

**Troutdale Gravel Aquifer Corrective Measure
2016 Annual Report and Five-Year Performance Evaluation
Boeing Portland Facility
Gresham, Oregon
ECSI #13**

April 25, 2017

Prepared for
The Boeing Company




130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

**Troutdale Gravel Aquifer Corrective Measure
2016 Annual Report and Five-Year Performance Evaluation
Boeing Portland Facility
Gresham, Oregon**

This document was prepared by, or under the direct supervision of, the technical professionals noted below.

Document prepared by:  _____ Brett H. Borgeson
Project Scientist

 _____ Clinton L. Jacob, PE
Principal

Document reviewed by:  _____ Christine B. Kimmel
Associate Geologist

Date: April 25, 2017
Project No.: 0025116.117
File path: P:\025\116\FileRm\R\TGA\TGA 5-Yr Annuals\2012-2016 Ann\Boeing_Portland_Landau_170425_TGA 5-yr Perf Eval.docx
Project Coordinator: tam

TABLE OF CONTENTS

<u>PAGE</u>		
1.0	INTRODUCTION	1-1
1.1	Report Organization	1-1
2.0	BACKGROUND INFORMATION	2-1
2.1	Interim Corrective Measures.....	2-1
2.1.1	Corrective Action Areas	2-1
2.1.2	Cleanup Levels and Points of Compliance.....	2-2
3.0	CORRECTIVE MEASURES IMPLEMENTATION.....	3-1
3.1	Groundwater Extraction and Treatment.....	3-1
3.2	Soil Vapor Extraction System.....	3-2
3.3	Institutional Controls Plan.....	3-3
3.4	Enhanced Bioremediation	3-5
3.4.1	Aerobic Biodegradation-Coolant Release Area	3-5
3.4.2	Anaerobic Bioremediation-Former Vapor Degreaser Source Area	3-6
3.5	Performance Monitoring.....	3-7
3.5.1	Well Decommissioning	3-8
3.5.2	TGA Well Installation.....	3-8
4.0	2016 REMEDY PERFORMANCE DATA RESULTS.....	4-1
4.1	TGA Groundwater Elevation Data	4-1
4.2	TGA Groundwater Quality	4-1
4.2.1	West Corrective Action Area	4-2
4.2.2	Central Corrective Action Area	4-2
4.2.3	Coolant Release Area	4-2
4.2.4	East Yard and East Corrective Action Areas	4-3
4.2.5	Southwest Corrective Action Area.....	4-3
4.2.6	Downgradient Corrective Action Area	4-3
4.2.7	Former Vapor Degreaser Source Area	4-4
4.2.8	Coolant Release	4-5
4.3	TSA Groundwater Quality Monitoring.....	4-5
4.4	Former Vapor Degreaser Source Area-Vapor Data	4-6
4.5	Treatment System Performance Data.....	4-6
4.5.1	Groundwater Treatment System	4-6
4.5.1.1	VOC Mass Removed.....	4-7
4.5.1.2	Groundwater Treatment System Discharge Monitoring	4-7
4.5.2	Soil Vapor Extraction System	4-8
5.0	SOURCE AREA REMEDIATION PROGRESS	5-1
5.1	Progress toward corrective action objectives.....	5-3
5.1.1	CAO-a	5-3
5.1.2	CAO-b	5-3

5.1.3	CAO-c.....	5-4
5.1.4	CAO-d	5-4
5.1.5	CAO-e	5-4
5.1.6	CAO-f	5-4
5.1.7	CAO-g	5-4
6.0	RECOMMENDATIONS.....	6-1
6.1	Groundwater Extraction and Treatment Program	6-1
6.2	Performance Monitoring Program	6-1
6.3	Enhanced <i>In Situ</i> Bioremediation	6-2
6.4	Future Reporting	6-3
7.0	USE OF THIS REPORT.....	7-1
8.0	REFERENCES.....	8-1

FIGURES

<u>Figure</u>	<u>Title</u>
2-1	Boeing Portland Site Map
2-2	Corrective Action Areas
2-3	TGA Groundwater Performance Monitoring Locations
3-1	Groundwater Extraction and Treatment System Configuration
3-2	Decommissioned Well Locations and Corrective Action Areas
4-1	TGA Groundwater Elevation Contours and Capture Zone – (West Season) February 2016
4-2	TGA Groundwater Elevation Contours and Capture Zone – (Dry Season) August 2016
4-3	TCE Groundwater Results in TGA August 2016
4-4	Historical Maximum and 2016 TCE Groundwater Results – Former Vapor Degreaser Source Control Area
4-5	Coolant Release Groundwater Results February/August 2016
4-6	Sub-Slab TCE Vapor Results – Former Vapor Degreaser Source Area
4-7	At-Depth TCE Vapor Results – Former Vapor Degreaser Source Area
4-8	SVE Mass Removal
5-1	Average Total VOC Mass Removal Rates for 2016
5-2	Mass Removal 2016
5-3	All Time Total VOC Mass Removed from Groundwater
5-4	Groundwater Treatment System Performance
6-1	Former Vapor Degreaser Source Area Progress Plume Maximum TCE Concentration
6-2	Former Vapor Degreaser Source Area Progress Plume November 2016 TCE Concentrations
6-3	Time versus Concentration Plot – BOP-73(i)
6-4	Molar Fraction Plot-BOP-73(i)
6-5	TGA Plume Progress Map

TABLES

<u>Table</u>	<u>Title</u>
2-1	Summary of TGA Corrective Action History
3-1	Summary of Corrective Measures Implementation
3-2	Performance Monitoring Program
3-3	Decommissioned Wells - January 1, 2016 –December 31, 2016
4-1	Groundwater Elevation Data - TGA Monitoring Program – January 1, 2016 – December 31, 2016
4-2	Groundwater Quality Summary, TGA Monitoring Program-2016
4-3	Water Analytical Results, TPH-Dx and Field Parameters for Coolant Release Area
4-4	Sub-Slab Vapor Well Analytical Results – Former Vapor Degreaser Source Area
4-5	Vapor Well Analytical Results – Former Vapor Degreaser Source Area
5-1	Summary of Groundwater Extraction Well Performance, Average Yield, Total Gallons, and Average Total Mass Removal Rates
5-2	Average Groundwater Extraction Rates – Gallons Per Minute
5-3	Groundwater Treatment System Quarterly Effluent Water Quality Summary
6-1	Bioremediation Summary – Former Vapor Degreaser Source Control Area

APPENDICES

<u>Appendix</u>	<u>Title</u>
A	BOP-7(d) Well Log
B	Institutional Controls Plan
C	Time vs Concentration Plots
D	Cumulative Data (DVD)
E	Lab Data Reports/Validation Memos July 1 through December 31, 2016 (DVD)

LIST OF ABBREVIATIONS AND ACRONYMS

ft ³ /min	Cubic Foot per Minute
CAAs	Correction Action Areas
CAOs	Corrective Action Objectives
cDCE	Cis-1,2-dichloroethene
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COPCs	Constituents of Potential Concern
DBS	Diffusion Bag Samplers
1,1-DCE	1,1-dichloroethene
EMC	East Multnomah County
EPA	US Environmental Protection Agency
FOG	Fats, Oil, and Greases
GAC	Granular Activated Carbon
gpm	Gallons per minute
GWTS	Groundwater Treatment System
ICA	Interim Corrective Action
ICP	Institutional Controls Plan
IRAM	Interim Remedial Action Measure
lbs	Pounds
MCLs	Maximum Contaminant Levels
µg/L	Micrograms per Liter
µg/m ³	Micrograms per cubic meter
µgmoles/L	Micromoles per Liter
mg/L	Milligrams per Liter
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
ODEQ	Oregon Department of Environmental Quality
OWRD	Oregon Water Resources Department
PCE	Tetrachloroethene
PRB	Permeable Reactive Barrier
RBC	Risk Based Cleanup Level
RCRA	Resource Conservation and Recovery Act
ROI	Radius of Injection
SCADA	Supervisory Control and data Acquisition
STS	Sump Treatment System
SVE	Soil Vapor Extraction
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TGA	Troutdale Gravel Aquifer
TOC	Total Organic Carbon
TPH-Dx	Total Petroleum Hydrocarbons-Diesel and Motor Oil
TSA	Troutdale Sandstone Aquifer
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
%Vol	Percent by Volume
VOW	Vapor Observation Wells

This page intentionally left blank.

1.0 INTRODUCTION

This report documents performance of the Troutdale Gravel Aquifer (TGA) corrective measures being implemented by The Boeing Company (Boeing) at the Portland Facility in Gresham, Oregon. Remedial activities discussed in this report were conducted on the behalf of Boeing and overseen by the Oregon Department of Environmental Quality (ODEQ) in accordance with the Order on Consent (Consent Order) No. LQSR-NWR-04-12(h) (ODEQ 2008). Oversight activities were initially conducted by the US Environmental Protection Agency (EPA); however, the 2008 ODEQ Order on Consent requires Boeing to continue to perform the remedial actions included within the final remedy as specified in the EPA Order on Consent (EPA 1994), the Decision and Response to Comments (Final Decision; EPA 1997a), and Statement of Basis (EPA 1997b). In addition to the consent order-driven corrective measures, additional measures such as bioremediation and soil vapor extraction have been implemented to improve remedy performance and decrease the projected remedy timeframe.

This report includes data collected and evaluated during calendar year 2016, and provides a 5-year progress and performance review to evaluate the performance of the remedy toward achieving cleanup goals, as specified in the Final Decision. The Final Decision upheld by ODEQ requires ongoing performance monitoring to provide data for assessing progress toward achievement of corrective action objectives (CAOs). In addition to annual reporting, the ODEQ Consent Order requires a progress and performance review to be completed every 5 years. The last progress and performance review was completed in 2011 (LAI 2012a).

1.1 Report Organization

Following this introductory section, this report is organized into six main subsections as follows:

- Section 2.0 presents remedy background information including a description of the project location; and provides a brief review of the regulatory background for the corrective measures.
- Section 3.0 provides a summary of the cleanup implementation and current status of each of the components of the interim corrective measures, Consent Order corrective measures, and selected additional corrective measures (measures installed after the consent order).
- Section 4.0 presents the remedy performance data collected during the reporting period.
- Section 5.0 presents treatment system performance data collected during the reporting period.
- Section 6.0 provides a 5-year evaluation describing progress made toward attaining CAOs and restoration goals.
- Section 7.0 provides recommendations for future operation of the corrective measures, and proposed performance monitoring program modifications.

Report appendices include the following:

- Appendix A provides the BOP-7(d) boring log.
- Appendix B contains the Institutional Controls Plan (ICP) component of the corrective measures.
- Appendix C provides plots of trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) concentrations verses time for TGA remedy wells.
- Appendix D provides summary tables of remedy groundwater quality, groundwater elevation data, and vapor data.
- Appendix E presents laboratory reports and data validation memorandums for data collected between January 1 and December 31, 2016.

2.0 BACKGROUND INFORMATION

The Boeing Facility is located at 19000 N.E. Sandy Boulevard (Figure 2-1) and is approximately 7 miles east of Portland International Airport. The current facility, which occupies approximately 90 acres, is used for the manufacture, assembly, and warehousing of aircraft components and subassemblies. Boeing has conducted investigations and implemented corrective actions for volatile organic compounds (VOCs) in soil and groundwater at the Boeing Facility since 1986. Additional corrective action measures have been identified and incorporated into the TGA remedial programs following finalization of the Consent Order. Table 2-1 provides a list of key reports that document the history of facility investigations and the design and implementation of corrective measures.

2.1 Interim Corrective Measures

Several interim corrective actions (ICAs) were undertaken by Boeing beginning in 1986 to stabilize VOCs in the soil and groundwater at the Boeing Facility and to address protection of human health and the environment. These ICAs included providing an alternate water supply to owners of impacted wells, decommissioning of supply wells, excavation of soil, installation and phased expansion of the ICA groundwater extraction and treatment system, installation and testing of a soil vapor extraction (SVE) system, and pilot testing of a dual-phase extraction system. These ICAs were documented in the interim measures evaluation report (LAI 1995a) and summarized again in the Phase 2 corrective measures study (CMS; LAI 1996).

2.1.1 Corrective Action Areas

Corrective Action Areas (CAAs) were implemented as part of the Phase 2 CMS (LAI 1996), the EPA Final Decision (1997a), and the EPA Statement of Basis (EPA 1997b). These CAAs were based on the known or potential presence of VOCs in soil and groundwater, and on the evaluation of the source areas identified in the Phase III Resource Conservation and Recovery Act (RCRA) facility investigation report (LAI 1995b). These CAAs are shown on Figure 2-2, and are described in detail the TGA corrective measures implementation (CMI) work plan (LAI 1997).

The objective of delineating the groundwater CAAs was to identify areas of the site that were potentially amenable to a specific corrective action approach. The delineation of these CAAs effectively separates the site into two distinct areas: 1) a downgradient corrective action area that is more amenable to groundwater restoration, and is characterized by the absence of potential source areas, generally lower groundwater VOC concentrations, and a higher aquifer transmissivity; and 2) the remaining corrective action areas for which there is less certainty with respect to restoration potential, characterized by the presence of potential source areas, higher groundwater VOC concentrations, and low aquifer transmissivity. The current groundwater performance monitoring locations used to evaluate the CAAs is shown on Figure 2-3.

Corrective actions have been implemented at the Boeing Facility to address VOC contamination in the TGA, specifically to provide protection of human health and the environment from exposure to the

TGA VOC plume through ingestion, dermal contact, or inhalation pathways. CAOs were developed to meet this goal and are as follows:

- CAO-a. Decrease VOC concentrations (i.e., mass removal) throughout the site to achieve maximum contaminant levels (MCLs). If this is not feasible, then minimize the areal extent of groundwater contamination that exceeds MCLs and provide long-term containment for those areas with concentrations above MCLs.
- CAO-b. Prevent exposure to TGA groundwater that contains VOCs at concentrations above MCLs.
- CAO-c. Protect environmental receptors by preventing discharge of TGA groundwater to surface water at VOC contaminant concentrations that may exceed ambient water quality criteria.
- CAO-d. Prevent further spread of contamination in the TGA (i.e., prevent the migration of groundwater containing VOCs above MCLs).
- CAO-e. Protect groundwater quality in the Troutdale Sandstone Aquifer (TSA).
- CAO-f. Facilitate existing uses of groundwater resources in eastern Multnomah County.
- CAO-g. Reduce concentrations of VOCs and minimize migration of VOCs from vadose zone soil to the TGA that could compromise satisfying CAO-a for groundwater.

2.1.2 Cleanup Levels and Points of Compliance

The EPA Final Decision and Statement of Basis establish constituents of potential concern (COPC) and target groundwater cleanup levels for the TGA corrective measures based on MCLs as follows:

Constituent	Cleanup Level (µg/L)
1,1-Dichloroethene (1,1-DCE)	7
cis-1,2-Dichloroethene (cDCE)	70
TCA	200
TCE	5
Tetrachloroethene (PCE)	5
Vinyl chloride (VC)	2

µg/L = micrograms per liter

VC was not identified as a COPC, but EPA identified a cleanup level for this constituent in response to comments received on the Statement of Basis. The Final Decision established the point of compliance for the groundwater cleanup levels as throughout the plume, meaning everywhere within the TGA that is contaminated by VOCs.

3.0 CORRECTIVE MEASURES IMPLEMENTATION

This section provides a summary of the implementation and current status of each of the components of the corrective measures implemented at the site. A summary is also provided in Table 3-1. Both the Consent Order and the later selected additional corrective measures are discussed below.

3.1 Groundwater Extraction and Treatment

Groundwater extraction and treatment began in March 1989 with the installation of the ICA system as part of the Consent Order corrective measure. At the time, the ICA system consisted of nine groundwater extraction wells (E-1 through E-9) and a groundwater treatment system consisting of a 40-foot (ft) tall air stripper unit. The ICA system was designed to control groundwater flow in the TGA beneath and downgradient of the facility, and to capture and remove VOCs from TGA groundwater. Between 1990 and 1994, the ICA system was expanded to include wells E-10 through E-13. In 1996, the system was further expanded by adding extraction wells E-14 through E-16 and dual-phase well DP-1. Following corrective measures implementation, the groundwater extraction and treatment system was no longer referred to as the ICA system and was, instead, referred to as the Groundwater Treatment System (GWTS). The components of the GWTS (extraction wells, conveyance piping system, and stripper) are shown on Figure 3-1.

In 2000, the pumping at E-1 was suspended due to achievement of groundwater cleanup goals and, thus, was no longer needed for the hydraulic capture of the TGA plume (LAI 2000). Subsequently, the well was decommissioned in 2004 as part of a land transfer procedure.

Operational shutdown of extraction wells E-5 (West Corrective Action Area), E-6 and E-7 (Central Corrective Action Area), E-8 (East Corrective Action Area), and E-9 (East Yard Corrective Action Area) was conducted in the summer of 2002 due to low mass removal rates and low groundwater yields (LAI 2002). Extraction wells E-5 through E-9 remain in shutdown mode and are maintained for sampling purposes only and for resumed pumping, as warranted.

Extraction wells E-10, E-11, E-14, E-15, and E-16 (located in the West Corrective Action Area) were shut down to facilitate bioremediation injection activities in late 2008 (LAI 2009). Extraction wells E-10, E-14, and TSA extraction well EW-22 were decommissioned during 2010 in preparation for the Building 85-001 expansion project (LAI 2010a). Extraction wells E-15 and E-16 resumed pumping on December 20, 2012 after 4 years of pilot shutdown following injection of donor to these wells during the 2008 bioremediation injection program within the West Corrective Action Area. Extraction well E-11 remains shut down due to the presence of donor material injected at that well in 2008 and is currently maintained for sampling purposes only and resumed pumping, as warranted.

Extraction wells E-2 and E-3 (located in the Downgradient Corrective Action Area) were shut down with ODEQ approval (ODEQ 2015) in July 2015 because COPC concentrations were below the respective MCLs and in an effort to minimize the biofouling of these wells and the treatment system.

These wells pump aquifer zones that are along preferred pathways from the Former Vapor Degreaser Source Area where bioremediation activities are ongoing. Groundwater quality samples are collected from extraction wells E-2 and E-3 on a quarterly basis; if TCE concentrations rebound to above the MCLs for two consecutive events, then operational pumping of the specific well will be evaluated and discussed with ODEQ.

The original 40-ft tall air stripper tower and 25-horse power blower system with a design capacity of approximately 800 gallon per minute (gpm) was replaced in 2014 with a more energy efficient system designed for current groundwater extraction rates (LAI 2014a). The replacement GWTS consists of two low-profile air stripper trays run in parallel for a design flow rate of 70 gpm per unit or 140 gpm with both units operating. As part of the GWTS replacement, the Supervisory Control and data Acquisition (SCADA) system was upgraded from the old and non-supported software to the latest Wonderware software program and processing system. GWTS components and specifications are documented in the draft Operations and Maintenance (O&M) manual (LAI 2016a).

Currently, groundwater pumping is performed at the following wells as part of the TGA groundwater extraction and treatment system (Figure 3-1):

- E-4, E-12, E-13 (located in the Downgradient Corrective Action Area)
- E-15 and E-16 (located in the West Corrective Action Area)
- DP-1 (located in the Central Corrective Action Area).

3.2 Soil Vapor Extraction System

An SVE system operated in the West and Central Corrective Action Areas between 1994 and 2009, as part of the Consent Order corrective measures. Initially, a pilot test for both the SVE and dual-phase extraction systems was conducted; however, the results of the testing indicated that site conditions were not favorable for dual-phase. Upon completion of the pilot testing phase, the SVE system consisted of four vapor extraction wells (VE-3 through VE-6) in the West Corrective Action Area and one dual-phase extraction well (DP-4) in the Central CAA. A series of 14 vapor observation well pairs [VOW-1(s,d) through VOW-14(s,d)] were installed with vadose zone screens (shallow and deep) to evaluate vacuum rates and mass removal calculations. The SVE system was shut down in 2009 due to low mass removal rates and ODEQ approved the decommissioning of the system (ODEQ 2009). Cumulatively, the SVE system removed approximately 3,750 pounds (lbs) of VOCs from the unsaturated zone between 1994 and 2009.

In 2012, the SVE system was modified and retrofitted for reuses inside the 85-001 building in the Former Vapor Degreaser Source Area (LAI 2011a). During the investigation phase of the Former Vapor Degreaser Source Area, TCE vapor concentrations above the ODEQ “hot spot” screening level (290,000 micrograms per cubic meter [$\mu\text{g}/\text{m}^3$]) were observed in the sub-slab interval. Elevated TCE concentrations were also reported for samples collected at-depth during drilling activities. Based on this information, vapor samples were collected from at-depth locations during drilling activities. A

total of seven multiple-purpose wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] were connected to the above-grade SVE system through a series of subgrade conveyance piping to allow system operation with minimal disruption of facility operations. The retrofitted SVE system was installed and currently operates in the Vapor Degreaser Source Area. The system consists of a control panel, Rotron regenerative blower, condensate pump, knockout tank, and two 2,000-lb granular activated carbon (GAC) vessels for vapor treatment. Exhaust piping was routed from the GAC vessels to a roof stack for venting. The SVE system operates in accordance with the Boeing Portland facility-wide air discharge permit at an extraction rate of approximately 250 cubic feet per minute (ft³/min). Vapor sampling is conducted at the seven multiple-purpose wells to monitoring vapor concentrations at-depth in the vadose zone. A total of nine vapor pins (VP-1 through VP-9) were installed in the sub-slab interval to monitor VOC concentrations. Sub-slab vapor samples were collected on a quarterly basis.

The SVE system started full-time operation in September 2012. The SVE system has operated on a full-time basis through July 2014, when the system switched to pulse pump operation, as approved by ODEQ (ODEQ 2014a). Due to decreased mass recovery and VOC mass removal rates that were below the shut-off criterion of 0.1 lbs/day, the system was pilot shutdown in July 2014. Quarterly sub-slab vapor and at-depth soil vapor sample results are utilized to determine the pulse operation timeframe for the system. Based on the vapor sample results, the SVE system has operated at the following schedule:

Date Range	SVE Operation Cycle
September 17, 2012 to June 21, 2013	Full-time operation of system
June 21, 2013 to July 22, 2013	Temporarily down to facilitate bio injection activities
July 22, 2013 to July 2, 2014	Full-time operation of system
July 2, 2014	Receive ODEQs approval to shut down system and start pulse-pump operation.
July 2, 2014 to January 29, 2015	System shut down
January 29, 2015 to June 8, 2015	Resume full-time operation of system due to increased TCE concentrations in either the sub-slab or at-depth sampling intervals
June 8, 2015 to June 29, 2015	Temporarily down to facilitate bio injection activities
June 29 to October 9, 2015	Resume full-time operation of system
October 9, 2015 to April 7, 2016	System shut down
April 7, 2016 to Present	Resume full-time operation of system

3.3 Institutional Controls Plan

Restrictive covenants in potential source areas at the site were developed as part of the Consent Order Institutional Controls Plan (ICP; LAI 2005). The ICP provides worker protection procedures and

notifications within potentially environmentally impacted areas of the site. These six areas are referred to as potential source areas and were defined based on past uses of the site. These source areas were identified as the West Source Area, Central Source Area, Former Vapor Degreaser Source Area, East Yard Source Area, Southwest Source Area, and East Source Area, as shown on Figure 2-2.

Investigations have been conducted within all of the potential source areas to characterize subsurface conditions and potential impacts to workers. Based on the soil, shallow groundwater, and/or soil vapor sample results collected as part of the investigation, ODEQ has either approved of additional corrective measures (Former Vapor Degreaser Source Area) or the removal of the source areas from the ICP. ODEQ has approved removal of the West Source Area, Central Source Area, Southwest Source Area, East Source Area, and East Yard Source Area from the ICP (ODEQ 2011, 2012, 2014b, and 2016a) due to low risk levels of exposure to workers.

Investigation results for the Former Vapor Degreaser Source Area indicated the need for additional corrective measures. The investigations collected representative samples of soil vapor and groundwater. Soil vapor samples were collected from sub-slab and from variable depths in the vadose zone. Groundwater samples were collected at various depths from wells that were installed through the TGA to terminate in the upper 2 ft of the confining layer between the TGA and the underlying TSA [i.e., within the second siltstone unit in confining layer (CU1)]. TCE concentrations were above the MCL in groundwater and above the screening levels for vapor within the sub-slab and at-depth sample intervals. Based on the findings of the investigations, two additional corrective action measures have been implemented consisting of SVE and enhanced *in situ* bioremediation. The SVE system and the *in situ* bioremediation are working in conjunction to remediate VOC contamination within the vadose and saturated zones of the TGA.

Between approximately 1963 to 1968, a vapor degreaser was operated inside the 85-001 building. In 1974, the degreaser was dismantled due to suspected leakage and replaced with a new vapor degreaser machine, which was subsequently taken out of service and dismantled in the late 1980's. Historical releases of TCE from former vapor degreasers inside Building 85-001 constitute a primary source of TCE contamination in the TGA. Prior to 2009, the area of the former degreasers was deemed inaccessible for soil and groundwater investigation due to limited access for drilling inside the active manufacturing building and difficult geologic conditions (dense to very dense soil with cobbles and boulders) that require specialized drilling equipment. Advancement in limited-access roto-sonic drilling techniques allowed for the investigation to occur, with three phased investigations conducted within the area between 2009 and 2011 (LAI 2010b, 2011b,c, and 2012b). During the investigation phases, a total of 17 groundwater wells and 3 soil vapor observation wells were installed in the degreaser source zone and downgradient. Seven of these wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] are multiple-purpose sampling and remediation wells with a well screen section in the vadose zone and a screen section below the water table. The multiple-purpose wells are utilized for SVE operation, groundwater quality monitoring, and aquifer injection for *in situ* bioremediation. Well locations are shown on Figures 2-3 and 4-4.

3.4 Enhanced Bioremediation

Enhanced *in situ* bioremediation is currently being implemented in conjunction with the GWTS (provides hydraulic capture of dissolved plume) to remediate the more persistent areas of groundwater contamination as an additional corrective measure. *Aerobic* biodegradation is being utilized to treat the petroleum-based coolant material release at the 85-105 building in the Coolant Release Area. *Anaerobic* bioremediation is being utilized for reductive dechlorination of TCE and its breakdown products (cDCE and VC) to non-toxic end products (ethane/ethene) in the Former Vapor Degreaser Source Area in the 85-001 building.

3.4.1 Aerobic Biodegradation-Coolant Release Area

In 2006, coolant material was discovered in the 85-105 building footing drain sump (sump). Immediately after the coolant release, Boeing disconnected the sump discharge from the GWTS and routed the accumulated water to temporary storage tanks for batch testing and processing through the facility treatment system for disposal to the sanitary sewer. Between August 2007 and August 2012, water collected in the 85-105 building footing sump was recovered and treated using the Sump Treatment System (STS). The STS consisted of a conveyance line that transported the accumulated water from the sump vault to Building 85-124, where the water was routed through an oil/water separator, then monitored by an in-line fats, oil, and grease (FOG) monitor. Water was discharged to the sanitary sewer, with automatic routing through a GAC vessel for pre-treatment when FOG concentrations were elevated. Based on STS influent groundwater concentrations being consistently below the stormwater discharge criteria, the system was shut down in August 2012 with approval by ODEQ (ODEQ 2012). Following STS shutdown, water that accumulates in the sump passes through the GWTS prior to discharge to the Storm Drain Creek; this is the same route of discharge used prior to the 2006 coolant release.

An investigation was conducted to evaluate the vertical and horizontal extent of the coolant release to the TGA by monitoring existing nearby wells and installing eight monitoring wells (LAI-1 through LAI-8) and five injection wells (I-1 through I-5), as shown on Figure 2-3. The results of the investigation indicated that the petroleum-based coolant, which floated on the water table, did not migrate far from the area of release because the building footing drain and sump acted as a collection system for the released coolant. The investigation also confirmed that nearby Upper TSA wells did not show evidence of impacts due to the coolant release (LAI 2007a).

Application of aerobic biodegradation as an interim remedial action measure (IRAM; LAI 2007b) was approved by ODEQ (ODEQ 2007). Biodegradation has been stimulated by injecting a slurry of water and an oxygen-releasing compound (EHC-O™) into injection wells. Below is a summary of the completed injections in this area:

Injection Event	EHC-O Donor Material (lbs)	EHC-O and Water Mixture (gallons)
(Pilot Injection) February 2008	850	1,000
September 2008	2,088	2,700
June 2010	2,100	2,800
June 2011	2,000	2,500
April 2012	2,100	2,700
January 2013	2,000	2,500
July 2015	2,000	2,500

Substantial reduction in diesel- and motor oil-range total petroleum hydrocarbon (TPH-Dx) concentrations have been observed in the coolant release wells with the exception of LAI-4, where concentrations are above the site-specific cleanup level (1.35 milligrams per liter [mg/L]). The maximum TPH-Dx concentration was reported at well LAI-4 at 31,800 mg/L; however, concentrations are currently below 30 mg/L. Another injection is currently planned for 2017 to address the remaining TPH-Dx at LAI-4.

3.4.2 Anaerobic Bioremediation-Former Vapor Degreaser Source Area

Anaerobic bioremediation is currently being implemented in the Former Vapor Degreaser Source Area within the 85-001 building. Investigation results indicated elevated concentrations of TCE in this area of the site and in the Downgradient Corrective Action Area (LAI 2009). A sequence of bioremediation injections have been conducted within the Former Vapor Degreaser Source Area, as summarized below:

- In November 2010, a pilot test injection was conducted at well BOP-72(i). During the injection, a total of 900 gallons of LactOil electron donor substrate and potable water mixture was injected. A larger injection volume was intended, but low injection rates indicated low hydraulic conductivity conditions in the direct vicinity of the well and prevented injection of additional volume.
- In December 2011, a Permeable Reactive Barrier (PRB) was created on the downgradient edge of the source area by injecting electron donor substrates to well BOP-74(i). BOP-74(i) is located directly downgradient of the former vapor degreaser(s) and in the area of maximum TCE concentrations in the groundwater. Well BOP-74(i) has a high injection flow rate (50 to 80 gpm), which indicates the well is located in a preferential flow path of higher hydraulic conductivity and groundwater flux from the source. During this initial injection, the PRB well was injected with 15,000 gallons of injection solution, achieving a radius of injection (ROI) of approximately 40 ft (LAI 2014b). The injection solution consisted of 15 drums of LactOil and sodium lactate mixed with potable water. Lactoil donor substrate consists of ethyl lactate [36 percent by volume (%vol)] and vegetable oil (41 %vol), with the remaining balance consisting of surfactants and water.
- In August 2012, a second PRB injection was conducted to maintain conditions conducive to treatment, create a larger ROI, achieve more extensive downgradient treatment, and increase

the longevity of treatment between injection events. To achieve these objectives, the second injection utilized double the volume of the first injection and a 40 percent higher concentration of electron donor. Approximately 27,800 gallons of potable water was mixed with 40 drums of LactOil to create 30,000 gallons of 7.3 percent LactOil solution that was injected to well BOP-74(i). Monitoring results indicated that the second PRB injection resulted in a ROI of at least 60 ft and less than 80 ft.

- In July 2013, an initial injection was completed at seven source area wells located upgradient of PRB injection well BOP-74(i) and immediately adjacent to the former vapor degreasers (source zone). The injection was conducted at the seven multiple-purpose source area wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)]. The injection event utilized a dedicated mixing and injection area created near the SVE unit and the sub-grade conveyance piping installed during the installation of the sub-grade SVE piping. Packers installed between the two screened intervals of each well were inflated during the injection to deliver injection fluid to the aquifer and not the vadose zone. A manifold at the mixing station allowed for simultaneous injection of the seven wells while measuring individual flow rates and pressures. The injection solution was delivered by gravity feed from the mixing tank due to relatively slow flow rates of individual wells (4.8 to 11.7 gpm). Each of the seven wells was injected with approximately 1,400 gallons of injection solution. A total of 9,800 gallons of injection solution consisted of approximately 9,200 gallons of potable water and 550 gallons of LactOil (5.6 %vol).
- In July 2014, a combined injection event delivered donor injection fluid both to the PRB and to source area wells. This event constituted the third injection to the PRB [well BOP-74(i)] and the second injection to the seven source area wells. The PRB injection volume was the same as the prior injection (30,000 gallons) and the total volume injected to the source area wells was doubled to 20,000 gallons, for a total of 50,000 gallons injected. The volume for source area injection wells was increased based on injection rates achieved during the first injection event and to increase to resulting extent of treatment. The injection solution was modified to utilize crude glycerin, a local and sustainable byproduct of biodiesel production, in place of the ethyl lactate component of LactOil used for prior injections. Ferrous sulfate was also added to the injection solution to promote complementary abiotic degradation of TCE and cDCE.
- In June 2015, a combined injection event delivered donor injection fluid both to the PRB and to source area wells. The target PRB injection volume was 30,000 gallons, but the actual injection volume was only 20,000 gallons due to reduced injection flow rates. The target volume injected to the source area wells was 20,000 gallons; however, a total of 30,000 gallons were injected (source well target volume plus the extra volume from the PRB injection). The injection solution was the same as the prior injection (crude glycerin, ferrous sulfate, and Textrol BR (TBR)).

3.5 Performance Monitoring

Performance monitoring is a Consent Order corrective measure that includes the collection of subsurface quality samples to evaluate remedy progress. The groundwater performance monitoring program consists of groundwater level elevation measurements, collection of groundwater quality samples, and collection of influent and effluent samples from the GWTS. The groundwater performance monitoring program is evaluated yearly and modified based on the continued remedy of the dissolved VOC plume and with ODEQ's approval. The current groundwater monitoring program is presented in Table 3-2.

3.5.1 Well Decommissioning

TGA groundwater monitoring wells D-2(i), D-3(i), and DP-4(i) were decommissioned in November 2016 in accordance with the Oregon Water Resources Department (OWRD) regulations. Decommissioning was by overdrilling methods described in the work plan (LAI 2016b), which was approved by ODEQ (ODEQ 2016b). These wells had been removed from the performance monitoring program and decommissioned because groundwater quality met the established cleanup levels. The locations of the decommissioned wells are shown on Figure 3-2 and the construction details of wells are summarized in Table 3-3.

3.5.2 TGA Well Installation

In October 2016, groundwater monitoring well BOP-7(d) was constructed in the Downgradient Corrective Action Area near existing well BOP-7(i) and former monitoring well BOP-7(s). Existing well BOP-7(i) is screened partly in the lower portion of the TGA and the upper siltstone layer of the confining unit between the TGA and the underlying TSA, similar to well BOP-57(ib). Based on the placement of the screened intervals of the two wells, the groundwater quality is more representative of the siltstone unit and not the TGA. Water quality data for BOP-7(i) and BOP-57(ib) are collected for informational purposes as they are not indicative of water quality in either the TGA or TSA.

Well BOP-7(d) was constructed with a 10-ft long screen installed fully in the lower portion of the TGA to represent water quality in the northwestern portion of the site. BOP-7(d) has been added to the groundwater monitoring plan with samples being collected on a quarterly basis and analyzed for VOCs using diffusion bag samplers (DBS). The BOP-7(d) well log is presented in Appendix A.

4.0 2016 REMEDY PERFORMANCE DATA RESULTS

This section presents a summary of performance monitoring data collected during this reporting period (calendar year 2016). This data includes TGA and TSA groundwater quality data, groundwater elevation data, groundwater extraction well performance data, and GWTS effluent water quality data. This section of the report also provides an evaluation, based on these performance monitoring data, of the progress made toward attaining the CAOs (Section 2.1.1) that are to be met during implementation of the corrective action measures.

4.1 TGA Groundwater Elevation Data

Water level measurements were collected at all of the TGA performance monitoring well locations in conjunction with the TGA water quality sampling events (i.e., in February and August) and in accordance with the Performance Monitoring Program (Table 3-2). Groundwater levels were measured with an electronic water meter and groundwater elevations were calculated (Table 4-1) from the surveyed reference points at individual wells. Groundwater elevation contours and inferred groundwater flow directions for the February and August 2016 events are presented on Figures 4-1 and 4-2. The TGA groundwater flow continues to be observed toward the northwest in areas not included in the radius of influence of the extraction wells. Groundwater elevation contour data indicate the active pumping at extraction wells in the Downgradient Corrective Action Area (E-4, E-12, E-13); West Corrective Action Area (E-15 and E-16); and the Central Corrective Action Area (DP-1) assists with providing hydraulic capture of COPC impacted groundwater.

4.2 TGA Groundwater Quality

TGA groundwater sampling is generally conducted in February (semiannual) and August (Annual) with August being the more extensive of the two events. In addition, groundwater samples were collected on a quarterly basis for active extraction wells, semiannual basis for extraction wells that are temporarily shut down, and on an annual basis for non-pumping extraction wells that have been utilized only for monitoring purposes. In addition, quarterly sampling is conducted at wells located within the Former Vapor Degreaser Source Area. The TGA groundwater monitoring program is summarized in Table 3-2 and well locations are shown on Figure 23.

Groundwater samples from each sampling event were analyzed for VOCs to evaluate the remediation progress of the TGA dissolved-VOC plume. A summary of 2016 analytical results for COPCs are presented for TGA monitoring wells and extraction wells in Table 4-2. The estimated extent of TCE, the compound with the highest mass in the TGA dissolved-VOC plume, is presented on Figures 4-3 and 4-4. Laboratory report and data validation memorandums for samples collected between January 1 and December 31, 2016 are included in Appendix E. Time series plots of historical selected COPCs are presented in Appendix C. Historical COPCs data is summarized in Appendix D. Additional parameters were analyzed for wells in the Former Vapor Degreaser Source Area, as described below.

4.2.1 West Corrective Action Area

The groundwater remedy in the West CAA is monitored at monitoring wells BOP-16(i) and BOP-57(ia), shutdown extraction wells E-5 and E-11, and operating extraction wells E-15 and E-16. TCE and TCA concentration trends are presented in Appendix C on Figures C-1 through C-6. Evaluation findings are as follows:

- TCE: TCE concentrations were observed to fluctuate near the MCL at BOP-16(i) (1.8 to 8.7 µg/L) and BOP-57(ia) (2.4 to 11 µg/L); and, concentrations consistently remain above the MCL at extraction well E-16 (6.3 to 8.8 µg/L). Well BOP-57(ib) is partly screened in the lower TGA and the upper siltstone layer of the confining layer and is, therefore, not representative of TGA groundwater; data for BOP-57(ib) is included in Table 4-2 for informational purposes only.
- TCA, PCE, cDCE, and 1,1-DCE: These COPCs were either not detected at the reporting limits or reported at concentrations below the respective MCLs
- VC: VC concentrations were reported above the MCL only at E-15.

4.2.2 Central Corrective Action Area

TCE and TCA concentration trends at TGA monitoring wells [BOP-10(i), BOP-56(i), and BOP 59(i)] and extraction wells (E-6, E-7, and DP-1) located in the Central CAA are presented in Appendix C on Figures C-7 through C-12. Evaluation findings are as follows:

- TCE: TCE concentrations at the other area wells continue to be above the MCL during the reporting period; however, 2016 concentrations continue to decrease over time. Examples of the decreasing concentration trend include BOP-56(i) with a maximum TCE concentration of 210 µg/L in March 1998 compared to the current concentration of 11 µg/L in August 2016, and well BOP 59(i) with a decrease from 1,800 to 5.7 µg/L (August 1997 to August 2016). While TCE concentrations continue to be above the MCL at extraction well DP-1, concentrations have decreased over time from 1,000 to 26 µg/L (October 1998 to August 2016).
- PCE: PCE concentrations were detected above the MCL (5 µg/L) at BOP-10(i), E-6, and E-7, and active extraction well DP-1. The highest concentration was reported at E-7 (37 µg/L in August 2016); however, concentrations have steadily decreased since November 2008 when the maximum concentration (300 µg/L) was reported at this well.
- cDCE: cDCE concentrations above the MCL were detected at active extraction well DP-1 with concentrations ranging from 74 to 88 µg/L. cDCE concentrations in other area wells are below the MCL.
- Other COPCs have been consistently below the MCLs at all area wells.

4.2.3 Coolant Release Area

TCE and TCA concentration trends for the three coolant release wells used to evaluate the dissolved VOC plume (LAI-4, LAI-6, and LAI-7) are shown on Figures C- 13 through C-15. The three coolant monitoring wells were installed in 2006 in response to the coolant release incident; however, VOCs are also sampled from the three wells to monitor the dissolved VOC plume. LAI-6 was removed from

the VOC monitoring program following 2012 due to TCE concentrations routinely below the MCL. Wells LAI-4 and LAI-7 mark the southeastern edge of the dissolved VOC plume.

COPC concentrations were below the respective MCLs for the coolant release wells, with the exception of one detection of TCE at 5.1 µg/L. TPH results for the coolant release area are discussed in Section 4.2.8.

4.2.4 East Yard and East Corrective Action Areas

TCE and TCA concentration trends at the East Yard CAA are shown on Figures C-16 and C-17, while concentration trends for the East CAA are presented in Appendix Con Figure C-18. No TGA COPCs were reported above the respective MCLs for either the East Yard or the East CAAs.

4.2.5 Southwest Corrective Action Area

TCE and TCA concentration trends at monitoring well BOP-9(i) within the Southwest CAA are presented in Appendix C on Figure C-19. No extraction wells exist within the Southwest CAA. Evaluation findings are as follows:

- TCE: concentrations were 30 and 35 µg/L, which are above the MCL (5 µg/L). Concentrations have decreased from the historic maximum of (1,600 µg/L in January 1989); however, concentrations increased from the historical minimum (3.4 µg/L in August 2008).
- Other COPCs concentrations are below their respective MCLs.

4.2.6 Downgradient Corrective Action Area

TCE and TCA concentration trends at monitoring wells [BOP-7(i), D-7(i), D-8(i), D-11(i), and D-12(i)] and at extraction wells (E-2, E-3, E-4, E-12, and E-13) within the Downgradient CAA are presented in Appendix C on Figures C-20 through C-30. Monitoring well D-2(i) was decommissioned in October 2016. Well BOP-7(d) was installed and sampled in November 2016. A total of four monitoring wells [D-7(i), D-8(i), D-11(i), and D-12(i)] and one extraction well (E-13) are located north of NE Sandy Boulevard, while the remaining wells are located south of the roadway, as shown on Figure 2-3. Wells south of the road are closer to higher concentration portions of the groundwater plume and source areas. Evaluation findings for the reporting period are as follows:

- North of NE Sandy Boulevard: With the exception of persistent TCE exceedances at monitoring well D-8(i) and extraction well E-13, COPC concentrations were below their respective MCLs. TCE concentrations at well D-8(i) have been consistently above the MCL; however, concentrations show a steady decrease from the maximum concentration (570 µg/L in 1988) to current concentrations 26 and 32 µg/L. TCE concentrations at extraction well E-13 were also consistently above the MCL; concentrations ranged of 10 and 13 µg/L.
- South of NE Sandy Boulevard: Extraction wells E-2 and E-3 have remained in shutdown mode since July 2015 because COPC concentrations were consistently below the respective MCLs and to minimize the amount of biofouling accumulation associated with pumping in preferred pathways from the Former Vapor Degreaser Source Area where bioremediation activities are ongoing (ODEQ 2015). COPC concentrations at E-2 remained below the respective MCLs. At

E-3, TCE was below the MCL for the first three quarters, then detected at 9.2 µg/L in November; VC concentrations were above the MCL (max 3.5 µg/L) during three quarters and not detected in August. If TCE concentrations remain above the MCL for two consecutive quarterly sampling events, then the resumed operation of E-3 will be evaluated with ODEQ. All COPCs were below their MCLs for the other wells in this area, with the following exceptions:

- TCE concentrations ranged from 5.1 to 11 µg/L at the newly installed well BOP-7(d). Two diffusion bags were installed in the screened interval to evaluate potential vertical distribution. As noted above, well BOP-7(i) is partly screened in the siltstone layer underlying the TGA and is included for information purposes.
- Extraction wells D-4 and E-12 had TCE concentrations ranging from 16 to 26 µg/L.

4.2.7 Former Vapor Degreaser Source Area

The groundwater monitoring for the Former Vapor Degreaser Source Area is performed at wells BOP-72(i) through BOP-88(i). TCE and TCA concentration trends at monitoring wells [BOP-72(i) through BOP-77(i), and BOP-80(i) through BOP-83(i)], and source area multiple-purpose (vadose zone and saturated zone screens) wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] are shown on Figures C-31 through C-42.

A total of five bioremediation injections have been completed in this source area following pilot testing. The first two injections (2011 and 2012) were conducted at well BOP-74(i) to create a treatment PRB in a highly permeable zone directly downgradient of the former vapor degreasers. Bioremediation injection in 2013 was to seven wells located in and upgradient of the degreaser source. Bioremediation injections in 2014 and 2015 were to the seven source area wells and to the PRB well BOP-74(i). 2016 TCE concentrations are shown with prior maximums on Figure 4-4. 2016 results indicate a continued decline in the concentrations of COPCs. TCE has decreased substantially from prior maximums with biodegradation to breakdown products cDCE and VC and to non-toxic end products ethene and ethane. Further discussion of remediation progress in this area is presented in Section 5. Comparison of 2016 COPC concentrations to MCLs is as follows:

- TCE: TCE concentrations were above the MCL at six wells [BOP-72(i), BOP-75(i), BOP-77(i), BOP-82(i), BOP-83(i), and BOP-88(i)] as presented on Figure 4-4. This compares to 14 wells that had TCE concentrations above the MCL during baseline source area monitoring in November 2011 and February 2012. Furthermore, the highest TCE concentration [10 µg/L at BOP-83(i) in November 2016] is much lower than prior maxima. Substantial concentration reduction is most apparent at well BOP-73(i), which is located directly downgradient of the two former degreasers and has not been utilized as an injection well during bioremediation activities. TCE concentrations at BOP-73(i) have decreased from the historical source zone maximum concentration of 17,000 µg/L (November 2013) to a maximum of 1.5 µg/L during 2016; this represents a 99.99 percent decrease.
- cDCE: cDCE concentrations were nondetect at the laboratory reporting limit or below the MCL, with the exception of well BOP-88(i). cDCE was detected twice above the MCL at well BOP-88(i) with concentrations of 100 and 110 µg/L.

- VC: VC concentrations were above the MCL (2 µg/L) at 11 source area wells with exceedances ranging from 2.1 to 13.0 µg/L. VC concentrations at BOP-73(i) have decreased from the historical maximum concentration of 13,000 µg/L (August 2014) to ranging from non-detect at the laboratory reporting limit to 8.8 µg/L during 2016.
- Other COPCs were not detected above their MCLs during this reporting period.

4.2.8 Coolant Release

Groundwater monitoring to evaluate the lateral extent of the coolant release and to monitor the effects of the EHC-O™ injections is conducted semiannually at three TGA coolant release monitoring wells (LAI-4, LAI-7, and LAI-8), and annually from eight monitoring wells (LAI-1 through LAI-8). The 2016 groundwater analytical results for total TPH-Dx from these wells are summarized in Table 4-3 and are shown on Figure 4-5.

With the exception of well LAI-4, TPH-Dx concentrations in the coolant release area wells are currently below the laboratory reporting limits for the respective carbon ranges. Historically, total TPH-Dx concentrations were reported above the site-specific cleanup level at LAI-1, LAI-4, LAI-5, LAI-6, LAI-7, and LAI-8. Wells LAI-8 has been dry since November 2011; therefore, no groundwater samples have been collected.

The highest total TPH-Dx concentrations have consistently been observed at well LAI-4; therefore, this well is a conservative indicator of treatment progress in the coolant release area. Total TPH-Dx concentrations at LAI-4 have decreased from the initial maximum concentration (31,800 mg/L in August 2006) to 29.1 mg/L (August 2017), a 99.91 percent reduction. This included a marked decrease in concentrations due to free-product recovery efforts followed by additional concentration reduction through bioremediation injection activities. Total TPH-Dx concentrations at this well have repeatedly decreased after an injection event followed by rebound as the injected EHC-O is consumed; however, concentrations exhibit an overall decline. This repeated rebound total TPH-Dx concentrations suggest some residual TPH mass in the vicinity of this well. Well LAI-4 is screened on top of a building footing with an associated footing drain. It appears that fluctuations in groundwater flow around the footing and to the drain result in periodic groundwater contact with residual TPH mass and observed periodic increases in TPH concentrations.

4.3 TSA Groundwater Quality Monitoring

Per the Consent Order, the potential for downward migration of VOCs from the TGA to the Upper TSA was monitored by collecting groundwater quality data at six Upper TSA wells [BOP-22R(ds), BOP-60R(ds), BOP-61(ds), BOP 62(ds), BOP 65(ds), and BOP-66(ds)]. The Upper TSA VOC analytical results from this reporting period are presented by respective area in Table 4-2 and the TCE concentrations are shown on Figure 4-3. TCE concentrations at the six Upper TSA wells were either below the laboratory reporting limit or below the MCL with the exception of BOP-61(ds), which is located in the East Yard CAA. TCE concentrations at BOP-61(ds) ranged from 5.8 to 7.6 µg/L in 2016 and have fluctuated near the MCL for the past 3 to 5 years. TGA wells in the direct vicinity of

BOP-61(ds) include E-9 and BOP 48(i), where TCE results are near the laboratory reporting limit and do not indicate a TGA source for the observed concentrations in the Upper TSA well. TSA extraction well EW-23, located 330 ft northeast of BOP 61(ds), is operated to capture and remediate groundwater in the vicinity of BOP-61(ds) as part of the East Multnomah County (EMC) Cleanup project.

4.4 Former Vapor Degreaser Source Area-Vapor Data

The SVE system has been operating in the Former Vapor Degreaser Source Area since 2012 with some periods of shut down, as described in Section 3.2 of this report. VOCs concentrations were reported in two vadose zones (sub-slab and at-depth). Sub-slab vapor VOCs concentrations are monitored at nine vapor pin locations (VP-1 through VP-9), while at-depth vapor sample are collected from the vadose zone screen in the seven multiple-purpose wells [BOP-78(i), BOP-79(i) and BOP-84(i) though BOP-88(i)] and three VOWs (VOW-16 through VOW-18). Sub-slab vapor sample results for 2016 are summarized in Table 4-4 and TCE concentrations are shown on Figure 4-6. At-depth vapor COPC concentrations for 2016 are summarized in Table 4-5 and TCE concentrations are shown on Figure 4-7.

Sub-slab vapor samples have been collected quarterly from nine vapor pins since monitoring began in May 2013. Sub-slab vapor results for 2016 indicate all COPC concentrations were below screening levels, with the exception of TCE. TCE vapor concentrations exceeded the screening level ($2,900 \mu\text{g}/\text{m}^3$) at VP-2 ($150,000 \mu\text{g}/\text{m}^3$) and VP-5 ($93,000 \mu\text{g}/\text{m}^3$) in February 2016. These concentrations are much lower than baseline concentrations, which are presented on Table 4-4. It should be noted that the two 2016 exceedances of the TCE screening level occurred when the SVE system was in pulse-pump shutdown mode. The SVE system resumed full-time operation on April 7, 2016. Since that time, TCE concentrations have been below the screening level at all sub-slab vapor pins locations with a maximum TCE concentration of $220 \mu\text{g}/\text{m}^3$.

At-depth vapor samples have been collected quarterly from seven multiple purpose wells since SVE system startup in September 2012. In 2016, all the COPCs were reported at concentration either below the laboratory reporting limit or below the respective screening levels.

4.5 Treatment System Performance Data

The GWTS and the SVE system are the two systems currently operating to remediate the TGA. This section of the report will focus on performance data for each system.

4.5.1 Groundwater Treatment System

The GWTS monitoring data includes VOC analytical data and flow rate data collected from each TGA extraction well. Active extraction wells were sampled on a quarterly basis with monthly water level measurements, while extraction wells in shutdown mode were sampled annually with quarterly water level measurements, as summarized in the Performance Monitoring Plan (Table 3-2). These data are presented and evaluated for each well in terms of an average daily mass removal rate in pounds of VOCs per day (lbs/day), total mass of selected VOCs removed (lbs), and total gallons extracted.

4.5.1.1 VOC Mass Removed

The performance of the GWTS focuses on the ability of individual extraction wells to achieve one or more of the following CAOs: 1) hydraulic containment of the VOC plume (CAO-a and CAO-d); 2) VOC mass removal (CAO-a); and 3) water table depression, which is intended to enhance the VOC mass removal rate from SVE wells (CAO-a). The 0.01 lb/day VOC mass removal criterion established for the Central CAA dual-phase extraction system (LAI 2001) is used as a benchmark criteria for potential discontinuation of pumping for the GWTS extraction wells. Currently, six extraction wells are operated continuously (E-4, E-12, E-13, E-15, E-16, and DP-1). Extraction wells E-5 through E-9 and E-11 are shut down due to low mass removal rates and are used for groundwater monitoring only. Extraction E-2 and E-3 are currently in shutdown mode based on consistent COPCs concentrations below the respective MCLs and to minimize bioaccumulation related to the upgradient treatment zone for the Former Vapor Degreaser Source Area bioremediation area.

In 2016, the average VOC mass removal rates for the six operating extraction wells ranged from 0.00012 (E-15) to 0.01156 (E-13) lb/day. Combined, the six extraction wells have an average VOC mass removal rate of 0.01636 lb/day. This information is presented in Table 5-1 along with data from the prior 5 years for comparison. In 2016, a total of 6 pounds of VOCs were removed and a total of 37 million gallons of groundwater was extracted. The average total VOC mass removal rates for 2016 are shown on Figure 5-1. Table 5-2 summarizes average pumping rates for each well during 2016. Total TCE, TCA, cDCE, and total VOC mass removed in 2016 in each area is shown on Figure 5-2.

Since the start of GWTS operation in 1983, a total of 4,301 pounds of VOC mass has been removed and 4,558 million gallons of water extracted. All time total VOC mass removed is summarized for each well and area on Figure 5-3. Figure 5-4 presents cumulative groundwater system performance.

The individual extraction well VOC mass removal rates (Table 5-1) are below the 0.01 lb/day VOC mass removal criterion, with the exception of E-13. The GWTS and the individual extraction wells were historically operated with the main goal of removing and, although the extraction system still removes mass, the focus has shifted from mass removal to maintaining hydraulic capture. Extraction wells continue to be operated to provide hydraulic capture and to operate in conjunction with the bioremediation additional corrective action in the source areas.

4.5.1.2 Groundwater Treatment System Discharge Monitoring

In compliance with National Pollutant Discharge Elimination System permit (NPDES Permit Number 101761) for the GWTS treated water discharge to the Columbia Slough, quarterly samples of the GWTS influent and effluent were collected and submitted for chemical analysis. The NPDES permit effluent water quality requirements and the analytical results for the reporting period are summarized in Table 5-3. NPDES permit requirements for the effluent were not exceeded during 2016.

4.5.2 Soil Vapor Extraction System

The SVE system, located in the Former Vapor Degreaser Source Area, was installed in 2012. The system operated full time until July 2014 at which time the system operated in a pulse-pump cycle schedule based on the quarterly vapor analytical data. However, since April 7, 2016, the SVE system has remained in full-time operation. Analytical results indicate that sub-slab vapor concentrations rebound to levels above the screening levels when the system is not operating. During non-operational cycles of the SVE system, TCE concentrations rebounded in the sub-slab interval as high as 260,000 $\mu\text{g}/\text{m}^3$ (sampling location VP-5 in November 2014) and 180,000 $\mu\text{g}/\text{m}^3$ (sampling location VP-2 in November 2014). Sampling locations VP-2 and VP-5 historically have been most sensitive to shutdown of the SVE system, as TCE concentrations have not rebounded in the other sub-slab sampling locations. Based on the observed rebound, the pulse-pump cycling of the SVE system was discontinued and the system started full-time operation in April 2016. The current TCE risk-based cleanup level (RBC) for sub-slab soil vapor is 2,900 $\mu\text{g}/\text{m}^3$. This is based on the RBC for indoor air in an industrial setting (2.9 $\mu\text{g}/\text{m}^3$) and an indoor attenuation factor of 1,000 that accounts for vapor intrusion through the building slab. Recently, ODEQ also adopted an Indoor Air Response Action Level for short-term exposure to TCE of 7 to 8 $\mu\text{g}/\text{m}^3$. With the continued operation of the SVE system, the sub-slab vapor concentrations are below the newly adopted short-term exposure limits; therefore, the SVE system will continue to operate until concentrations are reduced.

SVE system mass removal rates were calculated for the seven multiple-purpose wells. These wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] are screened in both the vadose zone for SVE operation and in the saturated zone for bioremediation injection/monitoring. During 2016, VOC mass removal rates ranged from 0.00031 lbs/day [at BOP-79(i)] to 0.00373 lbs/day [at BOP-84(i)], as summarized in Table 4-5; calculation of these mass removal rates does not include days when the system was shut down. A total of 2.05 lbs of VOC mass were removed from the vadose zone in 2016 and a cumulative total of 12.52 lbs of VOC mass removed since SVE system startup.

5.0 SOURCE AREA REMEDIATION PROGRESS

A primary source of TCE groundwater contamination in the TGA is the Former Vapor Degreaser Source Area where aquifer bioremediation has been performed. Aquifer bioremediation consists of the PRB created through electron donor injection to well BOP-74(i) on the downgradient edge of the source area, and source area treatment resulting from donor injection to the seven multiple-purpose wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)]. PRB injections occurred in 2011, 2012, 2014, and 2015. Injection of the seven multiple-purpose wells was performed in 2013, 2014, and 2015 (concurrent with the PRB injection). Well locations and ROIs are shown on Figures 6-1 and 6-2.

The PRB injections and multiple-purpose source area well injections have created a commingled treatment zone with overlapping ROI of injected donor and downgradient transport of donor by groundwater flow. The initial PRB injection (2011) resulted in an estimated 40 ft ROI; however, the ROI has increased to about 68 ft with the larger volumes delivered to well BOP-74(i) during subsequent injections. The ROI of each multiple-purpose well is 10 to 15 ft based on injection volumes and observations at non-injected wells BOP-72(i) and BOP-76(i). The combined area of overlapping ROI from the different injection wells is approximately 130 ft wide (north to south) and 150 to 160 ft thick (east to west) surrounding the former vapor degreasers. Over time, the treatment zone has extended farther downgradient to include wells BOP-80(i), BOP-81(i), and BOP-82(i). The extent of the treatment zone is based on the presence of injected donor (increased TOC); changing concentrations of TCE and breakdown products; and enhanced aquifer redox conditions for bioremediation (indicated by increased ferrous iron, sulfide, and methane, and by decreasing concentrations of nitrate and sulfate). Overlapping ROI and the downgradient extent of the treatment zone are shown on Figures 6-1 and 6-2. At monitoring well BOP-83(i), the northernmost in the line of downgradient monitoring wells, TOC and redox changes have not been observed, but TCE concentrations have decreased substantially from a baseline of 31 µg/L to as low as 1.7 µg/L in February 2016; this well is considered to be outside of the treatment zone, but within an area of concentration reduction resulting from donor injections.

The progress of the bioremediation remedy in the Former Vapor Degreaser Source Area is primarily demonstrated by the decrease in TCE concentrations and the increase in breakdown products (cDCE and VC) and in non-toxic end products ethene and ethane. These changes coincide with increased TOC and enhanced aquifer redox conditions indicative of the treatment zone. Cumulative bioremediation monitoring data for the Former Vapor Degreaser Source Area are summarized in Table 6-1. The following highlights observations of enhanced biodegradation in the source area and downgradient treatment zone through 2016:

- Initially, reported TCE concentrations in the source area were relatively low with concentrations ranging from nondetect at the reporting limit to 110 µg/L. However, following donor injections, TCE began to desorb from the aquifer soil, increasing the concentration in the aqueous phase. This resulted in increased concentrations of TCE to a maximum concentration 17,000 µg/L at well BOP-73(i). From the baseline sampling event in October 2010 through 2016, all of the

source area wells and three of the four downgradient wells have had maximum TCE concentrations above the cleanup level, as shown on Figure 6-1. Enhanced desorption is desired as it liberates mass from the sorbed phase to the aqueous phase where it can be treated *in situ* or extracted for treatment by the GWTS.

- TCE concentrations have decreased substantially due to donor injections. As of November 2016, results indicate only three source area wells with TCE above the MCL [6.2 µg/L at BOP-75(i) and BOP-88(i); and 6.7 µg/L at BOP-72(i)] along with two downgradient wells [8.7 µg/L at BOP-82(i) and 10.0 µg/L at BOP-83(i)], as shown on Figure 6-2. The decrease in TCE concentration at well BOP-73(i) from the maximum of 17,000 µg/L to 1.5 µg/L in November 2016 constitutes a 99.99% decrease.
- The predominant COPC at the 17 wells (source area and downgradient wells) has transitioned over time from the parent product (TCE) through breakdown products (cDCE and VC) to end products (ethene and ethane). This is a highly favorable result indicating progression of reductive dechlorination through breakdown products to non-toxic end products. The transition from TCE to breakdown and end products can be seen in the highlighting of the predominant ethene (i.e., compound with the highest molar fraction) in Table 6-1.
- Five source area wells [BOP-72(i), BOP-73(i), BOP-75(i), BOP-76(i), and BOP-77(i)] are utilized for monitoring purposes only and are not injected with electron donor. Data from these wells is important for understanding changes in the bulk aquifer due to donor injection at some distance from injection wells. Data from monitoring well BOP-73(i) (located 50 ft northwest of the former degreasers) is particularly helpful in understanding the progression of treatment in the source area, as the highest TCE concentrations were consistently detected at this well. BOP-73(i) is also located centrally within the extent of source area contamination and centrally to the injected multiple-purpose wells. Some observations at BOP-73(i) are as follows:
 - Enhanced desorption has peaked as evidenced by the drop in TCE and breakdown product concentrations in 2015 and 2016. In late 2013 and early 2014, peak concentrations of TCE (17,000 µg/L), cDCE (7,800), and VC (13,000) were observed that were 2 orders of magnitude higher than the baseline concentrations reported prior to donor injections. Drastic decreases were observed in May 2016 data as TCE, cDCE, and VC were all below the laboratory reporting limit. TCE concentrations were below the MCL during all of 2016. Enhanced desorption and the progression of TCE reductive dechlorination through breakdown products to end products continues to be evident on a time versus concentration plot for BOP-73(i) groundwater presented on Figure 6-3. Several peaks in TCE concentration show enhanced desorption effects following injection events. TCE then declines, followed by sequential peaks in cDCE, VC, and ethene+ethane concentrations.
 - TCE predominance on a molar basis (evaluated by molar fraction) has transitioned to cDCE, VC, and end product ethane predominance. The non-toxic end product ethene, which was not detected during baseline sampling, increased to a maximum of 77 µg/L at BOP-73(i) in February 2016. Ethene+ethane was predominant over TCE and breakdown products in November 2016 with a molar fraction of 0.90 (i.e., 90 percent of total ethenes), as shown in Table 6-1.
- Complete reductive dechlorination of TCE and breakdown products with substantial conversion of chlorinated compounds to non-toxic end products has occurred throughout the extent of the treatment zone (Figure 6-1). The average molar fraction for each compound (PCE, TCE, cDCE, VC,

and ethene+ethane) was calculated for each sampling event by averaging the data from every well in the treatment zone where VOC plus ethene/ethane data was collected. Figure 6-4 shows the average molar fraction distribution for each sampling event. The initial predominance of TCE (i.e., largest molar fraction) is apparent through August 2013. cDCE becomes predominant by February 2014, followed by VC predominance in August 2014. The non-toxic end products ethene+ethane have been predominant within the extent of the treatment zone since February 2015.

- Complete reductive dechlorination of TCE and breakdown products to ethene and ethane has resulted in contaminated mass destruction, not just conversion of PCE and TCE to chlorinated breakdown products. A plot of average total chlorinated ethenes (molar sum of PCE+TCE+cDCE+VC) is presented on Figure 6-4. The average total chlorinated ethenes was calculated for each monitoring event and includes all wells within the treatment zone. Increasing average total chlorinated ethenes in February and August 2014 reflects substantial desorption in the vicinity of BOP-73(i), followed by a continued decrease through 2016. Comparison of the peak average total chlorinated ethenes in August 2014 (39.6 $\mu\text{moles/L}$) to the minimum in August 2016 (0.2 $\mu\text{moles/L}$) represents a 99.5 percent decrease within the source and downgradient treatment zone.

5.1 Progress toward corrective action objectives

Based on the treatment system data (GWTS and SVE), along with analytical performance data results (groundwater and vapor), progress toward achieving the corrective action objections is estimated within the 10 to 15 year time frame. This section summarizes the progress made toward achieving CAO-a through CAO-g (Section 2.1.1), based on the data and evaluations discussed in this report.

5.1.1 CAO-a

“Decrease VOC concentrations (i.e., mass removal) throughout the site to achieve maximum contaminant levels (MCLs). If this is not feasible, then minimize the areal extent of groundwater contamination that exceeds MCLs and provide long-term containment for those areas with concentrations above MCLs.”

Groundwater quality results indicate that TGA groundwater is responding to the Consent Order-driven correction measures and the additional corrective action measures (i.e., bioremediation and SVE operation in identified source areas). Some areas have been more resistant to remediation efforts; these include the area near well BOP-9(i) and BOP-10(i), which are located in the Southwest and Central CAAs, respectively. TCE concentrations have reduced at these two areas from the maximum concentration; however, the decrease is slow.

5.1.2 CAO-b

“Prevent exposure to TGA groundwater that contains VOCs at concentrations above MCLs.”

This CAO is currently being achieved through historical decommissioning of water supply wells within the VOC plume, provision of alternate water supplies, and general monitoring of the area with respect to controlling the installation of new wells and the implementation of the requirements within the ICP. Investigations conducted within the West, Central, Southwest, East, and East Yard Source Areas

indicate COPCs are not present in the shallow soil or vapor concentrations above the screening limits; therefore, ODEQ has approved the removal of these areas from the ICP.

5.1.3 CAO-c

“Protect environmental receptors by preventing discharge of TGA groundwater to surface water at VOC contaminant concentrations that may exceed ambient water quality criteria.”

Evaluations conducted in the health and environmental assessment (LAI 1995b) indicate no potential impact to human health or environmental receptors in the Columbia Slough from groundwater or soil contamination. As a result, CAO-c has been achieved through implementation of the corrective measures.

5.1.4 CAO-d

“Prevent further spread of contamination in the TGA (i.e., prevent the migration of groundwater containing VOCs above MCLs).”

Groundwater elevation and contaminant concentration data collected during this reporting period indicate continued hydraulic capture of the plume. The progress of the remedy and prevention of further spread of the contamination is summarized in the plume progress map, shown on Figure 6-5. This CAO, therefore, continues to be achieved through implementation of the corrective measures.

5.1.5 CAO-e

“Protect groundwater quality in the Troutdale Sandstone Aquifer (TSA).”

Groundwater quality data for wells used to assess the potential effect of TGA groundwater on the TSA indicate that the TGA does not appear to be a continuing source of VOCs to the TSA. Decreasing VOC concentration trends have been observed over the long-term at the TSA wells. Based on these assessments, the corrective measures are currently achieving CAO-e.

5.1.6 CAO-f

“Facilitate existing uses of groundwater resources in eastern Multnomah County”.

The ICP provides protective measures to restrict the potential ingestion of TGA groundwater by decommissioning existing groundwater supply wells and placement of restrictions on future well installation activities. The ICP is provided in Appendix B.

5.1.7 CAO-g

“Reduce concentrations of VOCs and minimize migration of VOCs from vadose zone soil to the TGA that could compromise satisfying objective “a” for groundwater.”

This CAO has been achieved through the removal of 3,700 lbs of VOCs during operation of the SVE wells in the West and Central Corrective Action Areas prior to the shutdown of the SVE system. The SVE system was modified and installed within the Former Vapor Degreaser Source Area in 2012. Since SVE startup in the source area, a total of 12.52 lbs of VOCs has been removed.

6.0 RECOMMENDATIONS

This section provides recommendations for modifications to enhance and optimize the Consent Order corrective measures and the additional corrective measures utilized to conduct the TGA remedy.

6.1 Groundwater Extraction and Treatment Program

The VOC mass removed has appeared to have reached an asymptotic level relative to the first 15 years of groundwater treatment as shown on Figure 5-4. Over the past few years, the benefit of operating the GWTS has shifted more from providing VOC mass removal to providing hydraulic control of the dissolved plume. As the additional corrective measures continue to remove mass (i.e., SVE system in the vadose zone and enhanced in situ bioremediation in groundwater), the continued operation of individual extraction wells for the GWTS may be modified.

The continued operation of the GWTS is recommended to: 1) provide hydraulic control of the dissolved VOC plume and 2) provide VOC mass removal. The optimization of this Consent Order corrective measure will be reviewed monthly to verify individual extraction well pump rates and system compliance with the NPDES permit requirements. Continued operation of currently operating extraction wells (E-4, E-12, E-13, E-15, E-16, and DP-1) is recommended. Continued shutdown of extraction wells E-2, E-3, and E-11 are also recommended.

6.2 Performance Monitoring Program

Given the remedy progress and the continued reduction of the dissolved VOC plume, we propose that the following changes to the performance monitoring program be implemented beginning during the next annual sampling event (August 2017). The requested modifications are included in Table 3-2 and discussed below:

Extraction Well Monitoring

- Continue collection of water level measurements on a quarterly basis for actively operational extraction wells (E-4, E-12, E-13, E-15, E-16, and DP-1) and semiannually for remaining extraction wells that are shut down.
- Continue collection of water quality data on a quarterly basis for actively operational extraction wells, semiannually for conditionally shutdown extraction wells (E-2, E-3, and E-11), and annually for shutdown extraction wells that are being monitored for water quality only (E-5 through E-9).

Groundwater Monitoring Wells

We propose to maintain the current monitoring program for all groundwater monitoring exceptions noted below and summarized in Table 3-2:

- Monitoring well BOP-7(d), newly installed in 2016, will be sampled on a quarterly basis using multiple DBS at two intervals within the screened section. An upper DBS will be installed in the upper 5 ft of the screen and the second bag will be installed in the lower 5 ft of the screen. The multiple DBS data will be utilized to evaluate potential vertical variations in the COPC

concentrations. Based on four quarters of multiple DBS data, the interval with the highest TCE concentrations will be selected for future sampling using a single DBS.

- Both BOP-7(i) and BOP-57(ib) are partially screened in the first siltstone layer of the confining layer separating the TGA from the TSA. Groundwater quality from the wells does not characterize the TGA; however, the data does provide information on potential downward migration. We propose these wells be monitored (groundwater elevation and quality sampling) on an annual basis. This is a change from prior quarterly [BOP-7(i)] and semiannual [BOP-57(ib)] sampling.
- We recommend decreasing the groundwater quality and the at-depth vapor sampling frequency from quarterly to semiannual for the 17 wells associated with the Former Vapor Degreaser Source Area. The groundwater quality samples will continue to provide information on the enhance dechlorination progress and be utilized when evaluating when COPC concentrations rebound or when additional donor may be required. The at-depth vapor samples have consistently been below the screening level since November 2012. Vapor rebound has been observed in the sub-slab interval, but not in the at-depth interval. The SVE system will continue to operate to capture vadose zone vapor mass.
- Groundwater monitoring well D-13(i), located north of NE Sandy Boulevard, was removed from the monitoring program in 2009 due to COPC concentrations being below the respective MCLs. TCE concentrations have been below the MCL since August 1994 and consistently below the laboratory reporting limit since August 2001 (Appendix D). Based on this information, we recommend D-13(i) be decommissioned. A pending work plan with the process and procedures will be submitted to ODEQ.

6.3 Enhanced *In Situ* Bioremediation

The continued implementation of enhanced in situ bioremediation as an additional corrective measure is recommended. The use of bioremediation in additional areas of the site with persistent issues will be reviewed during routine remedy optimization evaluations. Following are recommendations for each of the areas on the site currently utilizing this additional corrective measure:

- Coolant Release Area: An additional injection of aerobic donor material (i.e., EHC-O™) is recommended to assist with Total TPH-Dx rebound observed at monitoring well LAI-4. We plan to conduct the injection event in May to June 2017, pending ODEQ approval of the submitted work plan (LAI 2017).
- Former Vapor Degreaser Source Area: Ongoing periodic injections of donor substrates to maintain adequate electron donor and the required reduced aquifer redox conditions for continued treatment of TCE and breakdown products are anticipated. The initial annual frequency of injection has been reduced based on monitoring results indicating effective contaminant treatment and aquifer conditions that remain conducive for continued biodegradation. Additional injections may be required to prevent rebound of contaminant concentrations due to expected back-diffusion of contaminant mass from the aquitard and other fine-grained zones in the TGA.

6.4 Future Reporting

As required by the ODEQ consent order, the next 5-year performance evaluation report will be conducted in 2021. Annual performance reports will continue to be prepared to summarize activities for the calendar year and provide an analysis of data collected during the reporting year and an assessment of remedy progress toward achieving cleanup goals.

7.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of The Boeing Company for specific application to the Boeing Portland facility. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

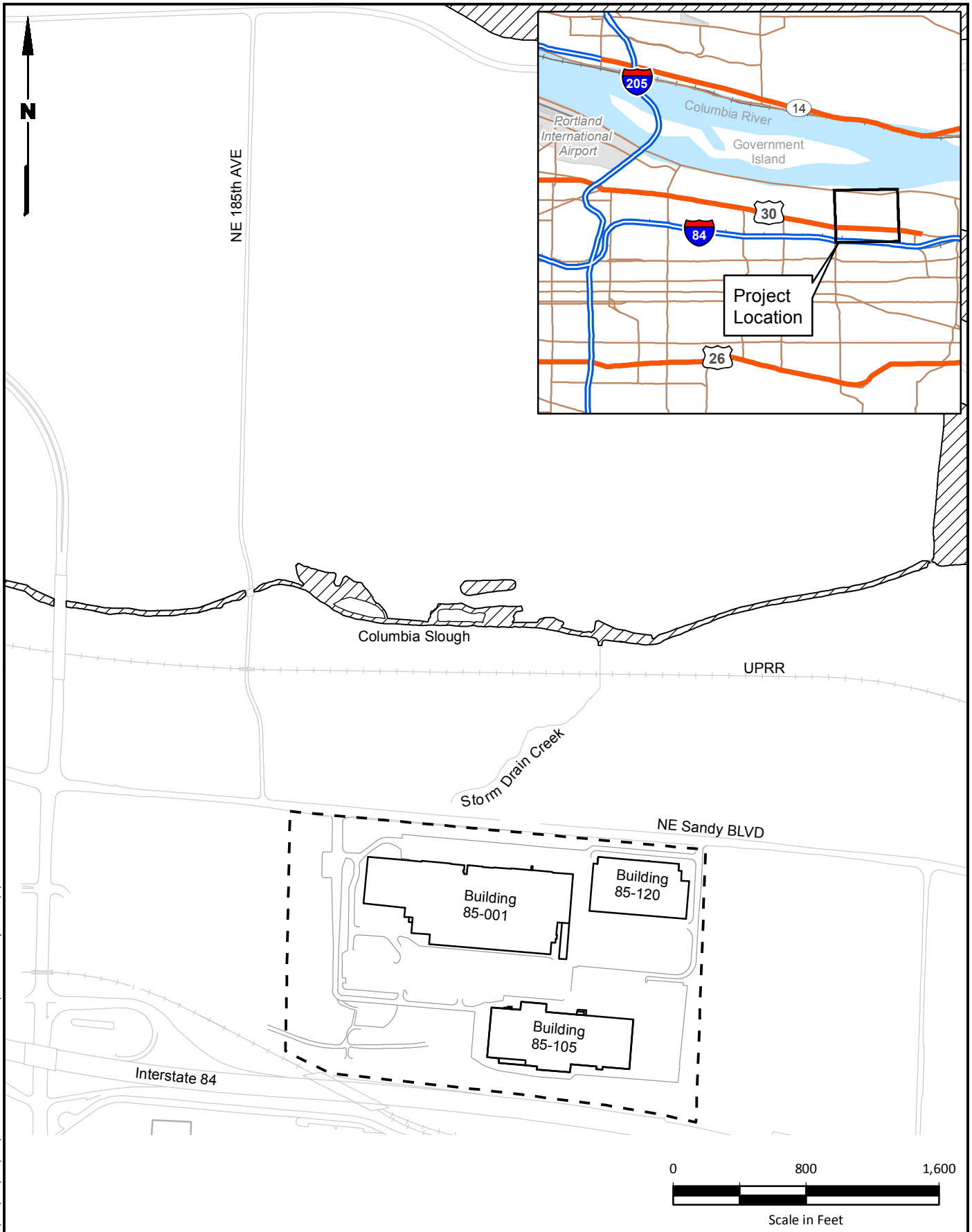
8.0 REFERENCES

- EPA. 1997a. Final Decision and Response to Comments for the Boeing Portland Facility Troutdale Gravel Aquifer. The Boeing Company, 19700 N.E. Sandy Blvd., Gresham, Oregon. ORD 054964481. July.
- EPA. 1997b. Statement of Basis for the Boeing Portland Facility Troutdale Gravel Aquifer. The Boeing Company, 19700 N.E. Sandy Blvd., Gresham, Oregon. ORD 054964481. March.
- EPA. 1994. Administrative Order on Consent, RCRA Docket No. 1093-04-02-3008(h). January 18.
- LAI. 2017. Addendum No. 3, Work Plan Addendum for Remedial Injection Activities, Building 85-105 Coolant Release, Boeing Portland Facility. April 3.
- LAI. 2016a. Operation and Maintenance Manual Addendum, Groundwater Extraction and Treatment System, Boeing Portland, Gresham, Oregon. September 19.
- LAI. 2016b. D-2(i), D-3(i), and DP-4 Well Decommissioning Work Plan, Boeing Portland – Troutdale Gravel Aquifer Remedy, Gresham, Oregon, Project No. 0025116.116.440, (ECSI #13). August 3.
- LAI. 2015. Technical Memorandum re: Addendum No. 2, Source Area Bioremediation Work Plan, Combined Treatment of Source Wells and Permeable Reactive Barrier, Building 85-001 Former Degreaser Source Area, Boeing Portland Facility, Gresham, Oregon. May 5.
- LAI. 2014a. Technical Memorandum re: Air Stripper and Blower Replacement or Rehabilitation Evaluation, Boeing Portland Facility – Gresham, Oregon. November 7.
- LAI. 2014b. Technical Memorandum re: Addendum No. 1, Source Area Bioremediation Work Plan, Combined Treatment of Source Wells and Permeable Reactive Barrier, Building 85-001 Former Vapor Degreaser Source Area, Boeing Portland Facility, Gresham, Oregon. May 29.
- LAI. 2013. Work Plan, Source Area Bioremediation, Building 85-001 Former Degreaser Area, Boeing Portland Facility, Portland, Oregon. Prepared for the Boeing Company. May 21.
- LAI. 2012a. Troutdale Gravel Aquifer Corrective Measure, Five-Year Performance Evaluation 2006 -2011, Boeing Portland Facility, Gresham, Oregon. Prepared for The Boeing Company. April 9.
- LAI. 2012b. Report, Well Installation – Building 85-001, Former Degreaser Area, Boeing Portland Facility, Portland, Oregon. Prepared for The Boeing Company. July 24.
- LAI. 2011a. Summary Report, 2010-2011 Supplemental Environmental Investigation Report, Building 85-001 Former Degreaser Area, Boeing Portland Facility, Gresham, Oregon. November 18.
- LAI. 2011b. Work Plan, Source Area Investigation, Troutdale Gravel Unit, Boeing Portland Facility, Portland, Oregon. Prepared for The Boeing Company. September 27.
- LAI. 2011c. Work Plan, Soil Vapor Extraction System, Building 85-001 Former Degreaser Area, Boeing Portland Facility, Portland, Oregon. Prepared for The Boeing Company. November 18.

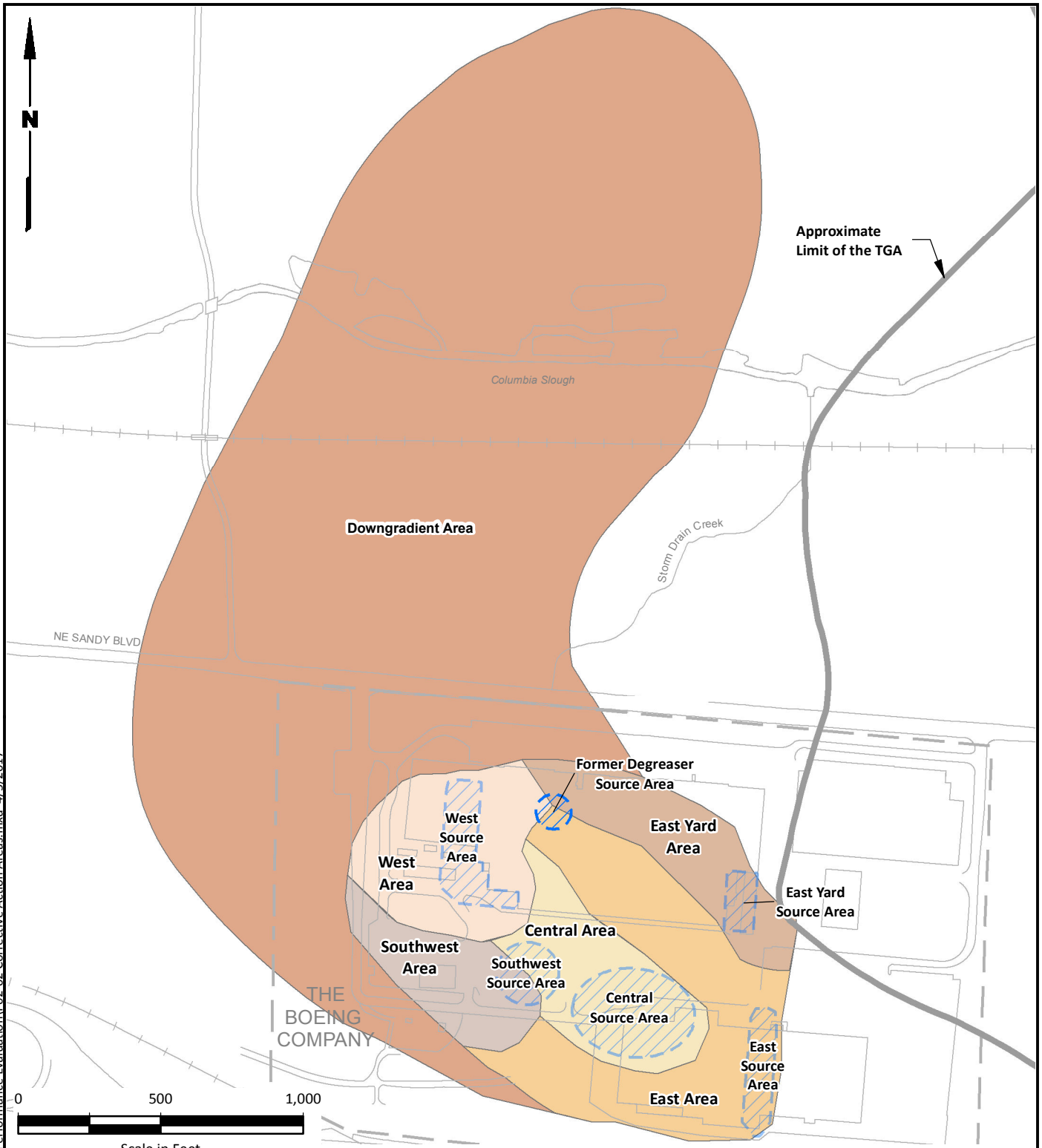
-
- LAI. 2010a. Semiannual Data Report, Troutdale Gravel Aquifer Corrective Measure January 1, 2010 through June 30, 2010, Boeing Portland Facility, Gresham, Oregon. Prepared for The Boeing Company. July 29.
- LAI. 2010b. Technical Memorandum, *Well Injection Testing Work Plan, Boeing Portland Facility, Portland, Oregon*. March 31.
- LAI. 2009. Bioremediation Injection Completion, Troutdale Gravel Aquifer, Boeing Portland Facility, Gresham, Oregon. Prepared for The Boeing Company. October 21.
- LAI. 2007a. Report, Building 85-105 Coolant Investigation, Boeing Portland Facility, Gresham, Oregon. Prepared for The Boeing Company. January 16.
- LAI. 2007b. Work Plan, Interim Remedial Action Measure, Building 85-105 Coolant Investigation, Boeing Portland Facility, Gresham, Oregon. Prepared for The Boeing Company. October 9.
- LAI. 2005. Institutional Controls Plan, Troutdale Gravel Aquifer, Boeing Portland, Gresham, Oregon. Prepared for The Boeing Company. December 20.
- LAI. 2002. Technical Memorandum re: Groundwater Extraction Well Shutdown, Troutdale Gravel Aquifer Corrective Measure, Boeing Portland. July 8.
- LAI. 2001. Technical Memorandum re: Groundwater and Soil Vapor Extraction Well Shutdown Procedures, Troutdale Gravel Aquifer Corrective Measure, Boeing Portland. September 25.
- LAI. 2000. Report, Troutdale Gravel Aquifer Corrective Measure Annual Performance Evaluation January 1, 1999 through December 31, 1999. Prepared for The Boeing Company. March 14.
- LAI. 1997. Troutdale Gravel Aquifer Corrective Measures Implementation Work Plan. Gresham, Oregon. Prepared for The Boeing Company. November 26.
- LAI. 1996. Phase 2 Corrective Measures Study, Boeing Portland, Gresham, Oregon. Prepared for The Boeing Company. September 13.
- LAI. 1995a. Interim Measures Evaluation, Boeing Portland, Gresham, Oregon. Prepared for The Boeing Company. September 15.
- LAI. 1995b. Phase III RCRA Facility Investigation, Boeing Portland, Gresham, Oregon. Prepared for The Boeing Company. July 31.
- ODEQ. 2016a. E-mail to Chris Kimmel, Landau Associates, re: *Boeing Portland Annual Progress Report and the East Yard Report - TGA*. From Robert Williams, Oregon Department of Environmental Quality. July 11.
- ODEQ. 2016b. E-mail to Brett Borgeson, Landau Associates, and Michael Gleason, The Boeing Company, re: Boeing Portland TGA Well Decommissioning Work Plan. From Robert Williams, Oregon Department of Environmental Quality. August 18

- ODEQ. 2015. E-mail to Chris Kimmel, Landau Associates, re: *Boeing Portland GWTS Update*. From Robert Williams, Oregon Department of Environmental Quality. July 7.
- ODEQ. 2014a. E-mail to Chris Kimmel, Landau Associates, re: Boeing Injection Work Plan. From Robert Williams, Oregon Department of Environmental Quality. June 17.
- ODEQ. 2014b. E-mail to Chris Kimmel, Landau Associates, re: *Boeing Portland Southwest Source Area Investigation Report*. From Robert Williams, Oregon Department of Environmental Quality. January 8.
- ODEQ. 2012. E-mail to Chris Kimmel, Landau Associates, re: *Central SA ODEQ approval*. From Robert Williams, Oregon Department of Environmental Quality. October 15.
- ODEQ. 2011. Email to Ken Chaput, The Boeing Company, and Christine Kimmel, Landau Associates. Re: Boeing Documents. August 23.
- ODEQ. 2009. E-mail to Chris Kimmel, Landau Associates and Ken Chaput, The Boeing Company re: Proposal to shutdown SVE System and Remaining Wells. Mavis Kent, Oregon Department of Environmental Quality. July 30.
- ODEQ. 2008. State of Oregon Department of Environmental Quality, Order on Consent, DEQ No. LQSR-NWR-04-12). September 28.
- ODEQ. 2007. Email message from Mavis Kent, Oregon Department of Environmental Quality, to Chris Kimmel, Landau Associates. Re: Boeing Building 85-105 IRAM.

G:\Projects\025\116\116\430\5 Year Performance Evaluation\F02-01\VicMap.mxd 1/2/2017



G:\Projects\025\116\116143015 Year Performance Evaluation\F02-02 Corrective Action Areas.mxd 4/5/2017



Legend

- Potential Source Area
- Source Areas Removed from the ICP Based on Investigation Results
- Central Area Soil and Groundwater
- Downgradient Area Groundwater
- East Area Soil and Groundwater
- East Yard Soil and Groundwater
- Southwest Area Soil and Groundwater
- West Area Soil and Groundwater

Notes

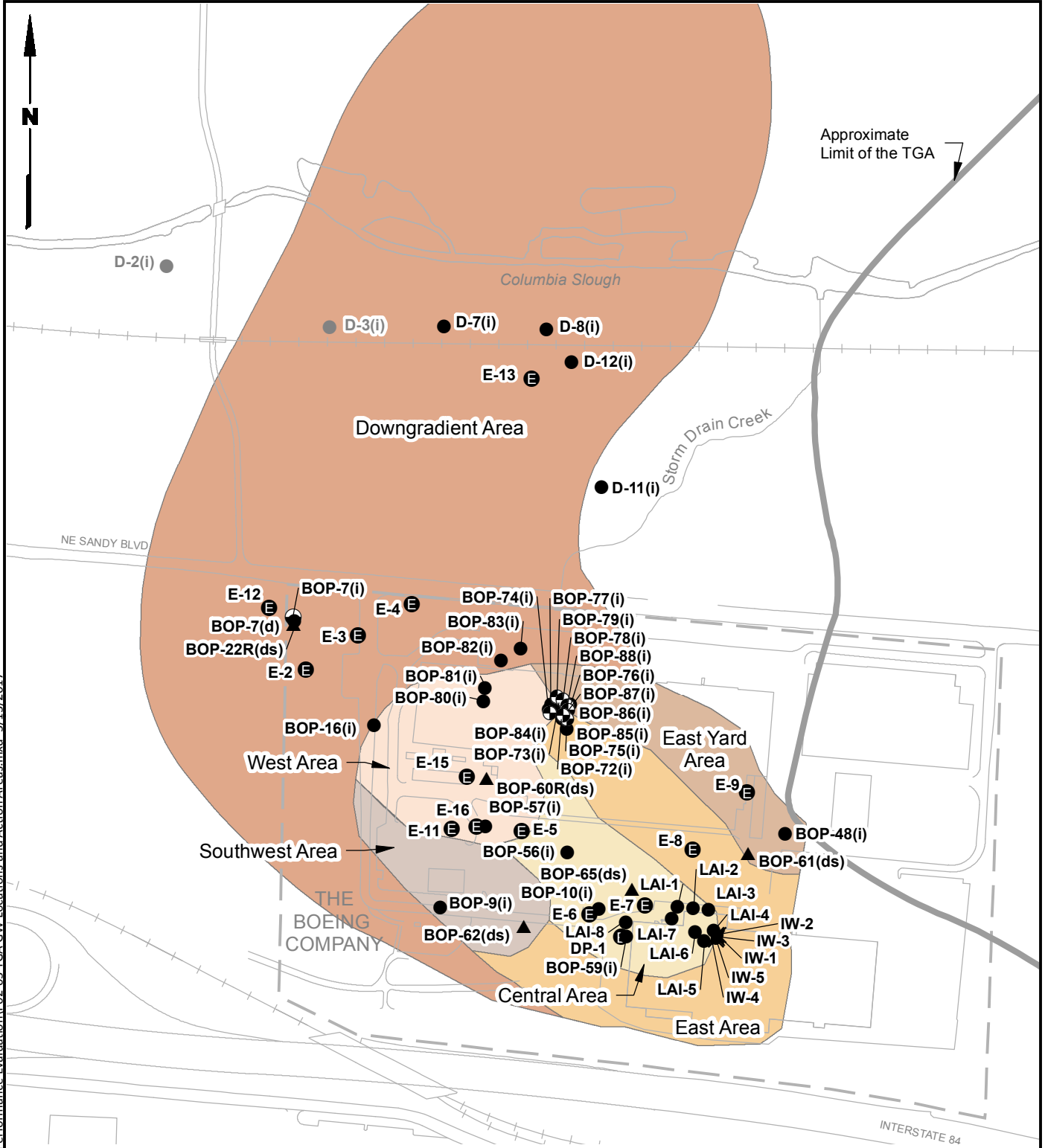
1. Corrective Action Areas defined in Phase 2 Corrective Measures Study (LAI 1996).
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Boeing Portland
Gresham, Oregon

Corrective Action Areas

Figure
2-2



G:\Projects\025\116\116143015 Year Performance Evaluation\F02-03 TGA GW Locations and Action Areas.mxd 3/13/2017

Legend

- ⊖ TGA Extraction Well
- ⊗ TGA Injection Well
- TGA Monitoring Well
- ⊕ TGA Multiple-Purpose Well
- ▲ TSA Monitoring Well
- Wells Screened in Lower TGA and Upper Siltstone
- ⊖ Layer of Confining Unit. Results are not Characteristic of TGA Condition
- Wells D-2(i) and D-3(i) were Decommissioned in 2016

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Scale in Feet

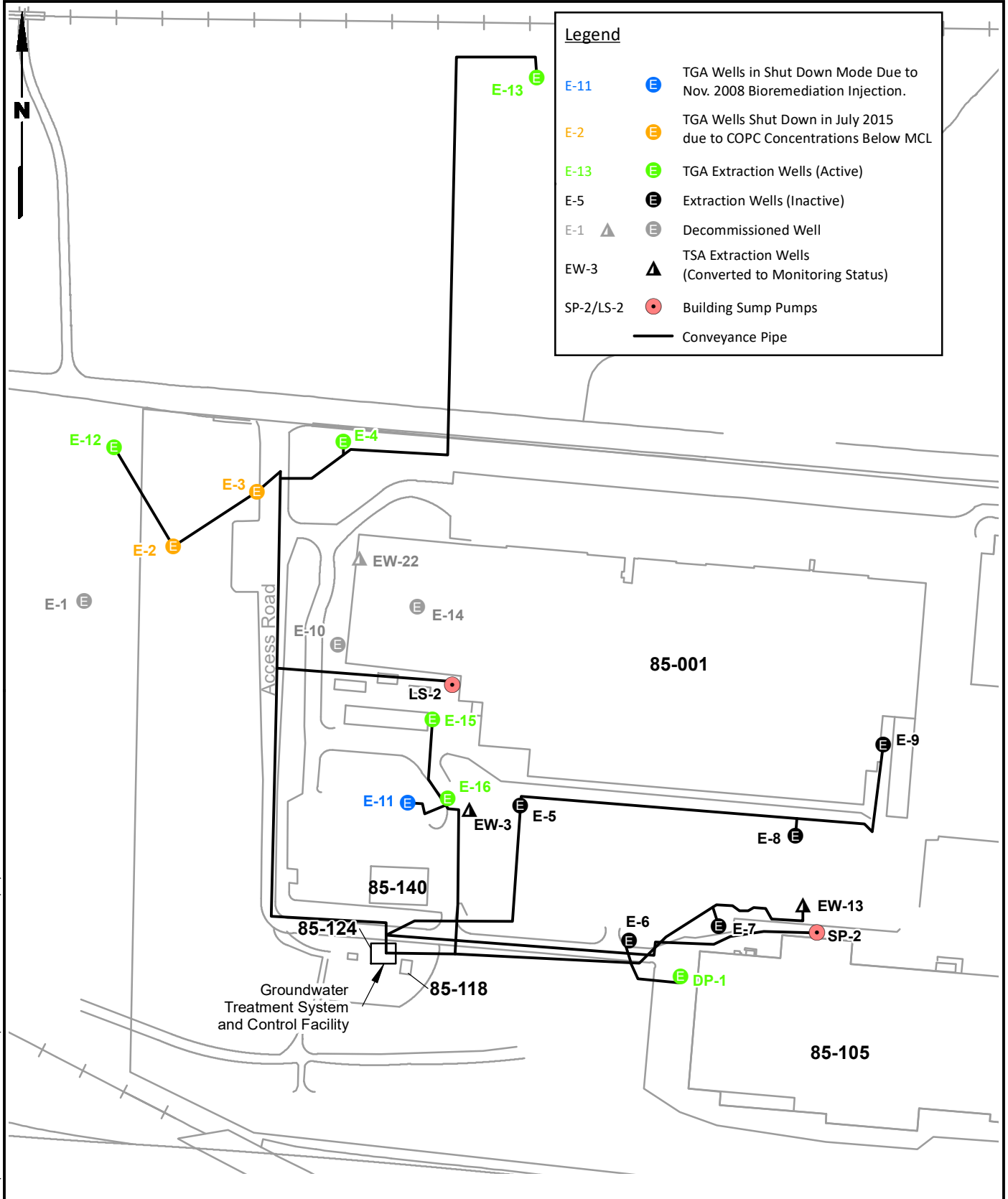


Boeing Portland
Gresham, Oregon

**TGA Groundwater Performance
Monitoring Locations**

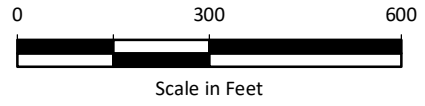
Figure
2-3

G:\Projects\025\116\116\430\5 Year Performance Evaluation\F03-01.GW Extraction.mxd 4/17/2017



Notes

1. E-1 decommissioned June 2004.
2. E-10, E-14, and EW-22 decommissioned February 2010.

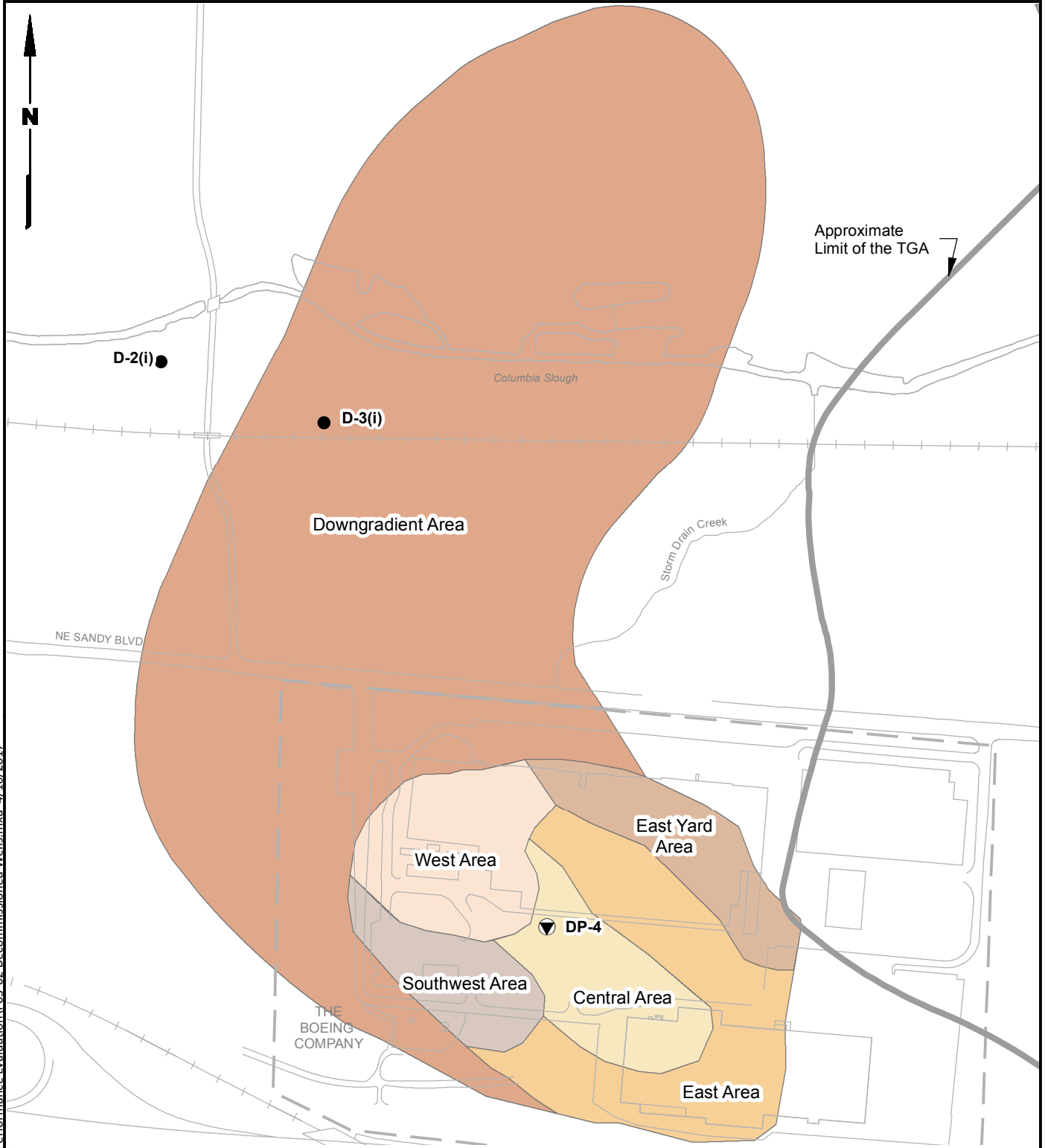


Boeing Portland
Gresham, Oregon

**Groundwater Extraction and
Treatment System Configuration**

Figure
3-1

G:\Projects\025\116\1116\430\5 Year Performance Evaluation\F03-02 Decommissioned Wells.mxd 4/16/2017

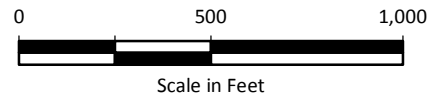


Legend

- Decommissioned TGA Well
- ▼ Dual Phase Extraction Well

Note

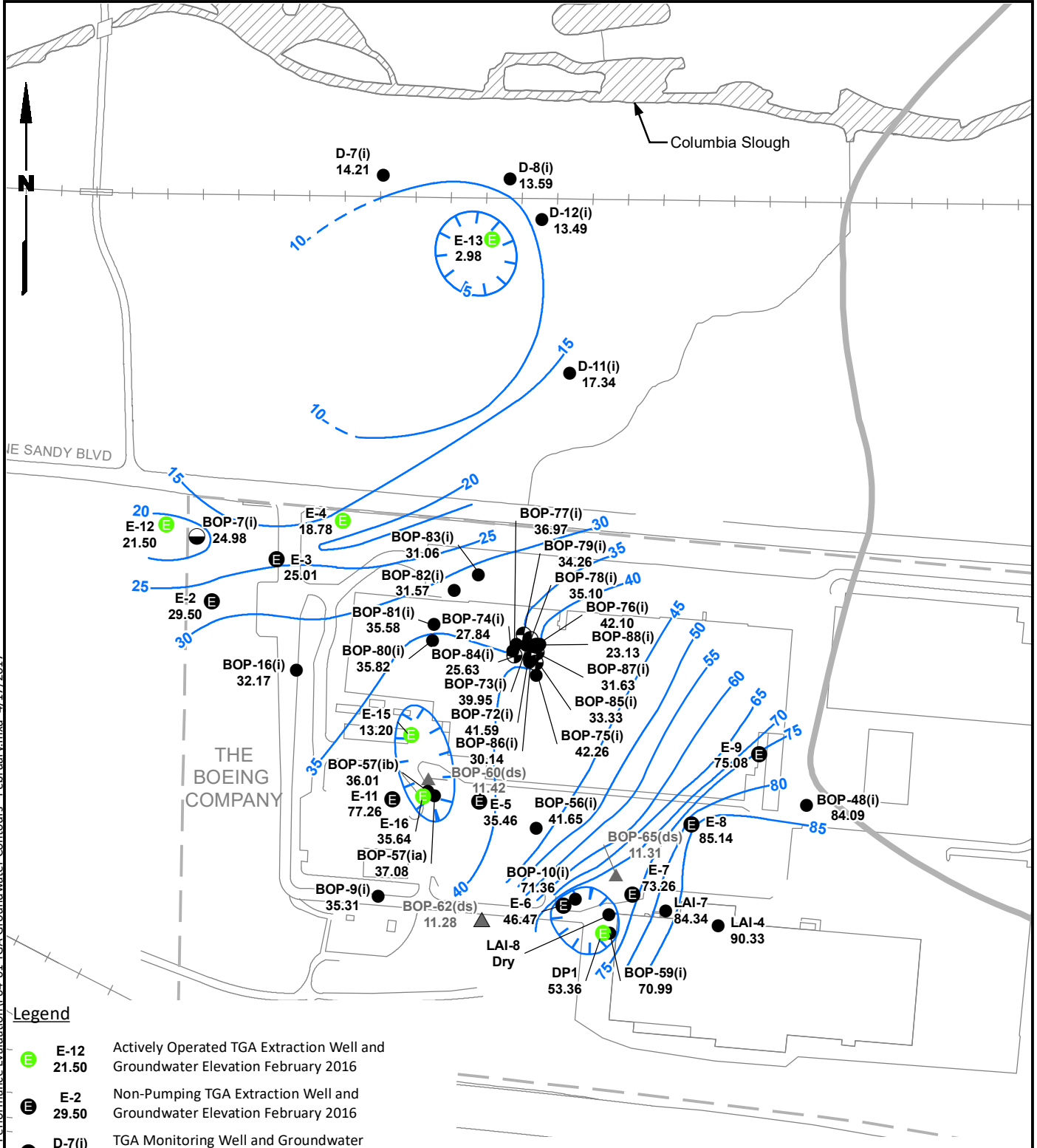
1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Boeing Portland
Gresham, Oregon

**Decommissioned Well Locations
and Corrective Action Areas**

Figure
3-2



G:\Projects\025\16\1116\430\5 Year Performance Evaluation\F04-01 TGA Groundwater Contours - Februarv.mxd 4/17/2017

Legend

- **E-12** 21.50 Actively Operated TGA Extraction Well and Groundwater Elevation February 2016
- **E-2** 29.50 Non-Pumping TGA Extraction Well and Groundwater Elevation February 2016
- **D-7(i)** 14.21 TGA Monitoring Well and Groundwater Elevation February 2016
- **BOP-7(i)** 24.98 Wells Screened in Lower TGA and Upper Siltstone Layer of Confining Unit. Results are not Characteristic of TGA Condition
- ▲ **BOP-60(ds)** 11.42 Upper TSA Monitoring Well and Groundwater Elevation February 2016
- **BOP-84(i)** 25.63 TGA Multiple-Purpose Wells









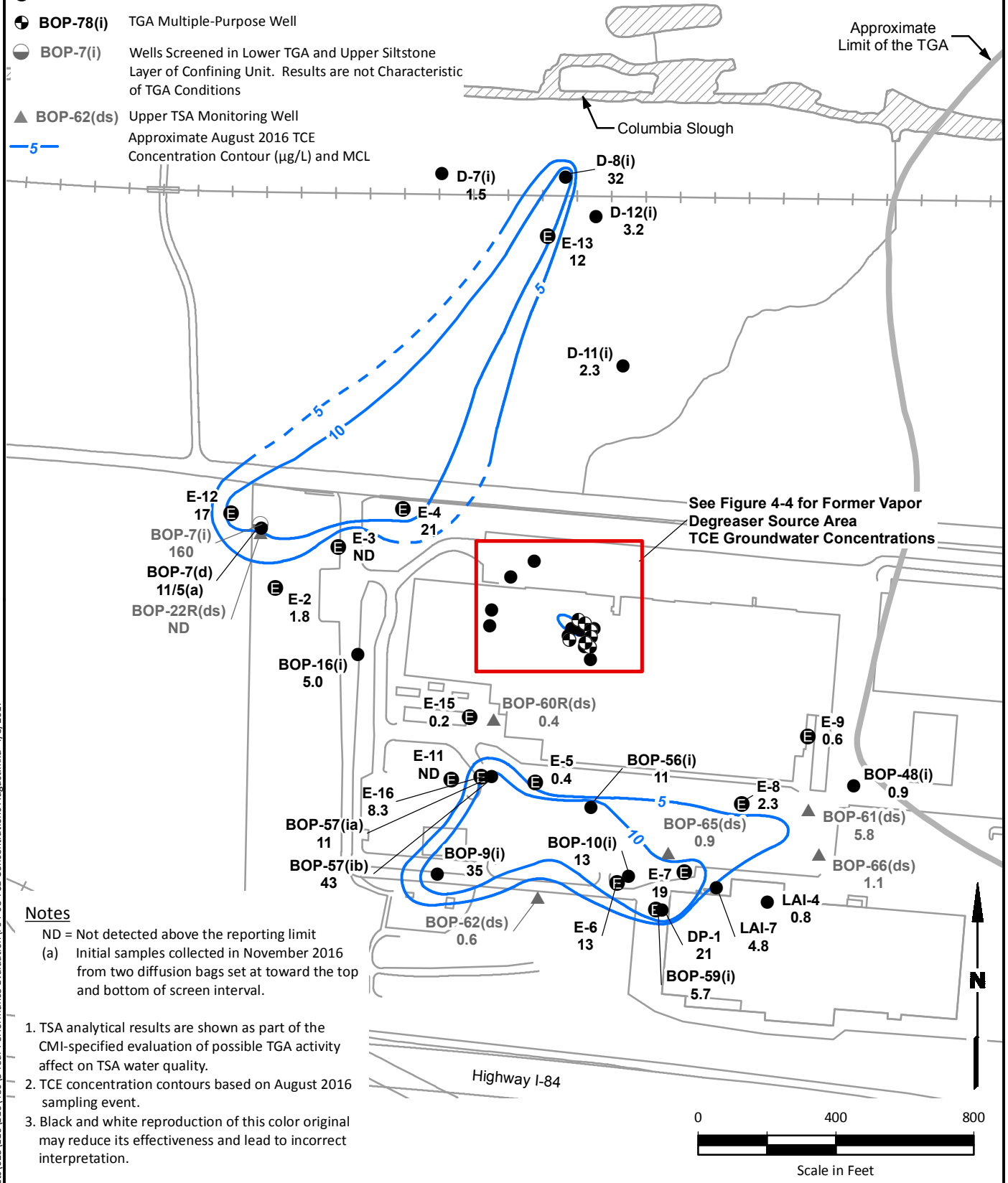
Boeing Portland
Gresham, Oregon

**TGA Groundwater Elevation Contours
and Capture Zone (Wet Season)
February 2016**

Figure
4-1

Legend

-  **E-13** TGA Extraction Well
-  **D-12** TGA Monitoring Well
-  **BOP-78(i)** TGA Multiple-Purpose Well
-  **BOP-7(i)** Wells Screened in Lower TGA and Upper Siltstone Layer of Confining Unit. Results are not Characteristic of TGA Conditions
-  **BOP-62(ds)** Upper TSA Monitoring Well
-  **5** Approximate August 2016 TCE Concentration Contour (µg/L) and MCL



Notes

ND = Not detected above the reporting limit
 (a) Initial samples collected in November 2016 from two diffusion bags set at toward the top and bottom of screen interval.

1. TSA analytical results are shown as part of the CMI-specified evaluation of possible TGA activity affect on TSA water quality.
2. TCE concentration contours based on August 2016 sampling event.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

G:\Projects\025\116\430\5 Year Performance Evaluation\F04-03 TCE Concentrations August.mxd 4/5/2017

Legend

- BOP-80(i) ● TGA Monitoring Well Location
- BOP-84(i) ● Multiple-Purpose Well Location
- VOW-16 ▽ Vapor Observation Well Location
- Approximate Location of Former Degreaser
- 5 — Approximate November 2016 TCE Concentration Contour (µg/L) and MCL

BOP- 78(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	69.5
08/2016	0.9

Sample Depth (Feet Below Ground Surface)
 Historical date and Maximum TCE Concentration

Collection Date and TCE Concentration (µg/L)

ND — Not Detected at Reporting Limit

BOP-81(i)	
Date	Sample Depth (Feet Below Ground Surface)
11/2011	98.5
02/2016	ND
05/2016	ND
08/2016	ND
11/2016	ND

BOP-80(i)	
Date	Sample Depth (Feet Below Ground Surface)
11/2012	102.5
02/2016	ND
05/2016	ND
08/2016	ND
11/2016	ND

BOP-82(i)	
Date	Sample Depth (Feet Below Ground Surface)
11/2011	72.5
02/2016	8.5
05/2016	8.3
08/2016	8.7
11/2016	8.7

BOP-83(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2012	79.5
02/2016	58
02/2016	1.7
05/2016	2.4
08/2016	2.6
11/2016	10

BOP-79(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	69.5
02/2016	99
02/2016	0.4
05/2016	0.5
08/2016	0.7
11/2016	0.6

BOP-78(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	69.5
02/2016	160
02/2016	0.3
05/2016	0.4
08/2016	0.9
11/2016	0.7

BOP-87(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	73.5
02/2016	52
02/2016	ND
05/2016	0.2
08/2016	0.3
11/2016	0.3

BOP-88(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	70.5
02/2016	130
02/2016	1.6
05/2016	3.3
08/2016	8.9
11/2016	6.2

BOP-77(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2011	78.7
02/2016	690
02/2016	6.2
05/2016	4.9
08/2016	2.7
11/2016	2.6

BOP-73(i)	
Date	Sample Depth (Feet Below Ground Surface)
11/2013	78
02/2016	17,000
02/2016	0.4
05/2016	ND
08/2016	0.7
11/2016	1.5

BOP-74(i)	
Date	Sample Depth (Feet Below Ground Surface)
05/2010	71
05/2010	74
02/2016	ND
05/2016	0.2
08/2016	0.2
11/2016	0.2

BOP-84(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2012	75
02/2016	15
02/2016	ND
05/2016	ND
08/2016	ND
11/2016	ND

BOP-86(i)	
Date	Sample Depth (Feet Below Ground Surface)
08/2012	69
02/2016	42
02/2016	0.3
05/2016	0.4
08/2016	0.6
11/2016	0.6

BOP-72(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2010	67
02/2010	49
02/2016	ND
02/2016	ND
05/2016	1.0
08/2016	2.7
11/2016	6.7

BOP-85(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2013	68.5
02/2013	37
02/2016	ND
05/2016	ND
08/2016	0.3
11/2016	0.3

BOP-75(i)	
Date	Sample Depth (Feet Below Ground Surface)
02/2011	68.7
02/2011	87
02/2016	1.1
05/2016	2.0
08/2016	1.0
11/2016	6.2

BOP-76(i)	
Date	Sample Depth (Feet Below Ground Surface)
11/2013	68.7
11/2013	140
02/2016	1.0
05/2016	0.5
08/2016	1.1
11/2016	3.5

Notes

1. Values shown in Red are above the MCL (5 µg/L)
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

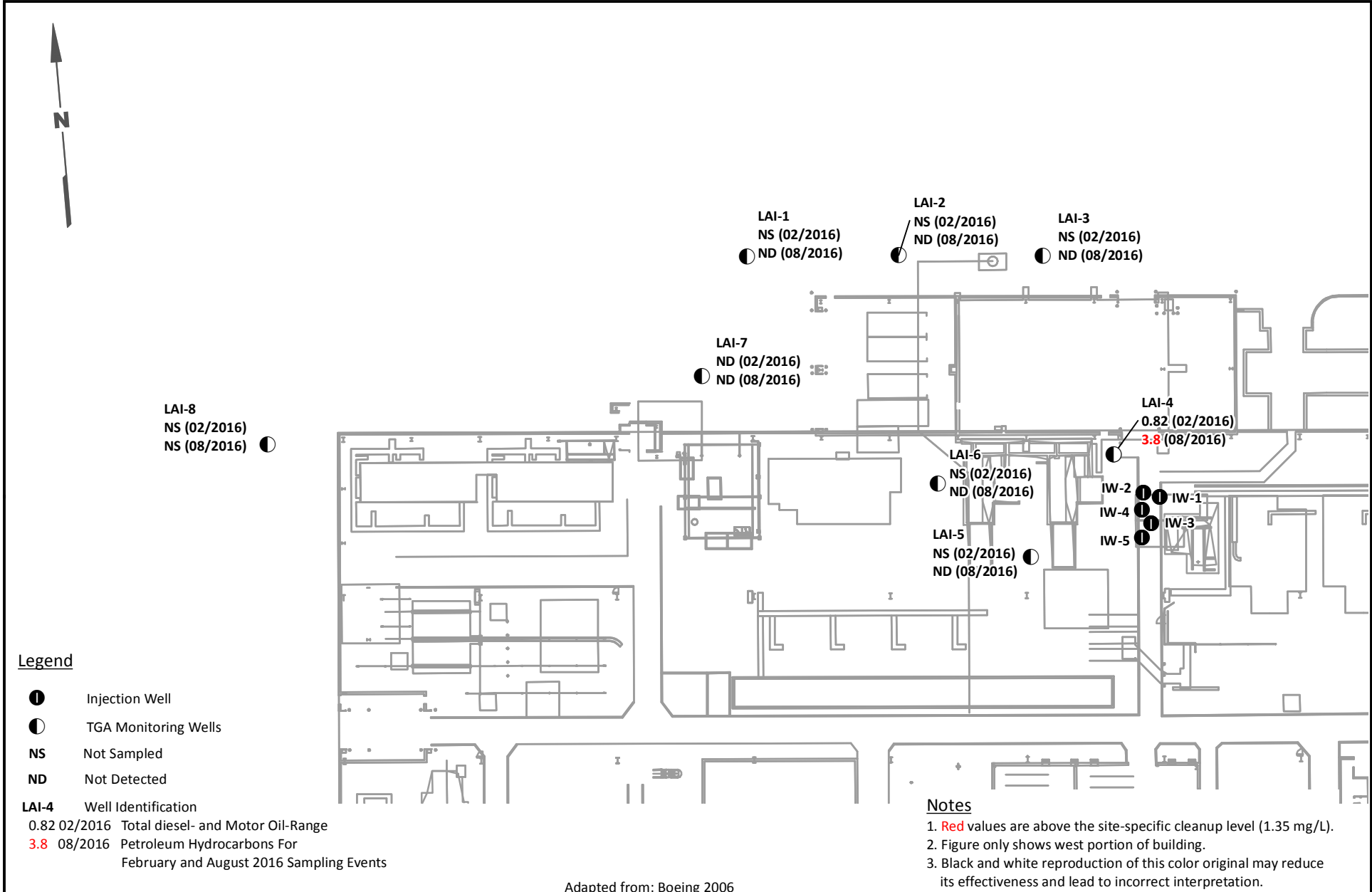
Data Source: The Boeing Company



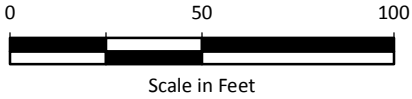
Boeing Portland
Gresham, Oregon

**Historical Maximum and 2016 TCE
Groundwater Results Former
Vapor Degreaser Source Area**

Figure
4-4



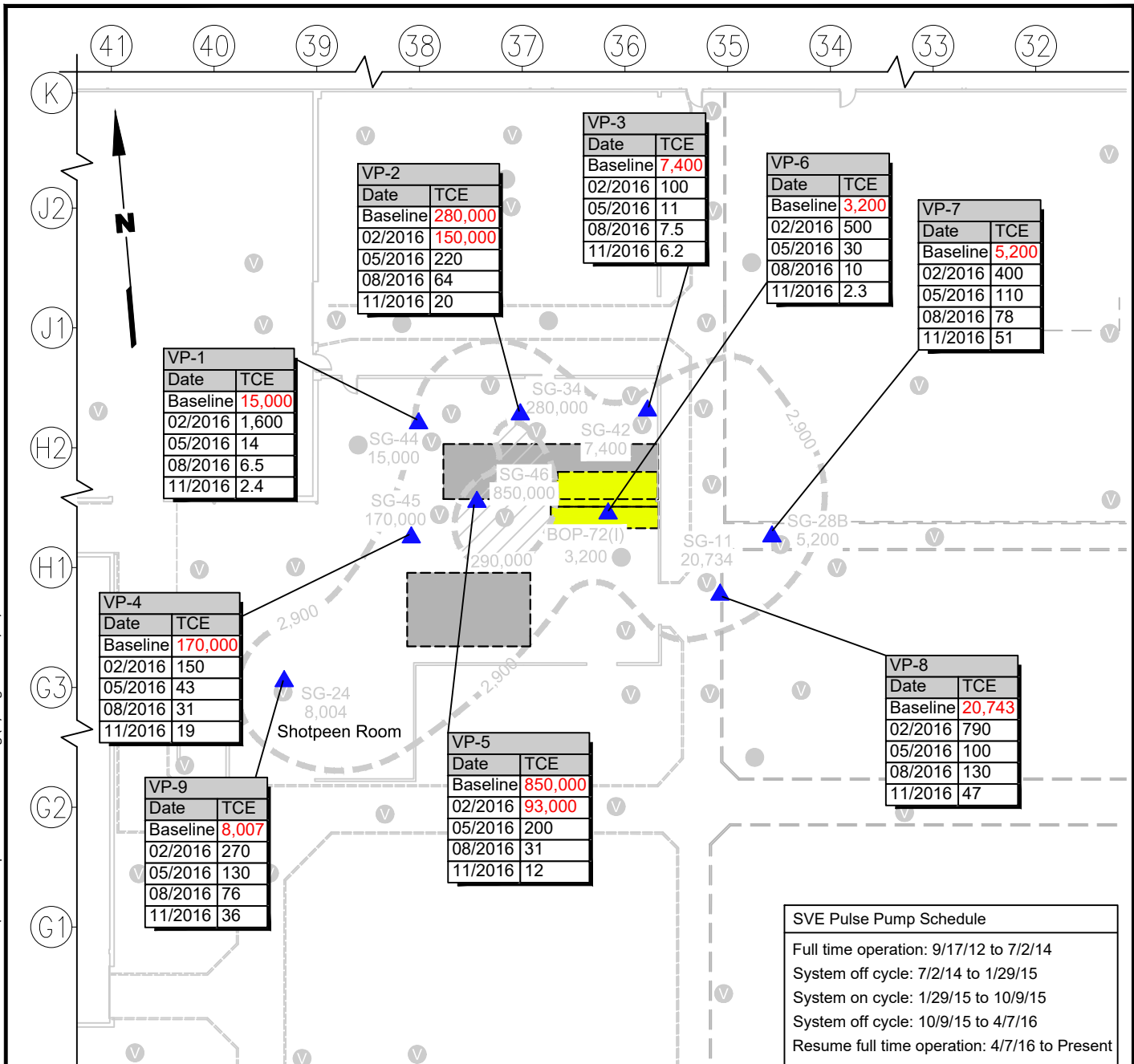
Adapted from: Boeing 2006



Boeing Portland
Gresham, Oregon

**Coolant Release
Groundwater Results
February/August 2016**

Figure
4-5



Notes

1. Values shown in **Red** are above the RBC screening level of 2,900 µg/m³.
2. Hot spot defined by ODEQ as 100 times greater than the RBC.
3. Sample results vary based on sampling date relative to SVE pulse pump operation schedule.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- BOP-72(i) ● TGA Monitoring Well and Sub-Slab Vapor Sampling Location and Designation
- VP-1 ▲ Sub-Slab Vapor Pin Location
- SG-05 ● Sub-Slab Vapor Grab Sampling Location
- ND TCE Not Detected above Laboratory Reporting Limits
- Baseline 2012 TCE Isoconcentration Contours
- ▨ Baseline 2012 Hot Spot
- ▭ Approximate Location of Basements
- ▭ (Yellow) Approximate Location of Former Degreasers



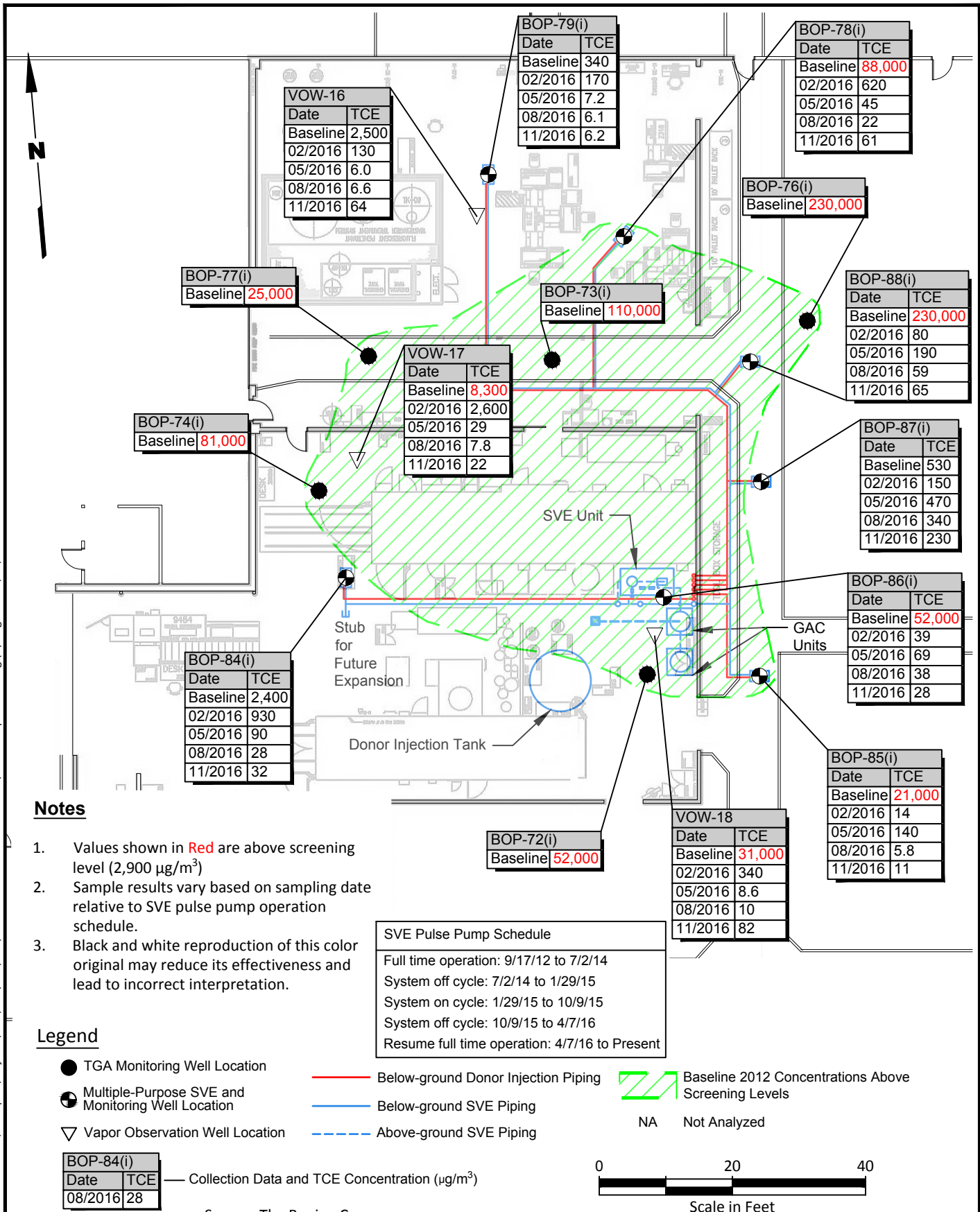
SVE Pulse Pump Schedule	
Full time operation:	9/17/12 to 7/2/14
System off cycle:	7/2/14 to 1/29/15
System on cycle:	1/29/15 to 10/9/15
System off cycle:	10/9/15 to 4/7/16
Resume full time operation:	4/7/16 to Present

VP-1		—
Date	TCE	Sample Location
08/2016	6.5	Collection Data and TCE Concentration (µg/m ³)

Source: Boeing 2009



Boeing Portland Gresham, Oregon	Sub-Slab TCE Vapor Results - Former Vapor Degreaser Source Area	Figure 4-6
------------------------------------	--	----------------------



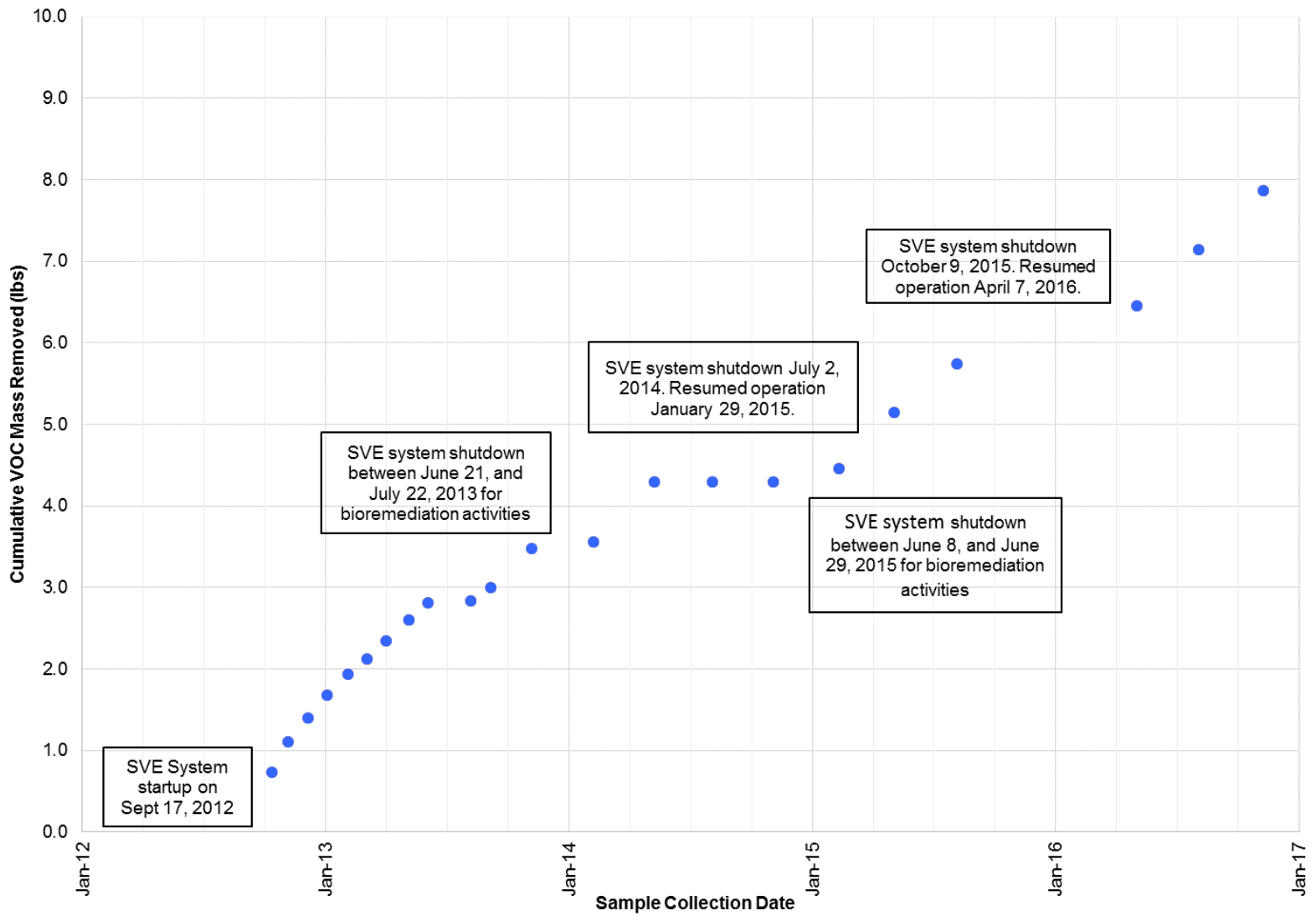
Source: The Boeing Company



Boeing Portland
Gresham, Oregon

At-Depth TCE Vapor Results - Former Vapor Degreaser Source Area

Figure
4-7

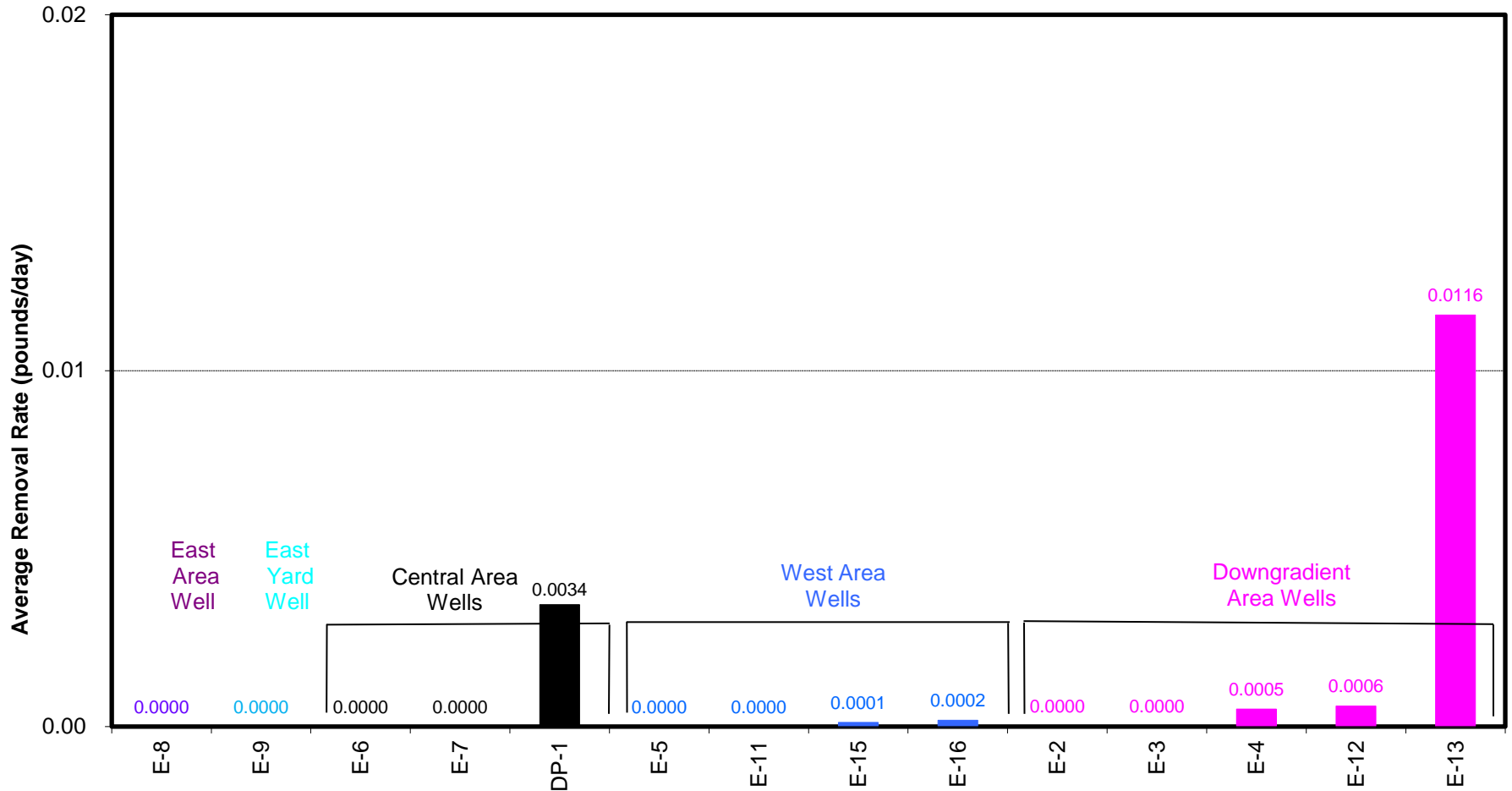


Boeing Portland
Gresham, Oregon

SVE Mass Removal

Figure
4-8





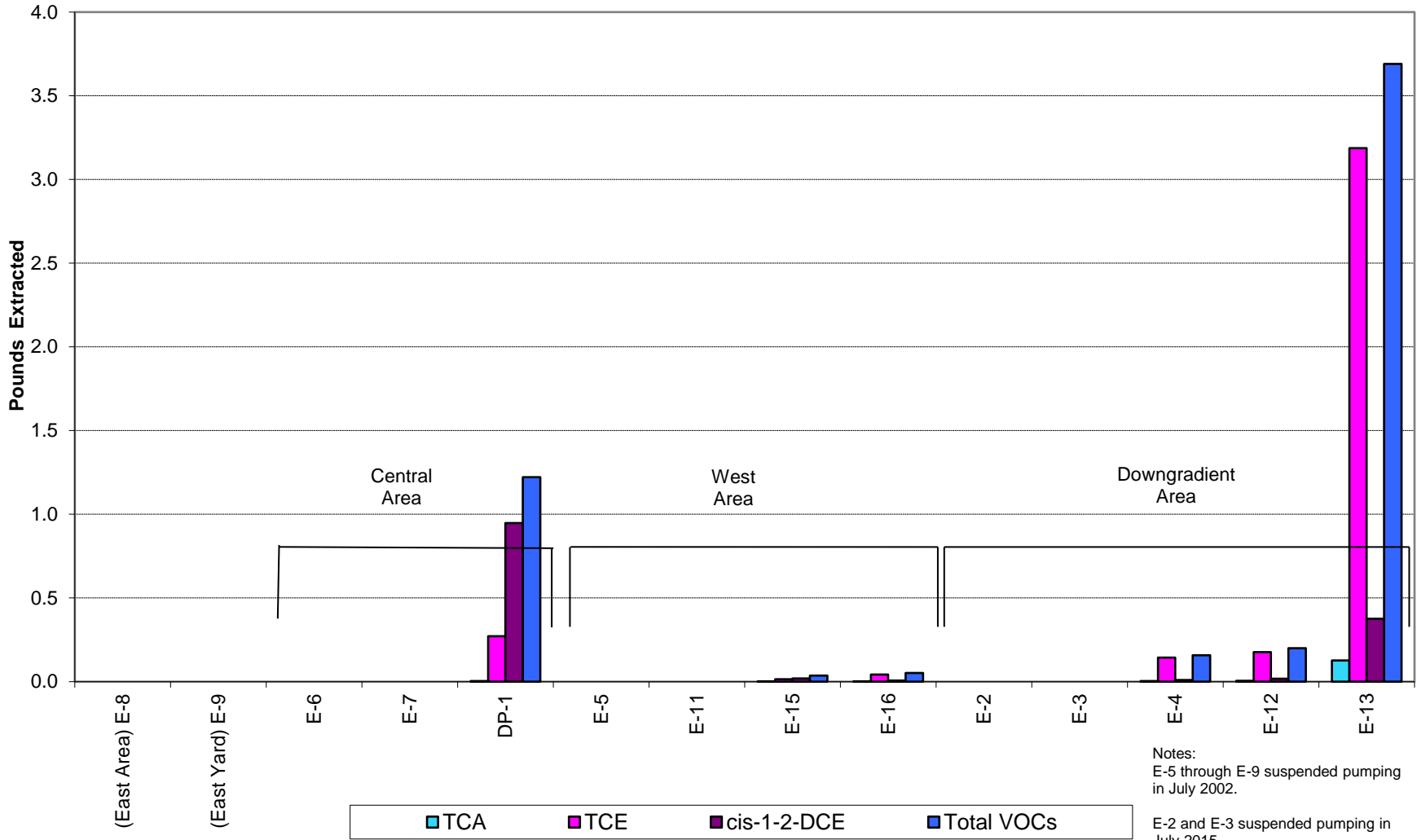
- Notes:
1. Total VOCs include the following constituents: TCA, TCE, total 1,2-DCE, PCE, and 1,1-DCE.
 2. Pumping operations at well E-1 were suspended in April 2000, well decommissioned in June 2004.
 3. Pumping operations at wells E-5 through E-9 were suspended in July 2002.
 4. Extraction wells E-10 and E-14 were decommissioned in March and April 2010, respectively.
 5. Pumping operations at wells E-2 and E-3 were suspended in July 2015.

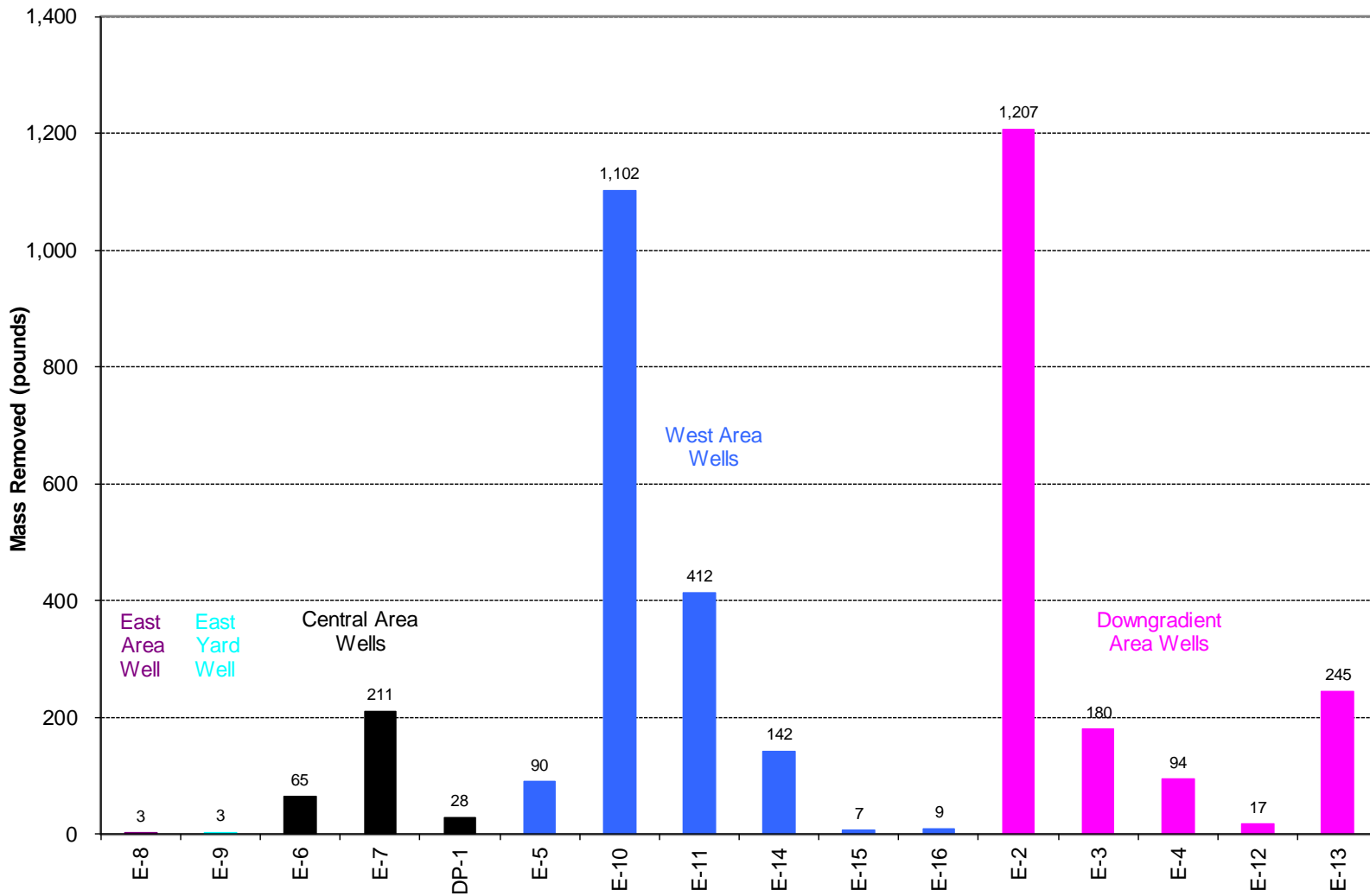


Boeing Portland
Gresham, Oregon

**Average Total VOC Mass Removal
Rates for 2016**

Figure
5-1





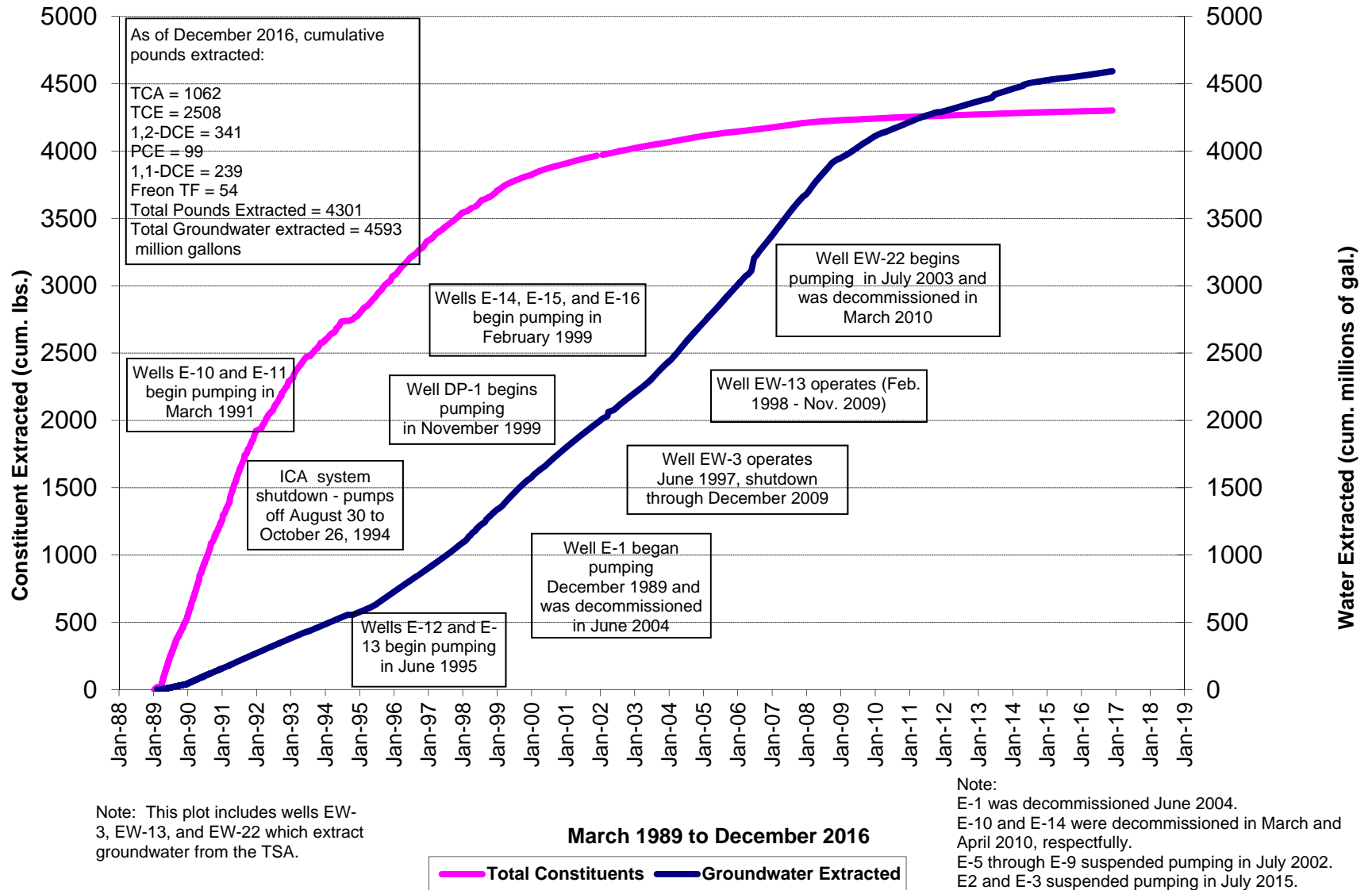
Note: Total VOCs include the following constituents: TCA, TCE, total 1,2-DCE, PCE, and 1,1-DCE.

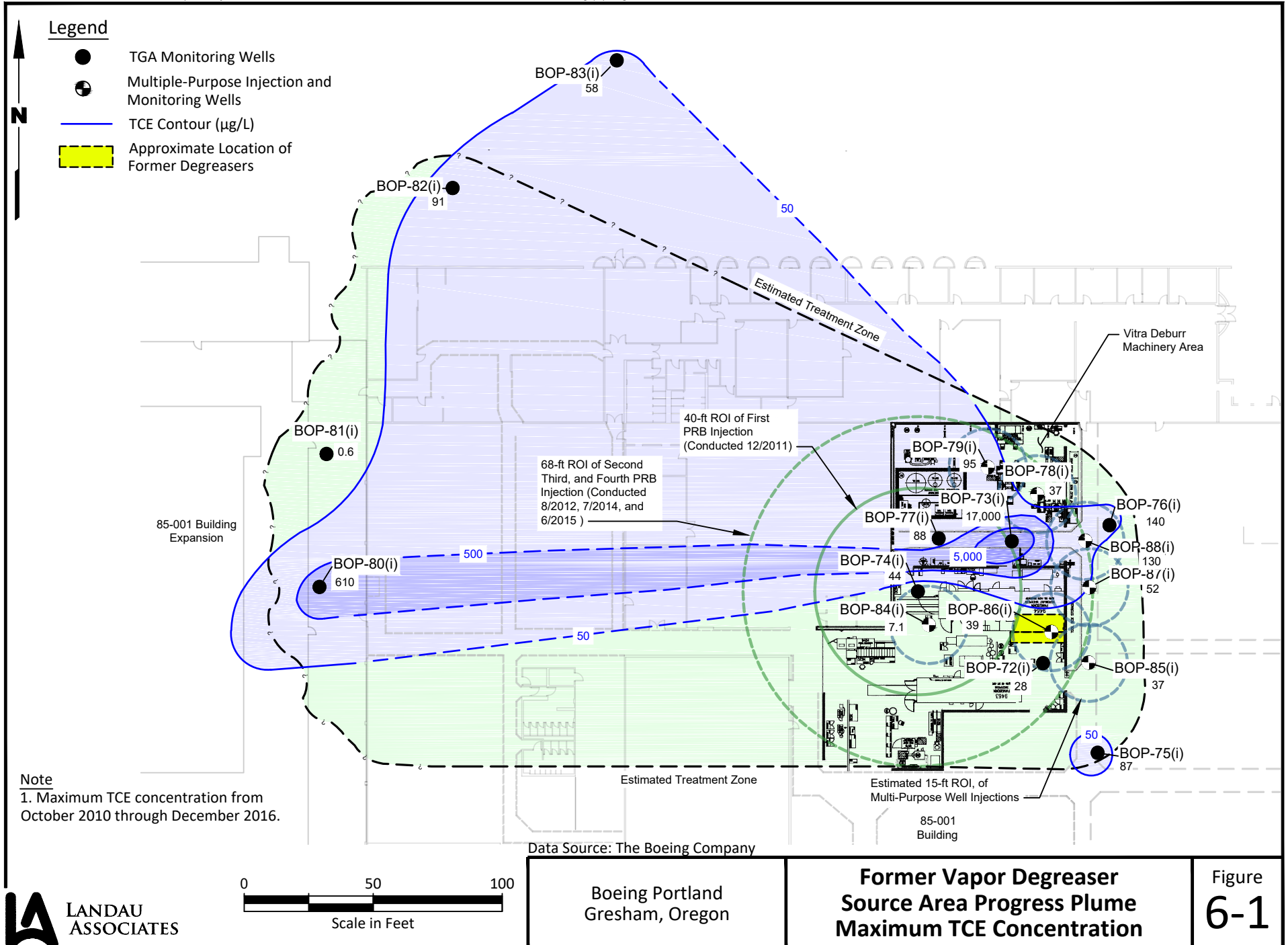


Boeing Portland
Gresham, Oregon

**All Time Total VOC Mass
Removed from Groundwater**

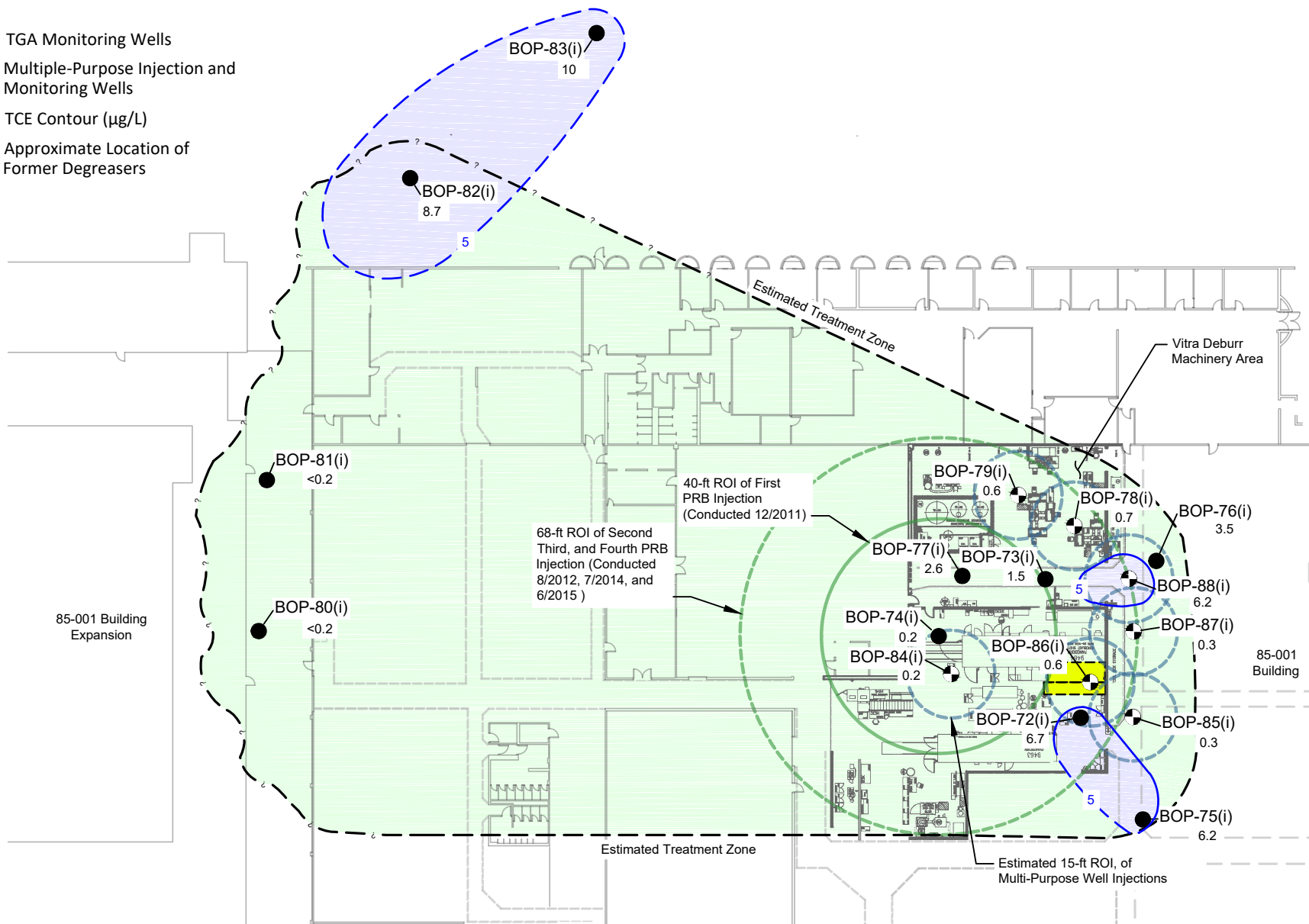
Figure
5-3



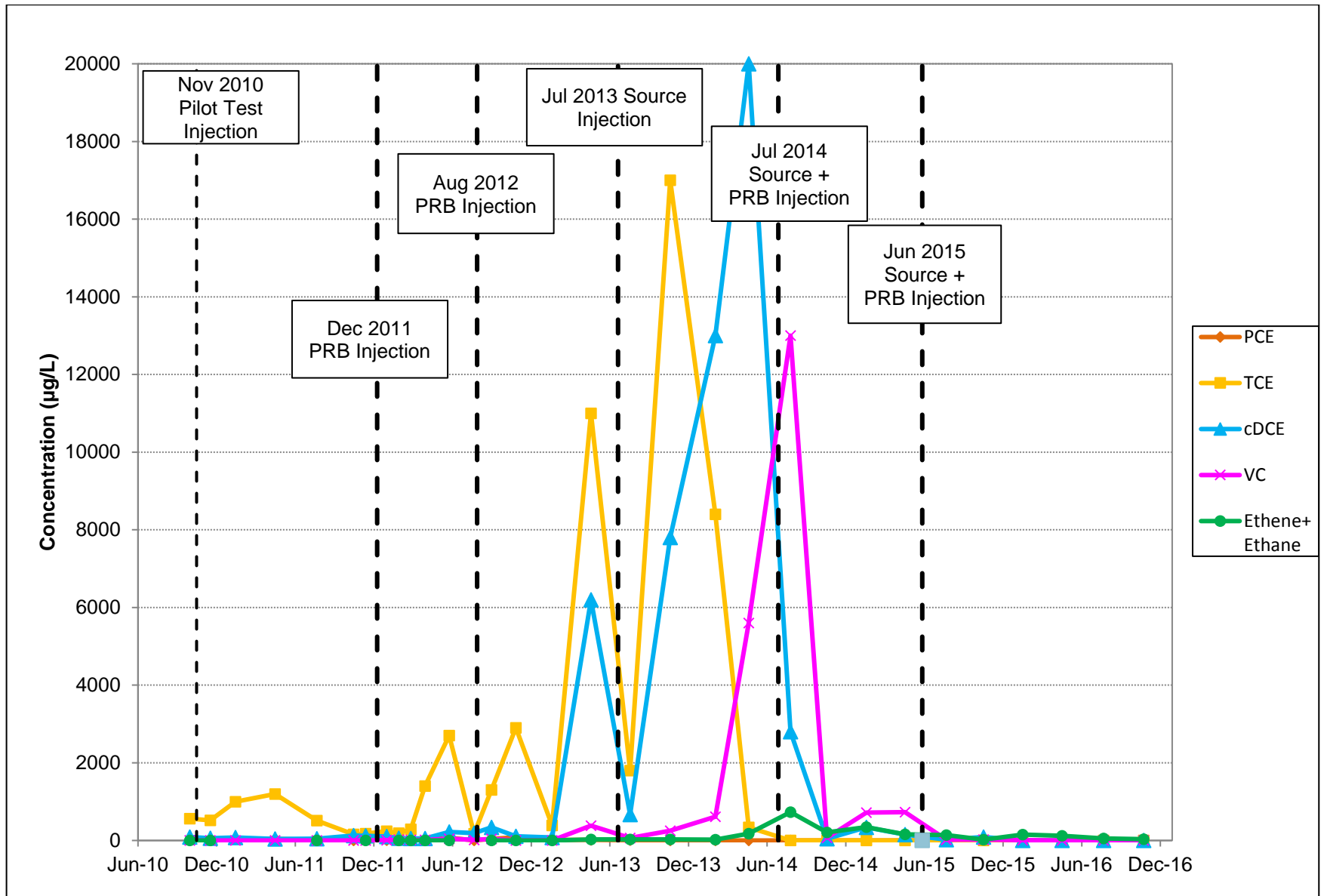


Legend

- TGA Monitoring Wells
- ⊙ Multiple-Purpose Injection and Monitoring Wells
- TCE Contour (µg/L)
- ▭ Approximate Location of Former Degreasers



Data Source: The Boeing Company

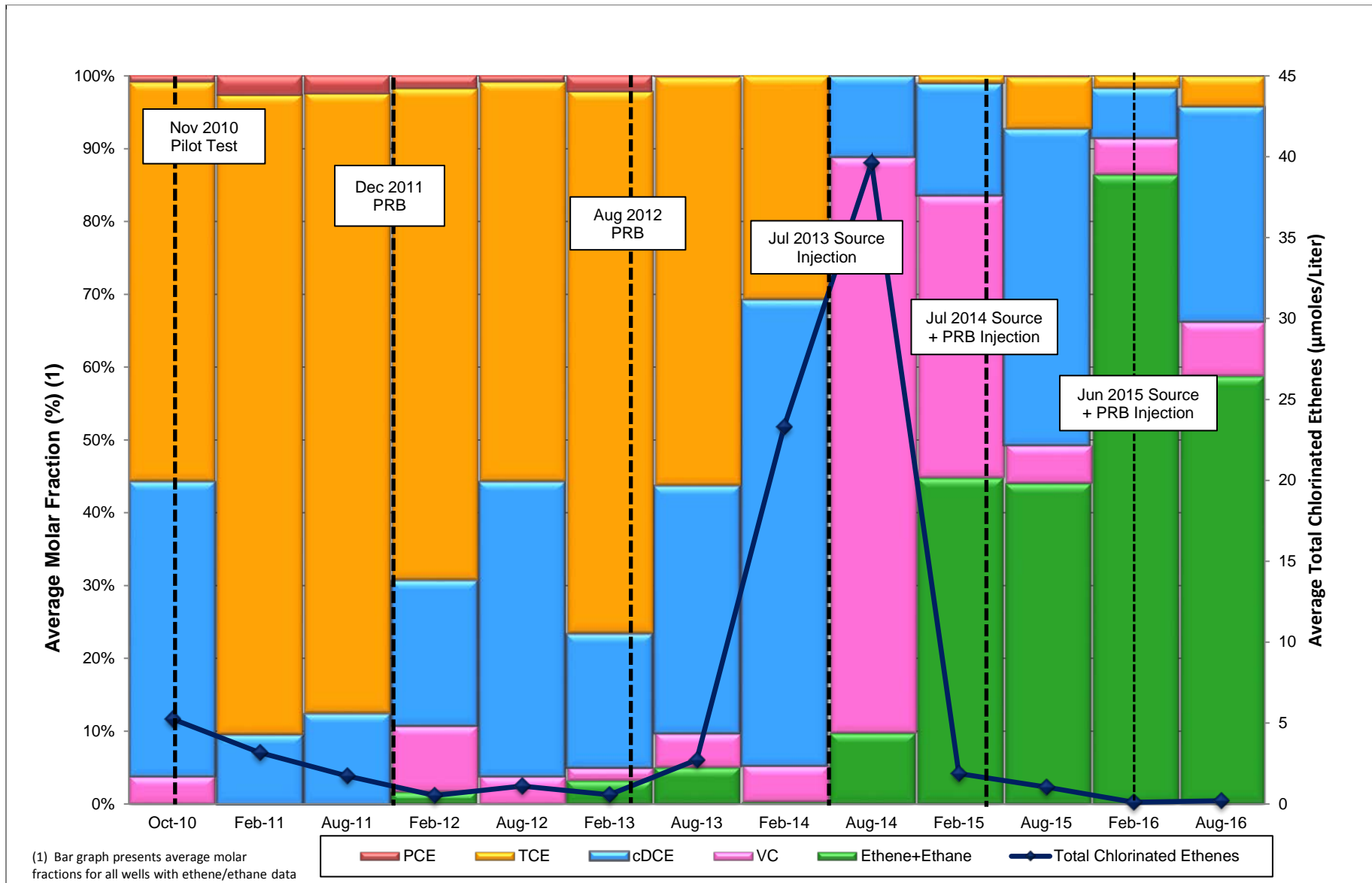


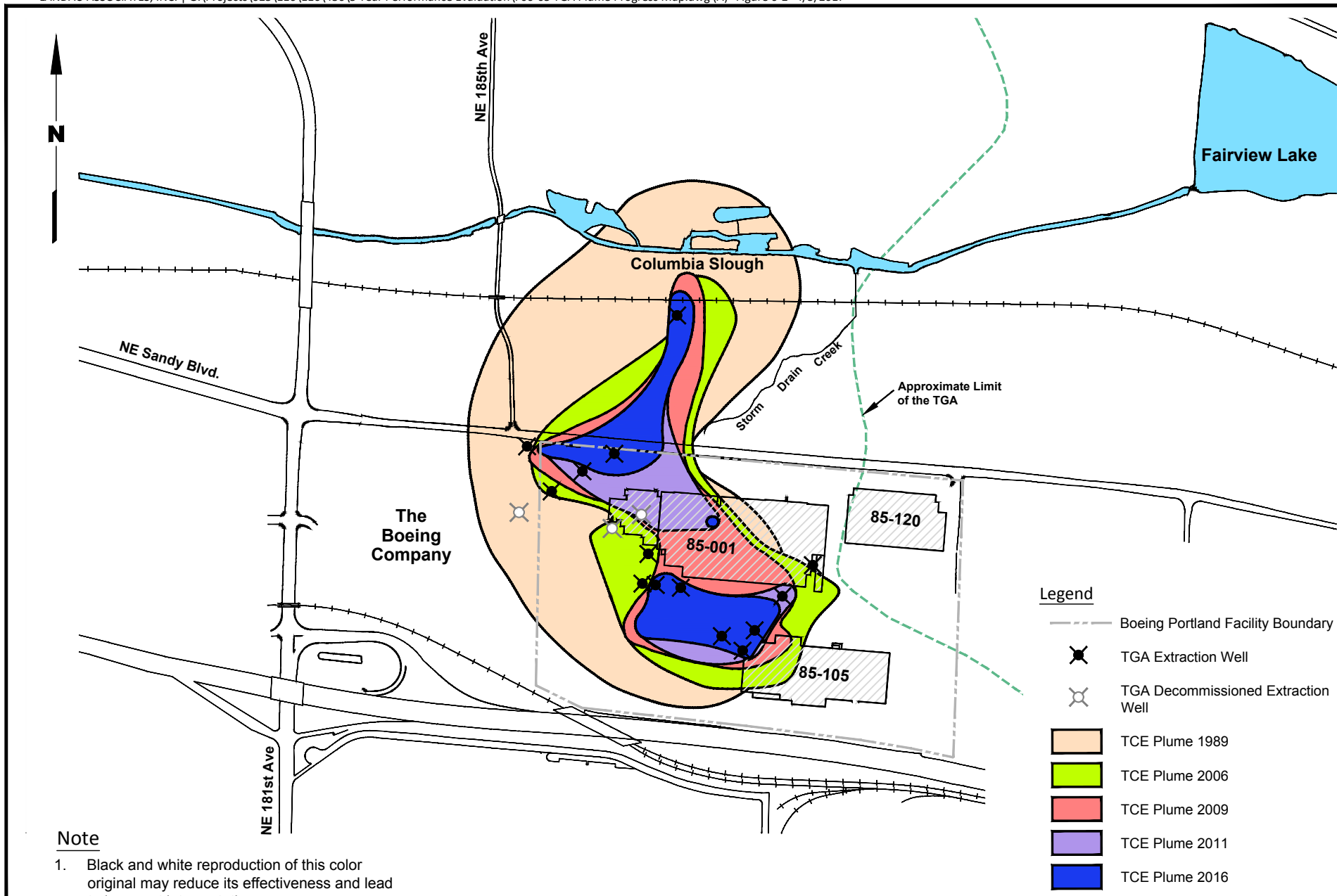
Boeing Portland
Gresham, Oregon

**Time versus Concentration
Plot-BOP-73(i)**

Figure
6-3

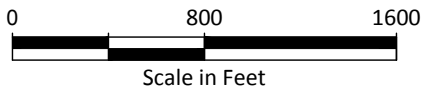






Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Boeing Portland
Gresham, Oregon

TGA Plume Progress Map

Figure
6-5

**TABLE 2-1
SUMMARY OF TGA CORRECTIVE ACTION HISTORY
BOEING PORTLAND**

Activity	Date	Description	References
I. Initial Investigation and Interim Corrective Actions			
EPA/ODEQ Consent Order Major Investigations	July 31, 1986 1986-1987 1987 1988-1993 1989-1990 1991 1991	Regulatory basis for initial TGA and onsite TSA investigations and interim corrective actions. Investigations to evaluate nature and extent of groundwater and soil contamination on and off site. Major elements included: <ul style="list-style-type: none"> • Phase I Investigation – characterize onsite groundwater and soils in TGA and TSA • Soil Gas Survey – further evaluate onsite potential source areas • Phase II Investigation – characterize offsite TGA groundwater • Onsite TSA Investigation – northern (downgradient) portion of facility • SE Corner investigation – further evaluation of southeast portion of facility • 85-105 Building expansion 	Docket # 1086-06-26-3008(h) (EPA 1986) LAI 1988a (3/17) LAI 1988b (8/19) LAI 1993 (6/21) LAI 1990a (2/26) LAI 1991 (6/117) LAI 1992 (4/24)
Interim Corrective Actions	1986-1997 1988 1989-1993 1990 1991	Interim corrective actions included: <ul style="list-style-type: none"> • Initial Actions Plan – Offsite Drinking Water Sampling Program Sampling area revised 1990 • Well A-2 Abandoned • ICA Implementation • Rockwood Water District supply well abandoned • 85-105 building excavation – for expansion of 85-105 building 	Sweet Edwards & Assoc. 1996, and quarterly reports by Sweet Edwards and Landau Associates. EPA Consent Order Amendment (EPA/ODEQ 1990) LAI 1989a (6/5) LAI 1989b (3/31), 1994 (3/4) LAI 1990b (11/6) LAI 1992 (4/24)
II. Final RFI Investigations, Additional Interim Corrective Actions, and Corrective Measures			
EPA Consent Order	January 18, 1994	Regulatory basis for Phase III RFI investigation and subsequent interim and final corrective measures studies and implementation	Docket # 1 093-04-02-3008(h) (EPA 1994)
RCRA Facility Investigation	1994-1995	Phase III RCRA facility investigation – further characterization of TGA and shallow TSA groundwater and soil for development of corrective measures	Landau Associates 1995b (7/31)
ODEQ Order on Consent	September 8, 2008	Transfer of regulatory oversight from EPA to ODEQ with adherence to “Final Decision and Response to Comments for the Boeing Portland Facility Troutdale Gravel Aquifer”	Consent Order #: LQSR-NWR-04-12 (ODEQ 2008)

**TABLE 2-1
SUMMARY OF TGA CORRECTIVE ACTION HISTORY
BOEING PORTLAND**

Activity	Date	Description	References
Additional Interim Corrective Measures	<p align="center">1994</p> <p align="center">1994</p> <p align="center">1994-1995</p> <p align="center">1994-1997</p>	<p>Additional corrective measures activities included:</p> <ul style="list-style-type: none"> • Status of Interim Measures – report presenting background and current status of interim measures • Phase I Corrective Measures Study – evaluated alternatives for beneficial reuse, performance of SVE pilot tests, and alternatives for ICA system modification • Interim Measures Evaluation – evaluated effectiveness of interim measures implemented to date and documented additional interim measures implementation including: ICA system shutdown, redevelopment of ICA extraction wells, and installation of new ICA extraction wells E-12 and E-13 • SVE in West Area 	<p>LAI 1994 (3/4)</p> <p>LAI 1995c (7/17)</p> <p>LAI 1995a (9/15)</p> <p>LAI 1995a,d (9/15, 9/11); 1996b,c (1/15, 1/31)</p>
Selected Corrective Measures	<p align="center">1996</p> <p align="center">1997</p> <p align="center">1997</p> <p align="center">1997 through 1999</p> <p align="center">2000</p> <p align="center">2001</p> <p align="center">2001</p> <p align="center">2002</p> <p align="center">2002-2003</p> <p align="center">2003</p> <p align="center">2005</p>	<ul style="list-style-type: none"> • Phase 2 Corrective Measures Study – documents the development and evaluation of potential alternatives for remediation of soil and groundwater in the TGA • EPA Statement of Basis – proposes and explains corrective measures for cleanup of contaminated groundwater at the Boeing facility • EPA Final Decision and Response to Comments – identifies the corrective measures alternative selected by EPA to be implemented at the Boeing facility • Corrective Measures Implementation – design, testing, and implementation of the EPA-selected corrective measure alternative • Performance Monitoring Plan • Institutional Controls Plan • TGA Corrective Measure Annual Performance Evaluation – provides summary of remedy performance for 1999 • TGA and TSA well abandonment • Procedures for groundwater and soil vapor extraction wells shutdown • VE-3 and VE-4 shutdown testing results • E-5 through E-9 shutdown testing results • Update to TGA Corrective Measures • Institutional Controls Plan 	<p>LAI 1996a (9/13)</p> <p>EPA 1997b (March 1997)</p> <p>EPA 1997a (July 1997)</p> <p>LAI 1997 (11/26); 1998 (6/5); 1999f (2/1) AGI 1998 (7/17); 1999a,b (9/17, 2/19 – 2 documents)</p> <p>LAI 1999b,e (2/19 – revised 11/9)</p> <p>LAI 1999c,d (2/19 – revised 12/99)</p> <p>LAI 2000 (3/14)</p> <p>LAI 2001 c (4/30)</p> <p>LAI 2001 b (9/25)</p> <p>LAI 2002b (4/25)</p> <p>LAI 2003b (1/17)</p> <p>LAI 2003a (9/3)</p> <p>LAI 2005 (12/20)</p>

**TABLE 2-1
SUMMARY OF TGA CORRECTIVE ACTION HISTORY
BOEING PORTLAND**

Activity	Date	Description	References
Selected Corrective Measures (con't)	2006	<ul style="list-style-type: none"> TGA Corrective Measure Annual Performance Evaluation provides summary of remedy performance for 2005 	LAI 2006 (3/31)
	2009	<ul style="list-style-type: none"> Shut down SVE treatment system 	LAI 2010 (3/16)
	Ongoing	<ul style="list-style-type: none"> Well decommissioning for compliance wells 	
Additional Corrective Measures	2006	<ul style="list-style-type: none"> Coolant release investigation – Building 85-105 	LAI 2007b (1/16)
	2007-2012	<ul style="list-style-type: none"> Sump treatment system installation – an oil-water separator treatment to address coolant-impacted water near Building 85-105 	LAI 2007 (1/23)
	2007-Ongoing	<ul style="list-style-type: none"> Enhanced <i>in situ</i> bioremediation – oxygen releasing compound for coolant remedy in groundwater – Building 85-105 	LAI 2007 (10/9)
	2008-2009	<ul style="list-style-type: none"> Enhanced <i>in situ</i> bioremediation – vegetable oil injection in west corrective action area 	LAI 2009a (10/21)
	2010	<ul style="list-style-type: none"> Soil excavation near proposed building expansion 	LAI 2010e (7/6)
	2010	<ul style="list-style-type: none"> West source control area investigation 	LAI 2011 (6/3)
	2010	<ul style="list-style-type: none"> Bioremediation pilot testing for anaerobic bioremediation – former degreaser source area 	LAI 2011e (11/16)
	2011-Ongoing	<ul style="list-style-type: none"> Permeable Reactive Barrier – <i>in situ</i> bioremediation using LactOil directly downgradient of former degreaser source area 	LAI 2011 (11/16)
	2011	<ul style="list-style-type: none"> Central Source Area Investigation 	LAI 2012 (6/5)
	2012	<ul style="list-style-type: none"> E-12 Equipment Failure Investigation 	LAI 2012 (5/31)
	2012-Ongoing	<ul style="list-style-type: none"> Soil Vapor Extraction System for vadose zone remedy – former degreaser source area 	LAI 2012 (11/18)
	2013-Ongoing	<ul style="list-style-type: none"> Source area Bioremediation – <i>in situ</i> bioremediation using multiple purpose wells in former degreaser source area 	LAI 2013 (5/21)
	2013	<ul style="list-style-type: none"> Southwest source control area investigation 	LAI 2013 (12/9)
	2015	<ul style="list-style-type: none"> East and East Yard source control area investigation 	LAI 2016 (3/23)
	2015	<ul style="list-style-type: none"> Groundwater treatment system selection and modification 	LAI 2015

**TABLE 2-1
SUMMARY OF TGA CORRECTIVE ACTION HISTORY
BOEING PORTLAND**

Acronyms/Abbreviations:

- AGI =
- EPA = US Environmental Protection Agency
- ICA = Interim Corrective Action
- LAI = Landau Associates, Inc.
- ODEQ = Oregon Department of Environmental Quality
- RCRA = Resource Conservation Recovery Act
- RFI = RCRA Facility Investigation
- SVE = Soil Vapor Extraction
- TGA = Troutdale Gravel Aquifer
- TSA = Troutdale Sandstone Aquifer

Information Sources:

Full reference citations are given in Section 9.0 of this report.

**TABLE 3-1
SUMMARY OF CORRECTIVE MEASURES IMPLEMENTATION
BOEING PORTLAND**

CORRECTIVE MEASURES ELEMENT	IMPLEMENTATION STATUS
Groundwater Extraction and Treatment	<ul style="list-style-type: none"> • Full-time operation of extraction wells: E-4, E-12, E-13, E-15, E-16, and DP-1. • Extraction wells in pilot shutdown: E-5 through E-9 (August 2002), E-11 (November 2008), and E-2 and E-3 (July 2015). • Extraction wells decommissioned: E-1 (June 2004), E-10 (March 2010), and E-14 (April 2010).
West Corrective Action Area Soil Vapor Extraction (SVE) with Water Table Depression Pumping	<ul style="list-style-type: none"> • West Corrective Action Area SVE wells VE-3 and VE-4 were shut down in July 2002 and wells were decommissioned in July 2004. • Pilot tests conducted on VE-5 and VE-7 in April and July 1999, respectively, under conditions of water table depression yielded volatile organic compound (VOC) mass removal rates below minimum criterion; therefore, SVE was not implemented in these wells. • SVE well VE-6 operated from 1999 through 2009. SVE system was shut down in 2009 due to low mass removal rates.
Central Corrective Action Area Dual-Phase Extraction	<ul style="list-style-type: none"> • Dual-phase extraction wells DP-1 through DP-4 were tested September-October 1998, and additional testing of DP-1 and DP-2 was conducted March-June 1999. • Based on test results, DP-1 was placed into full-time operation in November 1999 as a groundwater extraction well and DP-4 was placed into full-time operation in April 1999 as an SVE well. • Operation of DP-4 as an SVE well was shut down in 2009 and decommissioned in 2016. The SVE system was shut down in 2009 due to low mass removal rates.
Southwest Corrective Action Area and East Yard Corrective Action Area SVE Pilot Tests	<ul style="list-style-type: none"> • Pilot test was conducted in Southwest Corrective Action Area (VE-8) in April-May 1998 and in the East Yard Corrective Action Area (VE-9) in April 1998; because minimum mass removal rates were not achieved in both wells, SVE was not implemented in the Southwest Corrective Action Area or the East Yard Corrective Action Area.
Performance Monitoring	<ul style="list-style-type: none"> • Performance monitoring was implemented as outlined in the Phase 2 CMS (Landau Associates [LAI] 1996) and approved by the US Environmental Protection Agency (EPA 1997). • Performance monitoring plan was approved during project transfer from EPA to the Oregon Department of Environmental Quality (ODEQ) in 2008.
Institutional Controls Plan	<ul style="list-style-type: none"> • Institutional Controls Plan (LAI 2005) incorporated into DEQ Order on Consent.

**TABLE 3-1
SUMMARY OF CORRECTIVE MEASURES IMPLEMENTATION
BOEING PORTLAND**

CORRECTIVE MEASURES ELEMENT	IMPLEMENTATION STATUS
Additional Supplemental Corrective Measures:	Implementation Status:
Soil Removal	<ul style="list-style-type: none"> Source soil removal action: excavated 500 cubic yards in the West Corrective Action Area in 2010.
Investigations of Potential Source Areas	<ul style="list-style-type: none"> Conducted investigations of shallow subsurface conditions in the West Source Area, Central Source Area, Southwest Source Area, East Source Area, and East Yard Source Area.
Conveyance Line Relocation	<ul style="list-style-type: none"> Relocated conveyance piping to facilitate facility construction efforts.
<i>In Situ</i> Bioremediation	<ul style="list-style-type: none"> Anaerobic bioremediation injections in the West Corrective Action Area and the Downgradient Corrective Action Area in 2008, pilot sodium lactate donor injection in the Former Degreaser Source Area in 2010, and injection of lactOil and vegetable oil donor for the Permeable Reactive Barrier directly downgradient of the Former Degreaser Source Area in 2011 through 2015. Bioremediation injections in multiple purpose wells in the Former Degreaser Source Area in 2013 through 2015. Aerobic bioremediation injections of an oxygen-releasing compound for a localized coolant release in the 85-105 building
Coolant Treatment	<ul style="list-style-type: none"> Installation and operation of an oil-water separator treatment system (referred to as the Sump Treatment System [STS]) for coolant-impacted groundwater accumulated in the 85-105 building footing sump.
Soil Vapor Extraction	<ul style="list-style-type: none"> SVE system installation in the Former Degreaser Source Area to treat the vadose zone 2012.

Information Sources:

Full reference citations are given in Section 9.0 of this report.

**TABLE 3-2
PERFORMANCE MONITORING PROGRAM
BOEING PORTLAND**

Aquifer and Well Use	Location	Current Sampling Frequency		Proposed Sampling Frequency (a)	
		Groundwater Elevation	Groundwater Quality	Groundwater Elevation	Groundwater Quality
West Area					
TGA Well	BOP-16(i)	S	Q	S	S
TGA Well	BOP-57(ia)	S	S	S	S
TGA Well	BOP-57(ib)	S	S	A	A
TGA Extraction Well	E-5	S	A	S	A
TGA Extraction Well	E-11	S	A	S	A
TGA Extraction Well	E-15	Q	Q	Q	Q
TGA Extraction Well	E-16	Q	Q	Q	Q
Upper TSA Well	BOP-60R(ds) (b)	A	A	A	A
Central Area					
TGA Well	BOP-10(i)	S	S	S	S
TGA Well	BOP-56(i)	S	S	S	S
TGA Well	BOP-59(i)	S	S	S	S
TGA Extraction Well	E-6	S	A	S	A
TGA Extraction Well	E-7	S	A	S	A
TGA Extraction Well	DP-1	Q	Q	Q	Q
Upper TSA Well	BOP-65(ds) (b)	A	A	A	A
East Yard					
TGA Well	BOP-48(i)	S	A	S	A
TGA Extraction Well	E-9	S	A	S	A
Upper TSA Well	BOP-61(ds) (b)	A	A	A	A
East Area					
TGA Extraction Well	E-8	S	A	S	A
Southwest Area					
TGA Well	BOP-9(i)	S	S	S	S
Upper TSA Well	BOP-62(ds) (b)	A	A	A	A
Downgradient Area					
TGA Well	BOP-7(i)	S	Q	A	A
TGA Well	BOP-7(d)	--	--	Q	Q
TGA Well	D-7(i)	S	A	S	A
TGA Well	D-8(i)	S	S	S	S
TGA Well	D-11(i)	S	A	S	A
TGA Well	D-12(i)	S	S	S	S
TGA Extraction Well	E-2	S	S	S	S
TGA Extraction Well	E-3	S	S	S	S
TGA Extraction Well	E-4	Q	Q	Q	Q
TGA Extraction Well	E-12	Q	S	Q	Q
TGA Extraction Well	E-13	Q	S	Q	Q
Upper TSA Well	BOP-22R(ds) (b)	A	A	A	A

**TABLE 3-2
PERFORMANCE MONITORING PROGRAM
BOEING PORTLAND**

		Current Sampling Frequency		Proposed Sampling Frequency (a)	
		Groundwater Elevation	Groundwater Quality	Groundwater Elevation	Groundwater Quality
Aquifer and Well Use	Location				
Former Degreaser Source Control Area					
TGA Well	BOP-72(i)	Q	Q	S	S
TGA Well	BOP-73(i)	Q	Q	S	S
TGA Well	BOP-74(i)	Q	Q	S	S
TGA Well	BOP-75(i)	Q	Q	S	S
TGA Well	BOP-76(i)	Q	Q	S	S
TGA Well	BOP-77(i)	Q	Q	S	S
TGA Well	BOP-78(i)	Q	Q	S	S
TGA Well	BOP-79(i)	Q	Q	S	S
TGA Well	BOP-80(i)	Q	Q	S	S
TGA Well	BOP-81(i)	Q	Q	S	S
TGA Well	BOP-82(i)	Q	Q	S	S
TGA Well	BOP-83(i)	Q	Q	S	S
TGA Well	BOP-84(i)	Q	Q	S	S
TGA Well	BOP-85(i)	Q	Q	S	S
TGA Well	BOP-86(i)	Q	Q	S	S
TGA Well	BOP-87(i)	Q	Q	S	S
TGA Well	BOP-88(i)	Q	Q	S	S
Coolant Release					
TGA Well	LAI-1	Q	C-A	A	C-A
TGA Well	LAI-2	Q	C-A	A	C-A
TGA Well	LAI-3	Q	C-A	A	C-A
TGA Well	LAI-4	Q	S/C-S	S	S/C-S
TGA Well	LAI-5	Q	C-A	A	C-A
TGA Well	LAI-6	Q	C-A	A	C-A
TGA Well	LAI-7	Q	S/C-S	S	S/C-S
TGA Well	LAI-8	Q	S/C-S	S	S/C-S

Acronyms/Abbreviations:

- A = Annual
- BOP = Boeing of Portland
- C = Coolant
- D = Discontinue Monitoring
- ODEG = Oregon Department of Environmental Quality
- S = Semiannual
- TGA = Troutdale Gravel Aquifer
- TSA = Troutdale Sandstone Aquifer
- Q = Quarterly
- S/C-A = Well sampled for multiple purposes. First abbreviation indicates sampling frequency for VOC remedy/second abbreviation indicates sampling frequency for coolant release.
- '--' = New well not included in previous monitoring program.

Notes:

- (a) Proposed modifications based on performance review; will be inacted upon ODEQ approval.
 - (b) TSA water quality data collected to evaluate remedy performance as part of TGA corrective measure performance. Diffusion Bag Samples (DBS) to be utilized for TSA sample collection.
- Red colored text indicates proposed modification to monitoring frequency.

**TABLE 3-3
DECOMMISSIONED WELLS - JANUARY 1 - DECEMBER 31, 2016
BOEING PORTLAND**

Well	Installation Date	Decommissioned Date	Aquifer Screened	X Coordinate	Y Coordinate	Elevations, ft MSL				Depth of Well (ft)
						Ground Surface	Measuring Point	Top of Screen	Bottom of Screen	
TGA Monitoring Wells										
D-2(i)	05/13/88	10/31/16	TGA	1494818.0	692345.0	16.8	18.77	-75.2	-95.2	122
D-3(i)	05/03/88	10/06/16	TGA	1495389.0	692130.0	42.0	43.72	-79.8	-99.5	151.5
BOP-7d	10/28/16	--	TGA	1495265.0	691101.9	82.48	82.28	-65.0	-75.0	158.5
TGA Dual Phase Extraction Well										
DP-4	03/04/98	10/14/16	TGA	1496169.8	690364.4	NA	NA	NA	NA	78

Acronyms/Abbreviations:

BOP = Boeing of Portland

ft = feet

MSL = mean sea level = No data available in database

TGA = Troutdale Gravel Aquifer

TABLE 4-1
GROUNDWATER ELEVATION DATA
TGA MONITORING PROGRAM
JANUARY 1 THROUGH DECEMBER 31, 2016

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
TGA WELLS					
BOP-7(i)	2/1/2016	17:05	83.08	58.10	24.98
BOP-7(i)	5/3/2016	10:28	83.08	57.61	25.47
BOP-7(i)	8/2/2016	13:35	83.08	58.40	24.68
BOP-7(i)	11/4/2016	13:59	83.08	58.10	24.98
BOP-7(d)	11/3/2016	14:34	82.48	58.23	24.25
BOP-9(i)	2/1/2016	15:32	114.74	79.43	35.31
BOP-9(i)	8/2/2016	13:08	114.74	79.13	35.61
BOP-10(i)	2/1/2016	12:55	109.16	37.83	71.33
BOP-10(i)	8/2/2016	11:09	109.16	38.77	70.39
BOP-16(i)	2/1/2016	15:27	89.08	56.91	32.17
BOP-16(i)	8/2/2016	8:45	89.08	57.07	32.01
BOP-48(i)	2/1/2016	14:13	94.17	10.08	84.09
BOP-48(i)	8/2/2016	12:02	94.17	12.73	81.44
BOP-56(i)	2/1/2016	13:04	99.07	57.42	41.65
BOP-56(i)	8/2/2016	11:51	99.07	56.88	42.19
BOP-57(ia) (b)	2/1/2016	11:08	95.45	58.37	37.08
BOP-57(ia) (b)	8/2/2016	10:22	95.45	58.47	36.98
BOP-57(ib) (b)	2/1/2016	11:19	94.57	58.56	36.01
BOP-57(ib) (b)	8/2/2016	10:18	94.57	58.51	36.06
BOP-59(i)	2/1/2016	12:31	110.20	39.21	70.99
BOP-59(i)	8/2/2016	11:00	110.20	39.67	70.53
D-7(i)	2/1/2016	9:10	45.38	31.17	14.21
D-7(i)	8/2/2016	7:49	45.38	32.83	12.55
D-8(i)	2/1/2016	9:13	29.30	15.71	13.59
D-8(i)	8/2/2016	7:57	29.30	17.36	11.94
D-11(i)	2/1/2016	9:32	77.11	59.77	17.34
D-11(i)	8/2/2016	8:11	77.11	63.61	13.50
D-12(i)	2/1/2016	9:35	33.51	20.02	13.49
D-12(i)	8/2/2016	8:22	33.51	21.74	11.77
COOLANT RELEASE WELLS					
LAI-1	8/2/2016	14:29	109.86	26.47	83.39
LAI-2	8/2/2016	14:36	109.89	23.72	86.17
LAI-3	8/2/2016	14:40	109.85	21.26	88.59
LAI-4	2/1/2016	16:21	110.71	20.38	90.33
LAI-4	8/2/2016	14:44	110.71	21.62	89.09
LAI-5	8/2/2016	14:48	110.56	20.34	90.22
LAI-6	8/2/2016	14:51	110.65	21.22	89.43
LAI-7	2/1/2016	16:16	109.90	25.56	84.34
LAI-7	8/2/2016	14:27	109.90	27.17	82.73
LAI-8	2/1/2016	16:14	110.59	Dry	Dry
LAI-8	8/2/2016	11:03	110.59	Dry	Dry

TABLE 4-1
GROUNDWATER ELEVATION DATA
TGA MONITORING PROGRAM
JANUARY 1 THROUGH DECEMBER 31, 2016

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
<u>TSA WELLS</u>					
BOP-22R(ds)	8/2/2016	13:20	82.91	71.96	10.95
BOP-60R(ds)	8/2/2016	10:43	82.80	71.53	11.27
BOP-61(ds)	2/1/2016	14:03	94.64	86.00	8.64
BOP-61(ds)	8/2/2016	12:07	94.64	84.35	10.29
BOP-62(ds)	2/1/2016	16:39	112.29	101.01	11.28
BOP-62(ds)	8/2/2016	10:52	112.29	100.86	11.43
BOP-65(ds)	2/1/2016	16:34	104.22	92.21	11.31
BOP-65(ds)	8/2/2016	11:13	104.22	92.41	11.81
BOP-66(ds)	2/1/2016	16:28	102.97	92.80	10.17
BOP-66(ds)	8/2/2016	14:58	102.97	90.92	12.05
<u>FORMER VAPOR DEGREASER AREA WELLS</u>					
BOP-72(i)	2/1/2016	8:15	83.64	42.05	41.59
BOP-72(i)	5/2/2016	14:33	83.64	41.73	41.91
BOP-72(i)	8/2/2016	15:46	83.64	43.00	40.64
BOP-72(i)	11/4/2016	11:48	83.64	43.79	39.85
BOP-73(i)	2/1/2016	8:35	83.65	43.70	39.95
BOP-73(i)	5/2/2016	13:18	83.65	43.43	40.22
BOP-73(i)	8/2/2016	16:23	83.65	44.85	38.80
BOP-73(i)	11/4/2016	13:00	83.65	45.30	38.35
BOP-74(i)	2/1/2016	9:10	83.69	55.85	27.84
BOP-74(i)	5/2/2016	12:17	83.69	54.90	28.79
BOP-74(i)	8/3/2016	9:25	83.69	57.87	25.82
BOP-74(i)	11/4/2016	13:29	83.69	55.48	28.21
BOP-75(i)	2/1/2016	8:25	83.70	41.44	42.26
BOP-75(i)	5/2/2016	14:38	83.70	40.60	43.10
BOP-75(i)	8/2/2016	16:01	83.70	41.90	41.80
BOP-75(i)	11/4/2016	15:18	83.70	42.80	40.90
BOP-76(i)	2/1/2016	8:30	83.65	41.55	42.26
BOP-76(i)	5/2/2016	14:40	83.65	41.49	42.16
BOP-76(i)	8/2/2016	16:19	83.65	43.02	40.63
BOP-76(i)	11/4/2016	11:09	83.65	43.28	40.37
BOP-77(i)	2/1/2016	8:40	83.68	46.71	36.97
BOP-77(i)	5/2/2016	13:31	83.68	45.46	38.22
BOP-77(i)	8/3/2016	9:14	83.68	48.24	35.44
BOP-77(i)	11/4/2016	15:22	83.68	46.26	37.42
BOP-78(i)	2/1/2016	8:56	83.16	48.06	35.10
BOP-78(i)	5/2/2016	12:30	83.16	45.95	37.21
BOP-78(i)	8/3/2016	8:59	83.16	47.55	35.61
BOP-78(i)	11/4/2016	12:34	83.16	48.31	34.85
BOP-79(i)	2/1/2016	8:49	83.34	49.08	34.26
BOP-79(i)	5/2/2016	12:40	83.34	47.64	35.70
BOP-79(i)	8/3/2016	8:41	83.34	48.54	34.80
BOP-79(i)	11/4/2016	12:13	83.34	49.33	34.01
BOP-80(i)	2/1/2016	15:13	83.60	47.78	35.82
BOP-80(i)	5/2/2016	11:34	83.60	47.89	35.71
BOP-80(i)	8/2/2016	15:21	83.60	49.50	34.10
BOP-80(i)	11/4/2016	9:20	83.60	50.15	33.45

TABLE 4-1
GROUNDWATER ELEVATION DATA
TGA MONITORING PROGRAM
JANUARY 1 THROUGH DECEMBER 31, 2016

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
BOP-81(i)	2/1/2016	15:16	83.57	47.99	35.58
BOP-81(i)	5/2/2016	11:38	83.57	48.29	35.28
BOP-81(i)	8/2/2016	15:17	83.57	50.20	33.37
BOP-81(i)	11/4/2016	10:27	83.57	50.82	32.75
BOP-82(i)	2/1/2016	15:20	81.10	49.53	31.57
BOP-82(i)	5/2/2016	11:45	81.10	49.54	31.56
BOP-82(i)	8/2/2016	15:14	81.10	51.68	29.42
BOP-82(i)	11/4/2016	14:30	81.10	52.20	28.90
BOP-83(i)	2/1/2016	15:08	80.42	49.36	31.06
BOP-83(i)	5/2/2016	14:50	80.42	48.94	31.48
BOP-83(i)	8/2/2016	15:12	80.42	51.58	28.84
BOP-83(i)	11/4/2016	14:40	80.42	52.52	27.90
BOP-84(i)	2/1/2016	9:44	83.67	58.04	25.63
BOP-84(i)	5/2/2016	12:10	83.67	57.15	26.52
BOP-84(i)	8/3/2016	8:35	83.67	58.93	24.74
BOP-84(i)	11/4/2016	13:01	83.67	60.40	23.27
BOP-85(i)	2/1/2016	9:23	83.69	50.36	33.33
BOP-85(i)	5/2/2016	13:20	83.69	48.38	35.31
BOP-85(i)	8/2/2016	16:06	83.69	49.22	34.47
BOP-85(i)	11/4/2016	10:34	83.69	50.62	33.07
BOP-86(i)	2/1/2016	9:50	83.70	53.56	30.14
BOP-86(i)	5/2/2016	13:40	83.70	50.74	32.96
BOP-86(i)	8/2/2016	15:40	83.70	54.81	28.89
BOP-86(i)	11/4/2016	10:07	83.70	52.40	31.30
BOP-87(i)	2/1/2016	9:15	83.68	52.05	31.63
BOP-87(i)	5/2/2016	13:30	83.68	52.10	31.58
BOP-87(i)	8/2/2016	16:11	83.68	52.98	30.70
BOP-87(i)	11/4/2016	10:58	83.68	53.76	29.92
BOP-88(i)	2/1/2016	9:30	83.67	60.54	23.13
BOP-88(i)	5/2/2016	13:00	83.67	57.38	26.29
BOP-88(i)	8/3/2016	8:32	83.67	53.34	30.33
BOP-88(i)	11/4/2016	11:18	83.67	52.85	30.82
TGA EXTRACTION WELLS					
E-2	2/1/2016	7:40	86.55	57.05	29.50
E-2	5/3/2016	14:26	86.55	41.73	41.91
E-2	8/2/2016	13:12	86.55	57.06	29.49
E-2	11/3/2016	16:55	86.55	43.79	39.85
E-3	2/1/2016	8:03	82.29	57.28	25.01
E-3	5/2/2016	10:22	82.29	57.00	25.29
E-3	8/2/2016	13:28	82.29	59.13	23.16
E-3	11/3/2016	13:48	82.29	59.89	22.40
E-4	2/1/2016	10:10	74.53	55.75	18.78
E-4	5/3/2016	15:49	74.53	96.11	-21.58
E-4	8/2/2016	13:00	74.53	59.76	14.77
E-4	11/3/2016	15:57	74.53	61.13	13.40
E-5	2/1/2016	13:20	93.48	58.02	35.46
E-5	5/3/2016	9:20	93.48	57.12	36.36
E-5	8/2/2016	10:26	93.48	58.14	35.34
E-5	11/4/2016	11:59	93.48	59.30	34.18

TABLE 4-1
GROUNDWATER ELEVATION DATA
TGA MONITORING PROGRAM
JANUARY 1 THROUGH DECEMBER 31, 2016

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
E-6	2/1/2016	12:34	108.47	62.00	46.47
E-6	5/3/2016	10:00	108.47	61.52	46.95
E-6	8/2/2016	11:05	108.47	61.83	46.64
E-6	11/4/2016	12:11	108.47	62.47	46.00
E-7	2/1/2016	12:36	104.19	25.93	78.26
E-7	5/3/2016	9:43	104.19	25.69	78.50
E-7	8/2/2016	11:16	104.19	27.30	76.89
E-7	11/4/2016	12:14	104.19	27.96	76.23
E-8	2/1/2016	13:55	93.23	8.09	85.14
E-8	5/3/2016	9:26	93.23	8.99	84.24
E-8	8/2/2016	11:55	93.23	10.90	82.33
E-8	11/4/2016	13:59	93.23	9.76	83.47
E-9	2/1/2016	13:59	80.91	5.83	75.08
E-9	5/3/2016	9:50	80.91	6.56	74.35
E-9	8/2/2016	11:58	80.91	7.72	73.19
E-9	11/4/2016	13:56	80.91	7.62	73.29
E-11	2/1/2016	13:25	101.01	23.75	77.26
E-11	5/3/2016	8:58	101.01	30.38	70.63
E-11	8/2/2016	9:54	101.01	43.80	57.21
E-11	11/4/2016	16:18	101.01	NM	NM
E-12	2/1/2016	8:11	79.35	57.85	21.50
E-12	5/3/2016	7:16	79.35	88.05	-8.70
E-12	8/2/2016	7:19	79.35	88.91	-9.56
E-12	11/3/2016	13:59	79.35	86.87	-7.52
E-13	2/1/2016	9:02	43.14	40.16	2.98
E-13	5/3/2016	7:50	43.14	50.37	-7.23
E-13	8/2/2016	6:43	43.14	50.06	-6.92
E-13	11/3/2016	15:41	43.14	48.85	-5.71
E-15	2/1/2016	10:33	81.00	67.80	13.20
E-15	5/3/2016	9:09	81.00	60.43	20.57
E-15	8/2/2016	10:38	81.00	50.31	30.69
E-15	11/3/2016	16:10	81.00	54.03	26.97
E-16	2/1/2016	11:00	93.80	58.16	35.64
E-16	5/3/2016	9:04	93.80	61.31	32.49
E-16	8/2/2016	10:15	93.80	59.65	34.15
E-16	11/3/2016	16:13	93.80	61.17	32.63
DP1	2/1/2016	12:30	108.80	56.44	52.36
DP1	5/3/2016	10:10	108.80	57.02	51.78
DP1	8/2/2016	10:58	108.80	50.28	58.52
DP1	11/3/2016	16:20	108.80	58.34	50.46

ft = feet

MSL = mean sea level

TGA = Troutdale Gravel Aquifer

TSA = Troutdale Sandstone Aquifer

PVC = polyvinyl chloride

NM = not measured

(a) Reference Elevation for the top of PVC well casing.

(b) West Area wells BOP-57(ia, ib) are installed with short (5 ft) screens. BOP-57(ia) is screened at the base of the TGA, while BOP-57(ib) is screened within the first layer of the Confining Unit 1 (CU1).

**TABLE 4-2
GROUNDWATER QUALITY SUMMARY
TGA MONITORING PROGRAM 2016
BOEING PORTLAND**

Area	Location	Date	1,1-DCE	cDCE	1,1,1-TCA	PCE	TCE	VC	
			MCL:	7	70	200	5	5	2
<u>West Corrective Action Area:</u>									
	BOP-16(i)	2/4/2016	ND	0.2	ND	ND	3.5	0.3	
	BOP-16(i)	5/5/2016	ND	ND	ND	ND	1.8	ND	
	BOP-16(i)	8/11/2016	0.6	3.3	ND	ND	5.0	1.9	
	BOP-16(i)	11/8/2016	0.9	3.0	ND	0.8	8.7	0.8	
	BOP-57(ia) (a)	2/1/2016	ND	0.4	ND	0.2	2.4	ND	
	BOP-57(ia) (a)	8/3/2016	0.3	2.2	ND	1.7	11	ND	
	BOP-57(ib) (a)	2/1/2016	38	11	17	0.8	50	0.4	
	BOP-57(ib) (a)	8/3/2016	27	8.8	7.4	0.9	43	0.2	
	E-5	8/15/2016	ND	ND	ND	ND	0.4	ND	
	E-11	8/22/2016	ND	ND	ND	ND	ND	ND	
	E-15	2/5/2016	2.2	8.3	ND	ND	3.0	5.6	
	E-15	5/5/2016	0.9	5.2	ND	ND	0.4	5.5	
	E-15	8/10/2016	0.2	1.3	ND	ND	0.2	1.3	
	E-15	11/7/2016	ND	0.6	ND	ND	ND	0.9	
	E-16	2/26/2016	0.2	0.9	ND	1.5	6.3	ND	
	E-16	5/5/2016	0.3	1.2	ND	2.3	7.7	ND	
	E-16	8/10/2016	0.2	1.4	ND	2.8	8.3	ND	
	E-16	11/7/2016	0.3	1.2	ND	2.3	8.8	ND	
<u>Central Corrective Action Area:</u>									
	BOP-10(i)	2/5/2016	ND	1.6	ND	7.2	13	ND	
	BOP-10(i)	8/8/2016	ND	1.5	ND	6.6	13	ND	
	BOP-56(i)	2/1/2016	ND	2.2	ND	2.5	17	ND	
	BOP-56(i)	8/8/2016	ND	1.2	ND	3.9	11	ND	
	BOP-59(i)-Dup	2/5/2016	ND	3.3	ND	0.3	4.5	ND	
	BOP-59(i)	2/5/2016	ND	3.3	ND	0.3	4.5	ND	
	BOP-59(i)-Dup	8/8/2016	ND	1.3	ND	1.9	5.4	ND	
	BOP-59(i)	8/8/2016	ND	1.4	ND	2.0	5.7	ND	
	E-6	8/18/2016	ND	2.8	ND	7.0	13	ND	
	E-7	8/12/2016	ND	17	ND	37	19	ND	
	DP1	2/5/2016	0.3	74	ND	13	22	ND	
	DP1	5/3/2016	0.2	88	ND	16	24	ND	
	DP1	8/10/2016	0.2	74	ND	11	21	ND	
	DP1	11/7/2016	0.3	87	ND	17	26	ND	
	BOP-65(ds)	2/2/2016	ND	0.2	ND	ND	1.1	ND	
	BOP-65(ds)	8/10/2016	ND	ND	ND	ND	0.9	ND	
<u>Coolant Release Area:</u>									
	LAI-4	2/5/2016	ND	0.2	ND	ND	0.9	ND	
	LAI-4	8/4/2016	ND	0.3	ND	ND	0.8	ND	
	LAI-7	2/5/2016	ND	2.1	ND	2.0	5.1	ND	
	LAI-7	8/4/2016	ND	1.6	ND	2.7	4.8	ND	

**TABLE 4-2
GROUNDWATER QUALITY SUMMARY
TGA MONITORING PROGRAM 2016
BOEING PORTLAND**

Area	Location	Date	1,1-DCE	cDCE	1,1,1-TCA	PCE	TCE	VC
			MCL: 7	70	200	5	5	2
<u>East Yard Corrective Action Area:</u>								
	BOP-48(i)	8/8/2016	ND	ND	ND	ND	0.9	ND
	E-9	8/12/2016	ND	ND	ND	0.3	0.6	ND
	BOP-61(ds)	2/2/2016	ND	1.3	ND	0.3	7.6	ND
	BOP-61(ds)	8/10/2016	ND	0.6	ND	0.2	5.8	ND
<u>East Corrective Action Area:</u>								
	E-8	8/12/2016	ND	0.3	ND	3.0	2.3	ND
	BOP-66(ds)	2/2/2016	ND	ND	ND	ND	1.9	ND
	BOP-66(ds)	8/10/2016	ND	ND	ND	ND	1.1	ND
<u>Southwest Corrective Action Area:</u>								
	BOP-9(i)	2/1/2016	1.2	8.8	ND	2.6	30	ND
	BOP-9(i)	8/8/2016	1.5	11	ND	3.5	35	ND
	BOP-62(ds)	8/10/2016	ND	ND	ND	ND	0.6	ND
<u>Downgradient Corrective Action Area:</u>								
	BOP-7D(148)	11/16/2016	1.0	1.9	ND	0.3	11	1.1 J
	BOP-7D(155)	11/16/2016	0.7	1.3	ND	ND	5.1	1.1 J
	BOP-7(i)	2/4/2016	22	22	3.4	5.6	350	ND
	BOP-7(i)-Dup	2/4/2016	19	20	ND	5.0	350	ND
	BOP-7(i)	5/4/2016	23	25	3.6	7.1	250	0.3
	BOP-7(i)-Dup	5/4/2016	17	21	ND	5.5	250	ND
	BOP-7(i)	8/11/2016	12	14	1.9	3.2	160	ND
	BOP-7(i)-Dup	8/11/2016	9.9	11	1.6	2.6	140	ND
	BOP-7(i)	11/8/2016	16	18	2.2	4.5	230 J	ND
	BOP-7(i)-Dup	11/8/2016	18	19	2.5	4.7	160 J	ND
	D-7(i)	8/2/2016	ND	ND	ND	0.6	1.5	ND
	D-8(i)	2/1/2016	2.2	1.3	0.5	0.9	26	ND
	D-8(i)	8/2/2016	3.0	1.8	0.7	1.3	32	ND
	D-11(i)	8/2/2016	ND	0.3	ND	0.2	2.3	ND
	D-12(i)	2/1/2016	0.7	ND	ND	ND	3.2	ND
	D-12(i)	8/2/2016	0.7	ND	ND	0.3	3.2	ND
	E-2	2/5/2016	0.2	1.0	ND	0.2	1.4	1.1
	E-2	5/5/2016	0.2	1.0	ND	0.2	1.3	1.2
	E-2-Dup	5/5/2016	0.2	1.0	ND	0.3	1.5	1.2
	E-2	8/10/2016	0.4	1.5	ND	0.2	1.8	0.6
	E-2	11/7/2016	0.2	1.3	ND	ND	0.7	0.6 J
	E-2-Dup	11/7/2016	0.2	1.2	ND	ND	0.6	0.6 J
	E-3	2/5/2016	0.6	3.6	ND	ND	1.2	3.5
	E-3	5/5/2016	0.6	3.2	ND	ND	2.1	2.9
	E-3	8/10/2016	ND	ND	ND	ND	ND	ND
	E-3	11/7/2016	1.4	4.0	ND	ND	9.2	2.3 J
	E-4	2/4/2016	4.9	2.1	ND	1.2	26	ND
	E-4	5/5/2016	4.2	1.6	ND	1.2	21	ND
	E-4	8/10/2016	2.9	1.3	ND	0.8	21	ND

**TABLE 4-2
GROUNDWATER QUALITY SUMMARY
TGA MONITORING PROGRAM 2016
BOEING PORTLAND**

Area	Location	Date	1,1-DCE	cDCE	1,1,1-TCA	PCE	TCE	VC
			MCL: 7	70	200	5	5	2
	E-4	11/7/2016	5.0	1.8	ND	1.1	22	ND
	E-12	2/5/2016	1.6	1.5	ND	0.5	16	0.3
	E-12	5/3/2016	1.7	1.6	ND	0.6	16	0.2
	E-12	8/10/2016	2.1	1.6	ND	0.6	17	ND
	E-12	11/7/2016	2.0	2.0	ND	0.5	17	ND
	E-13	2/1/2016	2.5	1.6	ND	0.4	13	ND
	E-13	5/3/2016	2.3	1.2	ND	0.4	11	ND
	E-13	8/4/2016	2.6	1.4	ND	0.4	12	ND
	E-13	11/7/2016	2.2	1.3	ND	0.4	10	ND
	BOP-22R(ds)	8/8/2016	ND	ND	ND	ND	ND	ND
Former Degreaser Source Area:								
	BOP-72(i)	2/3/2016	ND	2.1	ND	ND	ND	3.2
	BOP-72(i)	5/4/2016	ND	2.2	ND	ND	1.0	2.9
	BOP-72(i)	8/9/2016	ND	6.5	ND	ND	2.7	5.2
	BOP-72(i)	11/10/2016	1.1	14	ND	ND	6.7	3.0
	BOP-73(i)	2/3/2016	ND	2.5	ND	ND	0.4	8.8
	BOP-73(i)	5/4/2016	ND	ND	ND	ND	ND	ND
	BOP-73(i)	8/9/2016	ND	2.7	ND	ND	0.7	2.6
	BOP-73(i)	11/10/2016	ND	5.1	ND	ND	1.5	3.2
	BOP-74(i)	2/3/2016	0.3	11	ND	ND	ND	3.1
	BOP-74(i)	5/4/2016	ND	11	ND	ND	0.2	2.6
	BOP-74(i)	8/9/2016	ND	11	ND	ND	0.2	1.6
	BOP-74(i)	11/10/2016	ND	9.9	ND	ND	0.2	1.3
	BOP-75(i)	2/3/2016	0.3	3.5	ND	ND	1.1	4.3
	BOP-75(i)	5/5/2016	0.4	3.9	ND	ND	2.0	5.4
	BOP-75(i)	8/9/2016	0.3	3.0	ND	ND	1.0	4.7
	BOP-75(i)	11/4/2016	0.5	3.0	ND	ND	6.2	3.4 J
	BOP-76(i)	2/3/2016	0.7	9.8	ND	ND	1.0	1.6
	BOP-76(i)	5/4/2016	0.6	10	ND	ND	0.5	3.8
	BOP-76(i)	8/9/2016	0.5	11	ND	ND	1.1	4.2
	BOP-76(i)	11/10/2016	0.4	7.4	ND	ND	3.5	2.5
	BOP-77(i)	2/3/2016	ND	61	ND	ND	6.2	8.7
	BOP-77(i)	5/4/2016	ND	44	ND	ND	4.9	6.7
	BOP-77(i)	8/9/2016	ND	33	ND	0.4	2.7	2.1
	BOP-77(i)	11/10/2016	ND	15	ND	ND	2.6	1.5
	BOP-78(i)	2/4/2016	ND	4.2	ND	ND	0.3	2.2
	BOP-78(i)	5/5/2016	ND	10	ND	ND	0.4	6.1
	BOP-78(i)	8/8/2016	ND	24	ND	ND	0.9	13
	BOP-78(i)	11/4/2016	ND	12	ND	ND	0.7	7.5 J
	BOP-79(i)	2/4/2016	ND	4.5	ND	ND	0.4	3.5
	BOP-79(i)	5/5/2016	ND	3.6	ND	ND	0.5	3.6
	BOP-79(i)	8/8/2016	ND	4.2	ND	ND	0.7	3.4
	BOP-79(i)	11/4/2016	ND	4.7	ND	ND	0.6	3.7 J
	BOP-80(i)	2/3/2016	ND	ND	ND	ND	ND	0.2
	BOP-80(i)	5/4/2016	ND	ND	ND	ND	ND	0.4
	BOP-80(i)	8/11/2016	ND	0.2	ND	ND	ND	0.7
	BOP-80(i)	11/11/2016	ND	ND	ND	ND	ND	0.3

**TABLE 4-2
GROUNDWATER QUALITY SUMMARY
TGA MONITORING PROGRAM 2016
BOEING PORTLAND**

Area	Location	Date	1,1-DCE	cDCE	1,1,1-TCA	PCE	TCE	VC
			MCL: 7	70	200	5	5	2
	BOP-81(i)	2/4/2016	ND	ND	ND	ND	ND	ND
	BOP-81(i)	5/4/2016	ND	ND	ND	ND	ND	ND
	BOP-81(i)	8/11/2016	ND	ND	ND	ND	ND	ND
	BOP-81(i)	11/11/2016	ND	ND	ND	ND	ND	0.3
	BOP-82(i)	2/4/2016	0.6	1.4	ND	0.5	8.5	0.4
	BOP-82(i)	5/3/2016	0.6	0.9	ND	0.6	8.3	ND
	BOP-82(i)	8/11/2016	0.7	0.6	ND	0.6	8.7	ND
	BOP-82(i)	11/16/2016	0.7	0.6	ND	0.5	8.7	ND
	BOP-83(i)	2/4/2016	ND	ND	ND	ND	1.7	ND
	BOP-83(i)	5/6/2016	ND	ND	ND	ND	2.4	ND
	BOP-83(i)	8/11/2016	ND	ND	ND	ND	2.6	ND
	BOP-83(i)	11/16/2016	0.6	4.5	ND	0.5	10	ND
	BOP-84(i)	2/4/2016	ND	3.4	ND	ND	ND	2.0
	BOP-84(i)	5/5/2016	ND	3.8	ND	ND	ND	2.2
	BOP-84(i)	8/8/2016	ND	4.6	ND	ND	ND	1.7
	BOP-84(i)	11/4/2016	ND	4.6	ND	ND	ND	1.5 J
	BOP-85(i)	2/4/2016	ND	0.7	ND	ND	ND	0.5
	BOP-85(i)	5/5/2016	ND	1.0	ND	ND	ND	0.9
	BOP-85(i)	8/8/2016	ND	1.3	ND	ND	0.3	0.9
	BOP-85(i)	11/4/2016	ND	1.3	ND	ND	0.3	0.9 J
	BOP-86(i)	2/4/2016	ND	1.9	ND	ND	0.3	2.2
	BOP-86(i)	5/5/2016	ND	2.0	ND	ND	0.4	ND
	BOP-86(i)	8/8/2016	ND	2.5	ND	ND	0.6	1.7
	BOP-86(i)	11/4/2016	ND	2.3	ND	ND	0.6	1.6 J
	BOP-87(i)	2/4/2016	ND	0.5	ND	ND	ND	0.6
	BOP-87(i)	5/5/2016	ND	0.6	ND	ND	0.2	1.0
	BOP-87(i)	8/8/2016	ND	0.9	ND	ND	0.3	0.8
	BOP-87(i)	11/4/2016	ND	1.0	ND	ND	0.3	0.8 J
	BOP-88(i)	2/4/2016	ND	24	ND	ND	1.6	4.1
	BOP-88(i)	5/5/2016	ND	65	ND	ND	3.3	6.8
	BOP-88(i)	8/9/2016	0.2	100	ND	ND	8.9	7.0
	BOP-88(i)	11/8/2016	ND	110 J	ND	ND	6.2 J	7.4 J

Acronyms/Abbreviations:

cDCE = cis-1,2-dichloroethene
 1,2-DCE = 1,2-dichloroethene
 MCL = Maximum Contaminant Level
 ND = Not detected
 PCE = tetrachloroethene
 trans-1,2-DCE = trans-1,2-dichloroethene
 1,1,1-TCA = 1,1,1-trichloroethane
 TCE = trichloroethene
 TGA = Troutdale Gravel Aquifer
 VC = vinyl chloride

Notes:

Results are reported in micrograms per liter (µg/L).

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

Boxed value indicates concentration above the MCL.

(a) West Area wells BOP-57(ia, ib) are installed with short (5 ft) screens. BOP-57(ia) is screened at the base of the TGA, while BOP-57(ib) is screened within the first layer of the Confining Unit 1 (CU1).

**TABLE 4-3
WATER ANALYTICAL RESULTS
TPH-Dx AND FIELD PARAMETERS FOR
COOLANT RELEASE AREA
BOEING PORTLAND**

Location	Laboratory ID	Date Collected Screening Level (b)	NWTPH-Dx (mg/L) (a)			Field Parameters			Conventional (mg/L)	
			Diesel	Motor Oil	Total TPH-Dx 1.35	pH	DO (mg/L)	ORP (mV)	Nitrate	Sulfate
LAI-1	8510419	8/3/2016	0.095 U	0.24 U	ND	6.20	5.20	85.5	NA	NA
LAI-2	8510420	8/3/2016	0.10 U	0.25 U	ND	6.12	2.88	112.7	NA	NA
LAI-3	8510421	8/3/2016	0.095 U	0.24 U	ND	6.56	3.95	106.9	NA	NA
LAI-4	8234032	2/5/2016	0.25	0.57	0.82	6.87	4.17	115.6	0.55	7.6
LAI-4	8510422	8/4/2016	1.2	2.6	3.8	6.72	1.82	1.5	0.10 U	9.1
LAI-5	8510423	8/4/2016	0.097 U	0.24 U	ND	6.56	4.97	-338.9	NA	NA
LAI-6	8510424	8/4/2016	0.095 U	0.24 U	ND	7.97	5.68	-345.9	NA	NA
LAI-7	8234033	2/5/2016	0.096 U	0.24 U	ND	6.77	5.26	114.9	2.9	16.0
LAI-7	8510425	8/4/2016	0.096 U	0.24 U	ND	6.40	2.43	162.5	3.9	15.0
LAI-8	---	2/5/2016	Dry in February 2016							
LAI-8	---	8/4/2016								

Acronyms/Abbreviations:

ID = identification
 mg/L = milligrams per liter
 mV = millivolt
 NA = Not analyzed.
 ND = Not detected.
 ODEQ = Oregon Department of Environmental Quality
 ORP = oxygen reduction potential
 TPH-Dx = total petroleum hydrocarbons - diesel range
 DO = dissolved oxygen

Notes:

U = Indicates compound was analyzed for, but was not detected at the given reporting limit.

Boxed value indicates concentration above the cleanup level.

(a) Samples analyzed after September 27, 2006 had silica gel and acid wash preparation steps conducted.

(b) Site-specific ODEQ Risk-Based cleanup standard based on sum of diesel and motor oil components.

TABLE 4-4
SUB-SLAB VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND

Location	Date Collected	VOLATILES (Method TO-15)					
		Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	cDCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)
	Screening Level (a)	2,800	880,000	22,000,000		2,900	47,000
VP-1 (SG-44)	Baseline	29 U	44 U	61 U	44 U	15,000	NA
VP-1	2/2/2016	3.0 U	4.6 U	7.3	4.6 U	1,600	99
	4/7/2016 (b)						
VP-1	5/3/2016	2.7 U	4.2 U	5.8 U	4.2 U	14	18
VP-1	8/5/2016	3.1 U	4.8 U	6.6 U	4.8 U	6.5 U	39
VP-1	11/9/2016	3.0 U	4.7 U	6.5 U	4.7 U	6.4 U	18
VP-2 (SG-34)	Baseline	200 U	310 U	NA	1100	280,000	NA
VP-2	2/2/2016	420 U	650 U	890 U	650 U	150,000	2,300
	4/7/2016 (b)						
VP-2	5/3/2016	3.3 U	5.1 U	7.1 U	5.1 U	220	25
VP-2	8/5/2016	3.0 U	4.7 U	6.5 U	4.7 U	64	35
VP-2	11/9/2016	2.8 U	4.4 U	6 U	4.4 U	20	17
VP-3 (SG-42)	Baseline	14 U	90	4700	27	7,400	NA
VP-3	2/2/2016	2.9 U	4.5 U	420	4.5 U	100	130
	4/7/2016 (b)						
VP-3	5/3/2016	3.2 U	5.0 U	22	15	11	35
VP-3	8/5/2016	3.0 U	4.6 U	18	4.6 U	7.5	49
VP-3	11/9/2016	2.6 U	4.1 U	11	4.1 U	6.2	26
VP-4 (SG-45)	Baseline	290 U	440 U	610 U	660	170,000	NA
VP-4	2/2/2016	3.0 U	4.6 U	16	4.6 U	150	100
	4/7/2016 (b)						
VP-4	5/3/2016	2.6 U	4.1 U	5.6 U	4.1 U	43	37
VP-4	8/5/2016	7.7 U	12 U	16 U	12 U	31	45
VP-4	11/9/2016	2.6 U	4.1 U	5.7 U	4.1 U	19	18
VP-5 (SG-46)	Baseline	1100	1700	2400	3800	850,000	NA
VP-5	2/2/2016	250 U	390 U	2,500	390 U	93,000	1700
	4/7/2016 (b)						
VP-5	5/3/2016	2.6 U	4.1 U	5.6 U	4.1 U	200	20
VP-5	8/5/2016	3.3 U	5.1 U	7.0 U	5.1 U	31	30
VP-5	11/9/2016	3.0 U	4.6 U	6.3 U	4.6 U	12	18
VP-6 (SG-1)	Baseline	13 U	59	7600	160	3,200	NA
VP-6	2/2/2016	3.0 U	4.6 U	490	15	500	190
	4/7/2016 (b)						
VP-6	5/3/2016	2.8 U	4.3 U	38	4.5	30	49
VP-6	8/5/2016	2.8 U	4.4 U	29	4.4 U	10	68
VP-6	11/9/2016	2.9 U	4.5 U	7.6	4.5 U	6.1 U	54
VP-7 (SG-28B)	Baseline	30 U	3200	NA	1900	5,200	NA
VP-7	2/2/2016	7.1 U	120	4,600	120	400	150
	4/7/2016 (b)						
VP-7	5/3/2016	3.3 U	30	1000	36	110	78
VP-7	8/5/2016	2.8 U	25	820	20	78	92
VP-7	11/9/2016	3.0 U	20	600	18	51	64

**TABLE 4-4
SUB-SLAB VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND**

Location	Date Collected	VOLATILES (Method TO-15)					
		Vinyl Chloride (µg/m ³)	1,1-DCE (µg/m ³)	1,1,1-TCA (µg/m ³)	cDCE (µg/m ³)	TCE (µg/m ³)	PCE (µg/m ³)
	Screening Level (a)	2,800	880,000	22,000,000		2,900	47,000
VP-8 (SG-11)	Baseline	100 U	14,273	190,975	7,414	20,743	NA
VP-8	2/2/2016	20 U	460	14,000	260	790	180
	4/7/2016 (b)						
VP-8	5/3/2016	3.1 U	100	2200	36	100	75
VP-8	8/5/2016	7.6 U	110	2800	30	130	100
VP-8R (c)	11/15/2016	3.3 U	20	530	43	47	36
VP-9 (SG-24)	Baseline	100 U	103 U	185	103 U	8,007	NA
VP-9	2/2/2016	3.1 U	4.8 U	52	4.8 U	270	130
	4/7/2016 (b)						
VP-9	5/3/2016	2.9 U	4.5 U	14	4.5 U	130	74
VP-9	8/5/2016	3.0 U	4.6 U	8.6	4.6 U	76	58
VP-9	11/9/2016	2.9 U	4.5 U	6.2 U	4.5 U	36	28

Acronyms/Abbreviations:

cDCE = cis-1,2-dichloroethene
 1,1-DCE = 1,1-dichloroethene
 µg/m³ = micrograms per cubic meter
 NA = Not Analyzed
 PCE = tetrachloroethene
 1,1,1-TCA = 1,1,1-trichloroethane
 TCE = trichloroethene
 VOC = volatile organic compound

Notes:

U = Indicates the compound was undetected at the reported concentration.
 Boxed results are greater than the screening level.

Baseline samples collected during pilot tests.

- (a) Soil gas screening levels were developed by the Oregon Department of Environmental Quality (ODEQ) by multiplying the Risk-Based Concentration for air in an occupational setting by an attenuation factor of 1,000 to account for vapor intrusion through building slab. Screening levels updated June 7, 2012.
 (b) SVE system was shutdown on 10/9/2015 with ODEQ approval. Resumed operation on 4/7/2016
 (c) VP-8R was installed November 15, 2016 to replace VP-8 that was damaged by facility operation.

**TABLE 4-5
VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND**

Location	Lab ID	Date Collected	Cumulative days since startup	Days of Shutdown (since previous sample collection)	VOLATILES (Method TO-15)							VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
					Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	CDCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)			
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
VOW-16	1209159-03A	9/10/2012			4.8 U	7.4 U	190	7.4 U	2,500	480	NA			
VOW-16	1602135-08A	2/2/2016 4/7/2016 (b)	1233	91	3.0 U	4.7 U	22	4.7 U	130	160	NA	---	0	---
VOW-16	1605109-11A	5/3/2016	1324	64	2.9 U	4.5 U	6.1 U	4.5 U	6.0 U	67	NA	---	27	---
VOW-16	1608175-11A	8/5/2016	1418	0	2.9 U	4.5 U	6.2 U	4.5 U	6.6	120	NA	---	94	---
VOW-16	1611211-11A	11/9/2016	1514	0	3.2 U	5.0 U	6.8 U	5.0 U	6.7U	64	NA	---	96	---
VOW-17	1209159-05A	9/10/2012			13 U	20 U	87	20 U	8,300	1800	NA			
VOW-17	1602135-09A	2/2/2016 4/7/2016 (b)	1233	91	54	11	19	160	2,600	210	NA	---	0	---
VOW-17	1605109-12A	5/3/2016	1324	64	3.2 U	5.0 U	6.9 U	5.0 U	29	20	NA	---	27	---
VOW-17	1608175-12A	8/5/2016	1418	0	2.8 U	4.3 U	6.0 U	4.3 U	7.8	50	NA	---	94	---
VOW-17	1611211-10A	11/9/2016	1514	0	3.1 U	4.8 U	6.5 U	4.8 U	17	22	NA	---	96	---
VOW-18	1209159-01A	9/10/2012			62 U	450	7900	740	31,000	8800	NA			
VOW-18	1602135-10A	2/2/2016 4/7/2016 (b)	1233	91	3.0 U	4.7 U	200	15	340	360	NA	---	0	---
VOW-18	1605109-13A	5/3/2016	1324	64	2.9 U	4.6 U	6.3 U	4.6 U	8.6	75	NA	---	27	---
VOW-18	1608175-13A	8/5/2016	1418	0	3.1 U	4.8 U	6.6 U	4.8 U	10	120	NA	---	94	---
VOW-18	1611211-09A	11/9/2016	1514	0	3.0 U	4.7 U	6.4 U	4.7 U	6.3 U	82	NA	---	96	---
BOP-78(i)	1001038-05A Startup	12/28/2009 9/17/2012			110 U	410	360	420	88,000	NA	170 U			
BOP-78(i)	1602135-01A	2/2/2016 4/7/2016 (b)	1233	91	44	11	40	110	620	200	NA	0.00000	0	0.000
BOP-78(i)	1605109-04A	5/3/2016	1324	64	2.9 U	4.5 U	6.2 U	4.5 U	45	97	NA	0.0011	27	0.014
BOP-78(i)	1608175-04A	8/5/2016	1418	0	3.1 U	4.8 U	6.6 U	4.8 U	22	140	NA	0.0008	94	0.089
BOP-78(i)	1611211-04A	11/9/2016	1514	0	3.0 U	4.6 U	6.4 U	4.6 U	61	86	NA	0.0006	96	0.079

**TABLE 4-5
VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND**

Location	Lab ID	Date Collected	Cumulative days since startup	Days of Shutdown (since previous sample collection)	VOLATILES (Method TO-15)							VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
					Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	CDCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)			
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
BOP-79(i)	1101028-17A Startup	01/03/2011 9/17/2012			3.1 U	90	NA	15	340	NA	10			
BOP-79(i)	1602135-02A	2/2/2016 4/7/2016 (b)	1233	91	73	46 U	64 U	46 U	170	110	NA	0.00000	0	0.000
BOP-79(i)	1605109-05A	5/3/2016	1324	64	3.4 U	5.4 U	7.4 U	5.4 U	7.2 U	57	NA	0.00060	27	0.008
BOP-79(i)	1608175-05A	8/5/2016	1418	0	2.9 U	4.5 U	6.2 U	4.5 U	6.1 U	89	NA	0.00091	94	0.071
BOP-79(i)	611211-05A	11/9/2016	1514	0	3.0 U	4.6 U	6.3 U	4.6 U	6.2 U	52	NA	0.00031	96	0.058
BOP-84(i)	1001038-13A Startup	12/30/2009 9/17/2012			5.8 U	9.1 U	12 U	9.1 U	2,400	NA	9.3 U			
BOP-84(i)	1602135-03A	2/2/2016 4/7/2016 (b)	1233	91	3.2	4.8 U	23	8.1	930	240	NA	0.00000	0	0.000
BOP-84(i)	1605109-06A	5/3/2016	1324	64	3.4 U	5.3 U	7.2 U	5.3 U	90	38	NA	0.00114	27	0.015
BOP-84(i)	1608175-06A	8/5/2016	1418	0	2.7 U	4.3 U	5.9 U	4.3 U	28	54	NA	0.00058	94	0.081
BOP-84(i)	1611211-06A	11/9/2016	1514	0	3.1 U	4.8 U	6.5 U	4.8 U	32	32	NA	0.00045	96	0.069
BOP-85(i)	1101028-05A Startup	12/28/2010 9/17/2012			37 U	350	NA	400	21,000	NA	72			
BOP-85(i)	1602135-04A	2/2/2016 4/7/2016 (b)	1233	91	3.0 U	4.6 U	34	4.6 U	14	330	NA	0.00000	0	0.000
BOP-85(i)	1605109-07A	5/3/2016	1324	64	2.9 U	4.4 U	6.1 U	4.4 U	140	140	NA	0.00193	27	0.026
BOP-85(i)	1608175-07A	8/5/2016	1418	0	2.8 U	4.3 U	5.9 U	4.3 U	5.8 U	190	NA	0.00102	94	0.138
BOP-85(i)	1611211-07A	11/9/2016	1514	0	3.2 U	4.9 U	6.8 U	4.9 U	11	190	NA	0.00135	96	0.137
BOP-86(i)	1001038-17A Startup	01/02/2010 9/17/2012			91 U	510	340	850	52,000	NA	530			
BOP-86(i)	1602135-05A	2/2/2016 4/7/2016 (b)	1233	91	2.9 U	4.5 U	17	4.5 U	39	300	NA	0.00000	0	0.000
BOP-86(i)	1605109-08A	5/3/2016	1324	64	3.2 U	4.9 U	6.7 U	4.9 U	69	58	NA	0.00070	27	0.009
BOP-86(i)	1608175-08A	8/5/2016	1418	0	2.8 U	4.4 U	6.0 U	4.4 U	38	70	NA	0.00091	94	0.076
BOP-86(i)	1611211-08A	11/9/2016	1514	0	3.2 U	4.9 U	6.8 U	4.9 U	28	100	NA	0.00074	96	0.075

**TABLE 4-5
VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND**

Location	Lab ID	Date Collected	Cumulative days since startup	Days of Shutdown (since previous sample collection)	VOLATILES (Method TO-15)							VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
					Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	CDCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)			
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
BOP-87(i)	1602135-06A	2/2/2016	1233	91	3.0 U	5.0	600	7.9	150	230	NA	0.00000	0	0.000
		4/7/2016 (b)												
BOP-87(i)	1605109-09A	5/3/2016	1324	64	3.1 U	4.8 U	10	4.8 U	470	100	NA	0.00373	27	0.050
BOP-87(i)	1608175-09A	8/5/2016	1418	0	3.1 U	4.9 U	8.0	4.9 U	340	180	NA	0.00355	94	0.342
BOP-87(i)	1611211-09A	11/9/2016	1514	0	3.0 U	4.6 U	7.2	4.6 U	230	130	NA	0.00198	96	0.296
BOP-88(i)	1101028B-12A	12/30/2010			150 U	450	NA	230 U	230,000	NA	240 U			
		Startup												
BOP-88(i)	1602135-07A	2/2/2016	1233	91	2.9 U	6.3	300	4.5 U	80	140	NA	0.00000	0	0.000
		4/7/2016 (b)												
BOP-88(i)	1605109-10A	5/3/2016	1324	64	2.8 U	4.3 U	16	4.3 U	190	80	NA	0.00321	27	0.043
BOP-88(i)	1608175-10A	8/5/2016	1418	0	2.9 U	4.5 U	13	4.5 U	59	120	NA	0.00119	94	0.207
BOP-88(i)	1611211-10A	11/9/2016	1514	0	3.3 U	5.2 U	12	5.2 U	65	73	NA	0.00078	96	0.166

VOC Mass Removed in 2016 (lbs)	2.05
Cumulative VOC Mass Removed Since System Startup (lbs)	12.52

Acronyms/Abbreviations:

CDCE = cis-1,2-dichloroethene
 1,1-DCA = 1,1-dichloroethane
 1,1-DCE = 1,1-dichloroethene
 ID = identification
 µg/m3 = micrograms per cubic meter
 NA = Not Analyzed
 lbs = pounds
 PCE = tetrachloroethene
 1,1,1-TCA = 1,1,1-trichloroethane
 TCE = trichloroethene
 SVE = soil vapor extraction
 VOC = volatile organic compound

Notes:

U = Indicates the compound was undetected at the reported concentration.
 J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
 Boxed results are greater than the screening level.
 Baseline samples collected during pilot tests.
 --- = Indicates data not available for vapor observation wells.

(a) Soil gas screening levels were developed by the Oregon Department of Environmental Quality (ODEQ) by multiplying the Risk Based Concentration for air in an occupational setting by an attenuation factor of 1,000 to account for vapor intrusion through building slab. Screening levels updated June 7, 2012.
 (b) SVE system was shut down on 10/9/2015 with ODEQ approval. Resumed operation on 4/7/2016

**TABLE 5-1
SUMMARY OF GROUNDWATER EXTRACTION WELL PERFORMANCE
AVERAGE YIELD, TOTAL GALLONS, AND AVERAGE TOTAL MASS REMOVAL RATES
BOEING PORTLAND**

Well	2012			2013			2014			2015			2016		
	Average Extraction Rate (gpm)(a)	Total Gallons	Average Total VOC Mass Removal Rate (lbs/day) (b)	Average Extraction Rate (gpm)(a)	Total Gallons	Average Total VOC Mass Removal Rate (lbs/day) (b)	Average Extraction Rate (gpm)(a)	Total Gallons	Average Total VOC Mass Removal Rate (lbs/day) (b)	Average Extraction Rate (gpm)(a)	Total Gallons	Average Total VOC Mass Removal Rate (lbs/day) (b)	Average Extraction Rate (gpm)(a)	Total Gallons	Average Total VOC Mass Removal Rate (lbs/day) (b)
East Corrective Action Area:															
E-8 (c)	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000
<u>Total East Corrective Action Area</u>		0.00	0.00000		0.00	0.00000		0.00	0.00000		0.00	0.00000		0.00	0.00000
East Yard Corrective Action Area:															
E-9 (c)	0.00	0.04	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000
<u>Total East Corrective Action Yard</u>		0.04	0.00000		0.00	0.00000		0.00	0.00000		0.00	0.00000		0.00	0.00000
Central Corrective Action Area:															
E-6 (c)	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000
E-7 (c)	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000	0.00	0.00	0.00000
DP-1	2.67	1,480,998	0.00271	3.20	1,692,372	0.00567	2.92	1,425,143	0.00379	2.74	1,311,642	0.00403	2.65	1,376,324	0.00343
<u>Total Central Corrective Action Area</u>		1,480,998	0.00271		1,692,372	0.00567		1,425,143	0.00379		1,311,642	0.00403		1,376,324	0.00343
West Corrective Action Area:															
E-5 (c)	0.00	0.0	0.00000	0.00	0.0	0.00000	0.00	0.0	0.00000	0.00	0.0	0.00000	0.00	0.0	0.00000
E-11	0.00	6.8	0.00000	0.00	0.0	0.00000	0.01	1.2	0.00000	0.00	0.0	0.00000	0.00	0.0	0.00000
E-15	0.00	0.0	0.00000	0.50	265,097	0.00006	0.50	220,832	0.00002	0.85	359,157	0.00009	1.03	462,150	0.00012
E-16	0.35	54.1	0.00000	1.08	560,470	0.00020	2.10	956,352	0.00041	0.79	379,722	0.00011	1.67	674,730	0.00018
<u>Total West Corrective Action Area</u>		61	0.00000		825,567	0.00026		1,177,186	0.00042		738,879	0.00019		1,136,880	0.00030
Downgradient Corrective Action Area:															
E-2 (d)	8.31	3,844,476	0.00047	11.72	6,178,273	0.00068	15.27	7,484,146	0.00066	6.57	2,758,638	0.00020	0.00	0.0	0.00000
E-3 (d)	4.85	2,419,839	0.00142	3.45	1,889,276	0.00112	3.61	1,652,362	0.00066	1.40	642,354	0.00019	0.00	0.0	0.00000
E-4	2.53	1,493,818	0.00176	1.12	612,010	0.00054	0.92	460,753	0.00037	1.09	523,067	0.00034	1.12	760,673.0	0.00049
E-12	8.63	4,558,174	0.00079	6.53	3,486,614	0.00084	4.63	2,246,832	0.00059	1.45	675,892	0.00020	2.93	1,247,948.0	0.00058
E-13	119.92	65,675,839	0.01484	121.63	65,991,070	0.01729	100.38	49,910,972	0.01246	58.68	29,310,696	0.01067	64.87	32,591,930	0.01156
<u>Total Downgradient Corrective Action Area</u>		77,992,145	0.01929		78,157,243	0.02049		61,755,066	0.01474		33,910,647	0.01159		34,600,551	0.01263
Total All TGA Areas: (lbs/day)		79,473,204	0.02200		80,675,182	0.02642		64,357,396	0.01896		35,961,168	0.01581		37,113,755	0.01636

Acronyms/Abbreviations:

DCE = dichloroethene
 gpm = gallons per minute
 ODEQ = Oregon Department of Environmental Quality
 lbs = pounds
 PCE = tetrachloroethene
 TCA = trichloroethane
 TCE = trichloroethene
 TGA = troutdale Gravel Aquifer
 VOC = volatile organic compound

Notes:

- (a) Average extraction rate equals the total gallons pumped during the year divided by the number of minutes that the well was actively pumping.
- (b) Average total VOC mass removal rate calculated by multiplying the average extraction rate discussed in Section 5.4 by the concentration of total VOCs. Total VOCs include the following constituents: TCA, TCE, total 1,2-DCE, PCE, and 1,1-DCE.
- (c) Wells E-5 through E-9 have not been operated since 2002 except for intermittent short periods for sampling and maintenance.
- (d) Wells E-2 and E-3 were shut down on July 7, 2015 with ODEQ approval to minimize the amount of bio-solid accumulation.

**TABLE 5-2
AVERAGE GROUNDWATER EXTRACTION RATES - GALLONS PER MINUTE
BOEING PORTLAND**

PERIOD	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-11	E-12	E-13	E-15	E-16	DP-1
1/1/2016	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	2.90	54.00	0.55	0.10	2.70
2/1/2016	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	2.20	56.00	0.30	0.10	3.00
3/1/2016	0.00	0.00	1.10	0.00	0.00	0.00	0.00	0.00	0.00	1.20	71.20	1.05	3.50	2.95
4/1/2016	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	72.00	1.10	1.60	2.50
5/1/2016	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	1.13	73.28	1.85	2.85	3.02
6/1/2016	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.72	72.10	1.53	1.64	2.60
7/1/2016	0.00	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.9	72.00	1.10	1.50	2.40
8/1/2016	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	4.1	61.00	0.70	1.20	2.47
9/1/2016	0.00	0.00	2.16	0.00	0.00	0.00	0.00	0.00	0.00	5.29	61.55	0.70	1.44	2.82
10/1/2016	0.00	0.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00	5.8	58.50	1.08	1.42	2.18
11/1/2016	0.00	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	5.81	59.48	0.95	1.70	2.53
12/1/2016	0.00	0.00	2.68	0.00	0.00	0.00	0.00	0.00	0.00	4.26	56.45	1.00	1.45	2.65

Notes:

Extraction rates are gallons per minute (gpm).
 Actual pumping time varies for individual wells.
 Well E-10 was abandoned in 3/29/2010.
 Well E-14 was abandoned in 4/1/2010.

TABLE 5-3
GROUNDWATER TREATMENT SYSTEM
QUARTERLY EFFLUENT WATER QUALITY SUMMARY
BOEING PORTLAND

Parameter	NPDES Permit Requirement	Units	Effluent Water Quality			
			First Quarter 2/5/2016	Second Quarter 5/6/2016	Third Quarter 8/3/2016	Fourth Quarter 11/7/2016
pH (average)	6.5-8.5	SU	7.12	7.52	7.86	7.00
1,1,1-Trichloroethane	5	µg/L	ND	ND	ND	ND
1,1-Dichloroethene	5	µg/L	ND	ND	ND	ND
1,2-Dichloroethane	5	µg/L	ND	ND	ND	ND
1,2-Dichloropropane	5	µg/L	ND	ND	ND	ND
Benzene	5	µg/L	ND	ND	ND	ND
Bromodichloromethane	5	µg/L	ND	ND	ND	ND
Bromoform	5	µg/L	ND	ND	ND	ND
Carbon Tetrachloride	5	µg/L	ND	ND	ND	ND
Chloroform	5	µg/L	ND	ND	ND	ND
Dibromochloromethane	5	µg/L	ND	ND	ND	ND
Ethylbenzene	5	µg/L	ND	ND	ND	ND
Methylene Chloride	5	µg/L	ND	ND	ND	ND
Toluene	5	µg/L	ND	ND	ND	ND
trans-1,2-Dichloroethene	5	µg/L	ND	ND	ND	ND
Trichloroethene	5	µg/L	ND	ND	ND	ND
Vinyl Chloride	1	µg/L	ND	ND	ND	ND
Orthophosphate	N/A	mg/L				
Total Phosphate	N/A	mg/L	ND	ND	ND	ND
Nitrate Nitrogen	N/A	mg/L	2.5	2.4	2.3	2.1 J
Nitrite Nitrogen	N/A	mg/L	ND	ND	ND	ND
Ammonia Nitrogen	N/A	mg/L	ND	ND	ND	ND

Acronyms/Abbreviations:

- µg/L = micrograms per liter
- mg/L = milligrams per liter
- NPDES = National Pollutant Discharge Elimination System
- N/A = not applicable
- ND = Not Detected
- SU = standard unit

Notes:

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

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-72(i)	10/19/2010	-16					0.106	1.77		0.06	0.64	0.31	0.00	0.00	0.00
Monitoring Well	12/6/2010	32					0.849	3020	6.88	0.00	0.02	0.00	0.00	0.81	0.16
BOP-72(i)	2/2/2011	90					--	--	--	0.00	0.00	0.00	0.00	--	--
BOP-72(i)	5/5/2011	182					--	--	6.79	0.00	0.00	1.00	0.00	--	--
BOP-72(i)	8/10/2011	279					7.7	263	6.77	0.00	0.00	1.00	0.00	0.00	0.00
BOP-72(i)	11/3/2011	364	-55				--	--	6.71	0.00	0.00	0.22	0.78	--	--
BOP-72(i)	2/8/2012	461	42				--	--	7.46	0.00	0.00	0.00	1.00	--	--
BOP-72(i)	5/4/2012	547	128				--	--	6.69	0.00	0.00	0.00	1.00	--	--
BOP-72(i)	8/9/2012	644	225	-7			--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-72(i)	11/8/2012	735	316	84			--	--	--	0.00	0.00	0.02	0.98	--	--
BOP-72(i)	2/5/2013	824	405	173			--	--	--	0.00	0.00	0.05	0.95	--	--
BOP-72(i)	5/2/2013	910	491	259	-68		--	--	--	0.00	0.00	0.04	0.96	--	--
BOP-72(i)	8/6/2013	1006	587	355	28		13	47.4	6.66	0.00	0.00	0.03	0.19	0.78	0.00
BOP-72(i)	11/7/2013	1099	680	448	121		11	41.7	6.68	0.00	0.00	0.09	0.91	0.00	0.00
BOP-72(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.00	0.06	0.94	--	--
BOP-72(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-72(i)	8/13/2014	1378	959	727	400	28	14	36.6	6.12	0.00	0.00	0.10	0.90	0.00	0.00
BOP-72(i)	11/6/2014	1463	1044	812	485	113	14	13.6	6.56	0.00	0.00	0.09	0.91	0.00	0.00
BOP-72(i)	2/5/2015	1554	1135	903	576	204	13	8.6	6.34	0.00	0.00	0.04	0.18	0.77	0.00
BOP-72(i)	5/6/2015	1644	1225	993	666	294	11	6.7	6.33	0.00	0.07	0.26	0.67	0.00	0.00
BOP-72(i)	8/10/2015	1740	1321	1089	762	390	15	161.0	6.45	0.00	0.00	0.12	0.88	0.00	0.00
BOP-72(i)	11/4/2015	1826	1407	1175	848	476	18	3.7	6.54	0.00	0.00	0.20	0.80	0.00	0.00
BOP-72(i)	2/3/2016	1917	1498	1266	939	567	6	3.2	7.23	0.00	0.00	0.30	0.70	0.00	0.00
BOP-72(i)	5/4/2016	2008	1589	1357	1030	658	16	3.9	6.29	0.00	0.10	0.30	0.60	--	--
BOP-72(i)	8/9/2016	2105	1686	1454	1127	755	10	<1.0	6.32	0.00	0.12	0.39	0.49	0.00	0.00
BOP-72(i)	11/10/2016	2198	1779	1547	1220	848	20	2.2	6.34	0.00	0.21	0.59	0.20	0.00	0.00
BOP-73(i)	10/19/2010	-16					0.0599	1.6	--	0.01	0.81	0.18	0.00	0.00	0.00
Monitoring Well	12/6/2010	32					--	2.24	6.94	0.02	0.85	0.13	0.00	0.00	0.00
BOP-73(i)	2/2/2011	90					--	--	6.37	0.03	0.88	0.09	0.00	--	--
BOP-73(i)	5/5/2011	182					--	--	6.29	0.03	0.93	0.04	0.00	--	--
BOP-73(i)	8/10/2011	279					1.01	1.88	6.30	0.02	0.87	0.11	0.00	0.00	0.00
BOP-73(i)	11/3/2011	364					--	--	6.33	0.01	0.47	0.52	0.00	--	--
BOP-73(i)	12/1/2011	392	-27				0.759	1.93	6.71	0.01	0.52	0.47	0.00	0.00	0.00
BOP-73(i)	1/19/2012	441	22				--	9.26	7.04	0.02	0.59	0.33	0.06	--	--
BOP-73(i)	2/16/2012	469	50				1.35	<1.50	7.74	0.01	0.59	0.25	0.16	0.00	0.00
BOP-73(i)	3/15/2012	497	78				0.535	2.14	6.90	0.01	0.74	0.18	0.07	0.00	0.00
BOP-73(i)	4/17/2012	530	111				0.438	<1.50	7.66	0.01	0.92	0.04	0.02	0.00	0.00
BOP-73(i)	6/12/2012	586	167				0.787	1.61	6.37	0.02	0.85	0.09	0.03	0.00	0.00
BOP-73(i)	8/9/2012	644	225	-7			--	219	--	0.00	0.39	0.55	0.06	--	--
BOP-73(i)	9/18/2012	684	265	33			1.6	5.2	6.31	0.02	0.69	0.25	0.04	0.00	0.00
BOP-73(i)	11/14/2012	741	322	90			3.2	<1.0	6.57	0.02	0.93	0.05	0.00	0.00	0.00
BOP-73(i)	2/6/2013	825	406	174			1.4	--	6.26	0.02	0.76	0.20	0.02	0.00	0.00
BOP-73(i)	5/7/2013	915	496	264	-63		2.8	--	6.39	0.00	0.54	0.41	0.04	0.01	0.00
BOP-73(i)	8/6/2013	1006	587	355	28		4.8	2.4	6.18	0.00	0.60	0.31	0.05	0.04	0.00
BOP-73(i)	11/7/2013	1099	680	448	121		1.9	2.0	6.41	0.00	0.60	0.37	0.02	0.00	0.00
BOP-73(i)	2/20/2014	1204	785	553	226		2.6	1.5	6.54	0.00	0.31	0.64	0.05	0.00	0.00
BOP-73(i)	5/8/2014	1281	862	630	303		3.4	7.2	6.92	0.00	0.01	0.68	0.29	0.02	0.00
BOP-73(i)	8/13/2014	1378	959	727	400	28	4.8	32.9	5.87	0.00	0.00	0.11	0.79	0.10	0.00
BOP-73(i)	11/6/2014	1463	1044	812	485	113	5.6	11.9	6.41	0.00	0.00	0.05	0.13	0.82	0.00
BOP-73(i)	2/5/2015	1554	1135	903	576	204	8.4	4.3	6.41	0.00	0.00	0.13	0.42	0.44	0.01
BOP-73(i)	5/6/2015	1644	1225	993	666	294	13	7.2	6.35	0.00	0.00	0.08	0.62	0.30	0.00
BOP-73(i)	8/10/2015	1740	1321	1089	762	390	12	28.4	6.27	0.00	0.00	0.04	0.06	0.90	0.00
BOP-73(i)	11/4/2015	1826	1407	1175	848	476	7.5	5.1	6.36	0.00	0.02	0.49	0.16	0.16	0.17
BOP-73(i)	2/3/2016	1917	1498	1266	939	567	15	9.6	7.18	0.00	0.00	0.00	0.03	0.52	0.45

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions								
								Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)
BOP-73(i)	5/4/2016	2008	1589	1357	1030	658	290	<0.2	<0.2	<0.2	<0.2	22	98	<5.0	0.92	-153.3	<0.10	7.0	26.3	24.0	1.6	<2.0	
BOP-73(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	0.7	2.7	2.6	<5.0	54	<5.0	0.26	-124.8	<0.10	7.0	13.4	11.3	8.0	<2.0	
BOP-73(i)	11/10/2016	2198	1779	1547	1220	848	480	<0.2	1.5	5.1	3.2	<5.0	32	<5.0	0.30	-60.1	<0.10	7.0	10.1	10.6	7.3	<2.0	
BOP-74(i)	10/19/2010	-16						1.0	38	8.0	<1.0	<1.0	<2.0	--	--	--	0.9	--	--	--	9.1	--	
PRB Well	12/6/2010	32						<1.0	24	6.5	<1.0	<1.0	<2.0	--	3.07	53.3	0.2	0.2	--	--	--	9.9	--
BOP-74(i)	2/2/2011	90						2.6	44	3.8	<1.0	--	--	--	0.42	81.0	--	--	--	--	--	--	--
BOP-74(i)	5/5/2011	182						2.0	26	8.0	<1.0	--	--	--	0.25	56.5	--	--	--	--	--	--	--
BOP-74(i)	8/10/2011	279						<1.0	8.9	7.2	<1.0	<1.1	<1.2	<1.1	0.50	-124.9	<0.1	2.0	--	--	6.6	--	
BOP-74(i)	11/3/2011	364						<1.0	3.1	16	<1.0	--	--	--	0.10	-21.2	--	--	--	--	--	--	--
BOP-74(i)	12/1/2011	392	-27					<1.0	8.6	17	<1.0	<1.1	<1.2	<1.1	0.01	-302.2	<0.1	1.6	--	--	--	6.7	--
BOP-74(i)	1/19/2012	441	22					<1.0	11	18	<1.0	<1.1	1.6	<1.1	0.21	-170	<1.0	2.0	--	--	<1.0	--	
BOP-74(i)	2/16/2012	469	50					<1.0	2.4	44	1.6	<1.1	<1.2	<1.1	0.93	-154	<0.5	3.8	--	--	<0.5	--	
BOP-74(i)	3/15/2012	497	78					<1.0	1.4	210	3.2	<1.1	<1.2	<1.1	0.10	-244	<0.5	4.8	--	--	<0.5	--	
BOP-74(i)	4/17/2012	530	111					<5.0	<5.0	79	50	<1.1	<1.2	<1.1	0.13	-276.9	<0.1	1.8	--	--	0.8	--	
BOP-74(i)	6/12/2012	586	167					<1.0	<1.0	1.2	14	<1.1	<1.2	<1.1	0.72	-9.9	<0.1	4.8	--	--	<0.1	--	
BOP-74(i)	8/9/2012	644	225	-7				<1.0	<1.0	<1.0	1.9	--	--	--	--	--	--	--	--	--	--	--	--
BOP-74(i)	9/19/2012	685	266	34				<0.2	4.5	60	2.9	<5.0	<5.0	<5.0	1.20	18.0	<0.10	4.0	--	--	<1.0	--	
BOP-74(i)	11/14/2012	741	322	90				<0.2	0.6	6.9	18	<5.0	<7.0	<5.0	5.92	93.6	<0.10	4.0	--	--	<1.0	--	
BOP-74(i)	2/6/2013	825	406	174				<0.2	0.5	1.7	2.9	<5.0	<5.0	<5.0	0.28	-21.3	<0.10	5.0	--	--	<1.0	--	
BOP-74(i)	5/7/2013	915	496	264	-63			<0.2	4.0	2.7	1.8	<5.0	<5.0	<5.0	1.21	-53.0	<0.10	3.0	--	--	<1.0	--	
BOP-74(i)	8/6/2013	1006	587	355	28			<0.2	0.6	14	8.1	<5.0	<5.0	<5.0	2.35	-25.0	<0.10	3.5	--	--	<1.0	--	
BOP-74(i)	11/7/2013	1099	680	448	121			<0.2	<0.2	3.6	1.6	7.3	<5.0	<5.0	1.49	95.6	<0.10	3.5	--	--	<1.0	--	
BOP-74(i)	2/20/2014	1204	785	553	226			<0.2	<0.2	2.4	0.9	<5.0	5.0	<5.0	0.92	-71.6	<0.10	6.0	--	--	<1.0	--	
BOP-74(i)	5/8/2014	1281	862	630	303	-69		<0.2	<0.2	2.8	3.3	5.9	<5.0	<5.0	1.15	-33.7	<0.10	3.0	--	--	<1.0	--	
BOP-74(i)	11/6/2014	1463	1044	812	485	113		<0.2	0.3	11	2.1	<5.0	<5.0	<5.0	0.12	-134.5	0.63	7.0	592	578	501	10.5	
BOP-74(i)	2/6/2015	1555	1136	904	577	205		<0.2	0.4	15	1.9	<5.0	<5.0	<5.0	0.23	-95.9	0.54	7.0	291	317	626	4.0	
BOP-74(i)	5/6/2015	1644	1225	993	666	294	-74	<0.2	0.5	15	1.6	<5.0	<5.0	<5.0	0.79	-107.6	0.27	7.0	228	226	247	9.0	
BOP-74(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	<0.2	5.3	2.9	--	--	--	--	--	--	--	--	--	--	--	--
BOP-74(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	<0.2	11	3.1	<5.0	<5.0	<5.0	1.68	60.4	<1.0	7.0	964	961	1460	5.1	
BOP-74(i)	5/4/2016	2008	1589	1357	1030	658	290	<0.2	0.2	11	2.6	<5.0	<5.0	<5.0	0.52	-21.6	<1.0	7.0	534.0	482.0	601.0	31.9	
BOP-74(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	0.2	11	1.6	<5.0	<5.0	<5.0	--	-36.9	0.45	7.0	443	493	453	5.4	
BOP-74(i)	11/10/2016	2198	1779	1547	1220	848	480	<0.2	0.2	9.9	1.3	<5.0	<5.0	<5.0	0.34	-9.0	0.16	7.0	264	311	225	7.5	
BOP-75(i)	2/2/2011	90						2.5	87	11	<1.0	--	--	--	--	--	--	--	--	--	--	--	--
Upgradient Well	5/5/2011	182						1.1	52	11	<1.0	--	--	--	--	--	--	--	--	--	--	13.5	--
BOP-75(i)	8/10/2011	279						1.6	59	11	<1.0	<1.1	<1.2	<1.1	1.76	-16.3	1.1	2.4	--	--	--	--	--
BOP-75(i)	11/3/2011	364	-55					1.2	58	10	<1.0	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	2/8/2012	461	42					1.3	55	9.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	5/4/2012	547	128					<1.0	52	10	<1.0	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	8/9/2012	644	225	-7				1.6	39	7.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	11/8/2012	735	316	84				1.0	35	6.9	<0.2	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	2/5/2013	824	405	173				1.0	54	9.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	5/2/2013	910	491	259				0.8	42	7.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	6/17/2013	956	537	305	-22			0.7	35	9.8	<0.2	<5.0	<5.0	<5.0	1.91	73.6	1.7	0.0	--	--	13.6	--	
BOP-75(i)	8/6/2013	1006	587	355	28			0.2	1.3	37	0.2	<5.0	<5.0	<5.0	2.32	-159.5	<0.10	3.0	--	--	<1.0	--	
BOP-75(i)	11/7/2013	1099	680	448	121			<0.2	2.2	2.4	25	<5.0	<5.0	<5.0	0.77	-167.0	<0.10	3.5	--	--	4.5	--	
BOP-75(i)	2/5/2014	1189	770	538	211			<0.2	2.6	1.3	18	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	5/7/2014	1280	861	629	302	-70		<0.2	7.4	2.7	14	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	8/13/2014	1378	959	727	400	28		<0.2	6.2	9.5	10	<5.0	<5.0	<5.0	0.40	-30.2	<0.10	7.0	--	--	27.7	--	
BOP-75(i)	11/5/2014	1462	1043	811	484	112		<0.2	<0.2	4.3	11	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	2/6/2015	1555	1136	904	577	205		<0.2	9.1	8.6	4.2	<5.0	<5.0	<5.0	0.26	-117.3	<0.10	--	12.4	10.8	3.4	<2.0	
BOP-75(i)	5/4/2015	1642	1223	991	664	292	-74	<0.2	13	6.4	4.3	--	--	--	--	--	--	--	--	--	--	--	--
BOP-75(i)	8/10/2015	1740	1321	1089	762	390	22	<0.2	1.5	4.2	3.3	<5.0	<5.0	<5.0	0.50	-217.3	<0.10	7.0	196	189	255	10.4	
BOP-75(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	0.4	4.7	4.2	--	--	--	--	--	--	--	--	--	--	--	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-73(i)	5/4/2016	2008	1589	1357	1030	658	20.0	3.7	6.34	0.00	0.00	0.00	0.00	--	--
BOP-73(i)	8/9/2016	2105	1686	1454	1127	755	6.8	2.3	6.4	0.00	0.00	0.01	0.02	0.00	0.96
BOP-73(i)	11/10/2016	2198	1779	1547	1220	848	2.9	2.5	6.39	0.00	0.01	0.04	0.04	0.00	0.90
BOP-74(i)	10/19/2010	-16					0.1	<1.50	--	0.02	0.77	0.22	0.00	0.00	0.00
PRB Well	12/6/2010	32					--	2.79	6.61	0.00	0.73	0.27	0.00	--	--
BOP-74(i)	2/2/2011	90					--	--	6.22	0.04	0.86	0.10	0.00	--	--
BOP-74(i)	5/5/2011	182					--	--	6.23	0.04	0.68	0.28	0.00	0.00	0.00
BOP-74(i)	8/10/2011	279					4.3	2.69	6.42	0.00	0.48	0.52	0.00	0.00	0.00
BOP-74(i)	11/3/2011	364					--	--	6.46	0.00	0.13	0.87	0.00	--	--
BOP-74(i)	12/1/2011	392	-27				1.8	3.03	7.03	0.00	0.27	0.73	0.00	0.00	0.00
BOP-74(i)	1/19/2012	441	22				2.6	1450	5.48	0.00	0.26	0.58	0.00	0.00	0.16
BOP-74(i)	2/16/2012	469	50				6.68	668	5.23	0.00	0.04	0.91	0.05	0.00	0.00
BOP-74(i)	3/15/2012	497	78				8.41	330	6.40	0.00	0.00	0.97	0.02	0.00	0.00
BOP-74(i)	4/17/2012	530	111				8.8	72.0	6.83	0.00	0.00	0.50	0.50	0.00	0.00
BOP-74(i)	6/12/2012	586	167				5.72	67.6	5.78	0.00	0.00	0.05	0.95	0.00	0.00
BOP-74(i)	8/9/2012	644	225	-7			--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-74(i)	9/19/2012	685	266	34			13	1280	4.86	0.00	0.05	0.88	0.07	0.00	0.00
BOP-74(i)	11/14/2012	741	322	90			22	145	5.96	0.00	0.01	0.20	0.79	0.00	0.00
BOP-74(i)	2/6/2013	825	406	174			27	83.7	6.15	0.00	0.06	0.26	0.68	0.00	0.00
BOP-74(i)	5/7/2013	915	496	264	-63		21	128	6.04	0.00	0.35	0.32	0.33	0.00	0.00
BOP-74(i)	8/6/2013	1006	587	355	28		26	669	5.07	0.00	0.02	0.52	0.47	0.00	0.00
BOP-74(i)	11/7/2013	1099	680	448	121		17	330	6.05	0.00	0.00	0.11	0.08	0.81	0.00
BOP-74(i)	2/20/2014	1204	785	553	226		22	66.2	6.37	0.00	0.00	0.12	0.07	0.00	0.81
BOP-74(i)	5/8/2014	1281	862	630	303	-69	19	32.8	6.58	0.00	0.00	0.10	0.18	0.72	0.00
BOP-74(i)	11/6/2014	1463	1044	812	485	113	21	2860	4.16	0.00	0.02	0.76	0.22	0.00	0.00
BOP-74(i)	2/6/2015	1555	1136	904	577	205	21	2230	4.86	0.00	0.02	0.82	0.16	0.00	0.00
BOP-74(i)	5/6/2015	1644	1225	993	666	294	--	1240	4.92	0.00	0.02	0.84	0.14	0.00	0.00
BOP-74(i)	11/4/2015	1826	1407	1175	848	476	--	--	--	0.00	0.00	0.54	0.46	--	--
BOP-74(i)	2/3/2016	1917	1498	1266	939	567	21	4200	5.5	0.00	0.00	0.70	0.30	0.00	0.00
BOP-74(i)	5/4/2016	2008	1589	1357	1030	658	19.0	2480	4.57	0.00	0.01	0.72	0.27	--	--
BOP-74(i)	8/9/2016	2105	1686	1454	1127	755	18	1840	4.72	0.00	0.01	0.81	0.18	0.00	0.00
BOP-74(i)	11/10/2016	2198	1779	1547	1220	848	22	1430	4.87	0.00	0.01	0.82	0.17	0.00	0.00
BOP-75(i)	2/2/2011	90					--	--	--	0.02	0.84	0.14	0.00	--	--
Upgradient Well	5/5/2011	182					--	4.77	--	0.01	0.77	0.22	0.00	--	--
BOP-75(i)	8/10/2011	279					<0.0007	--	6.24	0.02	0.78	0.20	0.00	0.00	0.00
BOP-75(i)	11/3/2011	364	-55				--	--	--	0.01	0.80	0.19	0.00	--	--
BOP-75(i)	2/8/2012	461	42				--	--	--	0.01	0.80	0.19	0.00	--	--
BOP-75(i)	5/4/2012	547	128				--	--	--	0.00	0.79	0.21	0.00	--	--
BOP-75(i)	8/9/2012	644	225	-7			--	--	--	0.03	0.78	0.20	0.00	--	--
BOP-75(i)	11/8/2012	735	316	84			--	--	--	0.02	0.78	0.21	0.00	--	--
BOP-75(i)	2/5/2013	824	405	173			--	--	--	0.01	0.80	0.19	0.00	--	--
BOP-75(i)	5/2/2013	910	491	259			--	--	--	0.01	0.80	0.19	0.00	--	--
BOP-75(i)	6/17/2013	956	537	305	-22		<0.005	2.3	6.25	0.01	0.72	0.27	0.00	0.00	0.00
BOP-75(i)	8/6/2013	1006	587	355	28		0.39	51.3	6.43	0.00	0.02	0.96	0.01	0.00	0.00
BOP-75(i)	11/7/2013	1099	680	448	121		12	5.5	6.55	0.00	0.04	0.06	0.91	0.00	0.00
BOP-75(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.06	0.04	0.90	--	--
BOP-75(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.18	0.09	0.73	--	--
BOP-75(i)	8/13/2014	1378	959	727	400	28	9.9	258	5.38	0.00	0.15	0.32	0.52	0.00	0.00
BOP-75(i)	11/5/2014	1462	1043	811	484	112	--	--	--	0.00	0.00	0.20	0.80	--	--
BOP-75(i)	2/6/2015	1555	1136	904	577	205	14	3.9	6.11	0.00	0.31	0.39	0.30	0.00	0.00
BOP-75(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.42	0.28	0.29	--	--
BOP-75(i)	8/10/2015	1740	1321	1089	762	390	15	1170	5.34	0.00	0.11	0.40	0.49	0.00	0.00
BOP-75(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.03	0.41	0.57	--	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions							
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-75(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	1.1	3.5	4.3	<5.0	<5.0	<5.0	1.51	-65.6	<0.10	7.0	18.7	17.7	5.5	<2.0
BOP-75i(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	2.0	3.9	5.4	--	--	--	--	--	--	--	--	--	--	--
BOP-75i(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	1.0	3.0	4.7	<5.0	<5.0	<5.0	0.4	-125.9	<0.10	7.0	15.1	13.5	6.0	<2.0
BOP-75i(i)	11/4/2016	2193	1774	1542	1215	843	475	<0.2	6.2	3.0	3.4	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	2/2/2011	90						1.7	8.5	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--
Monitoring Well	5/5/2011	182						<1.0	6.8	1.2	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	8/10/2011	279						1.2	13	4.6	<1.0	<1.1	<1.2	<1.1	3.59	110	3.8	1.1	--	--	10.2	--
BOP-76(i)	11/3/2011	364	-55					1.4	27	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	2/8/2012	461	42					<1.0	2.1	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	5/4/2012	547	128					<1.0	9.2	1.5	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	8/9/2012	644	225	-7				1.1	33	2.2	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	11/8/2012	735	316	84				0.8	9.8	1.7	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	2/5/2013	824	405	173				0.8	11	1.5	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	5/2/2013	910	491	259				1.4	22	1.7	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	6/17/2013	956	537	305	-22			1.1	26	1.9	<0.2	<5.0	<5.0	<5.0	1.34	75.5	3.7	0.0	--	--	11.0	--
BOP-76(i)	8/6/2013	1006	587	355	28			<0.2	1.0	100	8.3	<5.0	<5.0	<5.0	2.24	-130.0	<0.10	3.5	--	--	<1.0	--
BOP-76(i)	11/7/2013	1099	680	448	121			2.4	140	37	42	<5.0	<5.0	<5.0	1.51	-204.2	<0.10	3.5	--	--	3.5	--
BOP-76(i)	2/5/2014	1189	770	538	211			1.0	45	5.8	8.5	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	5/7/2014	1280	861	629	302	-70		<0.2	7.2	1.2	4.6	--	--	--	--	--	--	--	--	--	--	--
BOP-76(i)	8/13/2014	1378	959	727	400	28		0.3	13	24	4.1	<5.0	<5.0	<5.0	0.45	1.8	<0.10	7.0	--	--	3.2	--
BOP-76(i)	11/6/2014	1463	1044	812	485	113		<0.2	1.4	9.5	2.1	15	<5.0	<5.0	0.20	-104.7	0.20	1.5	14.4	14.5	3.2	<2.0
BOP-76(i)	2/5/2015	1554	1135	903	576	204		<0.2	1.0	7.0	2.2	30	<5.0	<5.0	0.23	-154.7	0.21	2.75	10.1	8.99	5.1	<2.0
BOP-76(i)	5/7/2015	1645	1226	994	667	295	-73	<0.2	0.6	6.6	3.9	<5.0	<5.0	<5.0	1.52	-124.1	<0.10	4.0	17.0	14	5.5	2.2
BOP-76(i)	8/10/2015	1740	1321	1089	762	390	22	<0.2	2.2	14	2.0	<5.0	<5.0	<5.0	0.43	-190.8	<0.10	7.0	126.0	121	108	6.0
BOP-76(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	0.9	14	2.0	<5.0	<5.0	<5.0	0.83	-86.1	<0.10	7.0	26.2	28	4.0	2.7
BOP-76(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	1.0	9.8	1.6	<5.0	<5.0	<5.0	1.13	-85.0	<0.10	7.0	14.6	8.01	6.3	3.9
BOP-76i(i)	5/4/2016	2008	1589	1357	1030	658	290	<0.2	0.5	10	3.8	<5.0	<5.0	<5.0	8.65	-227.8	<0.10	7.0	11.7	9.91	4.5	3.1
BOP-76i(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	1.1	11	4.2	<5.0	<5.0	<5.0	0.81	-136.0	<0.10	7.0	9.40	7.15	6.7	<2.0
BOP-76i(i)	11/10/2016	2198	1779	1547	1220	848	480	<0.2	3.5	7.4	2.5	<5.0	<5.0	<5.0	0.40	-31.5	<0.10	7.0	9.19	8.88	21.9	<2.0
BOP-77(i)	2/2/2011	90						1.7	88	2.7	<1.0	--	--	--	--	--	--	--	--	--	--	--
Monitoring Well	5/5/2011	182						<1.0	41	3.8	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	8/10/2011	279						1.8	17	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	11/3/2011	364						<1.0	11	6.7	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	12/1/2011	392	-27					1.1	32	7.1	<1.0	<1.1	<1.2	<1.1	0.0	-274.8	0.2	0.8	--	--	8.4	--
BOP-77(i)	12/28/2011	419	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	12/28/2011	419	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	1/19/2012	441	22					<20	21	<20	<20	--	--	--	1.09	-154.4	<1.0	2.1	--	--	4.0	--
BOP-77(i)	2/16/2012	469	50					<1.0	8.4	48	1.8	<1.1	<1.2	<1.1	0.58	-154.4	<0.5	5.0	--	--	<0.5	--
BOP-77(i)	3/15/2012	497	78					<1.0	2.2	120	4.6	<1.1	<1.2	<1.1	0.72	-261.9	<0.5	4.4	--	--	<0.5	--
BOP-77(i)	4/17/2012	530	111					<3.0	<3.0	21	62	<1.1	<1.2	<1.1	0.40	-274.5	<0.1	5.6	--	--	0.6	--
BOP-77(i)	6/12/2012	586	167					<1.0	1.4	1.2	60	<1.1	<1.2	<1.1	0.67	-50.4	<0.1	4.3	--	--	<0.1	--
BOP-77(i)	8/9/2012	644	225					<1.0	<1.0	<1.0	59	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	8/16/2012	651	232					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-77(i)	9/18/2012	684	265	33				<4.0	<4.0	28	4.1	<5.0	<5.0	<5.0	0.78	25.8	<0.50	3.8	--	--	6.3	--
BOP-77(i)	11/14/2012	741	322	90				<0.2	17	150	15	<5.0	<6.0	<5.0	1.49	160.5	<1.0	3.5	--	--	<10.0	--
BOP-77(i)	2/6/2013	825	406	174				<0.4	11	31	3.2	5.5	<5.0	<5.0	0.35	6.4	<0.10	2.5	--	--	4.1	--
BOP-77(i)	5/7/2013	915	496	264	-63			<0.2	18	17	11	13	<5.0	<5.0	1.52	-74.9	<0.10	2.5	--	--	<1.0	--
BOP-77(i)	8/6/2013	1006	587	355	28			<0.2	0.7	14	13	8.6	<5.0	<5.0	1.14	-44.3	<0.10	3.5	--	--	<1.0	--
BOP-77(i)	11/7/2013	1099	680	448	121			<0.2	<0.2	9.5	19	22	<5.0	<5.0	0.91	-106.7	<0.10	3.5	--	--	<1.0	--
BOP-77(i)	2/20/2014	1204	785	553	226			<0.2	2.7	6.1	7.6	22	<5.0	<5.0	1.14	-8.9	<0.10	3.5	--	--	<1.0	--
BOP-77(i)	5/8/2014	1281	862	630	303	-69		<0.2	0.2	5.1	14	58	6.4	<5.0	0.76	-16.4	<0.10	3.0	--	--	<1.0	--
BOP-77(i)	8/13/2014	1378	959	727	400	28		<0.2	0.6	81	17	24	<5.0	<5.0	0.88	71.4	<0.50	6.0	--	--	2750	--
BOP-77(i)	11/6/2014	1463	1044	812	485	113		<0.2	2.7	200	24	63	<5.0	<5.0	0.17	-165.75	<0.50	7.0	961	981	1850	11.3

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-75(i)	2/3/2016	1917	1498	1266	939	567	18	2.5	7.26	0.00	0.07	0.32	0.61	0.00	0.00
BOP-75(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.11	0.28	0.61	--	--
BOP-75(i)	8/9/2016	2105	1686	1454	1127	755	18	1.9	6.19	0.00	0.07	0.27	0.66	0.00	0.00
BOP-75(i)	11/4/2016	2193	1774	1542	1215	843	--	--	--	0.00	0.36	0.23	0.41	0.00	0.00
BOP-76(i)	2/2/2011	90					--	--	--	0.14	0.86	0.00	0.00	--	--
Monitoring Well	5/5/2011	182					--	--	--	0.00	0.81	0.19	0.00	--	--
BOP-76(i)	8/10/2011	279					<0.0007	2.37	6.20	0.05	0.64	0.31	0.00	0.00	0.00
BOP-76(i)	11/3/2011	364	-55				--	--	--	0.04	0.89	0.07	0.00	--	--
BOP-76(i)	2/8/2012	461	42				--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-76(i)	5/4/2012	547	128				--	--	--	0.00	0.82	0.18	0.00	--	--
BOP-76(i)	8/9/2012	644	225	-7			--	--	--	0.02	0.90	0.08	0.00	--	--
BOP-76(i)	11/8/2012	735	316	84			--	--	--	0.05	0.77	0.18	0.00	--	--
BOP-76(i)	2/5/2013	824	405	173			--	--	--	0.05	0.80	0.15	0.00	--	--
BOP-76(i)	5/2/2013	910	491	259			--	--	--	0.04	0.87	0.09	0.00	--	--
BOP-76(i)	6/17/2013	956	537	305	-22		<0.005	1.6	6.18	0.03	0.88	0.09	0.00	0.00	0.00
BOP-76(i)	8/6/2013	1006	587	355	28		3.4	111	6.14	0.00	0.01	0.88	0.11	0.00	0.00
BOP-76(i)	11/7/2013	1099	680	448	121		11	6.9	6.44	0.01	0.50	0.18	0.31	0.00	0.00
BOP-76(i)	2/5/2014	1189	770	538	211		--	--	--	0.01	0.63	0.11	0.25	--	--
BOP-76(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.39	0.09	0.52	--	--
BOP-76(i)	8/13/2014	1378	959	727	400	28	7.6	170	5.27	0.00	0.24	0.60	0.16	0.00	0.00
BOP-76(i)	11/6/2014	1463	1044	812	485	113	21	51.2	5.88	0.00	0.02	0.14	0.05	0.79	0.00
BOP-76(i)	2/5/2015	1554	1135	903	576	204	19	12.7	6.08	0.00	0.01	0.06	0.03	0.90	0.00
BOP-76(i)	5/7/2015	1645	1226	994	667	295	20	7.5	6.14	0.00	0.03	0.50	0.46	0.00	0.00
BOP-76(i)	8/10/2015	1740	1321	1089	762	390	12	659	5.54	0.00	0.09	0.75	0.17	0.00	0.00
BOP-76(i)	11/4/2015	1826	1407	1175	848	476	15	115	6.15	0.00	0.04	0.79	0.17	0.00	0.00
BOP-76(i)	2/3/2016	1917	1498	1266	939	567	16	5.0	7.16	0.00	0.06	0.75	0.19	0.00	0.00
BOP-76(i)	5/4/2016	2008	1589	1357	1030	658	18	26.4	6.15	0.00	0.02	0.61	0.36	--	--
BOP-76(i)	8/9/2016	2105	1686	1454	1127	755	14	7.8	6.1	0.00	0.04	0.60	0.36	0.00	0.00
BOP-76(i)	11/10/2016	2198	1779	1547	1220	848	14	3.4	6.14	0.00	0.19	0.53	0.28	0.00	0.00
BOP-77(i)	2/2/2011	90					--	--	--	0.01	0.95	0.04	0.00	--	--
Monitoring Well	5/5/2011	182					--	--	--	0.00	0.89	0.11	0.00	--	--
BOP-77(i)	8/10/2011	279					--	--	--	0.07	0.83	0.11	0.00	--	--
BOP-77(i)	11/3/2011	364					--	--	--	0.00	0.55	0.45	0.00	--	--
BOP-77(i)	12/1/2011	392	-27				<0.0007	2.41	6.77	0.02	0.75	0.23	0.00	0.00	0.00
BOP-77(i)	12/28/2011	419	0				--	12100	--	--	--	--	--	--	--
BOP-77(i)	12/28/2011	419	0				--	13800	--	--	--	--	--	--	--
BOP-77(i)	1/19/2012	441	22				--	3800	5.40	0.00	1.00	0.00	0.00	--	--
BOP-77(i)	2/16/2012	469	50				6.6	884	5.69	0.00	0.11	0.84	0.05	0.00	0.00
BOP-77(i)	3/15/2012	497	78				10	148	6.96	0.00	0.01	0.93	0.06	0.00	0.00
BOP-77(i)	4/17/2012	530	111				12.2	208	7.12	0.00	0.00	0.18	0.82	0.00	0.00
BOP-77(i)	6/12/2012	586	167				0.314	314	6.36	0.00	0.01	0.01	0.98	0.00	0.00
BOP-77(i)	8/9/2012	644	225				--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-77(i)	8/16/2012	651	232				--	23,800	--	--	--	--	--	--	--
BOP-77(i)	9/18/2012	684	265	33			9.2	4670	4.66	0.00	0.00	0.81	0.19	0.00	0.00
BOP-77(i)	11/14/2012	741	322	90			22	2270	5.66	0.00	0.07	0.81	0.13	0.00	0.00
BOP-77(i)	2/6/2013	825	406	174			15	1136	5.76	0.00	0.13	0.49	0.08	0.30	0.00
BOP-77(i)	5/7/2013	915	496	264	-63		23	112	6.15	0.00	0.14	0.184	0.185	0.49	0.00
BOP-77(i)	8/6/2013	1006	587	355	28		17	888	5.38	0.00	0.01	0.217	0.313	0.46	0.00
BOP-77(i)	11/7/2013	1099	680	448	121		20	111	6.21	0.00	0.00	0.083	0.256	0.66	0.00
BOP-77(i)	2/20/2014	1204	785	553	226		19	40	6.29	0.00	0.02	0.064	0.123	0.79	0.00
BOP-77(i)	5/8/2014	1281	862	630	303	-69	23	36.4	6.41	0.00	0.00	0.021	0.088	0.81	0.08
BOP-77(i)	8/13/2014	1378	959	727	400	28	15	10100	4.32	0.00	0.00	0.42	0.138	0.43	0.00
BOP-77(i)	11/6/2014	1463	1044	812	485	113	22	4920	4.13	0.00	0.00	0.44	0.081	0.48	0.00

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions							
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-77(i)	2/6/2015	1555	1136	904	577	205		<0.2	4.2	120	24	58	<5.0	<5.0	0.83	-38.7	<0.50	7.0	727	596	855	4.0
BOP-77(i)	5/6/2015	1644	1225	993	666	294	-74	<0.2	6.2	220	20	47	5.6	<5.0	0.98	-85.9	1.0	7.0	541	536	519	9.5
BOP-77(i)	8/10/2015	1740	1321	1089	762	390	22	<0.2	6.2	86	11	75	6.8	<5.0	0.94	-73.3	<1.0	7.0	2120	2080	3830	4.1
BOP-77(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	8.2	72	13	22	5.1	<5.0	0.59	34.5	<5.0	7.0	1580	1510	2860	12.3
BOP-77(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	6.2	61	8.7	16	5.0	<5.0	1.87	35.2	<1.0	--	1100	1100	1530	2.4
BOP-77(i)	5/4/2016	2008	1589	1357	1030	658	290	<0.2	4.9	44	6.7	21.0	18.0	<5.0	0.73	-103.0	<1.0	7.0	582.0	607	892.0	13.0
BOP-77(i)	8/9/2016	2105	1686	1454	1127	755	387	0.4	2.7	33	2.1	<5.0	6.0	<5.0	0.22	-88.5	0.51	7.0	289	282	165	9.2
BOP-77(i)	11/10/2016	2198	1779	1547	1220	848	480	<0.2	2.6	15	1.5	8.5	<5.0	<5.0	0.35	-36.3	0.13	7.0	78.0	76.7	5.3	<2.0
BOP-78(i)	11/21/2011	382	-37					1.7	37	6.1	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	8/9/2012	644	225	-7				1.1	30	9.3	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	11/8/2012	735	316	84				<0.2	0.3	7.2	51	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	2/6/2013	825	406	174				<0.2	0.3	11	78	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	5/2/2013	910	491	259	-68			<0.2	0.3	0.6	19	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	8/7/2013	1007	588	356	29			0.2	5.5	120	98	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	11/8/2013	1100	681	449	122			<0.2	<0.2	1.1	17	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	2/5/2014	1189	770	538	211			<0.2	1.0	1.3	3.0	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	5/7/2014	1280	861	629	302	-70		<0.2	3.6	2.7	1.7	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	11/5/2014	1462	1043	811	484	112		<0.2	1.7	23	2.6	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	2/5/2015	1554	1135	903	576	204		<0.2	3.2	12	1.8	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	1.0	7.8	2.4	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	0.2	3.1	1.4	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	0.3	4.2	2.2	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	0.4	10	6.1	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	0.9	24	13	--	--	--	--	--	--	--	--	--	--	--
BOP-78(i)	11/4/2016	2193	1774	1542	1215	843	475	<0.2	0.7	12	7.5	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/21/2011	382	-37					1.8	42	5.0	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	8/9/2012	644	225	-7				2.2	95	12	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/8/2012	735	316	84				<0.2	0.2	3.7	68	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	2/6/2013	825	406	174				<0.2	0.2	0.6	5.7	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	5/2/2013	910	491	259	-68			<0.2	0.4	24	41	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	8/7/2013	1007	588	356	29			<0.2	1.0	37	20	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/8/2013	1100	681	449	122			<0.2	1.9	13	16	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	2/5/2014	1189	770	538	211			<0.2	3.4	17	7.2	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	5/7/2014	1280	861	629	302	-70		0.9	58	43	15	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/7/2014	1464	1045	813	486	114		<0.2	1.5	21	5.6	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	2/5/2015	1554	1135	903	576	204		<0.2	2.1	10	3.8	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	0.4	2.2	2.0	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	0.5	8.6	4.3	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	0.4	4.5	3.5	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	0.5	3.6	3.6	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	0.7	4.2	3.4	--	--	--	--	--	--	--	--	--	--	--
BOP-79(i)	11/4/2016	2193	1774	1542	1215	843	475	<0.2	0.6	4.7	3.7	--	--	--	--	--	--	--	--	--	--	--
BOP-80(i)	11/21/2011	382	-37					<1.0	2.4	7.0	7.0	--	--	--	--	--	--	--	--	--	--	--
Downgradient Well	12/1/2011	392	-27					<1.0	15	6.1	5.3	2.9	<1.2	<1.1	0.0	-272.8	<0.1	2.4	--	--	3.8	--
BOP-80(i)	1/9/2012	431	12					<1.0	<1.0	<1.0	1.4	--	--	--	0.15	-255	0.2	1.7	--	--	0.4	--
BOP-80(i)	2/16/2012	469	50					<1.0	<1.0	<1.0	<1.0	<1.1	2.2	<1.1	0.29	-237	0.1	2.7	--	--	2.4	--
BOP-80(i)	3/15/2012	497	78					<1.0	<1.0	<1.0	1.7	1.6	2.4	<1.1	0.43	-241	<0.1	4.0	--	--	0.5	--
BOP-80(i)	4/17/2012	530	111					<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.28	-263.4	<0.1	3.6	--	--	1.0	--
BOP-80(i)	6/12/2012	586	167	-65				<1.0	<1.0	<1.0	1.7	2.9	4.4	<1.1	0.24	12.8	<0.1	2.3	--	--	0.1	--
BOP-80(i)	9/18/2012	684	265	33				2.0	160	35	14	<5.0	7.1	<5.0	0.28	-160.1	<0.10	2.9	--	--	1.9	--
BOP-80(i)	11/14/2012	741	322	90				3.0	610	240	33	<5.0	6.1	<5.0	1.47	76.0	<0.10	2.5	--	--	3.1	--
BOP-80(i)	2/6/2013	825	406	174				<0.2	1.4	<0.2	0.4	<5.0	5.2	<5.0	0.40	-7.0	0.15	3.0	--	--	<1.0	--

**TABLE 6-1
 BIOREMEDIATION SUMMARY
 FORMER DEGREASER SOURCE CONTROL AREA
 BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-77(i)	2/6/2015	1555	1136	904	577	205	26	4330	4.78	0.00	0.01	0.33	0.103	0.56	0.00
BOP-77(i)	5/6/2015	1644	1225	993	666	294	19	3030	4.84	0.00	0.01	0.50	0.071	0.37	0.04
BOP-77(i)	8/10/2015	1740	1321	1089	762	390	15	9110	4.30	0.00	0.01	0.22	0.04	0.67	0.06
BOP-77(i)	11/4/2015	1826	1407	1175	848	476	15	6350	4.55	0.00	0.03	0.38	0.11	0.40	0.09
BOP-77(i)	2/3/2016	1917	1498	1266	939	567	20	4650	5.80	0.00	0.03	0.41	0.09	0.37	0.11
BOP-77(i)	5/4/2016	2008	1589	1357	1030	658	17.0	2990	4.71	0.00	0.02	0.23	0.06	0.38	0.31
BOP-77(i)	8/9/2016	2105	1686	1454	1127	755	16	1450	4.99	0.00	0.03	0.57	0.056	0.00	0.33
BOP-77(i)	11/10/2016	2198	1779	1547	1220	848	29	265	5.53	0.00	0.04	0.31	0.048	0.60	0.00
BOP-78(i)	11/21/2011	382	-37				--	--	--	0.03	0.79	0.18	0.00	--	--
Injection Well	8/9/2012	644	225	-7			--	--	--	0.02	0.69	0.29	0.00	--	--
BOP-78(i)	11/8/2012	735	316	84			--	--	--	0.00	0.00	0.08	0.91	--	--
BOP-78(i)	2/6/2013	825	406	174			--	--	--	0.00	0.00	0.08	0.92	--	--
BOP-78(i)	5/2/2013	910	491	259	-68		--	--	--	0.00	0.01	0.02	0.97	--	--
BOP-78(i)	8/7/2013	1007	588	356	29		--	--	--	0.00	0.01	0.43	0.55	--	--
BOP-78(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.00	0.04	0.96	--	--
BOP-78(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.11	0.19	0.70	--	--
BOP-78(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.33	0.34	0.33	--	--
BOP-78(i)	11/5/2014	1462	1043	811	484	112	--	--	--	0.00	0.04	0.81	0.14	--	--
BOP-78(i)	2/5/2015	1554	1135	903	576	204	--	--	--	0.00	0.14	0.70	0.16	--	--
BOP-78(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.06	0.64	0.30	--	--
BOP-78(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.03	0.57	0.40	--	--
BOP-78(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.03	0.54	0.44	--	--
BOP-78(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.01	0.51	0.48	--	--
BOP-78(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.01	0.54	0.45	--	--
BOP-78(i)	11/4/2016	2193	1774	1542	1215	843	--	--	--	0.00	0.02	0.50	0.48	--	--
BOP-79(i)	11/21/2011	382	-37				--	--	--	0.03	0.84	0.13	0.00	--	--
Injection Well	8/9/2012	644	225	-7			--	--	--	0.02	0.84	0.14	0.00	--	--
BOP-79(i)	11/8/2012	735	316	84			--	--	--	0.00	0.00	0.03	0.96	--	--
BOP-79(i)	2/6/2013	825	406	174			--	--	--	0.00	0.02	0.06	0.92	--	--
BOP-79(i)	5/2/2013	910	491	259	-68		--	--	--	0.00	0.00	0.27	0.72	--	--
BOP-79(i)	8/7/2013	1007	588	356	29		--	--	--	0.00	0.01	0.54	0.45	--	--
BOP-79(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.04	0.33	0.63	--	--
BOP-79(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.08	0.55	0.36	--	--
BOP-79(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.39	0.39	0.21	--	--
BOP-79(i)	11/7/2014	1464	1045	813	486	114	--	--	--	0.00	0.04	0.68	0.28	--	--
BOP-79(i)	2/5/2015	1554	1135	903	576	204	--	--	--	0.00	0.09	0.57	0.34	--	--
BOP-79(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.05	0.39	0.55	--	--
BOP-79(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.02	0.55	0.43	--	--
BOP-79(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.03	0.44	0.53	--	--
BOP-79(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.04	0.38	0.58	--	--
BOP-79(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.05	0.42	0.53	--	--
BOP-79(i)	11/4/2016	2193	1774	1542	1215	843	--	--	--	0.00	0.04	0.43	0.53	--	--
BOP-80(i)	11/21/2011	382					--	--	--	0.00	0.09	0.36	0.55	--	--
Downgradient Well	12/1/2011	392	-27				3.97	2.43	6.74	0.00	0.31	0.17	0.23	0.28	0.00
BOP-80(i)	1/9/2012	431	12				--	4.93	6.80	0.00	0.00	0.00	1.00	--	--
BOP-80(i)	2/16/2012	469	50				7.44	3.28	7.14	0.00	0.00	0.00	0.00	0.00	1.00
BOP-80(i)	3/15/2012	497	78				7.98	4.72	6.99	0.00	0.00	0.00	0.17	0.35	0.49
BOP-80(i)	4/17/2012	530	111				12.8	2.89	7.04	0.00	0.00	0.00	0.00	0.00	0.00
BOP-80(i)	6/12/2012	586	167	-65			10.4	2.50	6.01	0.00	0.00	0.00	0.10	0.37	0.53
BOP-80(i)	9/18/2012	684	265	33			14	13.9	6.35	0.01	0.59	0.18	0.11	0.00	0.12
BOP-80(i)	11/14/2012	741	322	90			7.5	1.5	6.48	0.00	0.59	0.31	0.07	0.00	0.03
BOP-80(i)	2/6/2013	825	406	174			23	1.2	6.44	0.00	0.06	0.00	0.03	0.00	0.91

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions							
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-80(i)	5/9/2013	917	498	266	-61			<0.2	0.8	<0.2	0.7	<5.0	12	<5.0	0.57	-13.5	0.11	2.5	--	--	<1.0	--
BOP-80(i)	8/19/2013	1019	600	368	41			<0.2	<0.2	<0.2	0.4	<5.0	9.7	<5.0	1.16	-54.0	0.36	2.5	--	--	2.3	--
BOP-80(i)	11/11/2013	1103	684	452	125			<0.2	<0.2	<0.2	0.2	<5.0	14	<5.0	0.57	-64.8	<0.10	4.5	--	--	<1.0	--
BOP-80(i)	2/21/2014	1205	786	554	227			2.7	23	0.4	<0.2	<5.0	<5.0	<5.0	2.59	114.5	3.8	0.5	--	--	17.6	--
BOP-80(i)	5/7/2014	1280	861	629	302	-70		<0.2	2.0	<0.2	<0.2	<0.5	17	<5.0	1.19	-26.0	0.19	2.5	--	--	1.0	--
BOP-80(i)	8/14/2014	1379	960	728	401	29		<0.2	0.5	1.1	3.1	<5.0	9.0	<5.0	1.14	-113.5	0.29	4.0	--	--	293	--
BOP-80(i)	11/6/2014	1463	1044	812	485	113		0.8	65	360	63	<5.0	<5.0	<5.0	0.45	-74.0	<0.10	2.5	11.8	4.21	10.9	<2.0
BOP-80(i)	2/6/2015	1555	1136	904	577	205		<0.2	<0.2	<0.2	0.3	<5.0	5.6	<5.0	0.30	-121.9	<0.10	7.0	12.5	12.6	1.4	<2.0
BOP-80(i)	5/6/2015	1644	1225	993	666	294	-74	<0.2	<0.2	0.2	0.6	<5.0	15	<5.0	1.54	-73.2	<0.10	4.0	18.0	11.9	<1.0	<2.0
BOP-80(i)	8/10/2015	1740	1321	1089	762	390	22	3.0	91	430	11	<5.0	<5.0	<5.0	0.30	-171.0	<0.10	7.0	10.0	5.59	8.2	<2.0
BOP-80(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	<0.2	0.5	2.1	<5.0	8.9	<5.0	1.20	-58.7	<0.10	7.0	15.6	11.9	1.6	<2.0
BOP-80(i)	2/3/2016	1917	1498	1266	939	567	199	<0.2	<0.2	<0.2	0.2	<5.0	<5.0	<5.0	2.00	-24.2	<0.10	5.0	12.9	7.57	1.4	<2.0
BOP-80(i)	5/4/2016	2009	1590	1358	1031	659	291	<0.2	<0.2	<0.2	0.4	<5.0	6.7	<5.0	0.90	-33.2	<0.10	7.0	27.2	9.5	<1.0	<2.0
BOP-80(i)	8/11/2016	2107	1688	1456	1129	757	389	<0.2	<0.2	0.2	0.7	<5.0	9.0	<5.0	0.19	-97.5	<0.10	7.0	12.1	10.9	<1.0	<2.0
BOP-80(i)	11/11/2016	2199	1780	1548	1221	849	481	<0.2	<0.2	<0.2	0.3	<5.0	10	<5.0	0.68	-9.2	<0.10	7.0	12.7	12.2	<1.0	<2.0
BOP-81(i)	11/21/2011	382						<1.0	<1.0	1.6	6.2	--	--	--	--	--	--	--	--	--	--	--
Downgradient Well	12/1/2011	392	-27					<1.0	<1.0	1.0	4.1	2.0	2.2	<1.1	0.0	-279.8	<0.1	1.1	--	--	0.5	--
BOP-81(i)	12/28/2011	419	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-81(i)	1/9/2012	431	12					<1.0	<1.0	<1.0	1.9	--	--	0.33	-238.4	0.2	1.5	--	--	--	0.5	--
BOP-81(i)	2/16/2012	469	50					<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.23	-242.8	<0.1	1.9	--	--	0.5	--
BOP-81(i)	3/15/2012	497	78					<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.31	-245.8	0.1	2.7	--	--	0.3	--
BOP-81(i)	4/17/2012	530	111					<1.0	<1.0	<1.0	<1.0	<1.1	<1.2	<1.1	0.28	-270.8	<0.1	2.6	--	--	0.2	--
BOP-81(i)	6/12/2012	586	167	-65				<1.0	<1.0	<1.0	<1.0	<1.1	1.8	<1.1	0.36	-1.8	<0.1	4.3	--	--	<0.1	--
BOP-81(i)	8/16/2012	651	232	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-81(i)	9/18/2012	684	265	33				<0.2	<0.2	<0.2	0.6	<5.0	8.4	<5.0	0.21	-125	<0.10	1.7	--	--	<1.0	--
BOP-81(i)	11/14/2012	741	322	90				<0.2	<0.2	<0.2	0.5	<5.0	8.6	<5.0	0.60	42.7	0.11	2.0	--	--	1.4	--
BOP-81(i)	2/6/2013	825	406	174				<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	0.56	-93.4	0.12	2.0	--	--	2.0	--
BOP-81(i)	5/9/2013	917	498	266	-61			<0.2	0.3	<0.2	0.5	<5.0	<5.0	<5.0	2.65	-18.1	0.39	1.5	--	--	7.4	--
BOP-81(i)	8/19/2013	1019	600	368	41			<0.2	<0.2	<0.2	0.9	<5.0	<5.0	<5.0	3.96	-24.4	1.2	0.0	--	--	16.4	--
BOP-81(i)	11/11/2013	1103	684	452	125			<0.2	<0.2	<0.2	0.4	<5.0	8.9	<5.0	0.42	-75.1	0.26	4.5	--	--	3.8	--
BOP-81(i)	2/21/2014	1205	786	554	227			0.6	0.6	<0.2	<0.2	<5.0	<5.0	<5.0	3.55	74.1	0.61	0.5	--	--	13.5	--
BOP-81(i)	5/7/2014	1280	861	629	302	-70		<0.2	0.2	<0.2	<0.2	<5.0	5.2	<5.0	0.65	-49.9	<0.10	2.0	--	--	2.3	--
BOP-81(i)	8/14/2014	1379	960	728	401	29		<0.2	<0.2	<0.2	0.4	<5.0	6.0	<5.0	1.17	-140.9	<0.10	4.5	--	--	49.7	--
BOP-81(i)	11/6/2014	1463	1044	812	485	113		<0.2	<0.2	<0.2	0.3	<5.0	11	<5.0	0.50	-85.6	<0.10	2.5	21.4	10.9	<1.0	<2.0
BOP-81(i)	2/6/2015	1555	1136	904	577	205		<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	0.10	-128.8	<0.10	5.0	10.1	3.71	6.7	<2.0
BOP-81(i)	5/6/2015	1644	1225	993	666	294	-74	<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	0.82	-74.0	<0.10	7.0	11.6	4.58	2.5	<2.0
BOP-81(i)	8/11/2015	1741	1322	1090	763	391	23	<0.2	<0.2	0.6	1.2	<5.0	<5.0	<5.0	1.49	-130.0	0.14	7.0	33.5	9.9	4.2	<2.0
BOP-81(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	<0.2	0.3	0.7	<5.0	5.4	<5.0	0.54	-42.6	<0.10	6.5	29.2	10.5	1.7	<2.0
BOP-81(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	1.93	-4.5	<0.10	5.0	4.19	2.86	7.1	<2.0
BOP-81(i)	5/4/2016	2009	1590	1358	1031	659	291	<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	2.88	-47.0	<0.10	7.0	17.4	3.8	3.8	<2.0
BOP-81(i)	8/11/2016	2107	1688	1456	1129	757	389	<0.2	<0.2	<0.2	<0.2	<5.0	<5.0	<5.0	0.25	-83.7	<0.10	7.0	12.3	8.98	<1.0	<2.0
BOP-81(i)	11/11/2016	2199	1780	1548	1221	849	481	<0.2	<0.2	<0.2	0.3	<5.0	<5.0	<5.0	0.51	17.4	<0.10	7.0	7.2	6.52	1.2	<2.0
BOP-82(i)	11/21/2011	382						4.6	91	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--
Downgradient Well	12/1/2011	392	-27					4.0	66	1.4	<1.0	<1.1	<1.2	<1.1	0.0	-152.8	3.3	1.1	--	--	9.4	--
BOP-82(i)	12/28/2011	419	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	1/9/2012	431	12					2.6	47	1.0	<1.0	--	--	--	0.31	-238.8	<0.2	2.1	--	--	7.3	--
BOP-82(i)	2/16/2012	469	50					1.9	38	6.8	<1.0	<1.1	<1.2	<1.1	1.61	-196.5	1.7	0.1	--	--	10.3	--
BOP-82(i)	3/15/2012	497	78					2.0	36	11	<1.0	<1.1	<1.2	<1.1	0.82	-183.5	1.3	1.5	--	--	10.0	--
BOP-82(i)	4/17/2012	530	111					1.6	29	4.5	<1.0	<1.1	<1.2	<1.1	1.29	-219.3	1.8	0.6	--	--	10.6	--
BOP-82(i)	6/12/2012	586	167	-65				1.3	24	2.5	<1.0	<1.1	<1.2	<1.1	2.76	145.6	1.8	0.1	--	--	9.9	--
BOP-82(i)	8/16/2012	651	232	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	9/18/2012	684	265	33				1.0	19	1.6	0.5	<5.0	<5.0	<5.0	2.75	-0.5	1.8	1.0	--	--	9.9	--
BOP-82(i)	11/14/2012	741	322	90				1.6	24	1.6	0.3	<5.0	<5.0	<5.0	3.03	72.7	1.8	0.0	--	--	10.3	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-80(i)	5/9/2013	917	498	266	-61		20	1.3	6.31	0.00	0.01	0.00	0.03	0.00	0.96
BOP-80(i)	8/19/2013	1019	600	368	41		17	1.5	5.53	0.00	0.00	0.00	0.02	0.00	0.98
BOP-80(i)	11/11/2013	1103	684	452	125		22	1.4	5.99	0.00	0.00	0.00	0.01	0.00	0.99
BOP-80(i)	2/21/2014	1205	786	554	227		0.45	2.6	6.59	0.08	0.90	0.02	0.00	0.00	0.00
BOP-80(i)	5/7/2014	1280	861	629	302	-70	16	3.8	6.73	0.00	0.03	0.00	0.00	0.00	0.97
BOP-80(i)	8/14/2014	1379	960	728	401	29	13	909	5.28	0.00	0.01	0.03	0.14	0.00	0.82
BOP-80(i)	11/6/2014	1463	1044	812	485	113	2.9	1.4	6.82	0.00	0.09	0.71	0.19	0.00	0.00
BOP-80(i)	2/6/2015	1555	1136	904	577	205	15	2.7	6.17	0.00	0.00	0.00	0.03	0.00	0.97
BOP-80(i)	5/6/2015	1644	1225	993	666	294	21	2.4	6.29	0.00	0.00	0.00	0.02	0.00	0.98
BOP-80(i)	8/10/2015	1740	1321	1089	762	390	3.6	1.6	6.30	0.00	0.13	0.83	0.03	0.00	0.00
BOP-80(i)	11/4/2015	1826	1407	1175	848	476	20	2.3	6.35	0.00	0.00	0.02	0.10	0.00	0.88
BOP-80(i)	2/3/2016	1917	1498	1266	939	567	27	1.1	6.90	0.00	0.00	0.00	1.00	0.00	0.00
BOP-80(i)	5/4/2016	2009	1590	1358	1031	659	15.0	<1.0	6.15	0.00	0.00	0.00	1.00	--	--
BOP-80(i)	8/11/2016	2107	1688	1456	1129	757	21	2.5	6.13	0.00	0.00	0.01	0.04	0.00	0.96
BOP-80(i)	11/11/2016	2199	1780	1548	1221	849	20	2.7	6.19	0.00	0.00	0.00	0.01	0.00	0.99
BOP-81(i)	11/21/2011	382					--	--	--	0.00	0.00	0.14	0.86	--	--
Downgradient Well	12/1/2011	392	-27				8.3	2.38	6.76	0.00	0.00	0.05	0.30	0.32	0.33
BOP-81(i)	12/28/2011	419	0				--	4.71	6.69	--	--	--	--	--	--
BOP-81(i)	1/9/2012	431	12				--	2.65	6.69	0.00	0.00	0.00	1.00	0.00	0.00
BOP-81(i)	2/16/2012	469	50				16.4	3.26	7.21	ND	ND	ND	ND	ND	ND
BOP-81(i)	3/15/2012	497	78				24.7	3.00	6.96	ND	ND	ND	ND	ND	ND
BOP-81(i)	4/17/2012	530	111				23.4	2.51	6.77	ND	ND	ND	ND	ND	ND
BOP-81(i)	6/12/2012	586	167	-65			20.9	2.34	6.10	0.00	0.00	0.00	0.00	0.00	1.00
BOP-81(i)	8/16/2012	651	232	0			--	3.2	--	--	--	--	--	--	--
BOP-81(i)	9/18/2012	684	265	33			18.0	3.0	6.49	0.00	0.00	0.00	0.03	0.00	0.97
BOP-81(i)	11/14/2012	741	322	90			15.0	<1.0	6.49	0.00	0.00	0.00	0.03	0.00	0.97
BOP-81(i)	2/6/2013	825	406	174			30.0	<1.0	6.55	ND	ND	ND	ND	ND	ND
BOP-81(i)	5/9/2013	917	498	266	-61		7.1	<1.0	6.49	0.00	0.22	0.00	0.78	0.00	0.00
BOP-81(i)	8/19/2013	1019	600	368	41		3.4	<1.0	6.74	0.00	0.00	0.00	1.00	0.00	0.00
BOP-81(i)	11/11/2013	1103	684	452	125		20.0	1.2	6.04	0.00	0.00	0.00	0.02	0.00	0.98
BOP-81(i)	2/21/2014	1205	786	554	227		0.33	1.4	6.14	0.44	0.56	0.00	0.00	0.00	0.00
BOP-81(i)	5/7/2014	1280	861	629	302	-70	24.0	2.0	6.73	0.00	0.01	0.00	0.00	0.00	0.99
BOP-81(i)	8/14/2014	1379	960	728	401	29	12.0	2.25	5.76	0.00	0.00	0.00	0.03	0.00	0.97
BOP-81(i)	11/6/2014	1463	1044	812	485	113	25.0	1.5	6.33	0.00	0.00	0.00	0.01	0.00	0.99
BOP-81(i)	2/6/2015	1555	1136	904	577	205	20.0	1.0	6.34	ND	ND	ND	ND	ND	ND
BOP-81(i)	5/6/2015	1644	1225	993	666	294	22.0	<1.0	6.33	ND	ND	ND	ND	ND	ND
BOP-81(i)	8/11/2015	1741	1322	1090	763	391	13.0	1.6	6.19	0.00	0.00	0.24	0.76	0.00	0.00
BOP-81(i)	11/4/2015	1826	1407	1175	848	476	20.0	1.6	6.34	0.00	0.00	0.02	0.06	0.00	0.93
BOP-81(i)	2/4/2016	1918	1499	1267	940	568	10	<1.0	6.90	ND	ND	ND	ND	ND	ND
BOP-81(i)	5/4/2016	2009	1590	1358	1031	659	21.0	<1.0	6.15	ND	ND	ND	ND	--	--
BOP-81(i)	8/11/2016	2107	1688	1456	1129	757	22	2.1	6.12	ND	ND	ND	ND	ND	ND
BOP-81(i)	11/11/2016	2199	1780	1548	1221	849	23	1.3	6.22	0.00	0.00	0.00	1.00	--	--
BOP-82(i)	11/21/2011	382					--	--	--	0.04	0.94	0.02	0.00	--	--
Downgradient Well	12/1/2011	392	-27				<0.0007	<1.50	6.36	0.04	0.93	0.03	0.00	0.00	0.00
BOP-82(i)	12/28/2011	419	0				--	3.12	--	--	--	--	--	--	--
BOP-82(i)	1/9/2012	431	12				--	9.81	6.74	0.04	0.93	0.03	0.00	--	--
BOP-82(i)	2/16/2012	469	50				0.0144	4.85	6.94	0.03	0.78	0.19	0.00	0.00	0.00
BOP-82(i)	3/15/2012	497	78				<0.0007	3.25	6.97	0.03	0.69	0.28	0.00	0.00	0.00
BOP-82(i)	4/17/2012	530	111				<0.0007	2.46	6.78	0.03	0.80	0.17	0.00	0.00	0.00
BOP-82(i)	6/12/2012	586	167	-65			<0.0007	2.56	5.54	0.04	0.84	0.12	0.00	0.00	0.00
BOP-82(i)	8/16/2012	651	232	0			--	1.6	--	--	--	--	--	--	--
BOP-82(i)	9/18/2012	684	265	33			<0.015	1.4	6.45	0.03	0.83	0.09	0.05	0.00	0.00
BOP-82(i)	11/14/2012	741	322	90			0.036	<1.0	6.61	0.05	0.86	0.08	0.02	0.00	0.00

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions							
								Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)
BOP-82(i)	2/6/2013	825	406	174				1.5	15	1.8	0.4	<5.0	<5.0	<5.0	3.53	93.9	1.3	0.0	--	--	10.7	--
BOP-82(i)	5/6/2013	914	495	263	-64			1.1	17	0.9	0.3	<5.0	<5.0	<5.0	4.24	202.8	1.0	0.0	--	--	11.6	--
BOP-82(i)	8/19/2013	1019	600	368	41			1.4	19	0.5	<0.2	<5.0	<5.0	<5.0	--	14.2	1.1	0.0	--	--	11.5	--
BOP-82(i)	11/7/2013	1099	680	448	121			1.1	17	0.5	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	2/21/2014	1205	786	554	227			1.0	14	0.4	<0.2	<5.0	<5.0	<5.0	3.15	189.6	0.88	0.5	--	--	9.2	--
BOP-82(i)	5/7/2014	1280	861	629	302	-70		0.7	12	0.5	<0.2	<5.0	<5.0	<5.0	1.29	82.9	0.30	0.0	--	--	8.4	--
BOP-82(i)	8/14/2014	1379	960	728	401	29		1.0	12	0.6	<0.2	<5.0	<5.0	<5.0	0.45	-135.4	<0.10	7.0	--	--	8.8	--
BOP-82(i)	11/7/2014	1464	1045	813	486	114		0.6	8.1	2.7	0.7	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	2/6/2015	1555	1136	904	577	205		0.7	11	1.7	0.5	<5.0	<5.0	<5.0	0.68	-62.7	0.36	3.0	8.96	2.09	13.2	<2.0
BOP-82(i)	5/4/2015	1642	1223	991	664	292	-76	0.7	9.7	1.3	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	8/11/2015	1741	1322	1090	763	391	23	0.6	8.6	1.4	0.6	<5.0	<5.0	<5.0	1.06	-186.1	<0.10	7.0	6.87	4.67	5.5	<2.0
BOP-82(i)	11/6/2015	1828	1409	1177	850	478	110	0.3	6.0	2.5	1.2	--	--	--	--	--	--	--	--	--	--	--
BOP-82(i)	2/4/2016	1918	1499	1267	940	568	200	0.5	8.5	1.4	0.4	<5.0	<5.0	<5.0	1.83	35.9	0.22	3.0	5.45	2.53	11.5	<2.0
BOP-82(i)	5/3/2016	2007	1588	1356	1029	657	289	0.6	8.3	0.9	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-82i(i)	8/11/2016	2107	1688	1456	1129	757	389	0.6	8.7	0.6	<0.2	<5.0	<5.0	<5.0	0.75	15.0	0.40	1.5	13.6	1.13	13.4	--
BOP-82i(i)	11/16/2016	2205	1786	1554	1227	855	487	0.5	8.7	0.6	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	11/21/2011	382						<1.0	31	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--
Downgradient Well	12/1/2011	392	-27					<1.0	16	<1.0	<1.0	<1.1	<1.2	<1.1	0.0	-149.7	8.0	1.0	--	--	20.0	--
BOP-83(i)	12/28/2011	419	0					--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	1/9/2012	431	12					1.8	36	<1.0	<1.0	--	--	--	6.18	-200.7	7.2	0.1	--	--	19.7	--
BOP-83(i)	2/16/2012	469	50					2.6	58	2.5	<1.0	<1.1	<1.2	<1.1	5.38	-181.3	6.6	0.1	--	--	24.5	--
BOP-83(i)	3/15/2012	497	78					1.1	19	<1.0	<1.0	<1.1	<1.2	<1.1	6.44	-164.7	7.5	0.1	--	--	16.7	--
BOP-83(i)	4/17/2012	530	111					<1.0	7.3	<1.0	<1.0	<1.1	<1.2	<1.1	3.56	-205.5	5.2	0.1	--	--	13.8	--
BOP-83(i)	6/12/2012	586	167	-65				<1.0	3.1	<1.0	<1.0	<1.1	<1.2	<1.1	8.16	147.4	6.8	0.1	--	--	14.2	--
BOP-83(i)	8/16/2012	651	232	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	9/18/2012	684	265	33				0.5	9.7	0.3	<0.2	<5.0	<5.0	<5.0	5.14	65.7	6.6	0.0	--	--	13.6	--
BOP-83(i)	11/14/2012	741	322	90				<0.2	5.3	<0.2	<0.2	<5.0	<5.0	<5.0	6.95	110.3	6.3	0.0	--	--	12.2	--
BOP-83(i)	2/6/2013	825	406	174				1.2	21	0.9	<0.2	<5.0	<5.0	<5.0	7.73	152.7	5.9	0.0	--	--	11.5	--
BOP-83(i)	5/6/2013	914	495	263	-64			0.8	14	0.6	<0.2	<5.0	<5.0	<5.0	9.40	206.6	6.0	0.0	--	--	11.8	--
BOP-83(i)	8/22/2013	1022	603	371	44			<0.2	3.4	<0.2	<0.2	<5.0	<5.0	<5.0	7.13	171.6	5.7	0.0	--	--	11.5	--
BOP-83(i)	11/7/2013	1099	680	448	121			<0.2	2.4	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	2/21/2014	1205	786	554	227			<0.2	2.3	<0.2	<0.2	<5.0	<5.0	<5.0	4.09	177.4	5.4	0.5	--	--	11.3	--
BOP-83(i)	5/7/2014	1280	861	629	302	-70		0.4	5.7	0.4	<0.2	<5.0	<5.0	<5.0	6.91	136.0	4.3	0.0	--	--	11.1	--
BOP-83(i)	8/14/2014	1379	960	728	401	29		<0.2	2.2	<0.2	<0.2	<5.0	<5.0	<5.0	7.68	-80.8	4.6	0.5	--	--	11.6	--
BOP-83(i)	11/11/2014	1468	1049	817	490	118		<0.2	2.1	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	2/6/2015	1555	1136	904	577	205		0.4	12	1.0	<0.2	<5.0	<5.0	<5.0	7.69	52.6	3.6	0.0	11.9	<0.400	8.9	<2.0
BOP-83(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	2.0	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	8/11/2015	1741	1322	1090	763	391	23	<0.2	2.0	<0.2	<0.2	<5.0	<5.0	<5.0	7.66	50.1	4.2	0.5	30.0	1.22	10	<2.0
BOP-83(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	1.9	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	1.7	<0.2	<0.2	<5.0	<5.0	<5.0	7.46	51.8	3.3	1.0	19.2	0.628	7.5	<2.0
BOP-83i(i)	5/6/2016	2010	1591	1359	1032	660	292	<0.2	2.4	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-83i(i)	8/11/2016	2107	1688	1456	1129	757	389	<0.2	2.6	<0.2	<0.2	<5.0	<5.0	<5.0	7.02	89.5	3.3	0.5	4.33	0.440	9.1	<2.0
BOP-83i(i)	11/16/2016	2205	1786	1554	1227	855	487	0.5	10	4.5	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	2/8/2012	461	42					<1.0	7.1	55	1.4	--	--	--	--	--	--	--	--	--	--	--
Injection Well	5/4/2012	547	128					<1.0	<1.0	1.8	150	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	6/12/2012	586	167					<1.0	<1.0	1.2	14	13.6	<1.2	<1.1	0.65	-37.3	<0.1	3.7	--	--	<0.1	--
BOP-84(i)	8/9/2012	644	225	-7				<1.0	<1.0	1.3	8.4	--	--	--	--	--	--	--	--	--	--	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-82(i)	2/6/2013	825	406	174			0.036	<1.0	6.50	0.06	0.77	0.13	0.04	0.00	0.00
BOP-82(i)	5/6/2013	914	495	263	-64		0.48	<1.0	6.26	0.04	0.86	0.06	0.03	0.00	0.00
BOP-82(i)	8/19/2013	1019	600	368	41		0.11	<1.0	6.24	0.05	0.91	0.03	0.00	0.00	0.00
BOP-82(i)	11/7/2013	1099	680	448	121		--	--	--	0.05	0.92	0.04	0.00	--	--
BOP-82(i)	2/21/2014	1205	786	554	227		1.3	2.5	6.08	0.05	0.91	0.04	0.00	0.00	0.00
BOP-82(i)	5/7/2014	1280	861	629	302	-70	1.0	1.9	6.25	0.04	0.91	0.05	0.00	0.00	0.00
BOP-82(i)	8/14/2014	1379	960	728	401	29	1.5	36.4	5.82	0.06	0.88	0.06	0.00	0.00	0.00
BOP-82(i)	11/7/2014	1464	1045	813	486	114	--	--	--	0.03	0.59	0.27	0.11	--	--
BOP-82(i)	2/6/2015	1555	1136	904	577	205	3.0	1.8	6.25	0.04	0.74	0.15	0.07	0.00	0.00
BOP-82(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.05	0.81	0.15	0.00	--	--
BOP-82(i)	8/11/2015	1741	1322	1090	763	391	7.5	9.5	6.26	0.04	0.70	0.16	0.10	0.00	0.00
BOP-82(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.02	0.49	0.28	0.21	--	--
BOP-82(i)	2/4/2016	1918	1499	1267	940	568	2.3	<1.0	7.02	0.03	0.73	0.16	0.07	0.00	0.00
BOP-82(i)	5/3/2016	2007	1588	1356	1029	657	--	--	--	0.05	0.83	0.12	0.00	--	--
BOP-82i(i)	8/11/2016	2107	1688	1456	1129	757	1.0	1.3	6.09	0.05	0.87	0.08	0.00	0.00	0.00
BOP-82i(i)	11/16/2016	2205	1786	1554	1227	855	--	--	--	0.04	0.88	0.08	0.00	0.00	0.00
BOP-83(i)	11/21/2011	382					--	--	--	0.00	1.00	0.00	0.00	--	--
Downgradient Well	12/1/2011	392	-27				<0.0007	<1.50	6.73	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	12/28/2011	419	0				--	2.87	--	--	--	--	--	--	--
BOP-83(i)	1/9/2012	431	12				--	<1.5	6.70	0.04	0.96	0.00	0.00	--	--
BOP-83(i)	2/16/2012	469	50				<0.0007	2.73	7.10	0.03	0.91	0.05	0.00	0.00	0.00
BOP-83(i)	3/15/2012	497	78				<0.0007	1.90	6.87	0.04	0.96	0.00	0.00	0.00	0.00
BOP-83(i)	4/17/2012	530	111				<0.0007	<1.50	6.34	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	6/12/2012	586	167	-65			<0.015	<1.50	5.98	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	8/16/2012	651	232	0			--	<1.0	--	--	--	--	--	--	--
BOP-83(i)	9/18/2012	684	265	33			<0.015	1.2	6.07	0.04	0.92	0.04	0.00	0.00	0.00
BOP-83(i)	11/14/2012	741	322	90			0.0064	<1.0	6.69	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	2/6/2013	825	406	174			<0.005	<1.0	6.63	0.04	0.91	0.05	0.00	0.00	0.00
BOP-83(i)	5/6/2013	914	495	263	-64		<0.005	<1.0	6.32	0.04	0.91	0.05	0.00	0.00	0.00
BOP-83(i)	8/22/2013	1022	603	371	44		<0.005	<1.0	6.35	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	11/7/2013	1099	680	448	121		--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-83(i)	2/21/2014	1205	786	554	227		<0.005	<1.0	6.33	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	5/7/2014	1280	861	629	302	-70	0.19	1.2	6.43	0.05	0.87	0.08	0.00	0.00	0.00
BOP-83(i)	8/14/2014	1379	960	728	401	29	0.041	1.5	6.05	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	11/11/2014	1468	1049	817	490	118	--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-83(i)	2/6/2015	1555	1136	904	577	205	0.38	<1.0	6.35	0.02	0.88	0.10	0.00	0.00	0.00
BOP-83(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-83(i)	8/11/2015	1741	1322	1090	763	391	0.1	<1.0	6.47	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-83(i)	2/4/2016	1918	1499	1267	940	568	0.36	<1.0	7.33	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83i(i)	5/6/2016	2010	1591	1359	1032	660	--	--	--	0.00	1.00	0.00	0.00	--	--
BOP-83i(i)	8/11/2016	2107	1688	1456	1129	757	0.0069	<1.0	6.01	0.00	1.00	0.00	0.00	0.00	0.00
BOP-83i(i)	11/16/2016	2205	1786	1554	1227	855	--	--	--	0.02	0.61	0.37	0.00	0.00	0.00
BOP-84(i)	2/8/2012	461	42				--	--	--	0.00	0.08	0.88	0.03	--	--
Injection Well	5/4/2012	547	128				--	--	--	0.00	0.00	0.01	0.99	--	--
BOP-84(i)	6/12/2012	586	167				9.82	16.7	6.33	0.00	0.00	0.02	0.31	0.67	0.00
BOP-84(i)	8/9/2012	644	225	-7			--	--	--	0.00	0.00	0.09	0.91	--	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results							Aquifer Redox Conditions							
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-84(i)	8/16/2012	651	232	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	9/19/2012	685	266	34				<0.4	4.1	69	2.9	<5.0	<5.0	<5.0	0.28	17.7	<0.10	3.5	--	--	<1.0	--
BOP-84(i)	11/8/2012	735	316	84				<0.2	0.5	11	35	<5.0	5.7	<5.0	--	--	<0.10	--	--	--	<1.0	--
BOP-84(i)	11/9/2012	736	317	85				--	--	--	--	--	--	--	0.81	131.2	--	3.0	--	--	--	--
BOP-84(i)	2/5/2013	824	405	173				<0.2	0.5	0.7	2.3	<5.0	<5.0	<5.0	0.97	-43.9	<0.10	2.0	--	--	<1.0	--
BOP-84(i)	5/6/2013	914	495	263	-64			<0.2	0.4	0.5	1.6	<5.0	<5.0	<5.0	1.92	-75.2	<0.10	2.0	--	--	<1.0	--
BOP-84(i)	8/7/2013	1007	588	356	29			<0.2	2.2	18	15	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	11/8/2013	1100	681	449	122			<0.2	0.7	3.3	1.3	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	2/5/2014	1189	770	538	211			<0.2	0.2	2.5	0.6	<5.0	<5.0	<5.0	2.03	-118.65	<0.10	5.5	--	--	<1.0	--
BOP-84(i)	5/8/2014	1281	862	630	303	-69		<0.2	<0.2	2.0	1.9	7.4	<5.0	<5.0	1.16	-32.6	<0.10	--	--	--	<1.0	--
BOP-84(i)	11/7/2014	1464	1045	813	486	114		<0.2	<0.2	8.0	2.9	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	2/3/2015	1552	1133	901	574	202		<0.2	0.5	15	3.4	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	0.3	8.9	3.1	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	<0.2	2.8	2.1	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	<0.2	3.4	2.0	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	<0.2	3.8	2.2	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	<0.2	4.6	1.7	--	--	--	--	--	--	--	--	--	--	--
BOP-84(i)	11/4/2016	2193	1774	1542	1215	843	475	<0.2	<0.2	4.6	1.5	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	2/8/2012	461	42					1.6	33	6.5	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	5/4/2012	547	128					<1.0	29	6.5	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	8/9/2012	644	225	-7				1.2	32	5.7	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	11/8/2012	735	316	84				0.9	20	4.3	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	2/6/2013	825	406	174				0.8	37	7.0	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	5/2/2013	910	491	259	-68			1.1	30	5.8	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	8/7/2013	1007	588	356	29			0.5	1.5	22	0.8	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	11/8/2013	1100	681	449	122			<0.2	0.2	2.4	2.1	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	2/5/2014	1189	770	538	211			<0.2	<0.2	<0.2	1.3	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	5/7/2014	1280	861	629	302	-70		<0.2	<0.2	<0.2	1.5	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	11/5/2014	1462	1043	811	484	112		<0.2	1.6	3.4	0.4	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	2/3/2015	1552	1133	901	574	202		<0.2	1.4	5.2	0.3	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	0.8	5.1	0.4	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	<0.2	0.4	0.3	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	<0.2	0.7	0.5	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	<0.2	1.0	0.9	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	0.3	1.3	0.9	--	--	--	--	--	--	--	--	--	--	--
BOP-85(i)	11/4/2016	2192	1773	1541	1214	842	474	<0.2	0.3	1.3	0.9	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	2/8/2012	461	42					1.2	21	17	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	5/4/2012	547	128					<1.0	28	5.2	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	8/9/2012	644	225	-7				1.0	39	7.7	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	11/8/2012	735	316	84				0.9	20	4.6	0.5	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	2/6/2013	825	406	174				0.6	31	6.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	5/2/2013	910	491	259	-68			0.7	35	7.4	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	8/7/2013	1007	588	356	29			0.6	9.1	15	1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	11/8/2013	1100	681	449	122			<0.2	1.4	2.0	2.6	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	2/5/2014	1189	770	538	211			0.3	0.4	0.4	0.6	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	5/7/2014	1280	861	629	302	-70		<0.2	0.4	1.3	0.8	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	11/5/2014	1462	1043	811	484	112		<0.2	0.6	4.6	3.0	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	2/3/2015	1552	1133	901	574	202		<0.2	0.9	5.5	3.5	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	3.5	5.0	2.8	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	0.3	1.6	2.8	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	0.3	1.9	2.2	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	0.4	2.0	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	0.6	2.5	1.7	--	--	--	--	--	--	--	--	--	--	--
BOP-86(i)	11/4/2016	2192	1773	1541	1214	842	474	<0.2	0.6	2.3	1.6	--	--	--	--	--	--	--	--	--	--	--

**TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-84(i)	8/16/2012	651	232	0			--	--	--	--	--	--	--	--	
BOP-84(i)	9/19/2012	685	266	34			14	2620	4.57	0.00	0.04	0.90	0.06	0.00	0.00
BOP-84(i)	11/8/2012	735	316	84			22	276	--	0.00	0.00	0.13	0.65	0.00	0.22
BOP-84(i)	11/9/2012	736	317	85			--	--	6.36	--	--	--	--	--	--
BOP-84(i)	2/5/2013	824	405	173			26	80.5	6.29	0.00	0.08	0.15	0.77	0.00	0.00
BOP-84(i)	5/6/2013	914	495	263	-64		21	102	6.12	0.00	0.09	0.15	0.76	0.00	0.00
BOP-84(i)	8/7/2013	1007	588	356	29		--	--	--	0.00	0.04	0.42	0.54	--	--
BOP-84(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.09	0.57	0.35	--	--
BOP-84(i)	2/5/2014	1189	770	538	211		19	378	6.54	0.00	0.04	0.70	0.26	0.00	0.00
BOP-84(i)	5/8/2014	1281	862	630	303	-69	14	40.1	6.61	0.00	0.00	0.07	0.10	0.84	0.00
BOP-84(i)	11/7/2014	1464	1045	813	486	114	--	--	--	0.00	0.00	0.64	0.36	--	--
BOP-84(i)	2/3/2015	1552	1133	901	574	202	--	--	--	0.00	0.02	0.73	0.26	--	--
BOP-84(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.02	0.64	0.35	--	--
BOP-84(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.00	0.46	0.54	--	--
BOP-84(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.00	0.52	0.48	--	--
BOP-84(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.00	0.53	0.47	--	--
BOP-84(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.00	0.64	0.36	--	--
BOP-84(i)	11/4/2016	2193	1774	1542	1215	843	--	--	--	0.00	0.00	0.66	0.34	--	--
BOP-85(i)	2/8/2012	461	42				--	--	--	0.03	0.77	0.20	0.00	--	--
Injection Well	5/4/2012	547	128				--	--	--	0.00	0.77	0.23	0.00	--	--
BOP-85(i)	8/9/2012	644	225	-7			--	--	--	0.02	0.79	0.19	0.00	--	--
BOP-85(i)	11/8/2012	735	316	84			--	--	--	0.03	0.75	0.22	0.00	--	--
BOP-85(i)	2/6/2013	825	406	174			--	--	--	0.01	0.79	0.20	0.00	--	--
BOP-85(i)	5/2/2013	910	491	259	-68		--	--	--	0.02	0.77	0.20	0.00	--	--
BOP-85(i)	8/7/2013	1007	588	356	29		--	--	--	0.01	0.04	0.89	0.05	--	--
BOP-85(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.03	0.41	0.56	--	--
BOP-85(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-85(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.00	0.00	1.00	--	--
BOP-85(i)	11/5/2014	1462	1043	811	484	112	--	--	--	0.00	0.23	0.65	0.12	--	--
BOP-85(i)	2/3/2015	1552	1133	901	574	202	--	--	--	0.00	0.15	0.78	0.07	--	--
BOP-85(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.09	0.81	0.10	--	--
BOP-85(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.00	0.46	0.54	--	--
BOP-85(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.00	0.47	0.53	--	--
BOP-85(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.00	0.42	0.58	--	--
BOP-85(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.08	0.45	0.48	--	--
BOP-85(i)	11/4/2016	2192	1773	1541	1214	842	--	--	--	0.00	0.08	0.45	0.48	--	--
BOP-86(i)	2/8/2012	461	42				--	--	--	0.02	0.47	0.51	0.00	--	--
Injection Well	5/4/2012	547	128				--	--	--	0.00	0.80	0.20	0.00	--	--
BOP-86(i)	8/9/2012	644	225	-7			--	--	--	0.02	0.78	0.21	0.00	--	--
BOP-86(i)	11/8/2012	735	316	84			--	--	--	0.03	0.71	0.22	0.04	--	--
BOP-86(i)	2/6/2013	825	406	174			--	--	--	0.01	0.78	0.21	0.00	--	--
BOP-86(i)	5/2/2013	910	491	259	-68		--	--	--	0.01	0.77	0.22	0.00	--	--
BOP-86(i)	8/7/2013	1007	588	356	29		--	--	--	0.01	0.28	0.64	0.07	--	--
BOP-86(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.15	0.28	0.57	--	--
BOP-86(i)	2/5/2014	1189	770	538	211		--	--	--	0.10	0.16	0.22	0.52	--	--
BOP-86(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.10	0.46	0.44	--	--
BOP-86(i)	11/5/2014	1462	1043	811	484	112	--	--	--	0.00	0.05	0.47	0.48	--	--
BOP-86(i)	2/3/2015	1552	1133	901	574	202	--	--	--	0.00	0.06	0.47	0.47	--	--
BOP-86(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.22	0.42	0.36	--	--
BOP-86(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.04	0.26	0.70	--	--
BOP-86(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.04	0.34	0.62	--	--
BOP-86(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.13	0.87	0.00	--	--
BOP-86(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.08	0.45	0.47	--	--
BOP-86(i)	11/4/2016	2192	1773	1541	1214	842	--	--	--	0.00	0.08	0.44	0.48	--	--

**TABLE 6-1
 BIOREMEDIATION SUMMARY
 FORMER DEGREASER SOURCE CONTROL AREA
 BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Elapsed Time from Injection (f) (days)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions								
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)	VC (µg/L)	Ethene (µg/L)	Ethane (µg/L)	Acetylene (µg/L)	DO (mg/L)	ORP (mV)	Nitrate (mg/L)	Iron II (mg/L)	Iron, Tot (mg/L)	Iron, Diss (mg/L)	Sulfate (mg/L)	Sulfide (mg/L)
BOP-87(i)	2/8/2012	461	42					1.3	14	1.8	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	5/4/2012	547	128					<1.0	24	1.4	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	8/9/2012	644	225	-7				2.2	52	2.6	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	11/8/2012	735	316	84				1.2	9.7	1.6	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	2/6/2013	825	406	174				0.4	8.5	1.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	5/2/2013	910	491	259	-68			0.2	7.1	1.2	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	8/7/2013	1007	588	356	29			0.7	21	6.3	0.3	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	11/8/2013	1100	681	449	122			<0.2	0.6	6.2	0.6	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	2/5/2014	1189	770	538	211			<0.2	0.3	1.2	1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	5/7/2014	1280	861	629	302	-70		<0.2	<0.2	0.3	0.5	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	11/5/2014	1462	1043	811	484	112		<0.2	0.6	1.5	0.8	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	2/3/2015	1552	1133	901	574	202		<0.2	2.1	2.2	0.9	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	5/4/2015	1642	1223	991	664	292	-76	<0.2	1.4	2.8	0.7	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	11/6/2015	1828	1409	1177	850	478	110	<0.2	<0.2	0.3	0.5	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	<0.2	0.5	0.6	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	0.2	0.6	1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	8/8/2016	2104	1685	1453	1126	754	386	<0.2	0.3	0.9	0.8	--	--	--	--	--	--	--	--	--	--	--
BOP-87(i)	11/4/2016	2192	1773	1541	1214	842	474	<0.2	0.3	1.0	0.8	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	2/8/2012	461	42					2.0	26	2.2	<1.0	--	--	--	--	--	--	--	--	--	--	--
Injection Well	5/4/2012	547	128					<1.0	19	2.5	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	8/9/2012	644	225	-7				2.8	130	8.9	<1.0	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	11/8/2012	735	316	84				1.2	11	1.5	<0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	2/6/2013	825	406	174				0.9	11	1.4	0.2	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	5/2/2013	910	491	259	-68			0.6	14	2.2	1.2	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	8/7/2013	1007	588	356	29			0.8	7.8	11	0.2	<5.0	<5.0	<5.0	1.19	-133.4	<0.10	2.0	--	--	<1.0	--
BOP-88(i)	11/11/2013	1103	684	452	125			<0.2	0.2	85	4.1	<5.0	<5.0	<5.0	1.21	-90.1	<0.10	4.0	--	--	<1.0	--
BOP-88(i)	2/5/2014	1189	770	538	211			<0.2	0.9	3.0	27	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	5/7/2014	1280	861	629	302	-70		<0.2	1.0	3.5	7.7	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	11/11/2014	1468	1049	817	490	118		<0.2	1.9	30	4.2	<5.0	<5.0	<5.0	1.36	-208.2	<1.0	4.0	639	624	276	9.7
BOP-88(i)	2/9/2015	1558	1139	907	580	208		0.3	12	90	4.0	<5.0	<5.0	<5.0	0.46	-94.9	<1.0	7.0	829	775	243	16.5
BOP-88(i)	5/6/2015	1644	1225	993	666	294	-74	1.0	28	150	8.5	7.4	<5.0	<5.0	0.82	-97.0	<1.0	7.0	611	603	138	15.6
BOP-88(i)	11/4/2015	1826	1407	1175	848	476	108	<0.2	0.8	8.7	2.4	--	--	--	--	--	--	--	--	--	--	--
BOP-88(i)	2/4/2016	1918	1499	1267	940	568	200	<0.2	1.6	24	4.1	7.2	<5.0	<5.0	1.68	58.4	<1.0	7.0	2520	2470	2270	<20.0
BOP-88(i)	5/5/2016	2009	1590	1358	1031	659	291	<0.2	3.3	65	6.8	7.9	<5.0	<5.0	1.12	9.7	<1.0	7.0	2530	2510	2370	6.2
BOP-88(i)	8/9/2016	2105	1686	1454	1127	755	387	<0.2	8.9	100	7.0	9.3	<5.0	<5.0	0.39	-43.7	4.8	7.0	2570	2660	2330	78.4
BOP-88(i)	11/8/2016	2196	1777	1545	1218	846	478	<0.4	6.2	110	7.4	11	<5.0	<5.0	0.92	115.1	1.1	7.0	2580	2490	2620	<2.0

**TABLE 6-1
 BIOREMEDIATION SUMMARY
 FORMER DEGREASER SOURCE CONTROL AREA
 BOEING PORTLAND**

Well	Date	Elapsed Time from Injections (a) (days)	Elapsed Time from Injection (b) (days)	Elapsed Time from Injection (c) (days)	Elapsed Time from Injection (d) (days)	Elapsed Time from Injection (e) (days)	Donor Indicators			Molar Fraction					
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	Methane (b) (mg/L)	TOC (mg/L)	pH	PCE	TCE	cDCE	VC	Ethene	Ethane
BOP-87(i)	2/8/2012	461	42				--	--	--	0.06	0.80	0.14	0.00	--	--
Injection Well	5/4/2012	547	128				--	--	--	0.00	0.93	0.07	0.00	--	--
BOP-87(i)	8/9/2012	644	225	-7			--	--	--	0.03	0.91	0.06	0.00	--	--
BOP-87(i)	11/8/2012	735	316	84			--	--	--	0.07	0.76	0.17	0.00	--	--
BOP-87(i)	2/6/2013	825	406	174			--	--	--	0.03	0.81	0.16	0.00	--	--
BOP-87(i)	5/2/2013	910	491	259	-68		--	--	--	0.02	0.80	0.18	0.00	--	--
BOP-87(i)	8/7/2013	1007	588	356	29		--	--	--	0.02	0.68	0.28	0.02	--	--
BOP-87(i)	11/8/2013	1100	681	449	122		--	--	--	0.00	0.06	0.82	0.12	--	--
BOP-87(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.07	0.40	0.52	--	--
BOP-87(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.00	0.28	0.72	--	--
BOP-87(i)	11/5/2014	1462	1043	811	484	112	--	--	--	0.00	0.14	0.47	0.39	--	--
BOP-87(i)	2/3/2015	1552	1133	901	574	202	--	--	--	0.00	0.30	0.43	0.27	--	--
BOP-87(i)	5/4/2015	1642	1223	991	664	292	--	--	--	0.00	0.21	0.57	0.22	--	--
BOP-87(i)	11/6/2015	1828	1409	1177	850	478	--	--	--	0.00	0.00	0.28	0.72	--	--
BOP-87(i)	2/4/2016	1918	1499	1267	940	568	--	--	--	0.00	0.00	0.35	0.65	--	--
BOP-87(i)	5/5/2016	2009	1590	1358	1031	659	--	--	--	0.00	0.06	0.26	0.67	--	--
BOP-87(i)	8/8/2016	2104	1685	1453	1126	754	--	--	--	0.00	0.09	0.38	0.53	--	--
BOP-87(i)	11/4/2016	2192	1773	1541	1214	842	--	--	--	0.00	0.09	0.41	0.50	--	--
BOP-88(i)	2/8/2012	461	42				--	--	--	0.05	0.85	0.10	0.00	--	--
Injection Well	5/4/2012	547	128				--	--	--	0.00	0.85	0.15	0.00	--	--
BOP-88(i)	8/9/2012	644	225	-7			--	--	--	0.02	0.90	0.08	0.00	--	--
BOP-88(i)	11/8/2012	735	316	84			--	--	--	0.07	0.79	0.15	0.00	--	--
BOP-88(i)	2/6/2013	825	406	174			--	--	--	0.05	0.78	0.14	0.03	--	--
BOP-88(i)	5/2/2013	910	491	259	-68		--	--	--	0.02	0.70	0.15	0.13	--	--
BOP-88(i)	8/7/2013	1007	588	356	29		1.9	294	5.88	0.03	0.33	0.63	0.02	0.00	0.00
BOP-88(i)	11/11/2013	1103	684	452	125		17	458	6.20	0.00	0.00	0.93	0.07	0.00	0.00
BOP-88(i)	2/5/2014	1189	770	538	211		--	--	--	0.00	0.01	0.07	0.92	--	--
BOP-88(i)	5/7/2014	1280	861	629	302	-70	--	--	--	0.00	0.05	0.22	0.74	--	--
BOP-88(i)	11/11/2014	1468	1049	817	490	118	13	3150	4.56	0.00	0.04	0.79	0.17	0.00	0.00
BOP-88(i)	2/9/2015	1558	1139	907	580	208	12	3990	4.90	0.00	0.08	0.86	0.06	0.00	0.00
BOP-88(i)	5/6/2015	1644	1225	993	666	294	16	3370	4.82	0.00	0.10	0.71	0.06	0.12	0.00
BOP-88(i)	11/4/2015	1826	1407	1175	848	476	--	--	--	0.00	0.05	0.67	0.29	--	--
BOP-88(i)	2/4/2016	1918	1499	1267	940	568	11	8570	5.64	0.00	0.02	0.43	0.11	0.44	0.00
BOP-88(i)	5/5/2016	2009	1590	1358	1031	659	15.0	8780	4.67	0.00	0.02	0.62	0.10	0.26	0.00
BOP-88(i)	8/9/2016	2105	1686	1454	1127	755	14	10000	4.67	0.00	0.04	0.67	0.07	0.21	0.00
BOP-88(i)	11/8/2016	2196	1777	1545	1218	846	12	9830	4.44	0.00	0.03	0.67	0.07	0.23	0.00

TABLE 6-1
BIOREMEDIATION SUMMARY
FORMER DEGREASER SOURCE CONTROL AREA
BOEING PORTLAND

Acronyms/Abbreviations:

cis = 1,2-dichloroethene	ORP = oxygen reduction potential
Diss = dissolved	PCE = tetrachloroethene
DO = dissolved oxygen	PRB = permeable reactive barrier
gpm = gallons per minute	TOC = total organic carbon
µg/L = micrograms per liter	TCE = trichloroethene
mg/L = milligrams per liter	VC = vinyl chloride

Injection Notes

- a) November 4-9, 2010: Conduct pilot injection test at BOP-72(i) with 900 gal of water mixed with 3/4 drum of Wilclear sodium lactate.
- b) December 28, 2011: PRB injection at BOP-74(i). Injected 15 drums of LactOil, Newman Zone vegetable oil emulsion, and Wilclear sodium lactate with 15,000 gallons of water. Injection rates were between 70 to 80 gpm.
- c) August 18, 2012: Conducted PRB injection at BOP-74(i) with 30,000 gallons of lactoil and water mixture.
- d) July 2-9, 2013: Conducted gravity injection at seven source area zone injection wells (BOP-78, 79, 84, 85, 86, 87, 88). Injection of 10,000 gallons total lactoil donor and water. Average injection rates ranged from 4.8 to 11.7 gpm.
- e) July 12-16, 2014: Conducted source area zone injection by gravity flow to seven multi-purpose injection wells and pump flow to PRB well BOP-74(i). Injection consisted of 50,000-gallon mixture of water, Textrol BR, glycerin, and ferrous sulfate.
- f) June 8-19, 2015: Conducted source area zone injection by gravity flow to seven multi-purpose injection wells and pump flow to PRB well BOP-74(i). Injection consisted of 50,000-gallon mixture of water, Textrol BR, glycerin, and ferrous sulfate.

Notes:

-- Data not collected or analyzed

Blue highlighted values indicate the compound with the highest micromoles per event, ethene and ethane combined are considered for maximum molar fraction. Compounds with 2 percent of maximum compound are also highlighted due to potential laboratory variability.