24/16	6/21/16	7/26/16	8/24/16
cis-1,2-Dichloroethene	520	350	310	270	220	230	200	210	67	160	160	140	140	140	150	75	96
Trichloroethene	6,000	6,000	4,900	3,700	3,100	3,300	2,500	2,900	760	2,100	1,700	1,800	1,800	1,900	1,700	940	1,100
Tetrachloroethene	370	490	360	270	230	220	210	200	57	170	120	140	130	170	110	69	84
TOTAL cVOCs	6,890	6,840	5,570	4,240	3,550	3,750	2,910	3,310	884	2,430	1,980	2,080	2,070	2,210	1,960	1,084	1,280

	System Outlet															
Compound	6/4/16	6/4/16	12/14/16	1/10/17	2/7/17	3/7/17	4/11/17	5/9/17	6/6/17	7/11/17	8/8/17	9/12/17	10/10/17	11/7/17	12/12/17	1/9/18
cis-1,2-Dichloroethene	0	0	0	160	110	99	130	96	100	76	65	60	61	68	60	38
Trichloroethene	0	0	0	2,000	1,400	1,400	1,400	1,400	1,300	1,100	1,000	770	870	970	860	490
Tetrachloroethene	0	0	0	140	120	160	140	140	140	110	110	73	88	84	88	58
TOTAL cVOCs	0	0	0	2,300	1,630	1,659	1,670	1,636	1,540	1,286	1,175	903	1,019	1,122	1,008	586

	Well VW17D-42.5							Well VW17D-75						
Compound	4/28/15	7/28/15	10/27/15	11/30/15	1/26/16	3/15/16	6/21/16	4/28/15	7/28/15	10/27/15	11/30/15	1/26/16	3/16/16	6/21/16
cis-1,2-Dichloroethene	390	150	130	4	*1.1*	3	72	400	150	70	53	58	52	*1.1*
Trichloroethene	2,800	1,200	1,200	31	*1.1*	17	440	4,500	950	520	710	1,600	550	*1.1*
Tetrachloroethene	97	54	53	*1.9*	*1.1*	13	25	260	140	120	120	120	93	*1.1*
TOTAL cVOCs	3,287	1,404	1,383	37	3	33	537	5,160	1,240	710	883	1,778	695	3

	Well VW17D-95.5												
Compound	4/28/15	7/28/15	10/27/15	11/30/15	1/26/16	3/15/16	6/21/16	9/27/16	12/14/16	1/10/17	2/7/17	5/9/17	8/8/17	11/7/17
cis-1,2-Dichloroethene	750	180	44	140	160	160	170	150	7	110	86	76	54	65
Trichloroethene	11,000	2,500	530	2,000	2,100	2,100	1,800	1,200	71	830	590	560	410	370
Tetrachloroethene	660	200	49	150	170	140	140	99	5	54	45	35	26	25
TOTAL cVOCs	12,410	2,880	623	2,290	2,430	2,400	2,110	1,449	83	994	721	671	490	460

	Well VMW-A							Well VMW-B						Well VMW-C						Well VMW-D					
Compound	12/14/16	1/10/17	2/7/17	2/7/17	5/9/17	8/8/17	11/7/17	12/14/16	1/10/17	2/7/17	5/9/17	8/8/17	11/7/17	12/14/16	1/10/17	2/7/17	5/9/17	8/8/17	11/7/17	12/14/16	1/10/17	2/7/17	5/9/17	8/8/17	11/7/17
cis-1,2-Dichloroethene	590	67	37	37	*1.1*	15	10	49	140	48	*1.2*	*1.1*	*1.0*	6	260	*1.0*	200	140	140	360	290	250	110	140	*1.0*
Trichloroethene	9,000	680	500	530	*1.1*	430	120	1,000	1,600	580	2.7	2.5	*1.0*	73	3,000	*1.0*	3,000	2,700	2,500	*9.5*	6,600	3,600	1,600	2,300	*1.0*
Tetrachloroethene	350	54	56	58	*1.1*	64	17	71	110	53	*1.2*	*1.1*	*1.0*	4	200	*1.0*	390	320	210	440	430	330	160	190	*1.0*
TOTAL cVOCs	9,940	801	593	625	3	509	147	1,120	1,850	681	5	5	3	82	3,460	3	3,590	3,160	2,850	810	7,320	4,180	1,870	2,630	3

All values are in micrograms per cubic meter (ug/m^3)

Notes:

cVOCs	=	Chlorinated volatile organic compounds
1.9	=	Red, underlined values shown as U flagged
1.1	=	Blue, underlined values shown as 1/2 MRL

Figures

SantaBarbara-01\Data P:\GIS\PNG\0564 - Cascade\Projects\2018\SVE WP\Fig00 SVE Angled Borings Proposed Locations.mxd (Author: SAntonelli) 2018/2/2

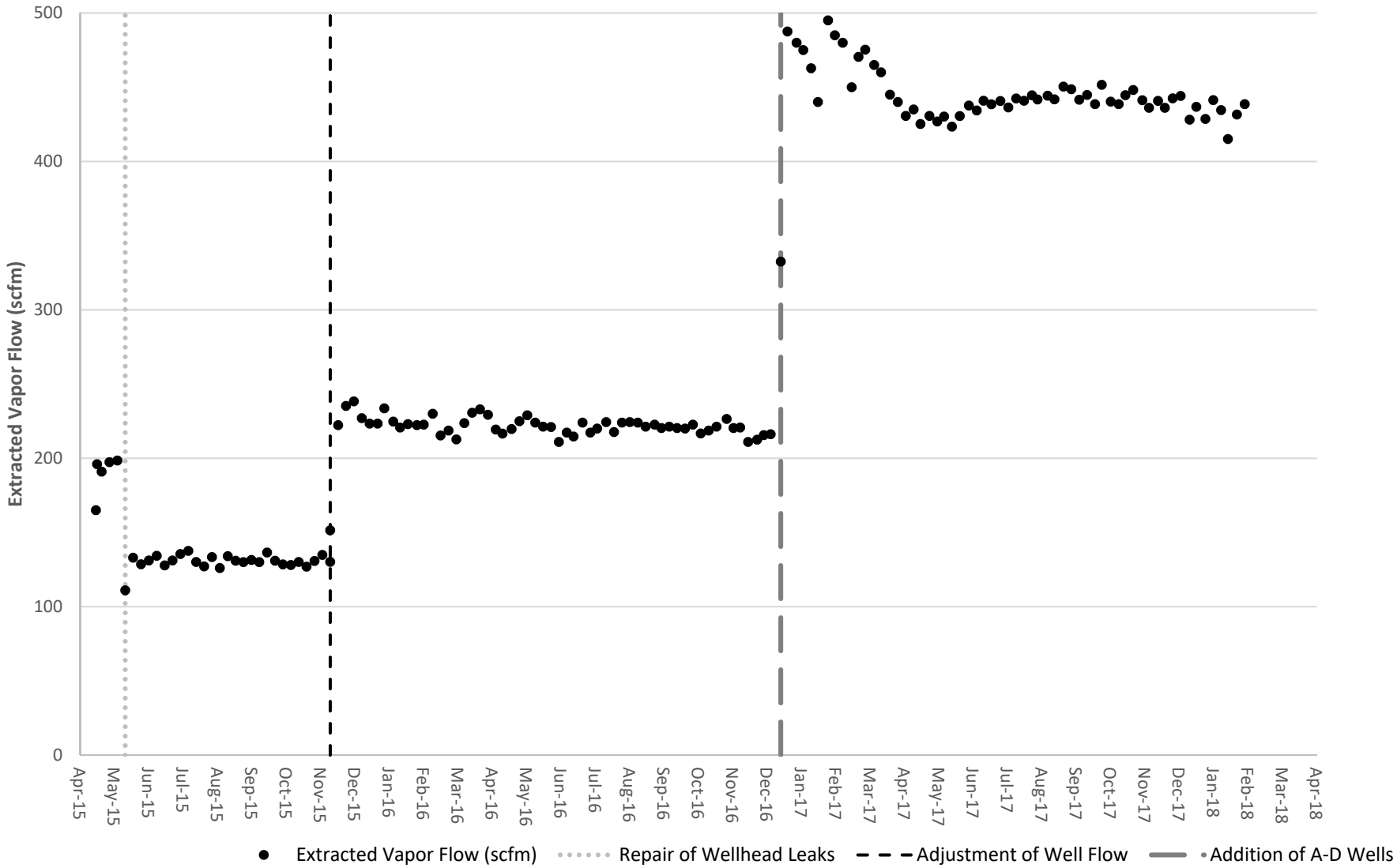
Site and Well Locations - East Multnomah County Troutdale Sandstone Aquifer Remedy

East Multnomah County

Geosyntec consultants

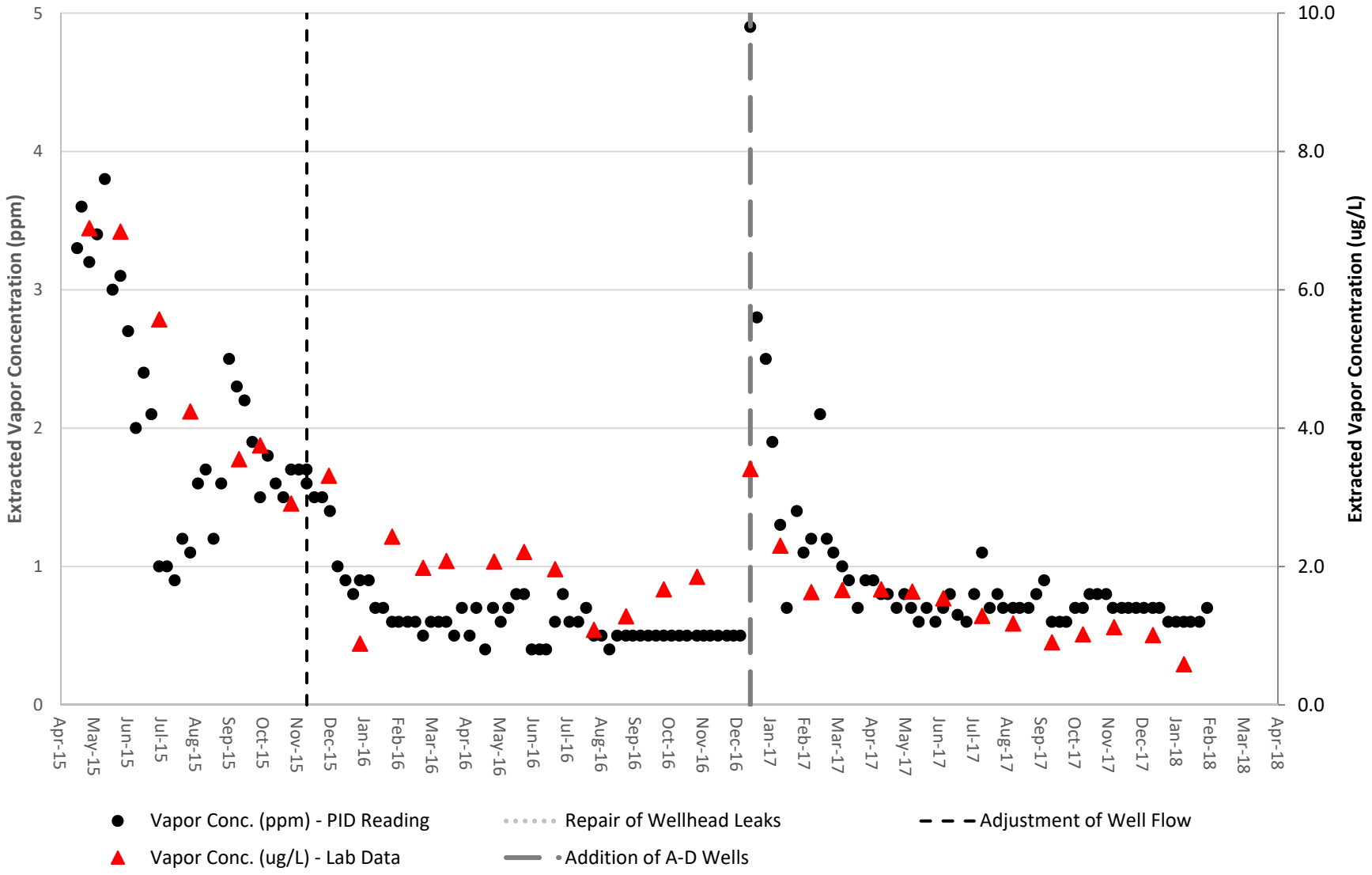
PNG0564S16 | February 2018

Figure 1



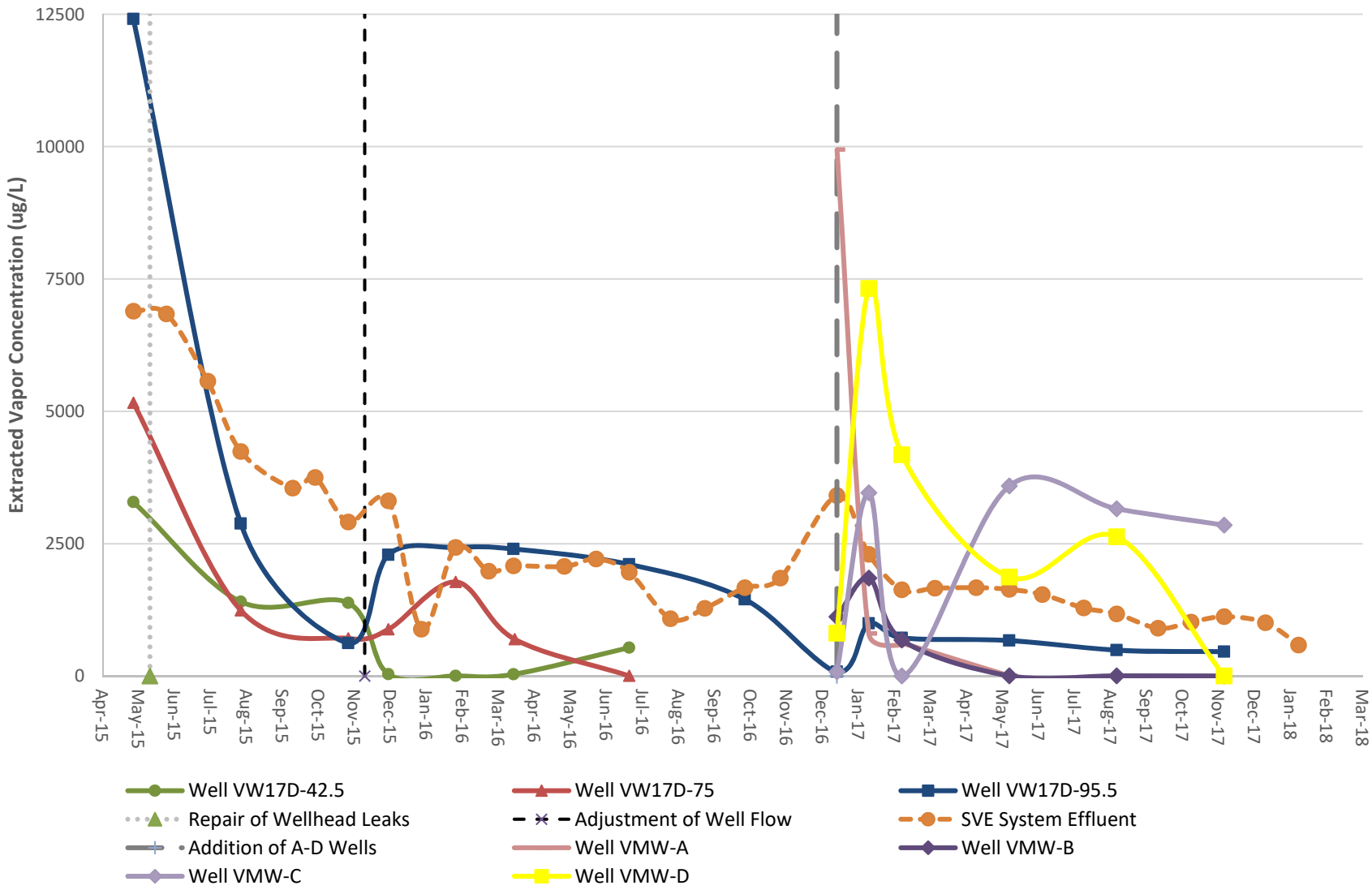
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Extracted Vapor Flow (Weekly Average)** **TSA Remedy**	Figure 2



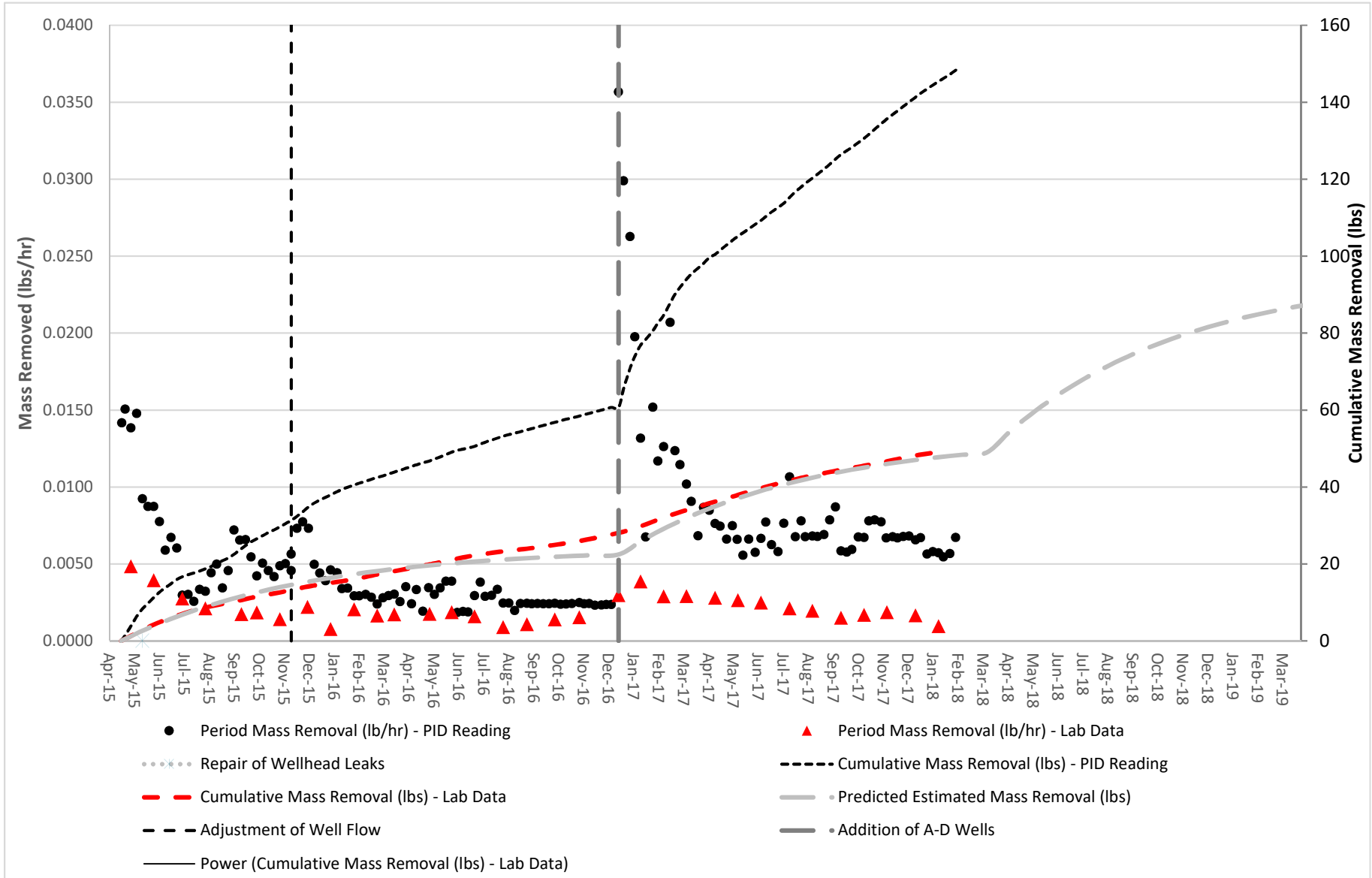
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Effluent cVOC Vapor Concentration** **TSA Remedy**	Figure 3



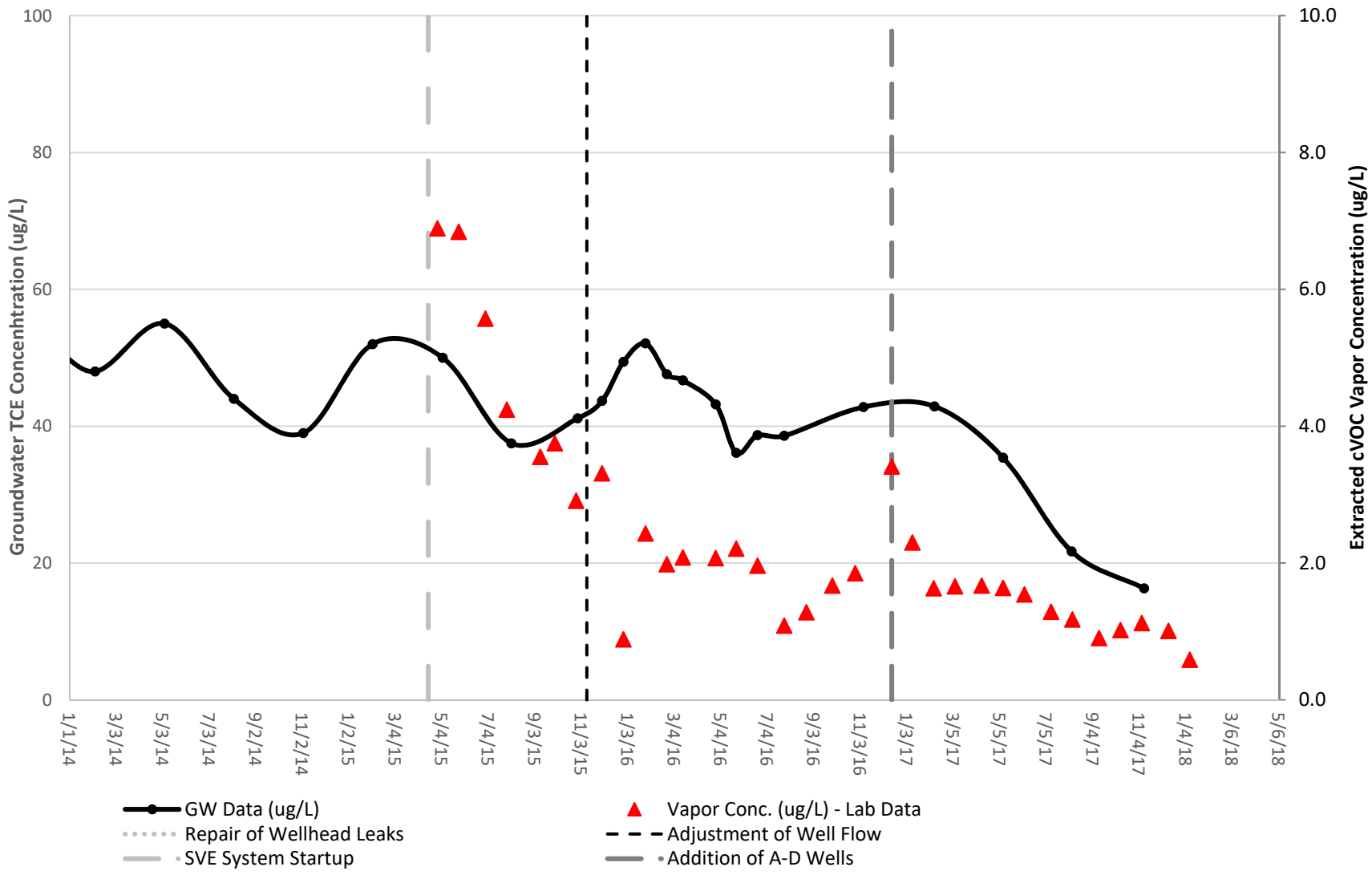
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Well cVOC Vapor Concentrations** **TSA Remedy**	Figure 4



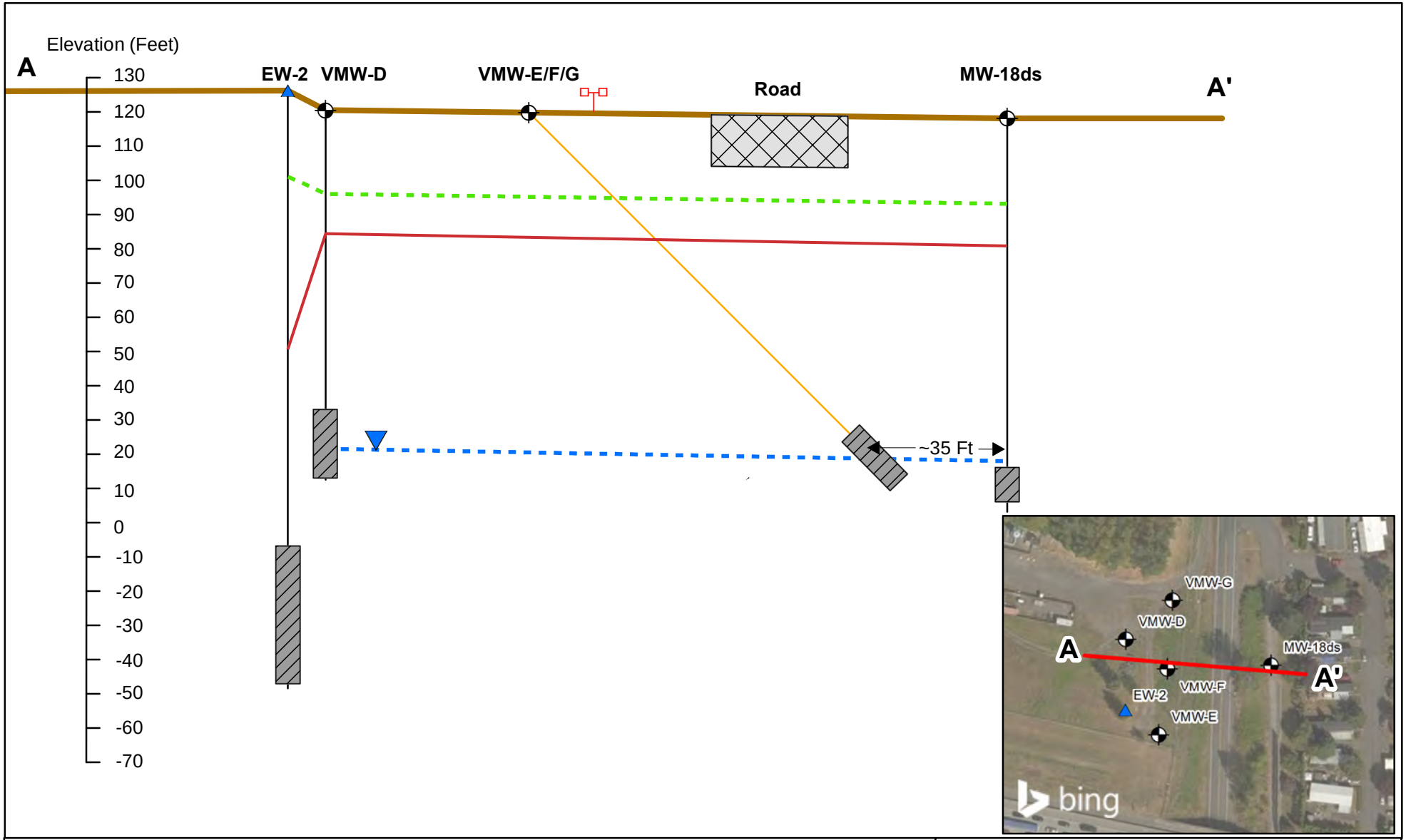
Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE System Mass Removal** **TSA Remedy**	Figure 5



Geosyntec consultants

Cascade Corporation Gresham, Oregon	**SVE Vapor Concentration versus Grondwater Concentration** **CMW-17(ds)** **TSA Remedy**	Figure 6



Legend

- Boring Location
- Well location
- Powerlines
- Well Screen
- Utility Location
- Ground Surface
- CU1
- Top TSA
- Ground Water Elevation
- Well Borehole
- 30 Degree Boring
- 45 Degree Boring

0 25 50 100 Feet

Schematic Cross Section, SVE Angle Borings

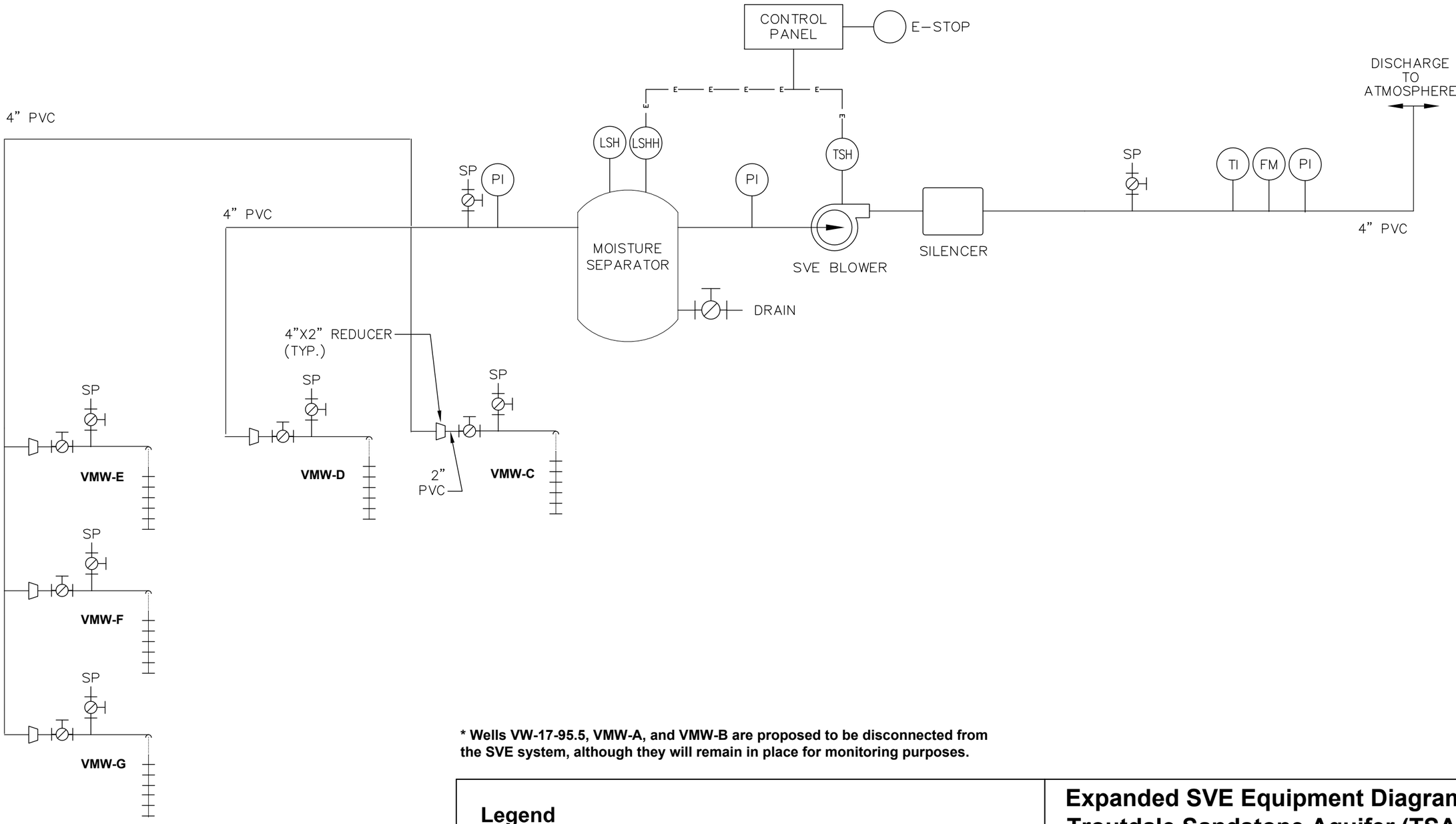
Cascade Corporation, 2525 NE 201st Ave, Fairview, OR

Geosyntec consultants

PNG0564S17 | January 2018

Figure 7

P:\CAD_GIS\Projects\Cascade_TSA\MXDs\Cross-Section.mxd 1/22/2018 9:31:58 AM



*** Wells VW-17-95.5, VMW-A, and VMW-B are proposed to be disconnected from the SVE system, although they will remain in place for monitoring purposes.**

Legend

TI	=	Temperature Indicator	LSHH	=	Level Switch - High-High
FM	=	Flow Meter	SP	=	Sample Point
PI	=	Pressure Indicator	TSH	=	Temperature Switch - High
LSH	=	Level Switch - High	E-Stop	=	Emergency Stop

Expanded SVE Equipment Diagram Troutdale Sandstone Aquifer (TSA)

East Multnomah County

Geosyntec consultants

PNG0564S | February 2018

FIGURE 8

O:\Clients\Cascade_Corporation\Projects\PNG0564S_TSA\Analyses_Technical\SVE\Proposed SVE System Equipment TSA Fig 1.dwg

Attachment A
SVE Process Data

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	Target	4/16/2015	4/17/2015	4/21/2015	4/28/2015	5/5/2015	5/12/2015	5/19/2015	5/26/2015	6/2/2015	6/9/2015	6/16/2015	6/23/2015	6/30/2015	7/7/2015	7/14/2015	7/21/2015	7/28/2015	8/4/2015	8/11/2015	8/18/2015	8/25/2015	9/1/2015
Time	---	---	12:30	15:30	10:00	11:45	16:00	12:30	13:30	12:30	13:20	12:10	10:10	8:40	10:05	13:00	11:30	9:30	14:30	7:15	12:00	11:30	14:40	13:20
System shutdown time	hrs	---	0	0	18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Vacuums																								
SVE System Inlet	in Hg	~9	4	3.03	3.2	3.9	3.3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
VW-17d-42.5	in Hg	6-7	<1	0.03	0.02	2	1.8	1.2	1.2	2.52	1	1.1	1	1	1	0.9	0.08	1	1	1	1	1	1	1
VW-17d-75	in Hg	6-7	1	1	1	2.9	2.1	5	5	5.11	5	5	5	4.9	5	4.9	4.8	4.6	4.8	4.7	4.8	4.7	4.8	4.8
VW-17d-95.5	in Hg	5-6	2	2	2	3.5	3.1	1.4	2	2.65	1.9	1.8	1.4	1.4	1.3	1.2	1	1	1	1	1	1	1	1.2
VMW-A	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	PSI	--	--	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temperatures																								
Ambient	Degrees F	--	NA	NA	NA	60	61	57	60	63	60	81	68	63	74	82	75	71	82	60	73	79	77	78
SVE System Inlet	Degrees F	--	--	NA	74.4	68.9	69.8	63.1	64.7	66.9	65.3	90.2	74.5	77.8	76.3	81	76	73	76	66.8	72	75	74	76
VW-17d-42.5	Degrees F	--	--	76.1	74.2	77.1	70.5	62.9	68.7	70.1	67.1	90.1	75.6	76.4	75.1	78	74	70	74	74.3	78	79	77	77
VW-17d-75	Degrees F	--	--	75.5	73.3	77.8	72.1	63.1	70.6	72	69.9	90.2	75.2	77.3	76.9	80	77	73	77	70.6	81	80	79	78
VW-17d-95.5	Degrees F	--	--	73.3	70.4	77.9	73.4	63.2	64	68.1	62.8	88.8	74.8	76.4	76	74	70	70	74	69.3	73	74	73	73
VMW-A	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	Degrees F	--	126	145	140	118.8	118	124	180	148.1	180	190	185	188	180	190	138	140	145	160	150	180	185	160
Concentrations																								
SVE System Outlet: Field Data	ppm	--	--	3.3	3.6	3.2	3.4	3.8	3	3.1	2.7	2	2.4	2.1	1	1	0.9	1.2	1.1	1.6	1.7	1.2	1.6	2.5
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	150-160	165	159	168	164.1	174.1	130	133.1	130.3	129.8	130.3	129.2	129.8	133.1	130.4	127.8	124.1	128.9	127	131	128	134	130.5
VW-17d-42.5 (2" pipe)	scfm	15-20	16.5	15.1	15.8	18.5	18.2	17	17.5	17	17.1	19.8	19.1	22.2	24.2	22.1	19.9	18	21.1	17.2	18	17.5	18.1	17.5
VW-17d-75 (2" pipe)	scfm	65-75	73	72.5	67.5	67.5	69.1	70.3	65.2	64.1	65.8	68.5	68.1	70.5	72.5	70.8	66.1	65	68.1	66.5	65.5	65	66	60.5
VW-17d-95.5 (2" pipe)	scfm	70-80	72	72.1	79.5	72.5	74.1	74.5	78	75.3	76.5	79.5	72.3	80.3	78.1	76.3	73.4	72.1	75.4	76.5	77.1	78.5	80	78.5
VMW-A (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet (3" pipe)	scfm	150-160	165	196	191	197.4	198.5	111	133	128.6	131.1	134.3	127.8	131.1	135.5	137.6	130.1	127.1	133.4	126	134	131	130	131.5
Calculations																								
Operating Time																								
Period Operating Time	hrs	---	---	27.00	72.50	169.75	172.25	163.50	169.00	167.00	168.83	166.83	166.00	166.50	169.42	170.92	166.50	166.00	173.00	160.75	172.75	167.50	171.17	164.67
Period Time	hrs	---	---	27.00	90.50	169.75	172.25	164.50	169.00	167.00	168.83	166.83	166.00	166.50	169.42	170.92	166.50	166.00	173.00	160.75	172.75	167.50	171.17	166.67
Period Operating %	%	---	---	100%	80%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%
Cumulative Operating Time	hrs	---	---	27.00	99.50	269.25	441.50	605.00	774.00	941.00	1109.83	1276.67	1442.67	1609.17	1778.58	1949.50	2116.00	2282.00	2455.00	2615.75	2788.50	2956.00	3127.17	3291.83
Cumulative Time Since Startup	hrs	---	---	27.00	117.50	287.25	459.50	624.00	793.00	960.00	1128.83	1295.67	1461.67	1628.17	1797.58	1968.50	2135.00	2301.00	2474.00	2634.75	2807.50	2975.00	3146.17	3312.83
Cumulative Operating %	%	---	---	100.0%	84.7%	93.7%	96.1%	97.0%	97.6%	98.0%	98.3%	98.5%	98.7%	98.8%	98.9%	99.0%	99.1%	99.2%	99.2%	99.3%	99.3%	99.4%	99.4%	99.4%
Flow Rates																								
Well Flow Rate	scfm			159.70	162.80	158.50	161.40	161.80	160.70	156.40	159.40	167.80	159.50	173.00	174.80	169.20	159.40	155.10	164.60	160.20	160.60	161.00	164.10	156.50
Outlet Flow Rate	scfm			196.00	191.00	197.40	198.50	111.00	133.00	128.60	131.10	134.30	127.80	131.10	135.50	137.60	130.10	127.10	133.40	126.00	134.00	131.00	130.00	131.50
Well/Outlet Comparison	%			81%	85%	80%	81%	146%	121%	122%	122%	125%	125%	132%	129%	123%	123%	122%	123%	127%	120%	123%	126%	119%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	--	--	19.29	21.04	18.71	19.88	22.21	17.54	18.12	15.78	11.69	14.03	12.28	5.85	5.85	5.26	7.01	6.43	9.35	9.94	7.01	9.35	14.61
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	--	--	0.0142	0.0151	0.0138	0.0148	0.0092	0.0087	0.0087	0.0078	0.0059	0.0067	0.0060	0.0030	0.0030	0.0026	0.0033	0.0032	0.0044	0.0050	0.0034	0.0046	0.0072
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	--	--	0.38	1.06	2.45	2.46	1.96	1.52	1.46	1.39	1.14	1.05	1.06	0.76	0.51	0.46	0.49	0.57	0.61	0.81	0.71	0.68	0.97
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	--	--	0.38	1.44	3.89	6.36	8.32	9.84	11.30	12.69	13.83	14.87	15.93	16.69	17.20	17.67	18.16	18.73	19.34	20.15	20.86	21.54	22.51

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	9/8/2015	9/15/2015	9/22/2015	9/29/2015	10/6/2015	10/13/2015	10/20/2015	10/27/2015	11/3/2015	11/10/2015	11/10/2015	11/17/2015	11/24/2015	12/1/2015	12/8/2015	12/15/2015	12/22/2015	12/28/2015	1/5/2016	1/11/2016	1/18/2016	1/26/2016	2/1/2016
Time	---	10:45	12:00	14:00	9:00	11:55	13:20	8:05	8:00	10:00	12:40	13:55	14:15	12:50	12:50	8:15	13:40	12:40	12:40	9:30	14:10	17:15	12:00	13:55
System shutdown time	hrs	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0
Vacuums																								
SVE System Inlet	in Hg	5	4.9	5	5	4.9	5	4.9	5	5	5	4	4	4.2	4	4	4	4	4.2	4.2	4.1	4.1	4	4
VW-17d-42.5	in Hg	1	0.8	0.6	0.8	1	1	1	1	1	1.1	1.2	1.1	2	2	2	2	2.1	2.2	2.1	2.1	2	1.9	2
VW-17d-75	in Hg	4.9	4.7	4.8	4.8	4.9	4.7	4.9	5	4.8	4.8	3.2	3.1	4.2	4	4	4	4	4.2	4	4.1	4	4	4
VW-17d-95.5	in Hg	1.1	1.2	1.1	1	1	1	1	1	1	1.3	3.2	3	4.1	4	4	4	4	4.2	4	4.1	4.1	1	4
VMW-A	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temperatures																								
Ambient	Degrees F	63	60	69	62	69	71	56	46	47	47	47	57	40	33	57	40	44	38	36	48	48	50	41
SVE System Inlet	Degrees F	72	70	74	64	70	72	60	55	56	56	56	56	50	40	51	50	48	47	49	51	48	49	48
VW-17d-42.5	Degrees F	69	62	70	62	68	70	58	54	56	55	56	56	50	40	50	50	48	49	47	51	49	48	48
VW-17d-75	Degrees F	70	68	77	66	72	75	62	56	52	55	56	56	48	38	52	47	48	48	45	48	47	48	48
VW-17d-95.5	Degrees F	68	60	65	62	67	70	62	58	56	56	56	56	50	43	50	50	48	48	47	51	50	50	50
VMW-A	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	Degrees F	158	162	184	160	170	170	135	128	170	130	148	125	150	138	130	135	135	138	135	138	148	140	145
Concentrations																								
SVE System Outlet: Field Data	ppm	2.3	2.2	1.9	1.5	1.8	1.6	1.5	1.7	1.7	1.6	1.7	1.5	1.5	1.4	1	0.9	0.8	0.9	0.9	0.7	0.7	0.6	0.6
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	128.5	128	132	126	130	128.3	126.5	128.3	127.6	128.1	135.1	213.0	229.1	225.1	218.0	219.0	215.7	222.0	215.0	209.0	210.0	213.0	214.7
VW-17d-42.5 (2" pipe)	scfm	16.5	18.5	17.5	17	16.5	17.5	16.3	15.8	23.7	18.6	26.1	25.2	26.3	25.2	25.2	24.8	24.7	25.1	25	25	24.8	24.6	24.5
VW-17d-75 (2" pipe)	scfm	68	73	74.5	71.3	70.5	74	70.1	68.8	68	68.7	101.4	100.8	96.8	95.4	98.7	97.7	98.3	99.6	97.55	96.35	96.1	97.8	96.3
VW-17d-95.5 (2" pipe)	scfm	74.5	78	80	78.5	75.8	77.3	72	75.1	72.5	71.5	103.6	102.1	103.1	101.5	104	101.2	100.5	103.1	100.3	99.8	99.1	100.3	99.8
VMW-A (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet (3" pipe)	scfm	130	136.5	131	128.5	128.1	130.1	127	130.8	134.9	130.2	151.5	222.3	235.3	238.3	227.0	223.3	223.3	233.7	224.7	220.7	223.0	222.3	222.7
Calculations																								
Operating Time																								
Period Operating Time	hrs	165.42	169.25	170.00	163.00	170.92	169.42	162.75	167.92	170.00	170.67	1.25	168.33	154.58	168.00	163.42	173.42	167.00	144.00	188.83	148.67	171.08	186.75	145.92
Period Time	hrs	165.42	169.25	170.00	163.00	170.92	169.42	162.75	167.92	170.00	170.67	1.25	168.33	166.58	168.00	163.42	173.42	167.00	144.00	188.83	148.67	171.08	186.75	145.92
Period Operating %	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	93%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cumulative Operating Time	hrs	3457.25	3626.50	3796.50	3959.50	4130.42	4299.83	4462.58	4630.50	4800.50	4971.17	4972.42	5140.75	5295.33	5463.33	5626.75	5800.17	5967.17	6111.17	6300.00	6448.67	6619.75	6806.50	6952.42
Cumulative Time Since Startup	hrs	3478.25	3647.50	3817.50	3980.50	4151.42	4320.83	4483.58	4651.50	4821.50	4992.17	4993.42	5161.75	5328.33	5496.33	5659.75	5833.17	6000.17	6144.17	6333.00	6481.67	6652.75	6839.50	6985.42
Cumulative Operating %	%	99.4%	99.4%	99.4%	99.5%	99.5%	99.5%	99.53%	99.55%	99.56%	99.58%	99.58%	99.59%	99.38%	99.40%	99.42%	99.43%	99.45%	99.46%	99.48%	99.49%	99.50%	99.52%	99.53%
Flow Rates																								
Well Flow Rate	scfm	159.00	169.50	172.00	166.80	162.80	168.80	158.40	159.70	164.20	158.80	231.10	228.10	226.20	222.10	227.90	223.70	223.50	227.80	222.85	221.15	220.00	222.70	220.60
Outlet Flow Rate	scfm	130.00	136.50	131.00	128.50	128.10	130.10	127.00	130.80	134.90	130.20	151.50	222.33	235.30	238.30	227.00	223.33	223.33	233.67	224.67	220.67	223.00	222.33	222.67
Well/Outlet Comparison	%	122%	124%	131%	130%	127%	130%	125%	122%	122%	122%	153%	103%	96%	93%	100%	100%	100%	97%	99%	100%	99%	100%	99%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	13.44	12.86	11.11	8.77	10.52	9.35	8.77	9.94	9.94	9.35	9.94	8.77	8.77	8.18	5.85	5.26	4.68	5.26	5.26	4.09	4.09	3.51	3.51
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	0.0065	0.0066	0.0054	0.0042	0.0050	0.0046	0.0042	0.0049	0.0050	0.0046	0.0056	0.0073	0.0077	0.0073	0.0050	0.0044	0.0039	0.0046	0.0044	0.0034	0.0034	0.0029	0.0029
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	1.14	1.11	1.02	0.79	0.79	0.81	0.71	0.76	0.84	0.82	0.01	1.09	1.16	1.26	1.00	0.81	0.69	0.61	0.85	0.58	0.58	0.59	0.43
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	23.65	24.76	25.78	26.57	27.36	28.17	28.88	29.64	30.48	31.30	31.31	32.40	33.56	34.82	35.82	36.64	37.33	37.94	38.80	39.38	39.96	40.55	40.98

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	2/9/2016	2/16/2016	2/23/2016	3/1/2016	3/8/2016	3/15/2016	3/22/2016	3/29/2016	4/5/2016	4/11/2016	4/19/2016	4/26/2016	5/3/2016	5/10/2016	5/17/2016	5/24/2016	5/31/2016	6/7/2016	6/13/2016	6/21/2016	6/28/2016	7/4/2016	7/12/2016
Time	---	9:40	10:00	10:30	8:10	10:00	11:40	9:40	9:50	9:30	15:00	8:15	8:30	9:50	12:00	9:00	10:50	9:40	8:00	8:00	7:30	6:50	13:00	14:00
System shutdown time	hrs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
Vacuums																								
SVE System Inlet	in Hg	4.1	4	4.5	4.1	4.2	4.1	4	4.1	4.1	4	4	4	4	4	4.1	4	4.1	4	4	4.1	4	4.1	3.9
VW-17d-42.5	in Hg	2	2	2.1	2	2	2	2	2.1	2.1	2	2.1	2	2.1	2	2	2.1	2	2	1.9	1.9	2	1.9	1.8
VW-17d-75	in Hg	4	4	4.1	4	4.1	4	4	4	4	4	4	4	4	4	4	4	3.9	4	3.9	3.9	3.8	4	3.8
VW-17d-95.5	in Hg	4.1	4	4.1	4	4.1	4	4	4	4.1	4	4.1	4	4..1	4	4	4	4	4	4	4	4	4.1	3.8
VMW-A	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temperatures																								
Ambient	Degrees F	51	57	51	48	43	44	48	52	50	63	62	50	65	70	63	60	66	61	60	60	58	64	73
SVE System Inlet	Degrees F	54	52	50	48	45	47	49	50	50	54	56	54	57	68	59	54	55	56	54	52	53	56	68
VW-17d-42.5	Degrees F	52	54	52	50	45	48	49	50	50	54	56	54	54	58	54	52	54	54	52	50	52	56	59
VW-17d-75	Degrees F	56	52	51	50	46	48	50	52	52	56	57	55	65	69	60	56	62	58	57	54	57	62	70
VW-17d-95.5	Degrees F	50	50	50	50	47	49	50	51	52	55	56	51	54	58	56	52	54	52	50	50	52	54	58
VMW-A	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet	Degrees F	154	145	130	128	125	125	128	134	130	138	150	138	150	152	138	138	147	135	128	130.1	130	140	144
Concentrations																								
SVE System Outlet: Field Data	ppm	0.6	0.6	0.5	0.6	0.6	0.6	0.5	0.7	0.5	0.7	0.4	0.7	0.6	0.7	0.8	0.8	0.4	0.4	0.4	0.6	0.8	0.6	0.6
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	220.3	218.7	222.7	218.7	221.0	218.3	219.0	223.7	215.7	217.7	216.0	216.0	220.7	216.3	217.7	220.7	215.7	211.7	208.7	218.0	216.7	216.3	213.7
VW-17d-42.5 (2" pipe)	scfm	25.1	24.9	25.2	24.8	24.3	25.1	25	24.95	24.3	23.8	24.1	25.1	25.2	24.8	25.1	25.2	25	25.1	24.8	24.3	25.1	25.1	24.8
VW-17d-75 (2" pipe)	scfm	99.8	97.8	99.9	98.9	99.1	99.4	98.5	99.9	99.5	98.9	99.4	100.3	100.4	98.9	100.1	100.2	99.3	100.1	97.8	100.1	98.8	100.0	99.6
VW-17d-95.5 (2" pipe)	scfm	100.1	99.7	100.8	100.1	99.9	100.1	100.6	100.1	100.9	99.9	100.3	100.6	100.6	100.1	100.4	100.4	100.3	100.4	99.8	102.1	101.2	100.1	100
VMW-A (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-B (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-C (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
VMW-D (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVE System Outlet (3" pipe)	scfm	230.0	215.3	218.7	212.7	223.7	230.7	233.0	229.3	219.3	216.6	219.7	225.0	229.0	224.0	221.3	221.0	211.0	217.3	214.7	224.0	217.3	220.0	224.3
Calculations																								
Operating Time																								
Period Operating Time	hrs	187.75	168.33	168.50	165.67	169.83	169.67	166.00	168.17	167.67	149.50	185.25	168.25	169.33	170.17	165.00	169.83	166.83	156.33	144.00	191.50	167.33	150.17	193.00
Period Time	hrs	187.75	168.33	168.50	165.67	169.83	169.67	166.00	168.17	167.67	149.50	185.25	168.25	169.33	170.17	165.00	169.83	166.83	166.33	144.00	191.50	167.33	150.17	193.00
Period Operating %	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	94%	100%	100%	100%	100%	100%
Cumulative Operating Time	hrs	7140.17	7308.50	7477.00	7642.67	7812.50	7982.17	8148.17	8316.33	8484.00	8633.50	8818.75	8987.00	9156.33	9326.50	9491.50	9661.33	9828.17	9984.50	10128.50	10320.00	10487.33	10637.50	10830.50
Cumulative Time Since Startup	hrs	7173.17	7341.50	7510.00	7675.67	7845.50	8015.17	8181.17	8349.33	8517.00	8666.50	8851.75	9020.00	9189.33	9359.50	9524.50	9694.33	9861.17	10027.50	10171.50	10363.00	10530.33	10680.50	10873.50
Cumulative Operating %	%	99.54%	99.55%	99.56%	99.57%	99.58%	99.59%	99.60%	99.60%	99.61%	99.62%	99.63%	99.63%	99.64%	99.65%	99.65%	99.66%	99.67%	99.57%	99.58%	99.59%	99.59%	99.60%	99.60%
Flow Rates																								
Well Flow Rate	scfm	225.00	222.40	225.90	223.80	223.30	224.63	224.05	224.90	224.70	222.55	223.75	226.00	226.20	223.80	225.60	225.80	224.55	225.60	222.40	226.50	225.10	225.20	224.40
Outlet Flow Rate	scfm	230.00	215.33	218.67	212.67	223.67	230.67	233.00	229.33	219.33	216.60	219.67	225.00	229.00	224.00	221.33	221.00	211.00	217.33	214.67	224.00	217.33	220.00	224.33
Well/Outlet Comparison	%	98%	103%	103%	105%	100%	97%	96%	98%	102%	103%	102%	100%	99%	100%	102%	102%	106%	104%	104%	101%	104%	102%	100%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	3.51	3.51	2.92	3.51	3.51	3.51	2.92	4.09	2.92	4.09	2.34	4.09	3.51	4.09	4.68	4.68	2.34	2.34	2.34	3.51	4.68	3.51	3.51
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	0.0030	0.0028	0.0024	0.0028	0.0029	0.0030	0.0026	0.0035	0.0024	0.0033	0.0019	0.0034	0.0030	0.0034	0.0039	0.0039	0.0018	0.0019	0.0019	0.0029	0.0038	0.0029	0.0029
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	0.56	0.49	0.44	0.43	0.49	0.51	0.46	0.51	0.50	0.43	0.49	0.45	0.55	0.55	0.60	0.66	0.48	0.29	0.27	0.46	0.56	0.50	0.56
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	41.53	42.03	42.47	42.90	43.38	43.89	44.35	44.86	45.36	45.79	46.27	46.72	47.27	47.82	48.42	49.08	49.56	49.85	50.12	50.58	51.15	51.65	52.22

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	7/19/2016	7/26/2016	8/2/2016	8/9/2016	8/16/2016	8/24/2016	8/30/2016	9/6/2016	9/13/2016	9/20/2016	9/27/2016	10/4/2016	10/11/2016	10/18/2016	10/27/2016	11/2/2016	11/8/2016	11/15/2016	11/23/2016	11/29/2016	12/5/2016	12/14/2016	12/20/2016
Time	---	8:10	11:40	9:50	10:10	9:40	13:30	10:40	9:50	14:00	10:00	9:10	10:40	9:40	17:00	13:30	8:30	9:00	11:50	11:30	10:50	13:00	11:10	13:00
System shutdown time	hrs	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	212	0
Vacuums																								
SVE System Inlet	in Hg	3.9	4.4	4.2	4.1	4	3.9	4.1	4	4	4	4	4	3.9	4.1	4	4.1	4	3.9	4.1	3.9	4	3.8	4
VW-17d-42.5	in Hg	2	2.2	2	1.9	2	1.9	2	1.9	2	1.9	2	1.9	2	2.1	1.9	1.8	1.8	1.7	2	1.9	2	---	---
VW-17d-75	in Hg	4	4	4.1	4	4	3.9	4	3.9	4	3.9	4	4	4	3.9	4	3.8	3.9	3.8	3.9	3.9	3.8	---	---
VW-17d-95.5	in Hg	4	4.2	5.1	4	4	3.9	4	3.9	4	3.9	3.9	4	4	4	3.8	3.8	4	3.8	4	4	4	2.2	3.4
VMW-A	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.2	2.8
VMW-B	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	3
VMW-C	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2.8
VMW-D	in Hg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	3
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5	1.5
Temperatures																								
Ambient	Degrees F	63	70	64	64	61	86	60	56	80	65	61	57	58	62	50	52	54	45	43	48	48	30	48
SVE System Inlet	Degrees F	58	60	54	52	50	80	54	53	70	55	55	56	54	56	54	52	54	50	48	50	50	48	57
VW-17d-42.5	Degrees F	57	54	54	52	50	54	52	52	52	52	52	52	52	54	52	52	52	50	48	50	50	---	---
VW-17d-75	Degrees F	62	64	60	61	60	86	57	55	74	64	58	57	56	60	50	52	54	50	47	50	50	---	---
VW-17d-95.5	Degrees F	57	52	52	53	51	54	52	52	52	52	52	52	52	54	52	52	52	50	48	50	50	50	55
VMW-A	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	46	54
VMW-B	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	46	58
VMW-C	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	47	55
VMW-D	Degrees F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	48	55
SVE System Outlet	Degrees F	130	145	135	138	140	160	130	130	150	138	135	130	135	125	125	125	125	124	118	115	115	110	125
Concentrations																								
SVE System Outlet: Field Data	ppm	0.7	0.5	0.5	0.4	0.5	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	4.9	2.8
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	218.7	216.3	221.7	222.0	215.0	217.7	216.3	218.0	223.3	215.7	217.3	215.3	215.0	220.3	213.7	215.2	209.5	202.0	202.6	204.2	212.6	292.5	485.0
VW-17d-42.5 (2" pipe)	scfm	25	25.1	25.1	25.3	24.9	24.9	25.1	24.8	25.1	24.8	25.1	24.8	25.1	25.3	27.3	25.3	24.8	27.3	20.9	19.8	19.7	---	---
VW-17d-75 (2" pipe)	scfm	100.1	102.4	100.0	99.7	99.8	98.8	100.0	99.6	99.8	99.7	100.1	99.7	100.0	95.0	101.2	99.0	106.7	101.8	103.5	104.6	110.4	---	---
VW-17d-95.5 (2" pipe)	scfm	100.4	102.8	101.1	102.1	100.3	99.1	100.3	100.2	100.4	100.1	100.4	100.6	100.1	100.5	101.5	103.1	100.1	103.1	105.1	105.1	102.3	103.7	114.4
VMW-A (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	139.0	120.6
VMW-B (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	132.8	125.4
VMW-C (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	142.6	136.8
VMW-D (2" pipe)	scfm	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	141.4	140.5
SVE System Outlet (3" pipe)	scfm	217.7	224.0	224.3	224.0	221.3	222.7	220.3	221.3	220.3	220.0	222.7	216.7	218.7	221.3	226.5	220.4	220.7	211.0	212.5	215.6	216.2	332.5	487.5
Calculations																								
Operating Time																								
Period Operating Time	hrs	162.17	171.50	166.17	168.33	167.50	195.83	141.17	167.17	172.17	164.00	167.17	169.50	167.00	135.33	212.50	139.00	144.50	170.83	191.67	143.33	146.17	2.17	145.83
Period Time	hrs	162.17	171.50	166.17	168.33	167.50	195.83	141.17	167.17	172.17	164.00	167.17	169.50	167.00	175.33	212.50	139.00	144.50	170.83	191.67	143.33	146.17	214.17	145.83
Period Operating %	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	77%	100%	100%	100%	100%	100%	100%	100%	1%	100%
Cumulative Operating Time	hrs	10992.67	11164.17	11330.33	11498.67	11666.17	11862.00	12003.17	12170.33	12342.50	12506.50	12673.67	12843.17	13010.17	13145.50	13358.00	13497.00	13641.50	13812.33	14004.00	14147.33	14293.50	14295.67	14441.50
Cumulative Time Since Startup	hrs	11035.67	11207.17	11373.33	11541.67	11709.17	11905.00	12046.17	12213.33	12385.50	12549.50	12716.67	12886.17	13053.17	13228.50	13441.00	13580.00	13724.50	13895.33	14087.00	14230.33	14376.50	14590.67	14736.50
Cumulative Operating %	%	99.61%	99.62%	99.62%	99.63%	99.63%	99.64%	99.64%	99.65%	99.65%	99.66%	99.66%	99.67%	99.67%	99.37%	99.38%	99.39%	99.40%	99.40%	99.41%	99.42%	99.42%	97.98%	98.00%
Flow Rates																								
Well Flow Rate	scfm	225.50	230.30	226.20	227.05	225.00	222.80	225.40	224.60	225.30	224.60	225.60	225.10	225.20	220.80	229.95	227.40	231.57	232.20	229.50	229.50	232.35	659.40	637.60
Outlet Flow Rate	scfm	217.67	224.00	224.33	224.00	221.33	222.67	220.33	221.33	220.33	220.00	222.67	216.67	218.67	221.33	226.50	220.35	220.67	211.00	212.50	215.60	216.15	332.50	487.50
Well/Outlet Comparison	%	104%	103%	101%	101%	102%	100%	102%	101%	102%	102%	101%	104%	103%	100%	102%	103%	105%	110%	108%	106%	107%	198%	131%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	4.09	2.92	2.92	2.34	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	28.64	16.37
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	0.0033	0.0025	0.0025	0.0020	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0025	0.0024	0.0024	0.0023	0.0023	0.0024	0.0024	0.0357	0.0299
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	0.51	0.50	0.41	0.37	0.37	0.48	0.34	0.40	0.42	0.40	0.41	0.41	0.40	0.33	0.52	0.34	0.35	0.40	0.44	0.34	0.35	0.04	4.78
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	52.73	53.22	53.63	54.00	54.37	54.84	55.19	55.59	56.01	56.40	56.81	57.22	57.61	57.94	58.46	58.80	59.15	59.55	60.00	60.33	60.68	60.72	65.50

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	12/28/2016	1/3/2017	1/10/2017	1/16/2017	1/25/2017	1/31/2017	2/7/2017	2/15/2017	2/21/2017	2/27/2017	3/7/2017	3/13/2017	3/21/2017	3/28/2017	4/4/2017	4/11/2017	4/17/2017	4/25/2017	5/2/2017	5/8/2017	5/15/2017	5/22/2017	5/30/2017
Time	---	11:30	7:40	11:00	11:30	10:40	15:00	10:15	9:30	8:10	11:40	14:30	14:30	8:20	8:30	14:00	12:20	***12:00***	13:50	15:50	***12:00***	11:20	9:45	8:45
System shutdown time	hrs	0	0	0	0	3.5	0	0	2	0	0	0	0	0	0	0	66.5	0	0	0	3.5	0	0	0
Vacuums																								
SVE System Inlet	in Hg	4	4	4	3.8	4	4	4.8	4.1	4	4	4.1	4	4.1	4	4	4.1	4	4	4	4.1	4.1	4	4.1
VW-17d-42.5	in Hg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	in Hg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	in Hg	3.5	3.6	3.4	3.5	3.8	3.9	4	4	4	3.4	3.8	3.9	4	4	3.7	3.8	3.7	3.7	3.6	3.3	3.2	3.2	3.3
VMW-A	in Hg	2.7	3	3.1	3.2	2.8	3	3.8	3.7	3.8	3.2	3.4	3.4	3.6	3.5	3.4	3.2	3.3	3.2	3.2	3.2	3.2	3.1	3.1
VMW-B	in Hg	2.8	2.8	2.8	3	2.8	3	3.8	3.7	3.8	3.1	3.2	3.2	3.4	3.5	3.4	3.2	3.3	3.2	3.2	3.3	3.2	3.1	3
VMW-C	in Hg	2.5	2.8	2.8	2.8	2.8	3	3.3	3.4	3.5	3.1	3.2	3.3	3.4	3.4	3.2	3	3.1	3	3	3.1	3.1	3.2	3.1
VMW-D	in Hg	2.8	2.7	2.8	2.8	2.8	2.8	3.4	3.4	3.4	3.2	3.2	3.3	3.3	3.4	3.4	3.2	3.3	3.2	3.2	3.1	3.1	3.2	3.1
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Temperatures																								
Ambient	Degrees F	41	27	33	25	46	39	37	37	40	37	45	53	48	53	55	60	54	53	50	68	57	63	60
SVE System Inlet	Degrees F	54	43	40	27	53	50	48	45	***47***	***44***	43	52	52	54	54	56	52	53	59	62	57	57	57
VW-17d-42.5	Degrees F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	Degrees F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	Degrees F	52	45	41	34	50	48	45	40	42	40	43	50	52	54	54	56	52	54	58	60	56	58	56
VMW-A	Degrees F	52	46	44	32	52	48	46	44	42	40	42	52	50	53	52	58	52	52	58	58	56	58	51
VMW-B	Degrees F	53	46	44	32	52	50	46	44	42	40	42	52	50	53	52	58	52	52	58	58	56	58	51
VMW-C	Degrees F	52	46	45	32	54	50	46	44	42	40	40	52	50	54	52	58	52	52	58	58	56	57	51
VMW-D	Degrees F	52	45	43	33	53	50	46	45	42	40	40	52	50	54	52	58	52	52	58	58	56	58	51
SVE System Outlet	Degrees F	120	105	100.3	120	115	110	120	110	118	112	118	118	115	130	110	112	110	115	120	130	120	120	115
Concentrations																								
SVE System Outlet: Field Data	ppm	2.5	1.9	1.3	0.7	1.4	1.1	1.2	2.1	1.2	1.1	1	0.9	0.7	0.9	0.9	0.8	0.8	0.7	0.8	0.7	0.6	0.7	0.6
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	475.0	456.0	436.7		465.0	435.0	460.0	450.0	460.4	450.0	450.0	430.0	430.0	440.0	430.0	425.0	440.1	420.3	410.1	420.1	418.0	421.4	426.4
VW-17d-42.5 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5 (2" pipe)	scfm	112.8	109.1	112.2	114.5	109.5	105.1	109.5	115.3	105.1	114.0	110.0	117.5	107.0	104.6	106.8	102.7	102.8	102.6	101.1	101.6	99.2	101.0	101.3
VMW-A (2" pipe)	scfm	122.5	118.5	114.1	127.0	130.0	122.5	132.5	133.9	130.2	127.5	124.0	125.0	130.0	125.5	126.9	121.5	123.3	122.7	126.5	127.9	124.8	123.4	125.6
VMW-B (2" pipe)	scfm	125.5	126.0	118.2	138.0	130.0	122.5	130.0	130.5	130.0	130.0	125.0	130.0	131.5	127.4	127.8	122.5	127.7	122.1	121.2	122.6	127.7	126.8	124.9
VMW-C (2" pipe)	scfm	132.5	130.0	123.0	128.5	135.0	130.0	135.0	132.8	125.6	130.0	130.0	122.5	124.0	128.1	123.2	122.0	128.4	123.2	124.1	125.1	123.6	124.4	122.6
VMW-D (2" pipe)	scfm	133.0	125.0	120.7	141.5	132.5	132.5	135.0	132.8	128.4	125.0	125.0	127.5	122.5	126.5	126.7	117.5	123.1	121.4	122.3	121.6	124.3	124.4	123.5
SVE System Outlet (3" pipe)	scfm	480.0	475.0	462.8	440.0	495.0	485.0	480.0	450.0	470.4	475.3	465.0	460.0	445.0	440.0	430.7	435.0	425.2	430.6	427.0	430.2	423.5	430.6	437.7
Calculations																								
Operating Time																								
Period Operating Time	hrs	190.50	140.17	171.33	144.50	211.67	148.33	163.25	189.25	142.67	147.50	194.83	144.00	185.83	168.17	173.50	99.83	143.67	193.83	170.00	136.67	167.33	166.42	191.00
Period Time	hrs	190.50	140.17	171.33	144.50	215.17	148.33	163.25	191.25	142.67	147.50	194.83	144.00	185.83	168.17	173.50	166.33	143.67	193.83	170.00	140.17	167.33	166.42	191.00
Period Operating %	%	100%	100%	100%	100%	98%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	60%	100%	100%	100%	98%	100%	100%	100%
Cumulative Operating Time	hrs	14632.00	14772.17	14803.33	14947.83	15159.50	15307.83	15471.08	15660.33	15803.00	15950.50	16145.33	16289.33	16475.17	16643.33	16816.83	16916.67	17060.33	17254.17	17424.17	17560.83	17728.17	17894.58	18085.58
Cumulative Time Since Startup	hrs	14927.00	15067.17	15098.33	15242.83	15458.00	15606.33	15769.58	15960.83	16103.50	16251.00	16445.83	16589.83	16775.67	16943.83	17117.33	17283.67	17427.33	17621.17	17791.17	17931.33	18098.67	18265.08	18456.08
Cumulative Operating %	%	98.02%	98.04%	98.05%	98.06%	98.07%	98.09%	98.11%	98.12%	98.13%	98.15%	98.17%	98.19%	98.21%	98.23%	98.24%	97.88%	97.89%	97.92%	97.94%	97.93%	97.95%	97.97%	97.99%
Flow Rates																								
Well Flow Rate	scfm	626.30	608.60	588.15	649.50	637.00	612.60	642.00	645.15	619.15	626.50	614.00	622.50	615.00	612.05	611.25	586.15	605.15	591.85	595.05	598.70	599.40	599.83	597.85
Outlet Flow Rate	scfm	480.00	475.00	462.75	440.00	495.00	485.00	480.00	450.00	470.40	475.30	465.00	460.00	445.00	440.00	430.70	435.00	425.20	430.64	426.95	430.20	423.45	430.55	437.65
Well/Outlet Comparison	%	130%	128%	127%	148%	129%	126%	134%	143%	132%	132%	132%	135%	138%	139%	142%	135%	142%	137%	139%	139%	142%	139%	137%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	14.61	11.11	7.60	4.09	8.18	6.43	7.01	12.28	7.01	6.43	5.85	5.26	4.09	5.26	5.26	4.68	4.68	4.09	4.68	4.09	3.51	4.09	3.51
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	0.0263	0.0198	0.0132	0.0067	0.0152	0.0117	0.0126	0.0207	0.0124	0.0114	0.0102	0.0091	0.0068	0.0087	0.0085	0.0076	0.0074	0.0066	0.0075	0.0066	0.0056	0.0066	0.0057
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	5.35	3.23	2.82	1.44	2.32	1.99	1.98	3.15	2.36	1.76	2.11	1.39	1.48	1.30	1.49	0.80	1.08	1.36	1.20	0.96	1.02	1.01	1.18
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	70.85	74.08	76.90	78.34	80.66	82.65	84.63	87.78	90.14	91.90	94.00	95.39	96.86	98.17	99.65	100.46	101.54	102.90	104.10	105.06	106.08	107.09	108.27

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	6/6/2017	6/12/2017	6/19/2017	6/27/2017	7/4/2017	7/11/2017	7/18/2017	7/25/2017	7/30/2017	8/8/2017	8/14/2017	8/22/2017	8/29/2017	9/5/2017	9/12/2017	9/19/2017	9/25/2017	10/3/2017	10/10/2017	10/16/2017	10/23/2017	10/31/2017	11/6/2017
Time	---	7:45	9:30	15:00	16:10	11:00	9:10	8:10	9:10	13:00	7:40	10:30	12:50	14:00	8:10	12:20	13:20	12:00	15:00	13:50	9:35	12:20	7:10	9:00
System shutdown time	hrs	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vacuums																								
SVE System Inlet	in Hg	4	4.1	4	4	4.1	4	3	4.1	4	4.1	4.1	4	4	4.1	4	4	4	4	4	4.1	4.1	4	4
VW-17d-42.5	in Hg	---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	in Hg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	in Hg	3.2	3.2	3.1	3.1	3.1	3.1	3	3	3.1	3.9	3.9	3.8	3.8	3.7	3.6	3.5	3.6	3.6	3.4	3.2	3.2	3.1	3
VMW-A	in Hg	3.2	3.1	3	3.1	3	3.1	3	3.1	3	3.3	3.2	3.2	3.1	3.1	3.1	3	3.1	3.1	3.1	3.2	3.2	3.2	3
VMW-B	in Hg	3.1	3.2	3	3	3	3	3.1	3.3	3	3.2	3.3	3.2	3.1	3.1	3.1	3	3	3.1	3	3.1	3.1	3.1	3
VMW-C	in Hg	3.1	3.1	3.1	3	3.1	3	3.1	3	3.1	3.2	3.3	3.2	3.1	3.1	3.1	3	3.1	3.1	3	3	3.2	3.1	3
VMW-D	in Hg	3	3	3	3	3.1	3.1	3.1	3	3	3.1	3.2	3.3	3.2	3.1	3.1	3	3.1	3.1	3	3.1	3.1	3.1	3
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
Temperatures																								
Ambient	Degrees F	58	54	78	74	73	61	68	66	72	63	64	76	88	70	78	60	61	71	57	42	60	40	58
SVE System Inlet	Degrees F	57	55	59	58	57	54	56	56	58	55	55	56	60	56	60	57	57	58	57	52	54	50	54
VW-17d-42.5	Degrees F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	Degrees F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	Degrees F	56	56	57	56	55	52	54	53	56	53	53	53	57	54	56	56	56	56	55	54	54	52	53
VMW-A	Degrees F	56	56	56	56	55	53	54	54	54	53	52	53	55	55	55	56	57	56	55	53	53	52	52
VMW-B	Degrees F	56	56	56	56	55	53	54	53	54	53	53	53	54	54	55	56	56	56	55	53	52	52	52
VMW-C	Degrees F	56	56	56	56	55	53	54	54	54	53	52	52	54	55	55	56	57	56	55	53	53	52	53
VMW-D	Degrees F	56	56	56	56	55	53	54	54	54	53	52	52	54	55	55	56	57	56	55	53	53	52	52
SVE System Outlet	Degrees F	124	***122***	138	145	135	125	130	128	136	130	125	130	144	140	138	128	128	125	128	122	125	119	128
Concentrations																								
SVE System Outlet: Field Data	ppm	0.7	0.8	0.65	0.6	0.8	1.1	0.7	0.8	0.7	0.7	0.7	0.7	0.8	0.9	0.6	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.7
Flow Rates																								
SVE System Inlet (3" pipe)	scfm	422.3	426.4	421.2	422.9	421.7	424.9	422.4	436.6	423.4	425.6	435.6	438.6	441.6	438.8	426.8	434.8	448.9	428.6	422.1	435.8	436.9	430.6	428.7
VW-17d-42.5 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5 (2" pipe)	scfm	102.1	101.2	101.8	102.5	101.0	101.4	101.2	101.5	101.5	100.3	101.1	100.6	99.8	100.1	100.3	100.5	101.9	102.1	101.8	101.9	101.1	99.8	99.5
VMW-A (2" pipe)	scfm	123.7	125.7	123.9	126.8	124.0	124.8	123.1	125.3	124.3	123.8	125.4	124.8	123.9	124.6	125.1	123.2	124.9	123.8	124.1	123.8	124.3	122.8	121.6
VMW-B (2" pipe)	scfm	124.5	125.2	121.8	126.3	124.9	124.6	123.1	122.6	124.1	124.6	124.1	124.1	124.6	124.4	124.6	128.1	128.2	126.8	125.4	125.6	123.3	123.5	122.3
VMW-C (2" pipe)	scfm	123.6	123.5	122.6	123.9	122.8	125.1	123.0	124.1	123.8	125.1	123.8	124.9	125.1	124.8	123.9	121.1	124.8	124.1	123.1	124.1	123.6	124.1	124.4
VMW-D (2" pipe)	scfm	126.4	125.1	123.4	124.4	124.9	125.9	123.2	122.4	122.7	124.6	125.3	125.6	125.4	125.3	124.7	122.4	125.1	123.7	123.8	124.3	124.8	122.9	123.2
SVE System Outlet (3" pipe)	scfm	434.4	440.9	438.5	440.7	436.4	442.5	440.9	444.5	441.7	444.3	441.8	450.4	448.6	441.6	444.8	438.6	451.6	440.3	438.6	444.6	448.1	441.2	436.1
Calculations																								
Operating Time																								
Period Operating Time	hrs	167.00	138.75	173.50	193.17	162.83	166.17	167.00	169.00	123.83	210.67	146.83	194.33	169.17	162.17	172.17	169.00	142.67	195.00	166.83	139.75	170.75	186.83	145.83
Period Time	hrs	167.00	145.75	173.50	193.17	162.83	166.17	167.00	169.00	123.83	210.67	146.83	194.33	169.17	162.17	172.17	169.00	142.67	195.00	166.83	139.75	170.75	186.83	145.83
Period Operating %	%	100%	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cumulative Operating Time	hrs	18252.58	18391.33	18564.83	18758.00	18920.83	19087.00	19254.00	19423.00	19546.83	19757.50	19904.33	20098.67	20267.83	20430.00	20602.17	20771.17	20913.83	21108.83	21275.67	21415.42	21586.17	21773.00	21918.83
Cumulative Time Since Startup	hrs	18623.08	18768.83	18942.33	19135.50	19298.33	19464.50	19631.50	19800.50	19924.33	20135.00	20281.83	20476.17	20645.33	20807.50	20979.67	21148.67	21291.33	21486.33	21653.17	21792.92	21963.67	22150.50	22296.33
Cumulative Operating %	%	98.01%	97.99%	98.01%	98.03%	98.04%	98.06%	98.08%	98.09%	98.11%	98.13%	98.14%	98.16%	98.17%	98.19%	98.20%	98.22%	98.23%	98.24%	98.26%	98.27%	98.28%	98.30%	98.31%
Flow Rates																								
Well Flow Rate	scfm	600.15	600.60	593.40	603.70	597.40	601.65	593.40	595.90	596.35	598.40	599.70	600.00	598.80	599.20	598.60	595.30	604.90	600.50	598.20	599.70	597.10	593.10	590.95
Outlet Flow Rate	scfm	434.35	440.90	438.50	440.70	436.35	442.45	440.90	444.50	441.70	444.30	441.80	450.40	448.60	441.60	444.80	438.60	451.60	440.30	438.60	444.60	448.10	441.20	436.10
Well/Outlet Comparison	%	138%	136%	135%	137%	137%	136%	135%	134%	135%	135%	136%	133%	133%	136%	135%	136%	134%	136%	136%	135%	133%	134%	136%
SVE Effluent VOC Conc.																								
SVE System Outlet (3" pipe)	ug/L	4.09	4.68	3.80	3.51	4.68	6.43	4.09	4.68	4.09	4.09	4.09	4.09	4.68	5.26	3.51	3.51	3.51	4.09	4.09	4.68	4.68	4.68	4.09
Mass Removal Rate																								
SVE System Outlet (3" pipe)	lb/hr	0.0067	0.0077	0.0062	0.0058	0.0076	0.0107	0.0068	0.0078	0.0068	0.0068	0.0068	0.0069	0.0079	0.0087	0.0058	0.0058	0.0059	0.0067	0.0067	0.0078	0.0078	0.0077	0.0067
Period Mass Removal																								
SVE System Outlet (3" pipe)	lbs	1.04	1.00	1.21	1.16	1.09	1.52	1.45	1.23	0.90	1.43	1.00	1.33	1.25	1.34	1.25	0.98	0.83	1.24	1.12	1.01	1.34	1.46	1.05
Cumulative Mass Removal																								
SVE System Outlet (3" pipe)	lbs	109.31	110.30	111.51	112.68	113.77	115.29	116.74	117.97	118.87	120.31	121.30	122.63	123.88	125.22	126.47	127.46	128.29	129.53	130.65	131.66	133.00	134.45	135.50

Attachment A - SVE Process Data
East Multnomah County Troutdale Sandstone Aquifer Remedy
Cascade Corporation, Gresham, OR

	Units	11/14/2017	11/20/2017	11/27/2017	12/4/2017	12/12/2017	12/18/2017	12/26/2017	1/2/2018	1/9/2018	1/15/2018	1/23/2018
Time	---	15:50	13:30	15:30	13:20	13:20	13:25	11:20	15:40	12:00	13:20	12:50
System shutdown time	hrs	0	0	0	0	0	0	0	0	0	0	0
Vacuums												
SVE System Inlet	in Hg	4	4.1	4	4	4.1	4	3.9	3.9	3.9	3.9	3.9
VW-17d-42.5	in Hg	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	in Hg	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	in Hg	3	3	3	3.1	3	3	2.8	2.9	3	3	2.9
VMW-A	in Hg	3	3.1	3	3	3	3	3	2.9	2.9	3	3
VMW-B	in Hg	3	3.1	3	3	3	3	3	3	3	3	3
VMW-C	in Hg	3	3	3	3	3	3	2.9	3	3	2.9	3
VMW-D	in Hg	3	3.1	3.1	3	3	3	2.9	2.9	2.9	2.9	3
SVE System Outlet	PSI	1	1	1	1	1	1	1	1	1	1	1
Temperatures												
Ambient	Degrees F	56	52	50	45	42	53	30	41	44	50	41
SVE System Inlet	Degrees F	54	52	50	52	52	53	38	46	44	52	50
VW-17d-42.5	Degrees F	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75	Degrees F	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5	Degrees F	53	52	52	52	52	52	40	50	52	52	50
VMW-A	Degrees F	53	52	52	52	52	52	40	47	52	52	50
VMW-B	Degrees F	53	52	52	52	52	52	42	48	52	52	50
VMW-C	Degrees F	53	52	52	52	52	52	40	47	52	52	50
VMW-D	Degrees F	53	52	52	52	52	52	40	47	52	52	50
SVE System Outlet	Degrees F	125	124	125	128	130	125	90	100	128	118	100.2
Concentrations												
SVE System Outlet: Field Data	ppm	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6
Flow Rates												
SVE System Inlet (3" pipe)	scfm	430.6	428.6	431.4	436.1	430.6	430.0	424.1	436.8	428.6	421.1	424.8
VW-17d-42.5 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---
VW-17d-75 (2" pipe)	scfm	---	---	---	---	---	---	---	---	---	---	---
VW-17d-95.5 (2" pipe)	scfm	100.1	99.8	100.3	99.8	100.3	99.7	98.6	100.2	99.6	99.1	102.8
VMW-A (2" pipe)	scfm	122.4	123.4	122.8	123.3	124.1	122.8	121.8	122.3	124.1	122.3	122.1
VMW-B (2" pipe)	scfm	124.2	123.8	123.6	123.6	122.5	124.3	122.3	122.8	123.2	121.8	124.1
VMW-C (2" pipe)	scfm	126.3	126.1	123.8	124.8	123.2	123.7	121.7	123.4	123.1	123.1	123.1
VMW-D (2" pipe)	scfm	125.3	125.6	124.7	125.3	123.5	124.3	122.3	123.8	122.8	122.1	123.6
SVE System Outlet (3" pipe)	scfm	440.8	436.1	442.5	444.1	428.1	436.8	428.6	441.3	434.6	415.1	431.6
Calculations												
Operating Time												
Period Operating Time	hrs	198.83	141.67	170.00	165.83	192.00	144.08	189.92	172.33	164.33	145.33	191.50
Period Time	hrs	198.83	141.67	170.00	165.83	192.00	144.08	189.92	172.33	164.33	145.33	191.50
Period Operating %	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cumulative Operating Time	hrs	22117.67	22259.33	22429.33	22595.17	22787.17	22931.25	23121.17	23293.50	23457.83	23603.17	23794.67
Cumulative Time Since Startup	hrs	22495.17	22636.83	22806.83	22972.67	23164.67	23308.75	23498.67	23671.00	23835.33	23980.67	24172.17
Cumulative Operating %	%	98.32%	98.33%	98.34%	98.36%	98.37%	98.38%	98.39%	98.41%	98.42%	98.43%	98.44%
Flow Rates												
Well Flow Rate	scfm	598.30	598.70	595.20	596.80	593.60	594.80	586.70	592.50	592.80	588.40	595.70
Outlet Flow Rate	scfm	440.80	436.10	442.50	444.10	428.10	436.80	428.60	441.30	434.60	415.10	431.60
Well/Outlet Comparison	%	136%	137%	135%	134%	139%	136%	137%	134%	136%	142%	138%
SVE Effluent VOC Conc.												
SVE System Outlet (3" pipe)	ug/L	4.09	4.09	4.09	4.09	4.09	4.09	3.51	3.51	3.51	3.51	3.51
Mass Removal Rate												
SVE System Outlet (3" pipe)	lb/hr	0.0068	0.0067	0.0068	0.0068	0.0066	0.0067	0.0056	0.0058	0.0057	0.0055	0.0057
Period Mass Removal												
SVE System Outlet (3" pipe)	lbs	1.34	0.95	1.14	1.13	1.28	0.96	1.17	0.98	0.95	0.81	1.07
Cumulative Mass Removal												
SVE System Outlet (3" pipe)	lbs	136.84	137.79	138.94	140.06	141.35	142.30	143.47	144.46	145.40	146.21	147.28