

**Final
2014 Progress and Performance Evaluation
Troutdale Gravel Aquifer
Boeing Portland Facility
Gresham, Oregon**

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Prepared for
The Boeing Company

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LIST OF ABBREVIATIONS AND ACRONYMS

mg/kg	Milligrams Per Kilogram
µg/kg	Micrograms Per Kilogram
µg/L	Micrograms Per Liter
µg/m ³	Micrograms Per Cubic Meter
yd ³	Cubic Yards
1,1-DCE	1,1-Dichloroethene
Boeing	The Boeing Company
BGS	Below Ground Surface
CAOs	Corrective Action Objectives
cDCE	cis-1,2-DCE
CFM	Cubic Feet Per Minute
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COPC	Constituents of Potential Concern
DEQ	Oregon Department of Environmental Quality
DNAPL	Dense Nonaqueous Phase Liquid
EPA	U.S. Environmental Protection Agency
FOG	Fats, Oil, and Grease
ft	Feet
GAC	Granular Activated Carbon
gpm	gallons per minute
GWTS	Groundwater Treatment System
HDPE	High-density Polyethylene
HOA	Hand/Off/Auto
HP	Horsepower
ICP	Institutional Controls Plan
ICAs	Interim Corrective Actions
IRAM	Interim Remedial Action Measure
Lbs	Pounds
MCLs	Maximum Contaminant Levels
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
PCE	Tetrachloroethene
PRB	Permeable Reactive Barrier
psi	Per Square Inch
RCRA	Resource Conservation and Recovery Act
RBC	Risk-based Cleanup Levels
RFI	RCRA Facilities Investigation
ROI	Radius of Injection
SCADA	Supervisory Control and Data Acquisition
STS	Sump Treatment System
SVE	Soil Vapor Extraction
TBR	Textrol BR
TCA	Trichloroethane
TCE	Trichloroethene
tDCE	trans-1,1-DCE
TGA	Troutdale Gravel Aquifer
TGWTS	Temporary Groundwater Treatment System
TOC	Total Organic Carbon
TSA	Troutdale Sandstone Aquifer
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
VOW	Vapor Observation Wells

1.0 INTRODUCTION

This corrective measures progress and performance evaluation report documents performance of the Troutdale Gravel Aquifer (TGA) remedy currently being conducted by The Boeing Company (Boeing) at the Boeing Portland facility in Gresham, Oregon (Figure 1). This report summarizes activities and analytical testing conducted from July 1 through December 31, 2014 [time period since the latest Data Report (Landau Associates 2014a)]. In addition, this report provides an evaluation of the TGA remedy progress and performance that entails a review of data collected throughout the calendar year (January 1 through December 31, 2014).

This report is submitted as required under Order on Consent No. LQSR-NWR-04-12(h) issued to Boeing by the Oregon Department of Environmental Quality (DEQ; DEQ 2008a). The DEQ Order on Consent requires Boeing to continue to perform the site remedial actions included within the final remedy specified in the U.S. Environmental Protection Agency (EPA) Order on Consent (EPA 1994), the Decision and Response to Comments (Final Decision; EPA 1997a), and the Statement of Basis (EPA 1997b). In addition to the consent order-driven corrective measures, additional measures such as bioremediation have been implemented to improve remedy performance and decrease the projected remedy timeframe.

This report provides an evaluation of TGA remedy performance, including:

- Remedy background information (Section 2.0)
- Significant issues, events, and actions (Section 3.0)
- Summary of remedy progress monitoring data (Section 4.0)
- An assessment of remedy performance and aquifer restoration progress (Section 5.0)
- Recommendations to optimize remedy performance (Section 6.0).

2.0 REMEDY BACKGROUND

Boeing has conducted investigations and implemented corrective measures relative to volatile organic compounds (VOCs) in soil and groundwater at the Boeing facility since 1986. Corrective measures consist of interim corrective actions (ICAs); consent order-driven corrective measures; and additional measures, such as bioremediation; implemented to improve remedy performance and decrease the projected remedy timeframe.

ICAs were the earliest corrective measures undertaken by Boeing beginning in 1986 to stabilize VOCs in the soil and groundwater at the Boeing Portland 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 supply wells; excavating impacted soil; installing and phased expansion of the groundwater extraction and treatment system (GWTS); and installing and testing of a soil vapor extraction (SVE) system and a dual-phase extraction system. These ICAs were previously documented in the interim measures evaluation report (Landau Associates 1995a) and summarized in the Phase 2 corrective measures study (CMS; Landau Associates 1996).

2.1 CONSENT ORDER CORRECTIVE MEASURES OBJECTIVES AND CLEANUP LEVELS

Subsequent to implementation of ICAs, the Phase 2 CMS, the EPA Final Decision, and the EPA Statement of Basis identified areas of the Boeing Facility where corrective measures were to be implemented. These corrective action areas 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 (RFI; Landau Associates 1995b). These corrective action areas and the current groundwater remedy wells (extraction and monitoring wells) are shown on Figure 2, and are described in detail in the Phase 2 CMS and the TGA corrective measures implementation (CMI) work plan (Landau Associates 1997).

Consent Order corrective measures 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. These objectives were confirmed in the EPA Final Decision (EPA 1997a) and provided the basis for corrective action implementation (Landau Associates 1997). The Corrective Action Objections (CAOs) to be achieved by the corrective measures for the TGA, as presented in the Final Decision, 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.

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 [micrograms per liter (µg/L)]
1,1-Dichloroethene (1,1-DCE)	7
cis-1,2-Dichloroethene (cDCE)	70
Trichloroethane (TCA)	200
Trichloroethene (TCE)	5
Tetrachloroethene (PCE)	5
Vinyl chloride (VC)	2

2.2 CONSENT ORDER CORRECTIVE MEASURES

TGA consent order corrective measures consist of several components: dual-phase extraction, soil vapor extraction, groundwater pump and treat, performance monitoring, well decommissioning to reduce liability and potential pathways, and the implementation of the Institutional Controls Plan (ICP; Landau Associates 2005). These components are discussed in the following sections.

2.2.1 DUAL-PHASE AND SOIL VAPOR EXTRACTION SYSTEMS

Dual-phase extraction system pilot tests were conducted during the late 1990s and the results indicated that TGA soil was not conducive to this type of system. Therefore, well DP-1 was converted from a dual-phase extraction to a groundwater extraction well and well DP-4 was incorporated into the Central and West Corrective Action Areas SVE system. The Central and West Corrective Action Areas SVE system consisted of 8 vapor extraction wells, DP-4, and 14 shallow and deep vapor observation wells (VOWs). The SVE system operated between 1994 and 2009 and removed approximately

3,750 pounds (lbs) of VOCs from the unsaturated zone. SVE system mass recovery declined with time and, in 2009, DEQ approved the decommissioning of the system because VOC mass removal rates were below the shutoff criterion of 0.1 lbs/day (DEQ 2009a). Three VOWs [VOW-4(s,d), VOW-6(s,d), and VOW-9(s,d)] were decommissioned in March 2010. A total of 7 VOWs [VOW-5(s,d), VOW-7(s,d), VOW-8(s,d), VOW-10(s,d), VOW-11(s,d), VOW-12(s,d), and VOW-14(s,d)] and 2 vapor extraction wells (VE-6 and VE-7) were decommissioned in March 2011.

2.2.2 GROUNDWATER TREATMENT SYSTEM

The GWTS, which expanded upon the former ICA groundwater extraction and treatment system, began operation in 1989 and has operated full-time with only minor shutdowns for maintenance or construction modifications. The locations of the extraction wells and the conveyance piping system are shown on Figure 3. In 2000, the pumping at E-1 was suspended due to compliant groundwater (Landau Associates 2000) and was subsequently decommissioned in June 2004.

The operational shutdown of individual extraction wells E-5 through E-9 was recommended in the 2000 TGA annual performance evaluation report due to low mass removal rates (Landau Associates 2001). The operational shutdown of E-5 through E-9 was approved by EPA and conducted in October 2002 (Landau Associates 2002); since the cessation of the extraction pumping, the wells have operated periodically for maintenance and monitoring purposes.

Additional extraction wells E-10, E-11, E-14, E-15, and E-16 were shut down to facilitate bioremediation injection activities in late 2008 (Landau Associates 2009). Extraction wells E-10 and E-14 were decommissioned, with DEQ approval (DEQ 2008b), during the first quarter of 2010 in preparation for the Building 85-001 expansion project. 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.

Currently, the following wells are actively pumping as part of the TGA groundwater extraction and treatment system (Figure 3):

- E-2, E-3, E-4, E-12, and 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 Correct Action Area).

In August 2014, the air stripper tower failed and a temporary groundwater tray stripper system was installed; groundwater treatment system failure and response is discussed further in Section 3.1.

2.2.3 GROUNDWATER PERFORMANCE MONITORING PROGRAM

The groundwater performance monitoring program consists of groundwater level measurements, collection of representative groundwater quality samples, and collection of influent and effluent samples from the GWTS. The current groundwater monitoring program is summarized in Table 1.

The groundwater performance monitoring program is evaluated yearly and modified based on the continued remedy of the dissolved VOC plume and with DEQ's approval. Criteria for modification to the monitoring program have been established (Landau Associates 2010a) to standardize the process for monitoring frequency modification:

- Criteria for Increasing Sampling Frequency
 - If COPC concentrations increase to detectable levels for two consecutive sampling events, after having been below detection limits for 2 or more years.
 - If COPC concentrations increase to above the respective MCLs for two consecutive sampling events, after having been below the MCLs for 2 or more years.
- Criteria for Reducing Sampling Frequency
 - If COPC concentrations have been consistently below detection limits for the prior 2 consecutive years. A well that meets this criterion could also be recommended for removal from the monitoring program.
 - If COPC concentrations have been stable to declining for the prior 2 years.
- Criteria for Discontinuing Monitoring
 - COPC concentrations have been consistently below detection limits for 2 or more years.
 - The well is located outside the limits of the plume and is no longer needed to monitor hydraulic plume control or progress of aquifer restoration.
 - The location of the well duplicates another well better suited to evaluate hydraulic control and progress of aquifer restoration.
- Confirmation Sampling Event
 - Wells that meet the above criteria for discontinued monitoring and have been removed from the Monitoring Program will have a confirmation sample collected one year later for evaluation of possible decommissioning.

2.2.4 WELL DECOMMISSIONING

Well decommissioning activities are proposed to DEQ if criteria for the removal of the well from the monitoring program have been met (Section 2.2.3) or if the well is no longer utilized for bioremediation injection, groundwater extraction, or vapor extraction. The utilization of wells is evaluated yearly and modified based on the continued remedy of the dissolved VOC plume and with DEQ's approval. No wells were decommissioned during this semiannual reporting period.

2.2.5 INSTITUTIONAL CONTROLS PLAN

The ICP (Landau Associates 2005) was developed as part of the selected corrective measures for the TGA. The ICP provides measures to restrict the potential ingestion of TGA groundwater exceeding the MCLs; provides a worker protection institutional control to restrict the potential exposure of workers during surface/subsurface disturbances within certain areas of the site (referred to as Source Areas); and provides a restrictive covenant for the facility. The groundwater use institutional control regulates groundwater use in the area by granting the lead agency the authority to review any proposed actions involving the installation of wells or modifications of existing well water use within the dissolved VOC plume. The worker protection institutional control provides procedures for notification to the lead agency of proposed worker activities within the source areas. Workers shall conduct activities under guidance of an approved health and safety plan and disposal criteria will be coordinated with the lead agency.

2.3 ADDITIONAL CORRECTIVE MEASURES

Additional corrective measures have been incorporated into the TGA remedy to decrease the remedy timeframe and to improve the remedy performance. The GWTS system continues to provide hydraulic capture and remedy of the TGA. Additional corrective measures currently being utilized at the Site are discussed in the following sections.

2.3.1 COOLANT RELEASE REMEDY AREA

In 2006, coolant material was discovered in the 85-105 building footing drain sump (sump). The sump is a collection location for water from building footing drains and other shallow perched groundwater. 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 granular activated carbon (GAC) vessel for pre-treatment when FOG concentrations were elevated. Based on STS influent groundwater concentrations being consistently below the stormwater discharge criteria, the shutdown of the STS was recommended in 2012 (Landau Associates 2012a) and approved by DEQ (DEQ 2012a). The STS was subsequently shut down in August 2012 and, since that time, water accumulating in the sump is re-routed to the GWTS (pre-2006 coolant release occurrence treatment method) prior to discharge to the Storm Drain Creek. The STS system was decontaminated and stored for potential future use at Boeing facilities (as needed).

An investigation was conducted to evaluate the vertical and horizontal extent of the release to the TGA by monitoring existing nearby wells and installing eight monitoring wells (LAI-1 through LAI-8). 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 (Landau Associates 2007a).

To address the isolated coolant impacts to the shallow TGA, five injection wells (IW-1 through IW-5) were installed directly upgradient of the release area to allow for stimulation of aerobic biodegradation as an interim remedial action measure (IRAM; Landau Associates 2007b). The DEQ-approved (DEQ 2007) interim remedial action plan detailed the process and procedures for using an oxygen-releasing compound (EHC-OTM) injected as slurry with water to enhance the aerobic biodegradation of the petroleum-based contaminant. In 2008, two EHC-O injections events were conducted. Annual EHC-O injections were conducted in 2010, 2011, 2012, and 2013. EHC-O injection was not conducted in 2014 because concentrations in the monitoring wells were below the site-specific cleanup levels.

2.3.2 SOURCE CONTROL AREA INVESTIGATIONS

In 1995, six potential TGA contaminant source areas were identified based on earlier investigations and current or past site uses (Landau Associates 1995a). These source areas were identified as the West Source Control Area, Central Source Control Area, Southwest Source Control Area, Former Vapor Degreaser Source Control Area, East Yard Source Control Area, and East Source Control Area, as shown on Figure 4. Restrictions on intrusive activities within the source areas and the use of groundwater are provided in the ICP.

Investigations have been conducted within some of the source areas and, based on these results, DEQ has either approved of additional corrective actions or the removal of the particular source area from the ICP. Based on these investigations, three of the investigated areas (West, Southwest, and Central) have been removed from the ICP. At the time of this report, source area investigations have not been completed in the East Yard Source Area and the East Source Area. The following sections provide a description of the four source area investigations that have been completed.

2.3.2.1 West Source Control Area Investigation

In preparation for the Building 85-001 expansion project, a series of subsurface environmental investigations were conducted in 2008 to evaluate the potential presence and extent of soil contamination within the West Source Control Area. The phased investigations were conducted by advancing a total of 34 borings to depths ranging from 5 to 40 feet (ft) below ground surface (BGS) using roto-sonic drilling.

Representative soil samples were collected for laboratory analysis. A total of 13 samples contained TCE above the reporting limit, with concentrations ranging from 1.0 to 120.0 micrograms per kilogram ($\mu\text{g}/\text{kg}$). TCE results were below the risk-based cleanup level exposure risk to workers (RBCs) with the exception of two samples located near the southwestern portion of the existing 85-001 building (Landau Associates 2011a).

Based on the results of the investigations, a remedial excavation was conducted to remove approximately 520 cubic yards (yd^3 ; 779 tons) of TCE-impacted soil for offsite disposal at the Hillsboro Landfill. Excavation confirmation soil samples were collected at the extent of the excavation to document that TCE was below RBCs in soil remaining in the bottom and sidewalls of the excavation (Landau Associates 2011a).

The results of the investigations and the remedial excavation demonstrated no unacceptable exposure risk to construction workers. Based on this demonstration, DEQ approved the removal of the West Source Control Area from the ICP (DEQ 2011).

2.3.2.2 Central Source Control Area Investigation

A review of historical data indicated the Central Source Control Area was first identified as a potential source area based on hydrogeologic field evidence, reviews of historical aerial photographs, and interviews with former employees. It was determined that this area may have been used for occasional liquid waste disposal between 1964 through 1967. In 1991, Boeing extended Building 85-105 to the west over the southeastern portion of the source area. Associated subsurface activities during the expansion exposed stained soil and three 55-gallon drums (one of which was intact and contained a mixture of approximately 50 percent TCE and 50 percent PCE), as well as drum lids, paint sludge, demolition debris, wood waste, and miscellaneous waste. Approximately 6,300 tons of VOC-contaminated soil and debris were removed during the 1991 building expansion (Landau Associates 2012b).

Pilot testing for SVE and dual-phase extraction systems was conducted in the source area in the early 1990s. The results of the pilot tests indicated that the area subsurface permeability was generally too low for effective SVE treatment with the exception of an isolated area near well DP-4. Well DP-4 was connected to the SVE for the source area and operated as an SVE extraction well from 1994 through 2009, removing approximately 631 lbs of VOCs from the vadose soil before being shut down due to vapor removal rates being below the 0.1 lbs/day target rate. The results of the early 1994 dual-phase extraction well investigation indicated well DP-1 would most likely not provide adequate soil vapor extraction due to low-permeability soil conditions; therefore, well DP-1 was converted to a groundwater extraction well and continues to operate through this semiannual reporting period.

Historical investigations in the Central Source Control Area detected TCE and PCE in a limited number of soil samples and concentrations were low [0.0007 to 0.0016 milligrams per kilogram (mg/kg)].

This does not include soil samples from the area of VOC contamination that was removed during the 1991 expansion of Building 85-105. No further investigation of the southwestern half of the source area was determined to be needed; however, additional soil vapor sampling was recommended for the northern portion (Landau Associates 2012b).

During November 2011, a total of 35 sub-slab vapor samples were collected primarily in the northern portion of the Central Source Control Area to address the need for additional soil vapor sampling. The analytical results were all below the Oregon DEQ RBCs. Based on the analytical results, it was concluded that the source area did not pose a VOC exposure risk to workers, and it was recommended that the area be removed from the ICP. DEQ agreed with the recommendation and the institutional controls within the Central Source Control Area were removed (DEQ 2012b).

2.3.2.3 Southwest Source Control Area Investigation

The Southwest Source Control Area was identified as a potential source area in the Phase 2 CMS (Landau Associates 1996). VOC analysis of historical groundwater samples from this area did not indicate that a significant source was present; however, additional data was needed to further characterize the potential source area.

Between April 17 and 18, 2013, a sub-slab vapor investigation was conducted in the source area using procedures presented in the DEQ-approved work plan (Landau Associates 2011b). A total of 17 sub-slab vapor samples were collected and submitted to the laboratory for VOC analysis. Results for the TGA COPCs were all below the laboratory reporting limits. The results of this investigation were documented in a summary report and submitted to DEQ with the conclusion that there is no VOC exposure risk to workers, and a recommendation that the area be removed from the ICP (Landau Associates 2013a). DEQ agreed with the recommendations and the institutional controls within the Southwest Source Control Area were removed (DEQ 2014a).

2.3.2.4 Former Degreaser Source Control Area Investigations

Historical releases of TCE from two 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. Recent 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 (Landau Associates 2010b, 2011c, and 2012c). During the investigation phases, a total of 17 groundwater wells were installed in the source zone and downgradient of the area [BOP-80(i) through BOP-83(i)], and 3 soil vapor observations wells. Seven wells installed in

2011 [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 5 and 6.

The degreaser source areas investigations collected representative samples of soil vapor and groundwater. Soil vapor samples were collected 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., of the second siltstone unit in confining layer (CU1)].

Based upon the findings of the investigations conducted at the Former Vapor Degreaser Source Control Area, two additional corrective actions are under way for source remediation. These corrective actions, consisting of enhanced *in situ* bioremediation and SVE, are described in the following sections.

2.3.3 ENHANCED *IN SITU* BIOREMEDIATION

Enhanced *in situ* bioremediation is currently being utilized in conjunction with the GWTS (provides hydraulic capture of dissolved plume) to remediate the more persistent areas of groundwater contamination. *Aerobic* biodegradation is being utilized to treat the petroleum-based coolant material release at the 85-105 building. *Anaerobic* bioremediation is being utilized for reductive dechlorination of TCE and its breakdown products [cis-1,2-DCE (cDCE) and VC] to non-toxic end products (ethane/ethene) in the Former Degreaser Source Control Area (Landau Associates 2012d, 2013b) and in the Downgradient Corrective Action Area (Landau Associates 2009).

The following bioremediation injections have been conducted within the Former Degreaser Source Control Area:

- 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 gallons per minute (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 (Landau Associates 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 of 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 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 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. These injection activities, completed during the reporting period, are described further in Section 3.3.

2.3.4 SOIL VAPOR EXTRACTION TREATMENT

To address soil vapor in the Former Degreaser Source Control Area, the SVE system previously utilized in the Central and West Corrective Action Areas was modified and installed during August and September 2012 (Landau Associates 2011d). The multiple-purpose wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] and three VOWs (VOW-16 through VOW-18) were installed around the former vapor degreasers, as access would allow. The multiple-purpose wells 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 SVE system consists of a control panel, rotron blower, condensate pump, knockout tank, and two 2,000-lb GAC vessels for vapor treatment. Exhaust piping was

routed from the GAC vessels to a roof stack for venting. Vapor samples are collected from the SVE system, extraction wells, and VOWs on a quarterly basis and are discussed in Section 5.3.1 of this report.

In April 2013, nine semi-permanent sub-slab vapor pins (VP-1 through VP-9) were installed around the Former Degreaser Source Control Area to monitor changes in the sub-slab interval as the SVE system continues to operate. Sub-slab vapor samples are collected from the nine vapor pins on a quarterly basis and results are also discussed in Section 5.3.1 of this report.

The SVE system started full-time operation in September 2012. Due to decreased mass recovery, DEQ approved the pilot shutdown of the system in July 2014 (DEQ 2014b). Since the pilot shutdown, quarterly soil vapor samples have been collected to monitor for potential rebound in TCE concentrations. During the November 2014 sampling event, TCE concentrations in the sub-slab interval were observed above the cleanup level; therefore, based on the DEQ-approved process (DEQ 2015), the SVE system resumed operation on January 30, 2015. SVE pilot shutdown is discussed further in Section 3.3.2.

3.0 SIGNIFICANT ISSUES, EVENTS, AND ACTIONS

This section of the report summarizes significant issues, events, and actions taken during this semiannual reporting period.

3.1 GROUNDWATER TREATMENT SYSTEM FAILURE AND RESPONSE

The GTWS and all active extraction wells were shut down between August 17 and September 11, 2014, due to problems with the air stripper tower. Packing media was found in the air stripper tower sump and the system effluent piping due to corrosion of the plate holding the tower packing media in place. The clogged GWTS effluent pipe resulted in the accumulated water inside the tower rising above the air duct level leading to the air stripper blower, which resulted in the blower malfunctioning.

Between August 25 and September 4, 2014, a temporary groundwater treatment system (TGWTS) consisting of two air stripper tray units running in parallel was installed. The TGWTS was rented from H2 Oil Recovery Equipment, Inc., and consists of two air stripper tray units (model number TS-600-3) with a combined capacity to treat between 130 to 140 gpm. Each air stripper tray unit is equipped with a 600-cubic feet per minute (CFM) blower and a 1.5 horse power (HP) transfer pump (Goulds model number 1BF11512) to route the treated groundwater to the existing effluent discharge piping. Flow meters were installed on the TGWTS influent to monitor the flow rates at each air stripper tray unit. No changes to the extraction well field or conveyance piping was required, except to modify the influent and effluent piping to bypass the air stripper tower. Full-time groundwater extraction resumed at 95 gpm on September 11, 2014 utilizing the TGWTS.

The TGWTS was connected to the existing Supervisory Control and Data Acquisition (SCADA) control system. The pH probe and flow rates are monitored through the SCADA system daily. Monthly summary reports are generated from the SCADA to evaluate if the system is operating within the National Pollutant Discharge Elimination System (NPDES) permit requirements. If measurements are outside the established variances, the SCADA will send out an alarm and automatically shut down the TGWTS. In addition, the TGWTS blowers are equipped with a low-air alarm that will also shut down the system. Prior to operation of the TGWTS, the system was tested under different scenarios to verify that the SCADA alarms were operating correctly.

Boeing is evaluating potential options to replace the currently oversized stripping tower in an effort to meet future needs and to operate in a more energy-sustainable manner. The TGWTS will remain in operation to provide hydraulic control until a final system can be designed and installed. Current project schedules anticipate the new system will be installed by the end of 2015 or early 2016.

3.2 GROUNDWATER EXTRACTION WELL OPERATION

The groundwater extraction wells were operated during 2014 with the following exceptions:

- Shut down between August 17 and September 11, 2014, due to problems with the air stripper tower, as described above (Section 3.1).
- All active extraction wells were shut down between September 19 and 25, 2014, due to a break in the conveyance line near extraction well E-5. When the GWTS was constructed in 1989, a short section of galvanized pipe was installed entering and exiting all the extraction well vaults. This short section of galvanized pipe was replaced with high-density polyethylene (HDPE) in 2010 at all active extraction wells. On September 19, 2014, water was observed seeping from the south asphalt parking lot approximately 20 ft northwest of extraction well E-5 (non-pumping extraction well). The TGWTS was shut down to allow for a phased restart of the wells to determine the source of the water. Upon completion of the field testing, a malfunctioning isolation valve was identified on the conveyance line leading to wells E-5, E-8, and E-9. Water bypassing the isolation valve was released to the subsurface through the corroded galvanized pipe at E-5. On September 25, 2014, the malfunctioning isolation valve was replaced, and manually set to shut off conveyance lines from wells E-5, E-8 and E-9 (all non-operating wells), and the TGWTS resumed operation. As a proactive step, Boeing also disconnected all non-operational extraction wells (E-5 through E-9, E-11, EW-3, and EW-13) from the conveyance system using lock out/tag out mechanisms installed on the hand/off/auto (HOA) switch at each of the electrical wellhead control panel. Future groundwater sampling (for monitoring purposes) will be conducted using a portable holding tank and manually transferring purge water to the decontamination pad for treatment through the TGWTS. If extraction pumping is required in the future from any of the currently non-operation wells (E-5 through E-9, E-11, EW-3, and EW-13), then the galvanized pipe will be replaced with HDPE and the lock out/tag out mechanisms will be removed.
- Extraction well E-12 was shut down between October 31 and November 10, 2014, due to flooding of the well vault. Surface water flooded the vault as a result of site grading activities around E-12. Upon removal of the surface water from the extraction vault, the well pump was not operational. The electrical panel inside the extraction well vault underwent troubleshooting protocol carried out by an electrician. A faulty module inside the electrical panel was replaced and the extraction well was restarted. Site development activities have altered the topography in the direct vicinity of E-12. As a result, Boeing plans to install a riser and seal the vault joints to reduce the amount of accumulated runoff.
- The SP-2 sump pump was shut down between December 15, 2014, and January 16, 2015, due to pump failure. An SP-2 sump high water level alarm was triggered on December 15, 2014. A replacement pump was ordered and was installed on January 16, 2015. During the shutdown period, accumulated water levels were monitored to ensure the sump did not overflow. On December 26, 2014, approximately 2,000 gallons of water was removed from the sump by vacuum truck to prevent overflowing. Water was transferred to the decontamination pad where it was passed through the TGWTS.

3.3 FORMER DEGREASER SOURCE AREA REMEDIATION

Remediation activities in the former degreaser source area consist of aquifer bioremediation and vadose zone soil vapor extraction.

3.3.1 BIOREMEDIATION

A combined bioremediation injection of the PRB and source area injection wells was conducted between July 11 and 17, 2014. This event constituted the third injection to PRB well BOP-74(i) and the second injection to the seven source area wells. The injection was conducted in general accordance with the work plan (Landau Associates 2014b) as approved by DEQ (DEQ 2014b). Approximately 50,000 gallons of total electron donor solution was injected. The PRB injection volume was the same as the prior injection (30,000 gallons) and the total volume injected to the multi-purpose source area wells [BOP-78(i), BOP-79(i), and BOP-84(i) through BOP-88(i)] was doubled to 20,000 gallons based on injection rates achieved during the first injection of these wells and to increase to resulting extent of treatment. Each of the seven multiple-purpose wells received approximately 2,857 gallons of donor mixture. Injection solution consisted of the following components:

- 42,455 gallons of potable water
- 1,290 gallons of Textrol BR (TBR) donor substrate, which consists of soy oil and soil lecithin surfactants
- 2,200 gallons of glycerin
- 4,145 gallons of 25% wt ferrous sulfate heptahydrate solution.

The resulting injection solution contained 2.6% vol TBR, 4.4% vol glycerin, and 8.3% vol (2% wt) ferrous sulfate. Average injection rates for the seven multiple-purpose injection wells ranged from 6.0 to 26.3 gpm. The PRB well [BOP-74(i)] was injected at 43 to 69 gpm.

The injection solution contained both fast- and slow-release electron donors, at similar concentrations to previous injections, but was modified to include glycerin and ferrous sulfate. Glycerin and TBR were substituted for the LactOil used for prior injections to achieve bioremediation in a more sustainable way. Glycerin, a fast-release donor similar to the ethyl lactate component of LactOil, is a locally produced and sustainable byproduct of biodiesel production from used fryer oil. TBR replaced the vegetable oil component of LactOil. Ferrous sulfate was added to the injection solution to promote *in situ* production of iron-sulfide minerals for abiotic degradation of TCE and cDCE through reductive elimination. Reductive elimination is a concurrent and complementary mass destruction reaction to biological reductive dechlorination.

To minimize the potential for donor material to migrate to the unsaturated SVE screened intervals, the SVE system was shut down on July 2, 2014 and packers in the multi-purpose wells were utilized. During the donor injection, packers installed between the two screen intervals in each well were inflated to approximately 40 pounds per square inch (psi) to seal off the lower aquifer injection interval from the SVE screened intervals.

3.3.2 SVE SYSTEM PILOT SHUTDOWN

The SVE system installed within the Former Degreaser Source Control Area was shut down on July 2, 2014, with DEQ approval (DEQ 2014b). The SVE system mass recovery has declined with time and VOC mass removal rates were below the shutoff criterion of 0.1 lbs/day. The SVE system remained in pilot shutdown with routine quarterly monitoring during this reporting period. Based on vapor analytical results from sub-slab interval collected during this reporting period, TCE concentrations have shown an increase to concentrations above the cleanup level. Based on the DEQ-approved process (DEQ 2015), the SVE system resumed full-time operation on January 29, 2015. Pulsed operation of the SVE system is recommended, as indicated in Section 6.0.

4.0 REMEDY PROGRESS DATA

This section of the report presents a summary of remedy progress monitoring data collected during this reporting period (July 1 through December 31, 2014), including TGA and Upper TSA groundwater quality data, groundwater level data, groundwater extraction well performance data, and GWTS effluent and influent water quality data. Activities during the first half of the year (January 1 through June 30) were reported the Semiannual Data Report (Landau Associates 2014a).

Laboratory reports and data validation memoranda for data collected during this semiannual reporting period are provided in Appendix A. Historical TGA and select Upper TSA data are presented in Appendix B.

4.1 TGA GROUNDWATER QUALITY

Groundwater quality monitoring for TGA wells and select Upper TSA monitoring wells was conducted in accordance with the Groundwater Performance Monitoring Program (Table 1). Sampling frequency for actively operated extraction wells was performed on a quarterly basis, while shut down extraction wells (non-pumping) were sampled on an annual basis. Groundwater samples from each sampling event were analyzed for VOCs and select wells were additionally analyzed for bioremediation monitoring parameters [total organic carbon (TOC), nitrate, sulfate, sulfide, total and dissolved iron, and dissolved gasses] and/or diesel-range petroleum hydrocarbons (TPH-Dx). The analytical results for the VOC COPCs at each TGA monitoring well and extraction well, select Upper TSA wells, and the GWTS are presented in Table 2. Historical TGA and Upper TSA water quality data is summarized in Appendix B, Table B-1. The interpreted extent of the dissolved VOC plume in the TGA, based on the results from August 2014 (more inclusive annual event), is shown site-wide on Figure 5 and for the Former Degreaser Source Control Area on Figure 6. TCE continues to be the predominant COPC in the TGA outside of the area of bioremediation in the Former Degreaser Source Control Area and will continue to be used to benchmark remediation progress.

The TGA dissolved-VOC plume continues to exhibit decreasing concentrations and aerial extent. Analytical results for the TGA wells indicate TCE concentrations have steadily decreased since operation of the GWTS began in March 1989. Groundwater quality for each of the Corrective Action Areas is discussed below.

4.1.1 EAST CORRECTIVE ACTION AREA

Extraction well E-8 was originally installed to assist with remediation within the East Area; however, active operation of the extraction well was discontinued in 2002 and, since its shutdown, the

well has only operated intermittently for groundwater quality monitoring, with sampling being conducted on an annual basis. Analytical results for the August 2014 sampling event indicate TCE concentrations have decreased from the historical maximum 140 µg/L (December 1991) to 7.0 µg/L, which is slightly above the MCL (5 µg/L). PCE was detected at a concentration of 5.3 µg/L, which is slightly above the MCL (5 µg/L), but below the 19 µg/L historical maximum concentration observed in September 1997. All other COPC concentrations at E-8 are below the respective MCLs.

4.1.2 EAST YARD CORRECTIVE ACTION AREA

The groundwater quality in the East Yard Corrective Action Area is currently evaluated using data from monitoring well BOP-48(i) and extraction well E-9. Active pumping at E-9 was ceased in 2002 due to low mass removal rates and is currently operated intermittently for groundwater quality sampling and maintenance purposes only. TCE concentrations at both wells have consistently been below the MCL since November 2007 for E-9 and February 2006 for BOP-48(i). Other COPC concentrations are either below the respective MCLs or the laboratory reporting limits.

4.1.3 CENTRAL CORRECTIVE ACTION AREA

August and November 2014 groundwater quality data within the Central Corrective Action Area indicate COPC concentrations were not detected at the respective laboratory reporting limits with the following exceptions:

- TCE concentrations at all wells [BOP-10(i), BOP-56(i), BOP-59(i), E-6, E-7, and DP-1] were above the MCL with concentrations ranging from 9.3 to 24 µg/L. TCE concentrations in the Central Corrective Action Area wells were highest at DP-1 (24 µg/L); however, concentrations have decreased over time at this well from the historical maximum concentration 1,000 µg/L (October 1998).
- PCE was above the MCL (5 µg/L) at BOP-10(i) at 7.8 µg/L, BOP-59(i) at 5.5 µg/L, E-6 at 17 µg/L, and DP-1 at 21 µg/L. PCE concentration trends continue to decrease within the Central Corrective Action Area with the exception of DP-1. PCE concentrations at DP-1 have historically fluctuated with concentrations above the MCL (May 2003 through February 2007) to below the MCL (May 2007 through August 2011) only to increase to above the MCL since 2012. PCE concentrations since 2012 have decreased from 24 to 16 µg/L.

4.1.4 WEST CORRECTIVE ACTION AREA

The groundwater remedy for the West Corrective Action Area is monitored at wells BOP-16(i) and BOP-57(ia, ib), and extraction wells E-5, E-11, E-15, and E-16. Specific findings of the August and November 2014 sampling events are as follows:

- TCE concentrations were reported above the MCL at BOP-16(i), BOP-57(ia), BOP-57(ib), E-5, and E-16. TCE concentrations ranged from 5.2 to 34 µg/L with the highest concentration at BOP-57(ib) at 34 µg/L.
- VC concentrations were above the MCL (2 µg/L) at monitoring well BOP-16(i) with concentrations of 2.4 and 3.7 µg/L (August and November events); and extraction well E-15 of 2.5 and 5.4 µg/L (August and November events).
- At BOP-57(ib), 1,1-DCE continued to be detected above the MCL (7 µg/L) with a concentration of 35 µg/L; however, well below the historical maximum of 56 µg/L (August 2010).

All other COPC concentrations were either below the laboratory reporting limits or detected at low levels (below the respective MCLs).

Extraction well E-16 continues to show an increasing trend in TCE concentrations above the MCL since November 2012. Well pair BOP-57(ia) (screened at the base of the TGA) and BOP-57(ib) (screened in the first layer of the CU1) are located near former supply well A-2, which was screened within the TGA and the underlying TSA before being decommissioned in 1988. The well A-2 investigation and decommissioning activities are summarized in the RFI (Landau Associates 1995b). Data from the well A-2 investigation suggested the former supply well was a conduit for contamination to migrate from the TGA to the underlying Upper TSA (i.e., contaminant source to the TSA) prior to well decommissioning. August 2014 TCE data from wells BOP-57(ia) at 18 µg/L and BOP-57(ib) at 34 µg/L continue to show a continuing decrease from the prior maximums 1,400 µg/L [August 1994, BOP-57(ia)] and 380 µg/L [August 2006, BOP-57(ib)], respectively.

4.1.5 SOUTHWEST CORRECTIVE ACTION AREA

Groundwater quality in the Southwest Corrective Action Area is characterized at monitoring well BOP-9(i). The August 2014 sample for BOP-9(i) indicates a TCE concentration of 50 µg/L, which increased from February 2014 (24 µg/L), but which remains significantly lower than the historical maximum concentration (1,600 µg/L) in January 1989. All other COPCs were either non-detect at the reporting limit or reported at low concentrations below the respective MCLs.

4.1.6 DOWNGRAIENT CORRECTIVE ACTION AREA

The groundwater remedy for the Downgradient Corrective Action Area is monitored at wells BOP-7(i), D-7(i), D-8(i), D-11(i), D-12(i), and extraction wells E-2, E-3, E-4, E-12, and E-13. Specific findings of the August and November 2014 sampling events are as follows:

- TCE concentrations at D-8(i) have steadily decreased from 570 µg/L (November 1988) to 25 µg/L in August 2014. TCE concentrations at extraction wells E-3, E-4, E-12, and E-13 ranged from 8.4 to 28 µg/L at E-13 and E-4, respectively. BOP-7(i) is located between extraction wells E-12 (northwest of well) and E-2 (southeast of well); however, like

BOP-57(ib), the well is partially screened in the low-permeable first layer of the CU1. The August and November 2014 TCE results for BOP-7(i) were 190 and 250 µg/L, respectively. TCE has decreased at BOP-7(i) from the historical maximum concentration of 1,500 µg/L (June 1990); however, concentrations remain above the MCL.

- PCE concentrations at BOP-7(i) were 5.2 and 6.8 µg/L, which are near the MCL (5 µg/L).
- 1,1-DCE concentrations at BOP-7(i) were 13 and 22 µg/L, which are above the MCL (7 µg/L).
- TCE concentrations at extraction well E-2 have been below the MCL since October 2011. The continued operation of this well is for hydraulic containment of the plume. In addition, E-2 is located within a higher permeable zone of the TGA and is located downgradient of the Former Vapor Degreaser Source Control Area. E-2 is ideally located to observe downgradient affects of the bioremediation injections in the Former Degreaser Source Control Area. Groundwater extracted at E-2 has had a more reduced redox state following the July 2014 injection, as evidenced by markedly less fouling of the well screen and pump with iron oxide precipitate and iron oxidizing bacteria. Substantial fouling of this well has occurred since 2012 due to water with reduced iron (resulting from the 2008 bioremediation injection program within the West Corrective Action Area) mixing with more aerobic water at extraction well E-2.

4.1.7 FORMER DEGREASER SOURCE CONTROL AREA

The groundwater remedy for the Former Degreaser Source Control Area is monitored at wells BOP-72(i) through BOP-88(i). Specific findings of the August and November 2014 sampling events are as follows:

- TCE concentrations at four wells [BOP-75(i), BOP-76(i), BOP-80(i), and BOP-82(i)] were above the MCL with concentrations ranging from 6.2 to 65 µg/L. This compares to 14 wells with TCE concentrations above the MCL during baseline sampling in November 2011 and February 2012 (injection wells BOP-82 through BOP-88). The highest TCE concentration was at BOP-80(i) in November. TCE concentrations at the remaining source area wells were below the MCL or not detected above the laboratory reporting limit during this reporting period. Trans-1,1-DCE (tDCE) and/or cDCE concentrations were above the MCLs at three monitoring wells. tDCE exceeded the MCL (70 µg/L) at BOP-73(i) with a concentration of 190 µg/L. cDCE concentrations were above the MCL (70 µg/L) at three monitoring wells [BOP-73(i), BOP-77(i), and BOP-80(i)]; concentrations ranged from 81 to 2800 µg/L with the highest concentration observed at BOP-73(i) during the August 2014 event. Increased concentrations of cDCE have resulted from reductive dechlorination of TCE stimulated by bioremediation injections.
- 1,1-DCE concentrations were above the MCL (7 µg/L) at BOP-80(i) with a concentration of 10 µg/L.
- VC concentrations above the MCL (2 µg/L) were reported at 11 wells [BOP-73(i) through BOP-80(i), BOP-84(i), BOP-86(i), and BOP-88(i)]. VC concentrations above the MCL ranged from 2.1 µg/L at BOP-74(i) to 1300 µg/L at BOP-73(i). Increased concentrations of VC have resulted from reductive dechlorination of TCE through cDCE stimulated by bioremediation injections.

4.1.8 COOLANT RELEASE AREA

To monitor the extent of the coolant release and to monitor the effects of the EHC-O injections, groundwater samples were collected semiannually in 2014 from three TGA coolant release monitoring wells (LAI-4, LAI-7, and LAI-8), and annually from eight monitoring wells (LAI-1 through LAI-8). Wells LAI-4 and LAI-7 are also analyzed semiannually for TGA COPCs. TPH-Dx results for groundwater from these wells are summarized in Table 3, and shown on Figure 7. Historical total TPH-Dx concentrations are summarized in Appendix B, Table B-2. TGA COPCs are summarized in Table 2 and TCE concentrations are shown on Figure 5. Historical COPC concentrations are summarized in Appendix B, Table B-1.

The coolant release area groundwater analytical results for COPC (petroleum hydrocarbons and VOCs) were as follows:

- TCE and PCE were detected above their MCLs at monitoring well LAI-7 at 6.8 µg/L and 9.7 µg/L in August 2014, respectively.
- TPH-Dx was detected above the site-specific cleanup level (1.35 mg/L) at monitoring wells LAI-1 (2.78 mg/L) and LAI-4 (5.90 mg/L) during the August sampling event.

4.2 UPPER TSA GROUNDWATER QUALITY MONITORING DATA

Per the Consent Order, TSA 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)] were reviewed to evaluate possible migration of groundwater from the TGA downward through the CU1 to the underlying Upper TSA. The VOC analytical results from the August 2014 event are summarized in Table 2 and the TCE concentrations are shown on Figure 5. Historical TSA water quality data for the above-mentioned wells are summarized in Appendix B, Table B-1.

TCE concentrations at the six Upper TSA wells were either below the reporting limit or below the MCL, with the exception of BOP-61(ds). The TCE concentration at BOP-61(ds) was just above the MCL at 6.2 µg/L during the August 2014 sampling event, which is within the normal range for the past 3 years (see historical data in Appendix B). TGA wells located upgradient of BOP-61(ds) include E-9 and BOP-48(i), where TCE results are near the reporting limit and do not indicate a source for the observed concentrations at BOP-61(ds). 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 Cleanup project.

4.3 TGA GROUNDWATER LEVEL MONITORING

Groundwater levels in the TGA and Upper TSA wells measured during the August and November 2014 sampling events are presented in Table 4. The more inclusive August 2014

measurements were used to develop the water level contours presented on Figure 8. The TGA groundwater flow continues to be observed toward the northwest. Observations from the data area as follows:

- Groundwater contour data indicate that the active pumping at extraction wells in the Downgradient Corrective Action Area (E-2, E-3, E-4, E-12, and E-13), Central Corrective Action Area (DP-1), and West Corrective Action Area (E-15 and E-16) continue to be effective in maintaining an inward hydraulic gradient and capture of the TGA plume.
- An upward vertical gradient was observed at each of the six Upper TSA wells [BOP-22R(ds), BOP-60(ds), BOP-61(ds), BOP-62(ds), BOP-65(ds), and BOP-66(ds)] compared to the corresponding nearby TGA well.

4.4 FORMER DEGREASER SOURCE AREA-VAPOR DATA

During the Former Degreaser Source Area investigations, vapor sampling was conducted within the sub-slab interval and throughout the vadose zone. The results of the investigations indicated the highest at-depth vapor concentrations were observed between 45 to 60 ft BGS. At-depth vapor TCE concentrations ranged from 340 to 230,000 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Baseline TCE concentrations within the sub-slab interval ranged from 3,200 to 850,000 $\mu\text{g}/\text{m}^3$. Based on investigation vapor results above the screening level for TCE (2,900 $\mu\text{g}/\text{m}^3$) and above the hot spot evaluation criteria (290,000 $\mu\text{g}/\text{m}^3$), the existing site liquid-phase SVE system was modified for vapor treatment and installed within the source area, as shown on Figure 9. Vapor sampling is performed at-depth within the vadose zone and sub-slab.

Vapor samples are collected at-depth within the vadose zone from vapor observation wells (VOW) and SVE wells. At-depth concentrations for the reporting period are summarized in Table 5 and TCE concentrations are shown on Figure 9. During the August and November 2014 sampling events, at-depth TCE vapor concentrations ranged from not detected at the laboratory reporting limit (6.2 $\mu\text{g}/\text{m}^3$) at BOP-86(i) to 5,700 $\mu\text{g}/\text{m}^3$ at BOP-84(i).

Sub-slab vapor sample results are summarized in Table 6 and TCE concentrations are shown on Figure 10. During the August and November 2014 sampling events, TCE vapor concentrations in the sub-slab interval ranged from 130 $\mu\text{g}/\text{m}^3$ (VP-4) to 260,000 $\mu\text{g}/\text{m}^3$ (VP-5).

Historical vapor data for the source area is included in Appendix B. At-depth vapor data is presented in Table B-3. Sub-slab vapor data is presented in Table B-4.

5.0 SYSTEM PERFORMANCE EVALUATION

This section evaluates the performance of the various corrective measures.

5.1 GROUNDWATER EXTRACTION SYSTEM

As noted in Section 3.1, problems with the air stripper tower in August 2014 resulted in installation of a TGWTS and bypass of the air stripper tower. The TGWTS started full-time operation on September 11, 2014.

Groundwater extraction system monitoring data includes VOC analytical data from sampling the discharge of each TGA extraction well and extraction well flow rate data. The actively operated extraction wells (E-2, E-3, E-4, E-12, E-13, E-15, E-16, and DP-1), along with shutdown well E-11, were sampled quarterly during the reporting period and flow rate data were collected monthly. The shutdown extraction wells (E-5 through E-9) are sampled on an annual basis. These data are presented and evaluated in this section in terms of an average daily mass removal rate in pounds per day (lbs/day), total gallons extracted at each extraction well, and the average yield in gallons per minute (gpm) for each extraction well.

Average total mass removal rates (lbs/day) of VOCs (TCE, PCE, TCA, and total DCE) from each TGA groundwater extraction well for 2014 are presented on Figure 11. The mass removed for other COPCs is not presented because the constituents contributed less than 10 percent of the total VOC mass removed. Extraction well E-13, located in the Downgradient Corrective Action Area, continues to provide the highest average mass removal rate (0.0125 lbs/day), compared to the other TGA extraction wells, which range from 0.004 lbs/day (E-4 and E-16) to 0.0038 lbs/day (DP-1).

Data from each extraction well is provided for evaluation of the GWTS and the TGWTS performance. The average pump rates are based on the total gallons removed during each measurement period divided by the number of minutes in the measurement period that the well was actively pumping. The average pump rate for each operating extraction well is summarized in Table 7. Well E-15 had the lowest average pump rate during this reporting period (between 0.06 and 0.95 gpm), while E-13 continues to pump at the highest average rate (between 59.89 and 115.40 gpm). Extraction wells E-5 through E-9 have been shut down since 2002, with the exception of brief operation for sample collection and maintenance. Extraction well E-11 has been shut down since it was utilized in the 2008 *in situ* bioremediation injection; this well continues to indicate elevated TOC concentrations (24 mg/L in November 2014) and is recommended to remain shut down (Table 7).

TSA extraction wells EW-3, EW-13 and EW-22 were routed through the GTWS; however, with DEQ approval (DEQ 2009b), TSA extraction wells EW-3 and EW-13 were shut down in 2009.

Extraction well EW-22 was decommissioned in March 2010. The treatment system has been operating since 1989 and has extracted approximately 4,525 million gallons and removed a total of 4,289 lbs of VOC mass from the TGA aquifer, as shown on Figure 12.

In compliance with Boeing Portland's NPDES permit (NPDES number 101761), quarterly samples of the GWTS/TGWTS effluent were collected for chemical analysis. The analytical results for the August and November 2014 events are summarized in Table 2. TCE concentrations for the system influent ranged from 8.8 to 11 µg/L during this reporting period, while the system effluent remained below the laboratory reporting limits. All the NPDES permit requirements were met during this semiannual reporting period.

5.2 COOLANT RELEASE-AEROBIC BIOREMEDIATION

With the exception of well LAI -1 and LAI-4, TPH-Dx is either not detected at the laboratory reporting limits or below the site-specific cleanup level (1.35 mg/L) at coolant release monitoring wells. Prior to treatment, the TPH-Dx cleanup level was exceeded at wells LAI-5, LAI-6, LAI-7, and LAI-8 in addition to wells LAI-1 and LAI-4. However, well LAI-6 has been below the cleanup level since 2007, LAI-5 since 2006, and LAI-7 since 2008. Total TPH-Dx concentrations at LAI-8 have frequently been above the cleanup level since injections began; however, dry conditions at this well since November 2011 have prevented the collection of data from this well. TPH-Dx concentrations remain above the cleanup level at LAI-4, where TPH impacts have been most persistent. Total TPH-Dx concentrations at LAI-4 were initially 31,800 mg/L (September 2006); however, after six EHC- O™ injections (February 2008, October 2008, June 2010, June 2011, April 2012, and April 2013), concentrations decreased to near the laboratory reporting limit. Since the last injection, TPH-Dx concentrations have slowly, but steadily, increased to 5.9 mg/L (August 2014). Total TPH-Dx concentrations at LAI-1 have been below the cleanup level since 2007. However, during this reporting period, TPH-Dx was detected at LAI-1 at a concentration above the cleanup level (2.78 mg/L in August 2014).

The increase in TPH-Dx concentration at LAI-1 and LAI-4 indicates that another EHC-O injection is warranted. The last EHC-O injection was conducted in April 2013. Current project schedules indicate an EHC-O injection will be conducted in Spring 2015.

5.3 FORMER DEGREASER SOURCE CONTROL AREA

The additional corrective measure utilized at the Former Vapor Degreaser Source Control Area includes the operation of a SVE system, to address vapor concentrations in both the sub-slab interval and the deeper vadose zone, and the stimulation of *in situ* bioremediation to address VOC concentrations in the groundwater.

5.3.1 SVE SYSTEM

SVE system influent analytical results since system startup in September 2012 indicate that the majority of the TCE mass removal (0.74 lbs) occurred within the first 2 months of operation. During this semiannual reporting period, the SVE system was not operational due to an approved pilot shutdown in July 2014 to evaluate potential rebound of soil vapor concentration. Before pilot shutdown, the SVE system removal rate ranged from 0.001 to 0.008 lbs/day during the first half of 2014; approximately 0.74 lbs of total VOC was removed. To date, a cumulative total VOC mass of 4.3 lbs has been removed from the vadose zone.

The November 2014 analytical results indicate rebound of TCE concentrations within the sub-slab interval and at the deeper vadose zone wells. Following the 6 month pilot shutdown, rebound of TCE concentrations was not unexpected and the SVE system resumed operation on January 29, 2015 with DEQ approval (DEQ 2015). Based on the current data, quarterly monitoring of sub-slab and at-depth soil vapor will continue; the SVE system will continue to operate in a pulse-pump operation mode. The cycle time of the pulse-pump operation will be based on quarterly vapor sample results from the monitoring wells and sub-slab vapor points.

5.3.2 AQUIFER BIOREMEDIATION

Aquifer bioremediation at the Former Degreaser Source Area 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)] located closer to the former degreasers. PRB injections occurred in 2011 and 2012 with an additional injection conducted during July 2014. Injection of the seven multiple-purpose wells was first performed in July 2013 and a second injection was conducted in July 2014 (concurrent with the PRB injection). Well locations and estimated ROI are shown on Figure 13.

As designed, the PRB injections and multiple-purpose source area well injections have resulted in a commingled treatment zone with overlapping ROI of injected donor. The PRB ROI extends from injection well BOP-74(i) to overlap with the ROI from upgradient multiple-purpose injection wells. Following the 2012 PRB injection, elevated TOC observed at nearby monitoring wells and upgradient multiple-purpose injection wells (first injected in 2013) indicated an approximate PRB ROI of 70 ft; the volume and expected ROI of the July 2014 PRB injection is the same. ROI of multi-purpose wells is 10 to 15 ft based on injection volumes and observations at non-injected wells BOP-72(i) and BOP-76(i). The combined treatment zone of overlapping ROI is approximately 140 ft wide (north to south) and 150 to 160 ft thick (east to west), as shown on Figure 13. Increased TOC at well BOP-75(i) following the July 2013 injection (multi-purpose wells only) and July 2014 injection (PRB and multi-purpose wells)

indicates that overlapping injection ROI extend to this well. The progress of the bioremediation remedy within the immediate source zone 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. The presence of injected donor and enhanced aquifer redox conditions for bioremediation are indicated by increasing TOC, ferrous iron, sulfide, and methane; and decreasing nitrate and sulfate. Evaluation of ferrous iron and sulfate data must also take into account increases in both due to inclusion of ferrous sulfate in the injection fluid for the July 2014 injection. Bioremediation monitoring data for the Former Degreaser Source Control Area are summarized in Table 8. The following highlight some observations of enhanced biodegradation in and downgradient of the source zone:

- Enhanced dechlorination, evidenced by decreasing concentrations of TCE concurrent with increasing concentrations of breakdown products, is observed at most wells:
 - TCE concentrations exceed the MCL at 4 of 17 wells monitored within and downgradient of the source area, compared to the earlier data (baseline sampling in November 2011 and February 2012) where 14 of 17 wells reported TCE concentrations above the MCL. Following the July 2014 injection, TCE concentrations have generally decreased. A notable exception is downgradient well BOP-81(i) where TCE and breakdown products increased in November due to enhanced desorption following the July injection.
 - With the exception of downgradient wells BOP-82(i) and BOP-83(i), the predominant COPC at the 17 monitored wells has transitioned from the parent product TCE to breakdown products (cDCE and VC) or end products (ethene and ethane). This is a 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., COPC with the highest molar fraction) in Table 8.
- Following injection events, TCE concentrations often increase as a result of enhanced desorption of mass from the aquifer soil. Notable concentration increases due to enhanced desorption have occurred at well BOP-73(i) in the source zone and at downgradient well BOP-80(i) following injection events. 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. The increasing concentrations of TCE, cDCE, and VC observed at downgradient well BOP-80(i) in November and TGA 2014 are the result of enhanced desorption in the source zone.
- Aquifer redox conditions have become more reducing due to bioremediation injections. This is evidenced by a decrease in baseline nitrate detections, increased ferrous iron and methane, and decreased sulfate.
- Five of the 13 monitored source area wells are monitoring wells that are not injected with electron donor. These dedicated monitoring locations consist of BOP-72(i), BOP-73(i), BOP-75(i), BOP-76(i), and BOP-77(i). 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. The highest TCE concentrations in the source area 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 due to donor injections has been very substantial and beneficial at this well. Peak concentrations of TCE (17,000 µg/L), cDCE (20,000), and VC (13,000) have been 2 orders of magnitude higher than the baseline TCE concentration (560 µg/L) detected prior to donor injections.
- Concentrations of TCE and breakdown products dropped substantially in November, suggesting that the period of enhanced desorption may be nearing an end. For the first time since monitoring began at this well, TCE was below the MCL in August and November.
- Initial TCE predominance on a molar basis (evaluated by molar fraction) has transitioned to predominance of cDCE, VC, and end product ethene. The non-toxic end product ethene, which was not detected during baseline sampling, increased to a maximum of 730 µg/L in August. Ethene was predominant over TCE and breakdown products in August and November with a molar fraction of 0.82 and 0.44 (i.e., 82 and 44 percent of total ethenes), respectively (Table 8).
- Enhanced desorption and the progression of TCE reductive dechlorination through breakdown products to end products is evident on a time versus concentration plot for BOP-73(i) groundwater presented on Figure 14. 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.
- The progression of TCE predominance to ethene+ethane predominance is evident in the molar fraction plot presented on Figure 15. The baseline condition (October 2010) of mostly TCE with some cDCE progresses through repeated enhanced desorption events (i.e., increased TCE) to mostly cDCE (February 2014), mostly VC (August 2014), and mostly ethene+ethane (November 2014).
- The occurrence of substantial desorption followed by sequential reductive dechlorination of TCE through breakdown products to the non-toxic end product ethene demonstrates that optimal conditions for source area biotreatment have been achieved.

The treatment zone also extends downgradient due to donor transport by groundwater flow. The downgradient extent of treatment includes downgradient wells BOP-80(i), BOP-81(i), and BOP-82(i). The downgradient treatment zone is evidenced by increased TOC concentrations following injection events and more reduced redox conditions consisting of decreased sulfate (increased following the July 2014 injection of ferrous sulfate) and increased methane. Increases in TCE, cDCE, VC, and ethane have been observed at downgradient well BOP-80(i), including in November 2014. At well BOP-81(i), TCE, cDCE, and VC have remained low to not detected, but ethane has been periodically detected. Increased TOC in August and elevated methane since February indicate inclusion of well BOP-82(i) in the downgradient treatment zone. 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 2.1 µg/L in November; this well is considered

to be outside of the downgradient treatment zone, but within an area of concentration reduction resulting from donor injections. The downgradient extent of treatment is shown on Figure 13.

Ongoing periodic injections of donor substrates will be required to maintain adequate electron donor and the required reduced aquifer redox conditions for continued treatment of TCE and breakdown products in the source area. TCE has diffused into the low-permeability confining layer between the TGA and the underlying Upper TSA due to dense nonaqueous phase liquid (DNAPL) historically extending to the base of the TGA. Treatment of this TCE mass within the low-permeability aquitard will require an extended period of treatment and aquifer treatment occurring immediately above and extending into the confining layer (Landau Associates 2011b). Bioremediation of the TGA will substantially decrease levels of TCE in groundwater immediately above the confining layer, resulting in enhanced desorption/diffusion of TCE from the confining layer. Annual injections to the PRB [well BOP-74(i)] and multiple-purpose injection wells are anticipated for the near future. Current project schedules indicate a bioremediation injection will be conducted in Summer 2015.

6.0 RECOMMENDATIONS

This section presents recommendations based on the data and evaluations presented in this report.

Recommendations include:

- Continued water quality and soil vapor monitoring.
- Continued operation of the temporary groundwater extraction system until a permanent system has been installed (scheduled for end of 2015 or early 2016).
- Additional EHC-O injection in the Coolant Release Area to address rebound in TPH-Dx concentrations at wells LAI-1 and LAI-4. The existing EHC-O work plan will be updated and submitted to Ecology for review prior to the injection. The current anticipated schedule for the EHC-O injection is Spring 2015.
- Continued annual electron donor injections to maintain enhanced bioremediation in the Former Degreaser Source Control Area. The PRB and source area wells will be injected concurrently during future injection events. Modifications to the prior electron donor injection approach and quantities will be detailed in a subsequent work plan addendum. The current anticipated schedule for injection is Summer 2015.
- Continued pulse-pump operation of the SVE system in the Former Degreaser Source Control Area. The cycle interval of the operation will be based on analytical results from the sub-slab vapor points and the at-depth vapor samples collected from the multiple-purpose vadose screened wells.

6.1 GROUNDWATER MONITORING PROGRAM MODIFICATIONS

Monitoring program modifications include recommended changes to the monitoring well network, such as well installations and well decommissions. Based on the criteria for well decommissioning, we recommend that wells BOP-11(i), BOP-12(i), DPO-2, and DP-4 be decommissioned. Well BOP-11(i) is located within a Boeing easement along the western property boundary and the other wells are located on the Boeing facility. Analytical results for BOP-11(i) have consistently been not detected at the laboratory reporting limits, and subsequently the well was removed from the monitoring program in 1997. Wells DPO-2 and DP-4 were initially installed as part of a dual-phase extraction system pilot test and were never used for groundwater quality monitoring purposes. Well BOP-12(i) is located south of Building 85-105 and was removed from the monitoring program in 2009 due to consistent TCE results below the laboratory reporting limit since 1994.

We further recommend that groundwater quality sampling frequency at E-11 be modified from quarterly to an annual basis. Extraction well E-11 was shut down in 2008 to allow for the well to be utilized in the large-scale bioremediation injection program and we recommend continued shutdown due to continued elevated TOC concentrations (Section 5.1). Quarterly groundwater sampling has been conducted at E-11 to determine if the well is suitable for resumed extraction operation. The site hydraulic

capture is currently managed with the existing operating wells (E-2, E-3, E-4, E-12, E-13, E-15, E-16, and DP-1); therefore, the operation of E-11 is not required to maintain hydraulic control.

The sampling frequency at Upper TSA well BOP-65(ds) was modified from semiannual to annual as part of the East Multnomah Cleanup project. We recommend that continued monitoring of this well to evaluate potential for downward migration from the TGA be modified from the current semiannual frequency to an annual frequency. This recommendation to the groundwater monitoring program is shown in Table 1.

6.2 REPORT SCHEDULE MODIFICATIONS

Due to the mature nature of the TGA remediation program, we recommend future reporting to be conducted on an annual basis instead of the existing semiannual basis. We propose the annual report be prepared to cover activities through a calendar year, with the report being slated for submittal to DEQ within 75 days following the end of the year, per the Consent Order.

7.0 USE OF THIS REPORT

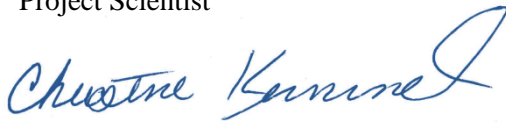
This report has been prepared for the exclusive use of Boeing for specific application to the TGA remedy at the Portland facility. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Landau Associates. 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.

This document has been prepared under the supervision and direction of the following key staff

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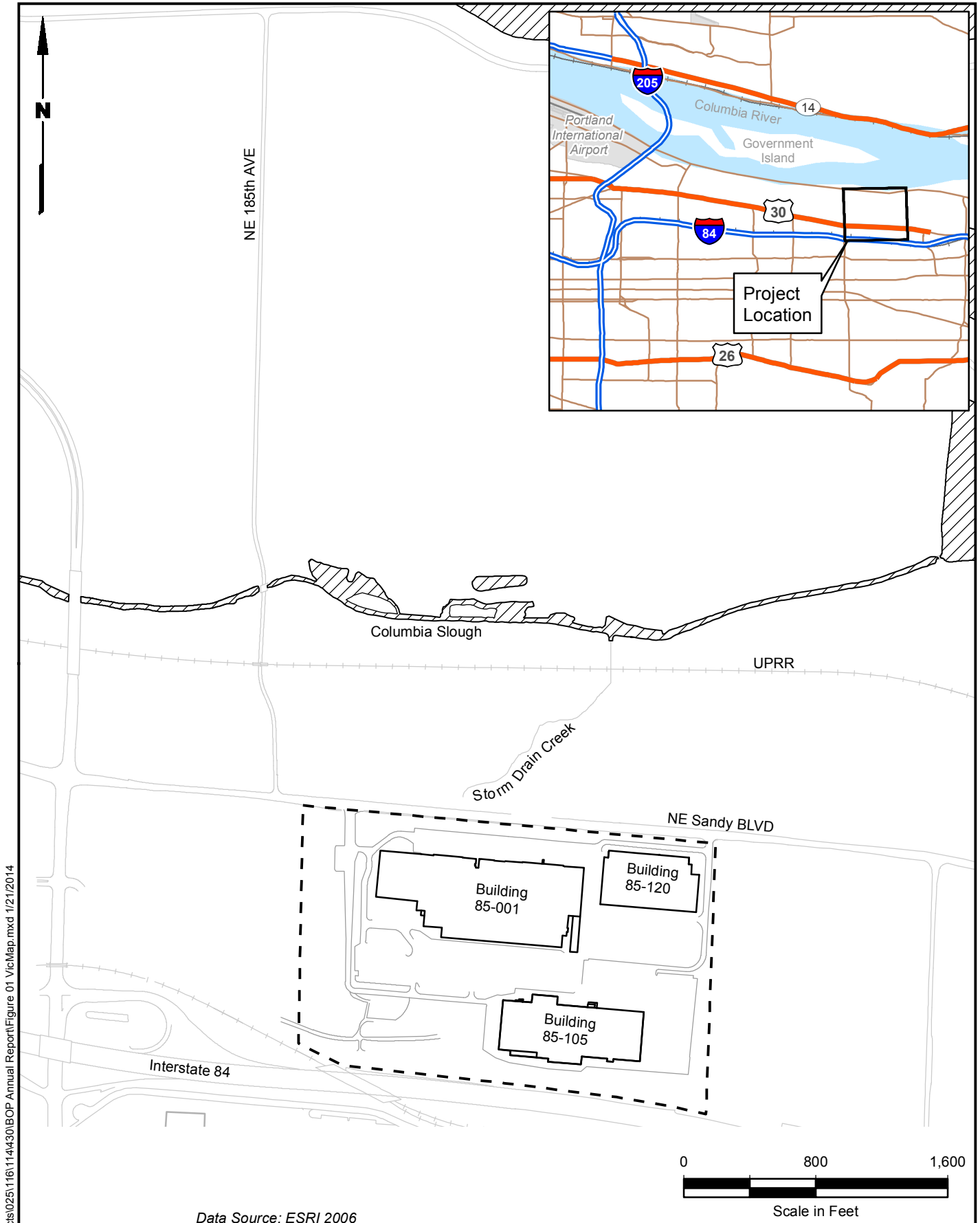
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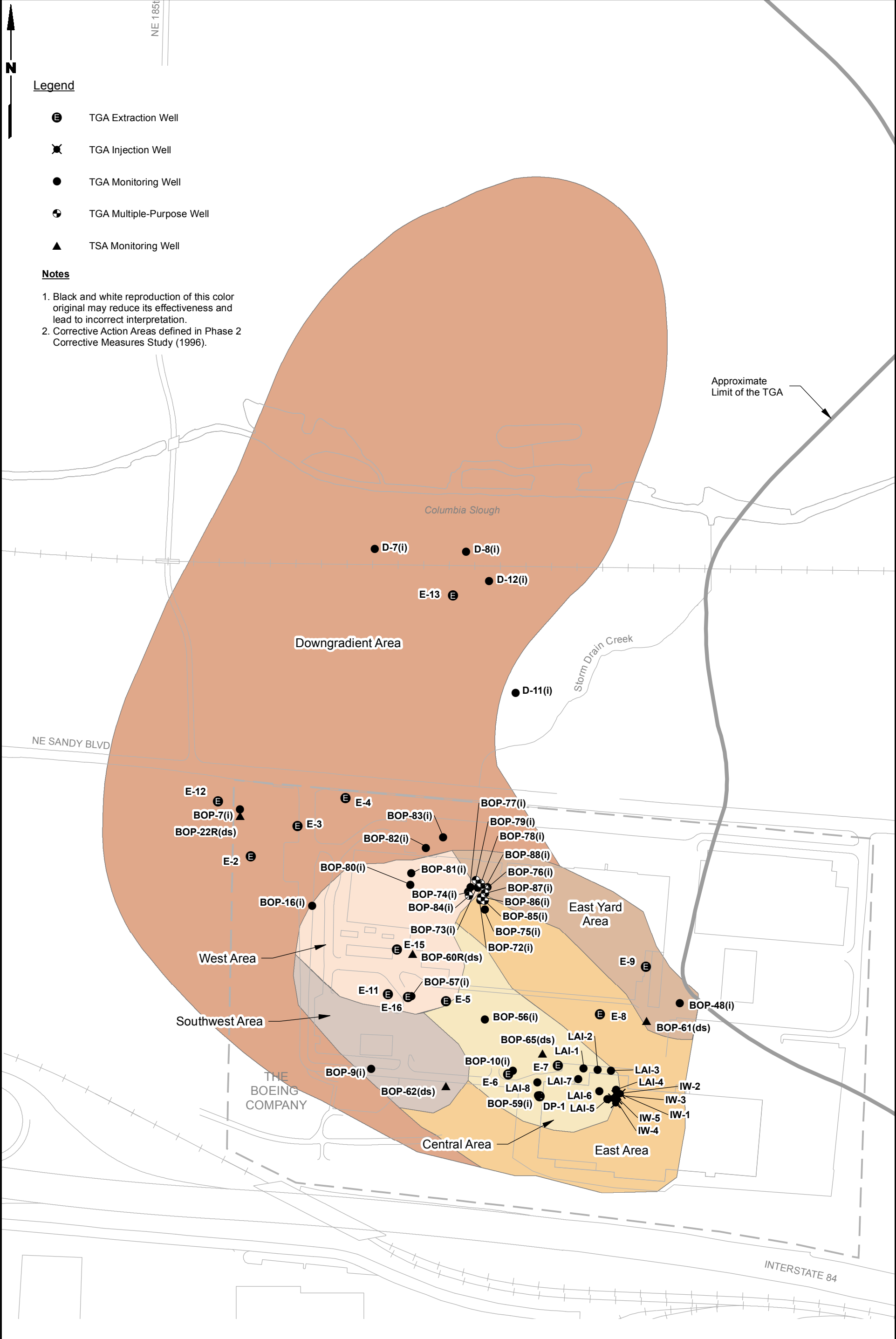
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Data Source: ESRI 2006

Scale in Feet



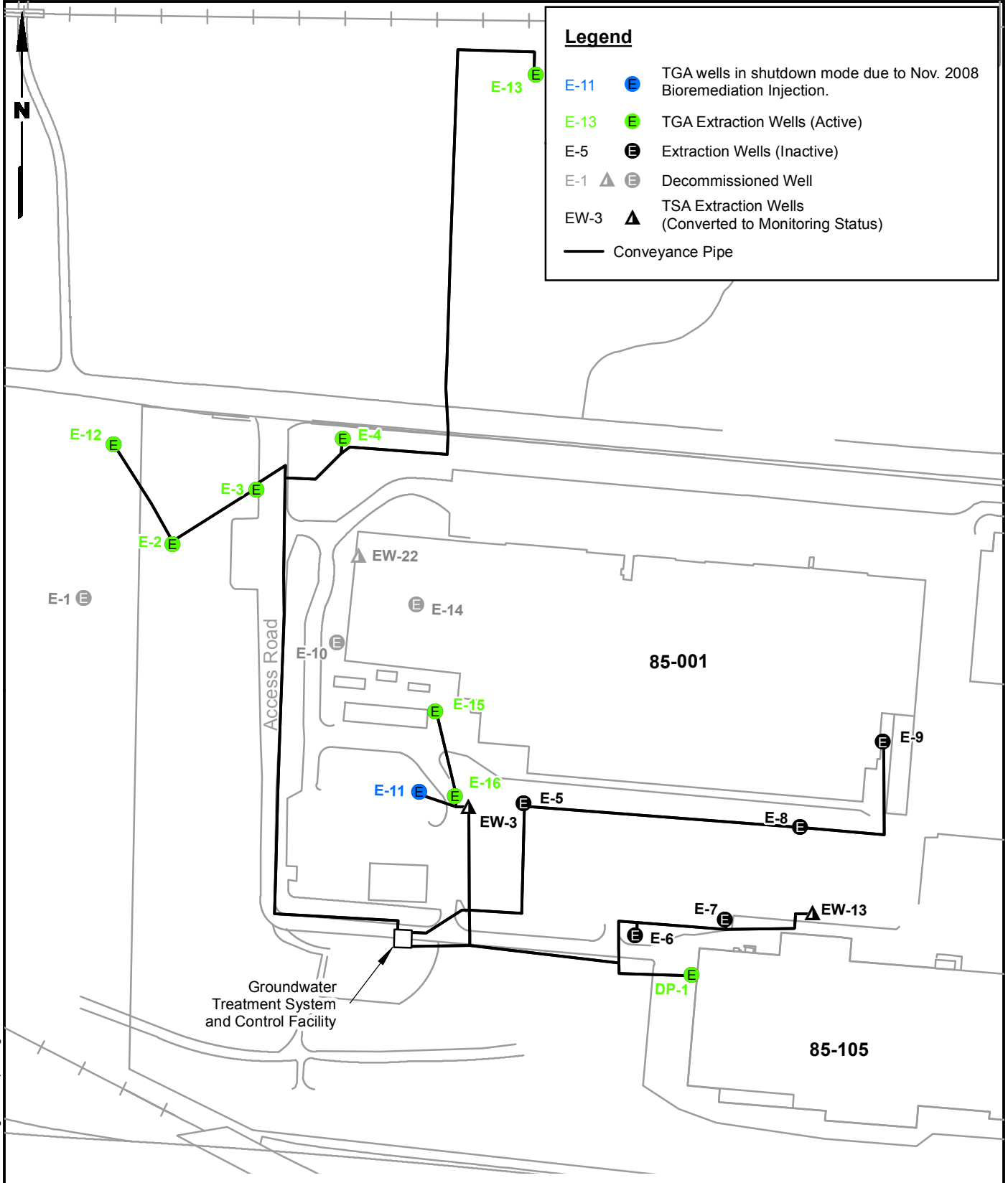
Legend

- ⊖ TGA Extraction Well
- ⊗ TGA Injection Well
- TGA Monitoring Well
- ⊕ TGA Multiple-Purpose Well
- ▲ TSA Monitoring Well

Notes

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

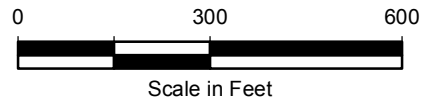
Approximate Limit of the TGA



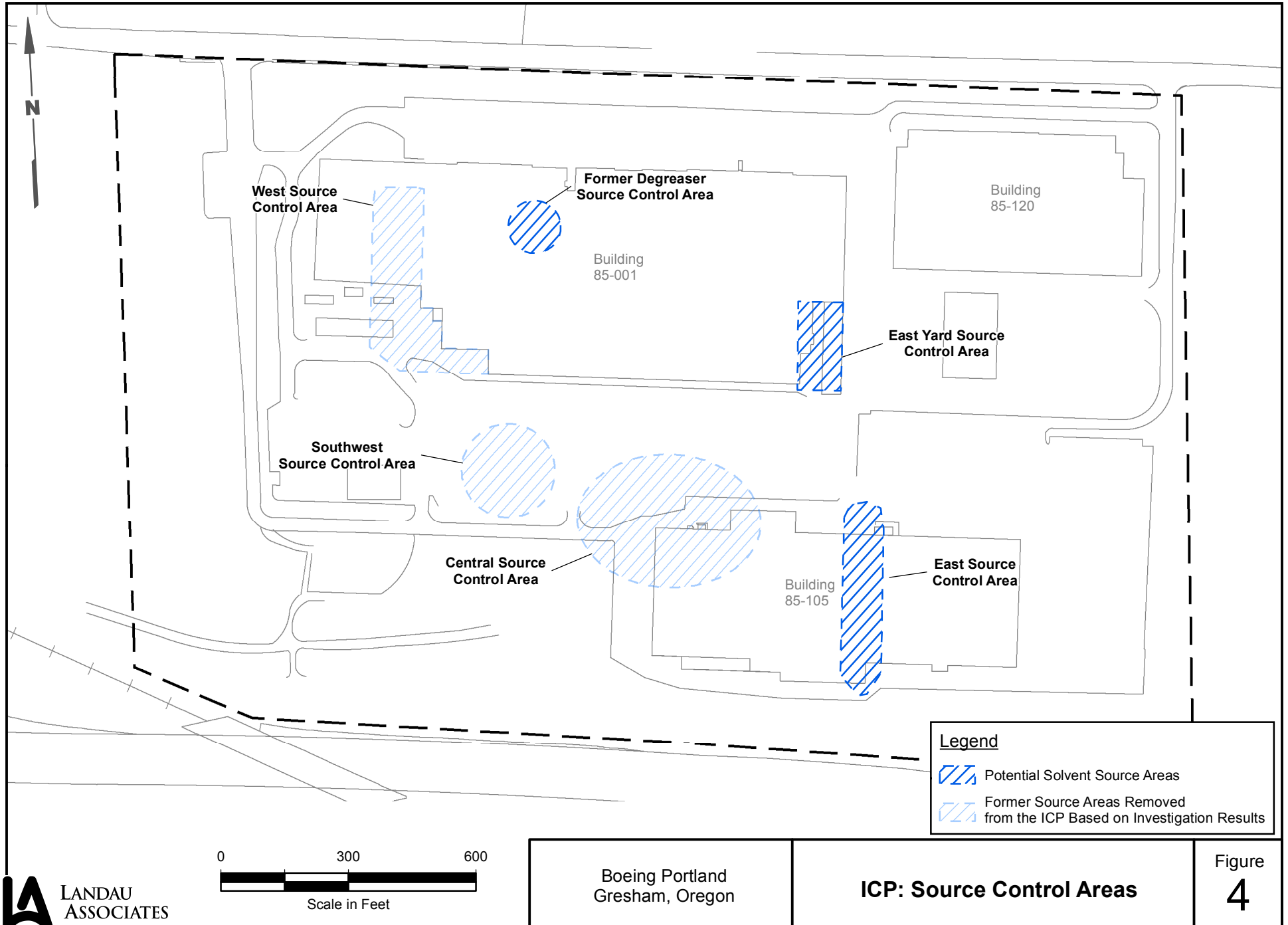
Legend

- E-11 TGA wells in shutdown mode due to Nov. 2008 Bioremediation Injection.
- E-13 TGA Extraction Wells (Active)
- E-5 Extraction Wells (Inactive)
- E-1 Decommissioned Well
- EW-3 TSA Extraction Wells (Converted to Monitoring Status)
- Conveyance Pipe

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



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Legend

- ⊕ E-13 TGA Extraction Well
- D-12 TGA Monitoring Well
- ⊕ BOP-78(i) TGA Multiple Purpose Well
- ▲ BOP-62(ds) Upper TSA Monitoring Well
- 5— Approximate August 2014 TCE Concentration Contour (µg/L) and MCL

Notes

ND = Not detected above the reporting limit
 MCL for TCE = 5.0 µg/L

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 the most recent annual sampling event.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Approximate Limit of the TGA

Columbia Slough

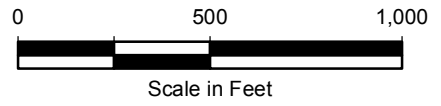


D-7(i) 1.3
 D-8(i) 25
 D-12(i) 2.7
 E-13 8.4
 D-11(i) 0.6

See Figure 6 for Former Vapor Degreaser Source Area TCE Groundwater Concentrations

E-12 11
 BOP-7(i) 190
 BOP-22R(ds) ND
 E-3 10
 E-4 25
 E-2 2.4
 BOP-16(i) 6.2
 E-15 0.5
 BOP-60R(ds) ND
 E-5 5.2
 BOP-56(i) 23
 E-9 0.5
 BOP-65(ds) 2.1
 BOP-48(i) 0.4
 E-11 0.2
 E-16 13
 BOP-57(ia) 18
 BOP-57(ib) 34
 BOP-9(i) 50
 BOP-62(ds) 0.4
 E-6 17
 BOP-10(i) 14
 E-7 19
 BOP-66(ds) 3.3
 BOP-61(ds) 6.2
 BOP-68(i) 7.0
 LAI-4 0.7
 DP-1 24
 LAI-7 6.8
 BOP-59(i) 9.4

Highway I-84



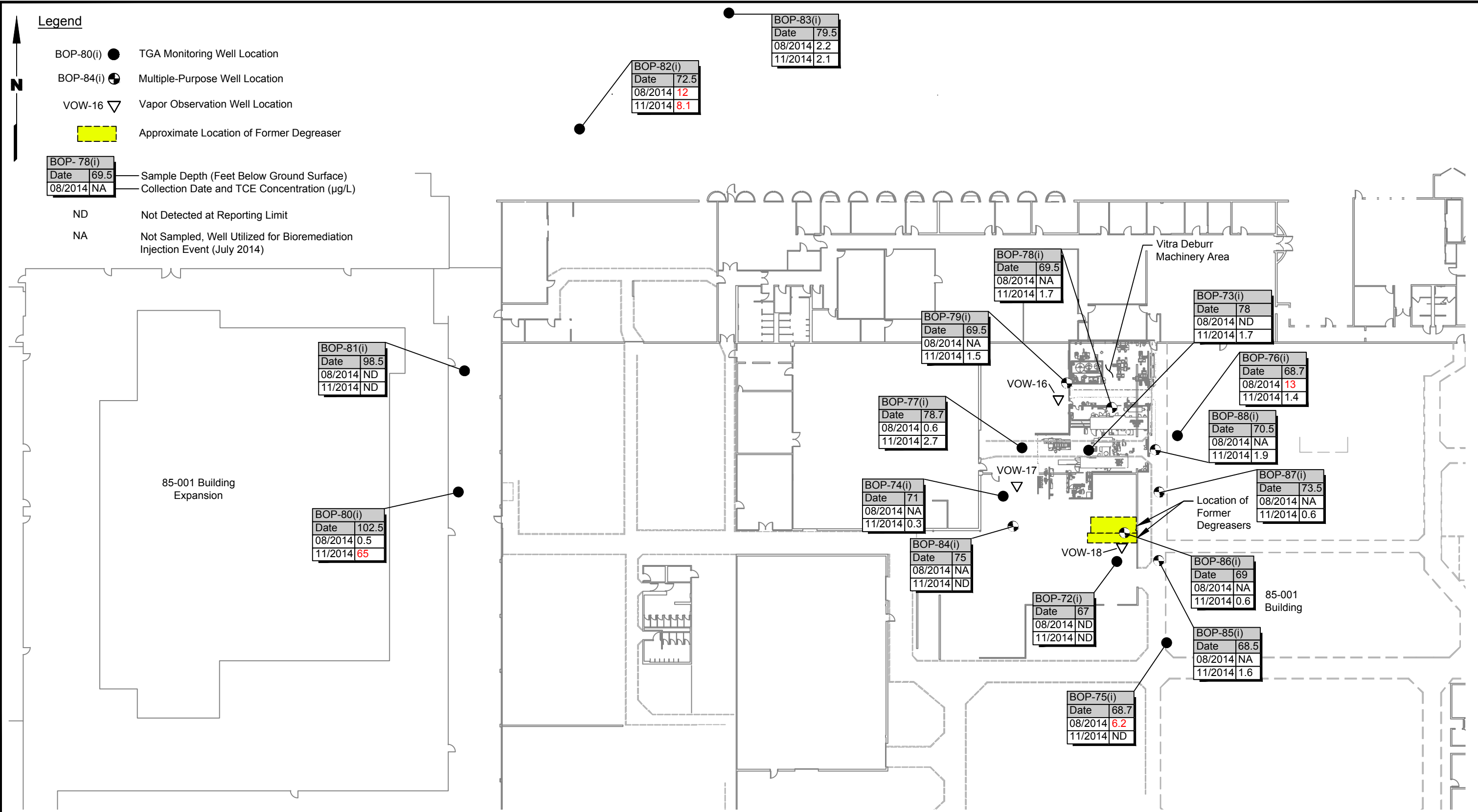
G:\Projects\025116\114430\2014 Prog-Perf Report\Figure 05 TCE Concentrations August.mxd 1/7/2015 NAD 1927 StatePlane Oregon North FIPS 3601



Boeing Portland
 Gresham, Oregon

**TCE Groundwater Results in TGA
 August 2014**

Figure
5



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

BOP-78(i)	
Date	69.5
08/2014	NA
11/2014	1.7

— Sample Depth (Feet Below Ground Surface)
— Collection Date and TCE Concentration (µg/L)

ND Not Detected at Reporting Limit
NA Not Sampled, Well Utilized for Bioremediation Injection Event (July 2014)

BOP-81(i)	
Date	98.5
08/2014	ND
11/2014	ND

BOP-80(i)	
Date	102.5
08/2014	0.5
11/2014	65

BOP-82(i)	
Date	72.5
08/2014	12
11/2014	8.1

BOP-83(i)	
Date	79.5
08/2014	2.2
11/2014	2.1

BOP-78(i)	
Date	69.5
08/2014	NA
11/2014	1.7

BOP-79(i)	
Date	69.5
08/2014	NA
11/2014	1.5

BOP-73(i)	
Date	78
08/2014	ND
11/2014	1.7

BOP-76(i)	
Date	68.7
08/2014	13
11/2014	1.4

BOP-77(i)	
Date	78.7
08/2014	0.6
11/2014	2.7

BOP-88(i)	
Date	70.5
08/2014	NA
11/2014	1.9

BOP-74(i)	
Date	71
08/2014	NA
11/2014	0.3

BOP-87(i)	
Date	73.5
08/2014	NA
11/2014	0.6

BOP-84(i)	
Date	75
08/2014	NA
11/2014	ND

BOP-86(i)	
Date	69
08/2014	NA
11/2014	0.6

BOP-72(i)	
Date	67
08/2014	ND
11/2014	ND

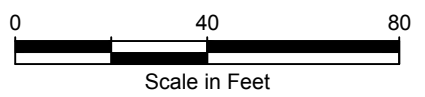
BOP-85(i)	
Date	68.5
08/2014	NA
11/2014	1.6

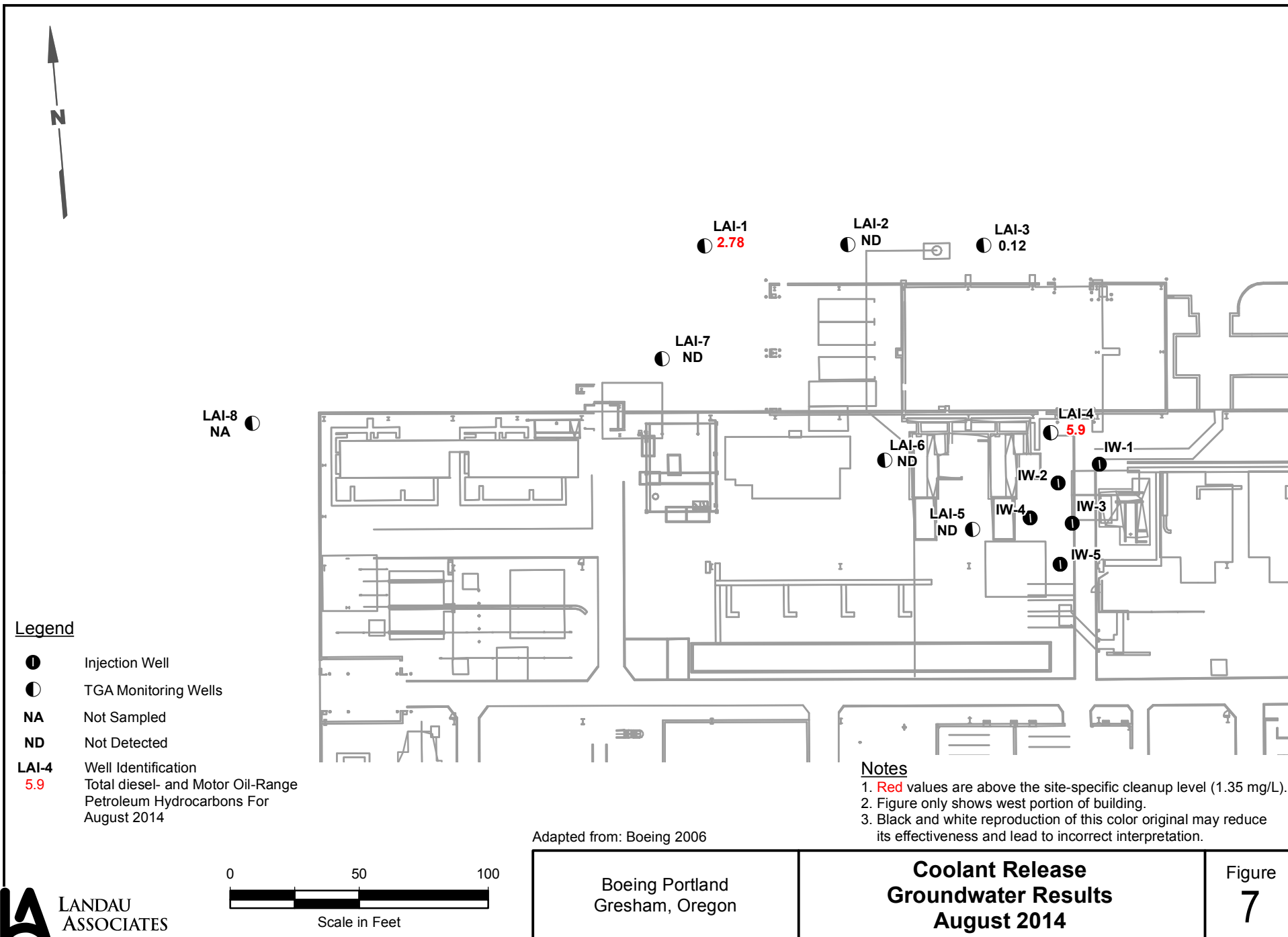
BOP-75(i)	
Date	68.7
08/2014	6.2
11/2014	ND

Notes

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

Data Source: The Boeing Company



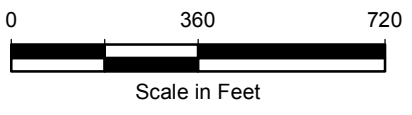
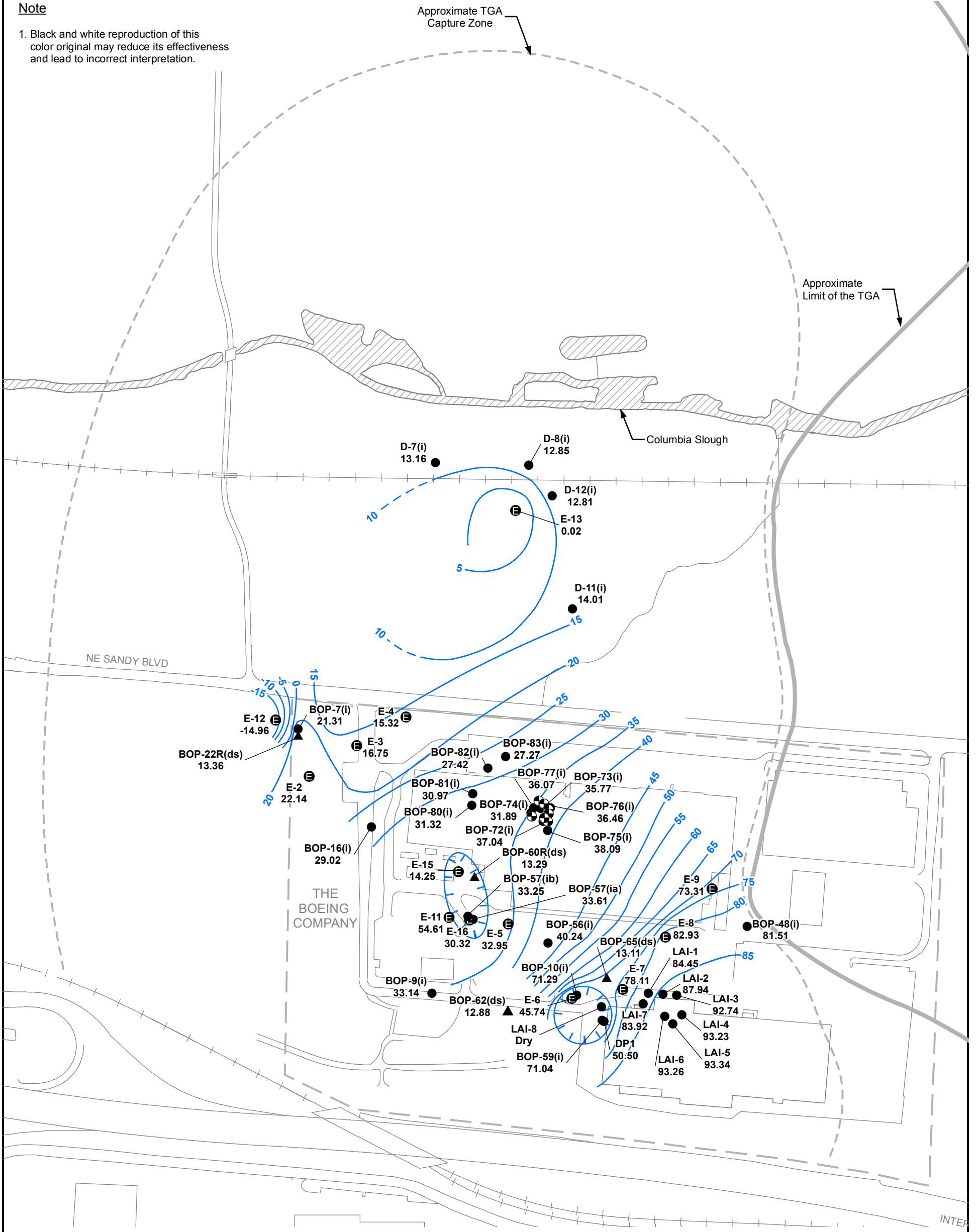


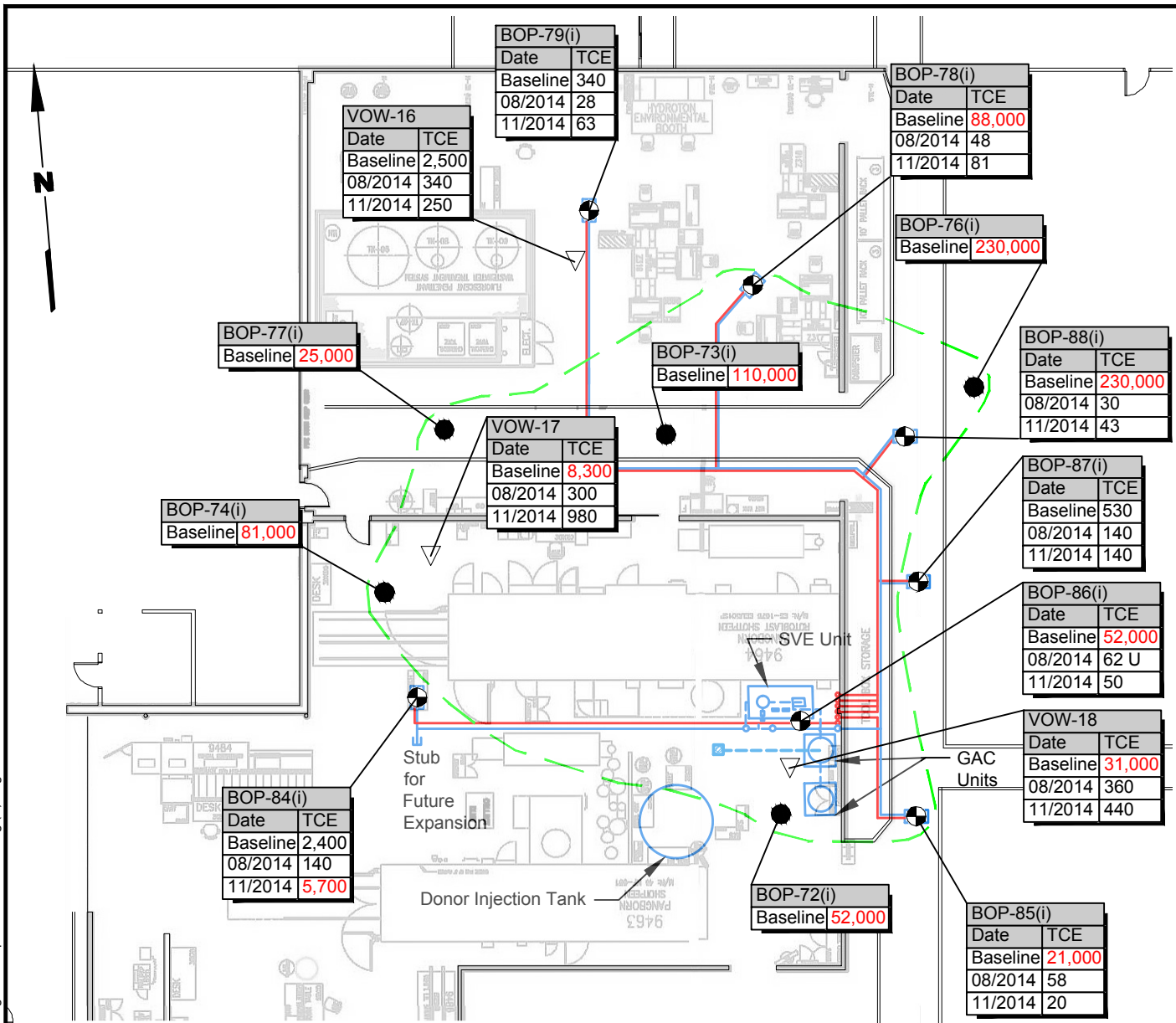
Legend

- ⊖ E-3 16.75 TGA Extraction Well and Groundwater Elevation August 2014
- BOP-7(i) 21.31 TGA Monitoring Well and Groundwater Elevation August 2014
- ▲ BOP-22R(ds) 13.36 Upper TSA Monitoring Well and Groundwater Elevation August 2014
- ⊕ BOP-84(i) TGA Multiple-Purpose Wells
- 5— Approximate Groundwater Elevation Contour (ft. MSL)

Note

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





Notes

1. Values shown in **RED** are above screening level (2,900 µg/m³)
2. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- TGA Monitoring Well Location
- ⊕ Multiple-Purpose Well Location
- ▽ Vapor Observation Well Location
- Below-ground Donor Injection Piping
- Below-ground SVE Piping
- Above-ground SVE Piping
- Baseline 2012 Concentrations Above Screening Levels

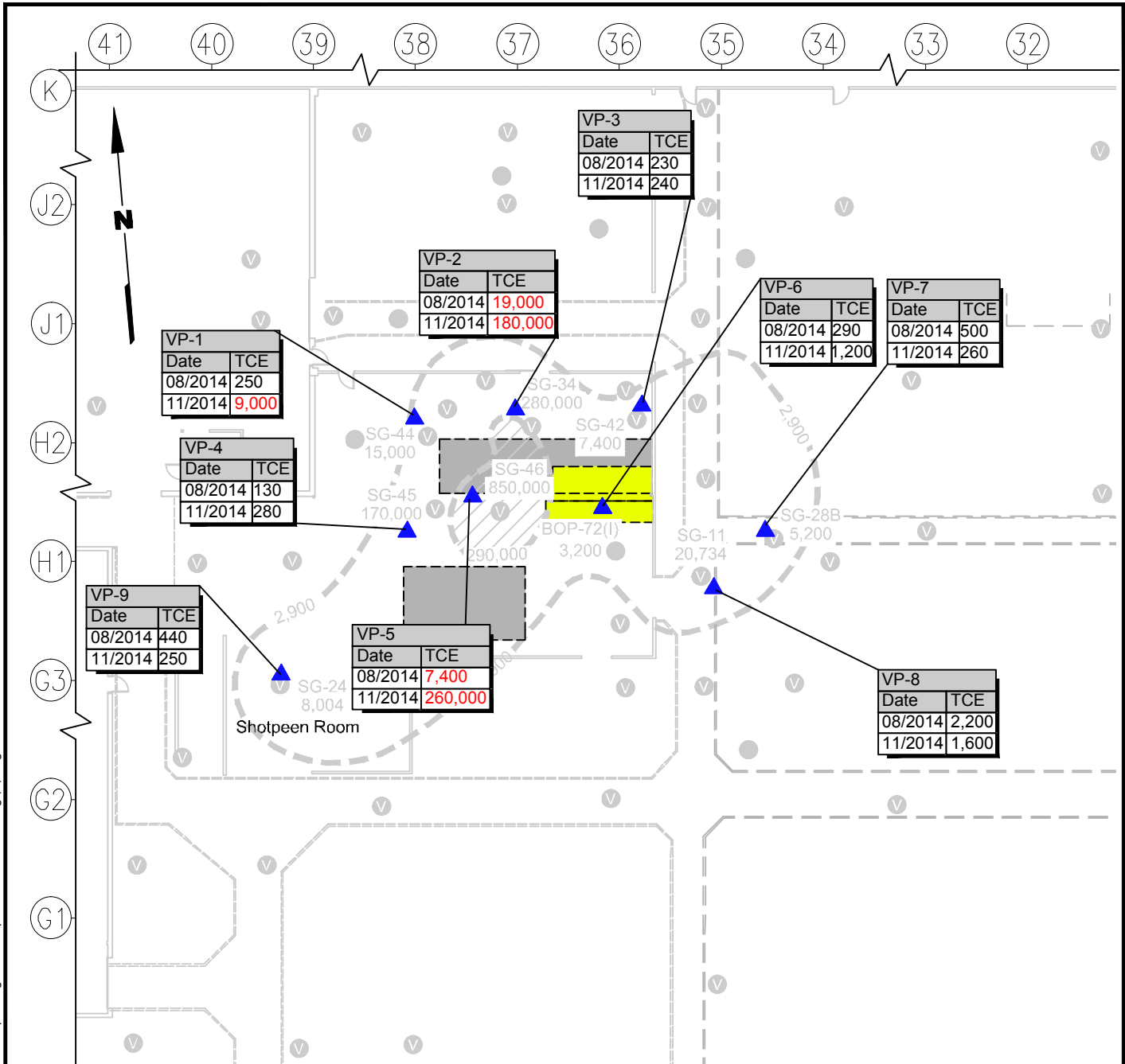
BOP-84(i)	
Date	TCE
08/2014	140

— Collection Data and TCE Concentration (µg/m³)



Source: The Boeing Company





Notes

1. Values shown in **Red** are above the RBC screening level of 2,900 $\mu\text{g}/\text{m}^3$.
2. Hot spot defined by DEQ as 100 times greater than the RBC.
3. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Legend

- BOP-74(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

- 1,490 TCE Concentration ($\mu\text{g}/\text{m}^3$)
- - - Baseline 2012 TCE Isoconcentration Contours
- ▨ Baseline 2012 Hot Spot
- ▭ Approximate Location of Basements
- ▭ Approximate Location of Former Degreasers



Source: Boeing 2009

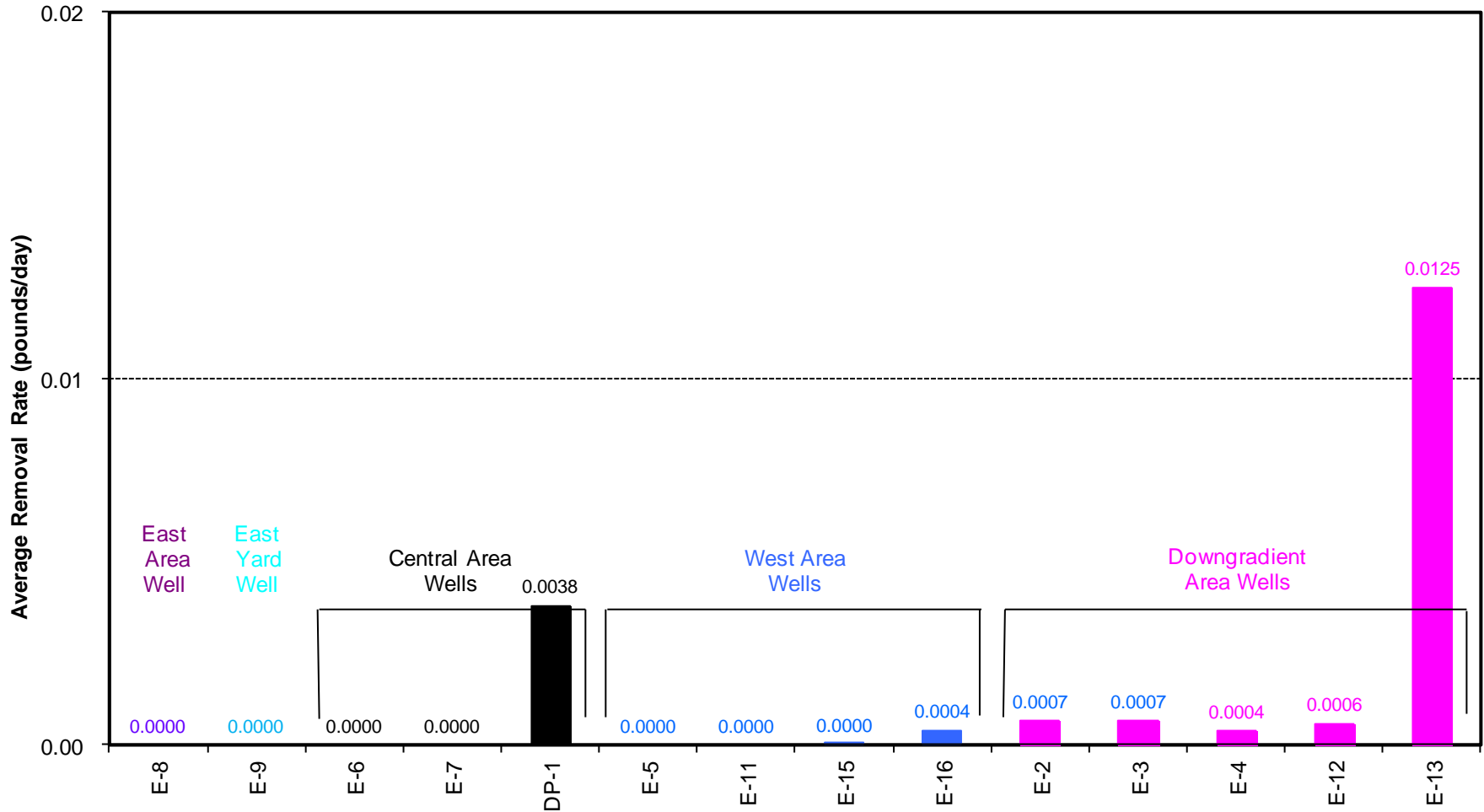
VP-1	—	Sample Location
Date	TCE	Collection Data and TCE Concentration ($\mu\text{g}/\text{m}^3$)
08/2014	250	



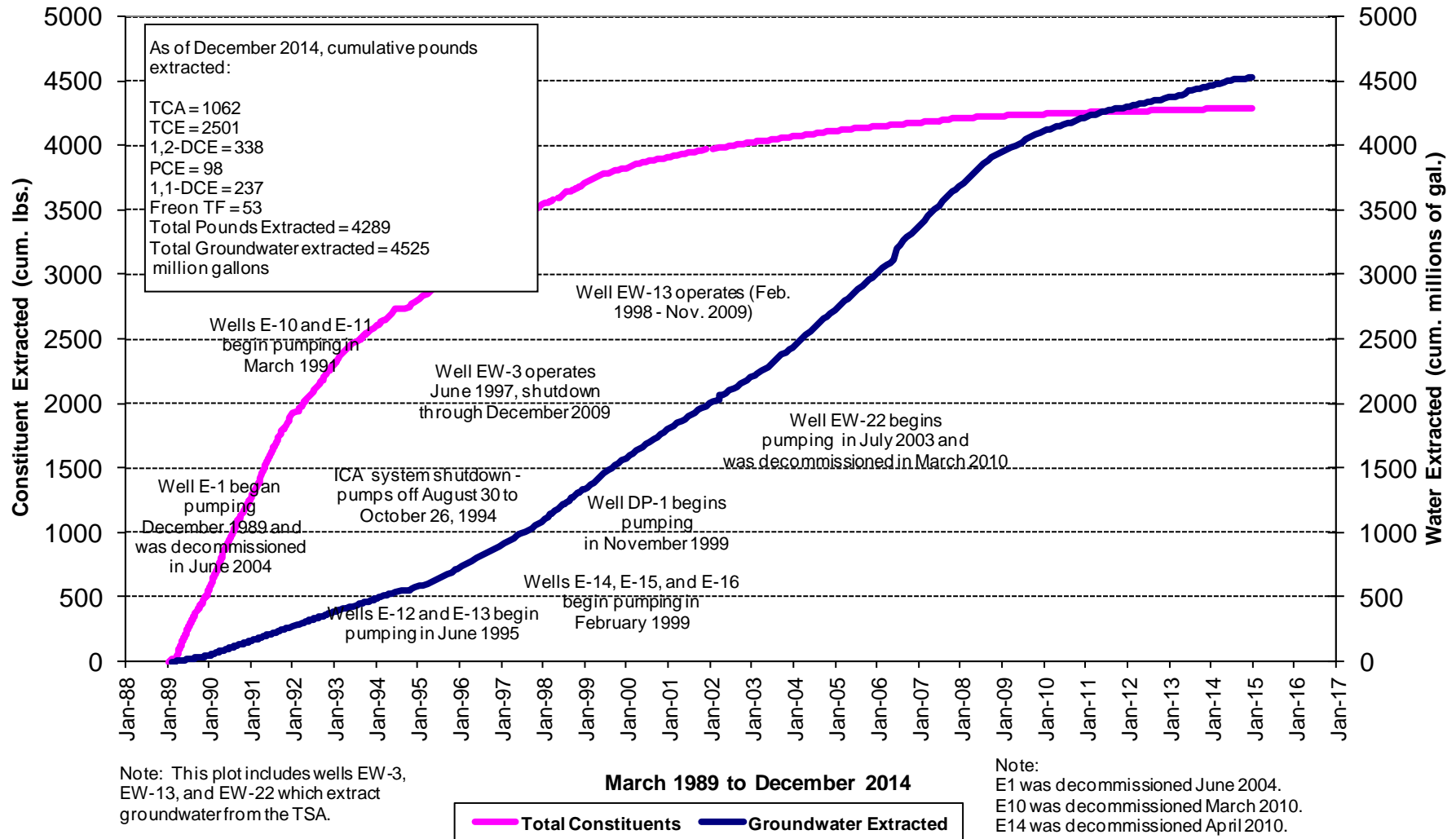
Boeing Portland
Gresham, Oregon

**Sub-Slab TCE Vapor Results -
Former Degreaser Source Area**

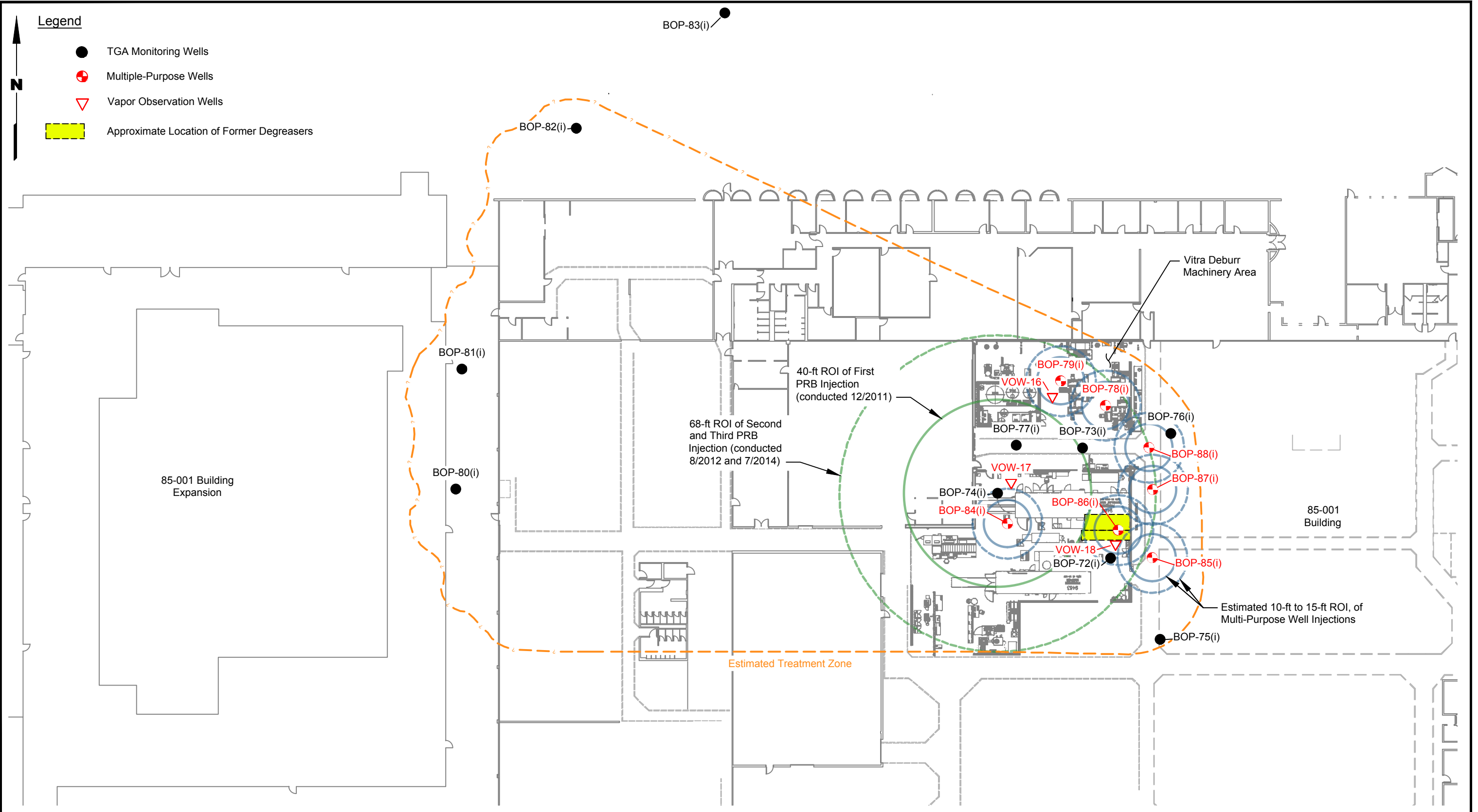
Figure
10



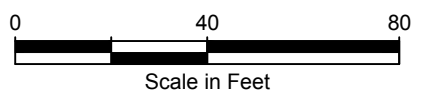
- Notes: 1. Total VOCs include the following constituents: TCA, TCE, total 1,2-DCE, PCE, and 1,1-DCE.
 2. Pumping operations at Well E-1 were suspended on 4/13/2000, well decommissioned on 6/29/2004.
 3. Pumping operations at Wells E-5 through E-9 were suspended on 7/8/2002.
 4. Extraction well E-10 was decommissioned on 3/29/2010.
 5. Extraction well E-14 was decommissioned on 4/1/2010.



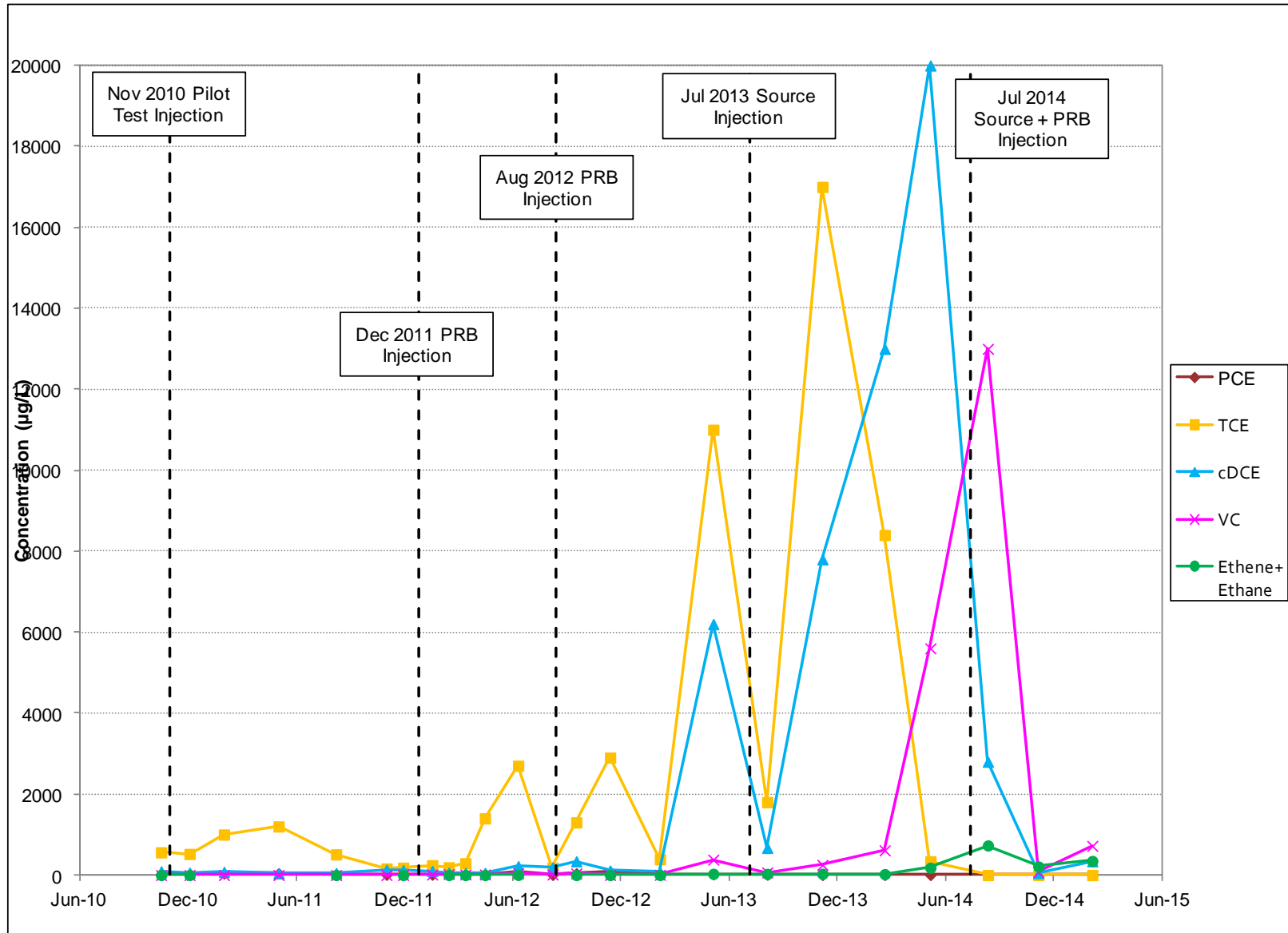
Landau Associates, Inc. | C:\Projects\025\116\114\520\Progress-Performance Evaluation Report\Figure 13.dwg (A) Figure 13 3/4/2015



Data Source: The Boeing Company



Boeing Portland Gresham, Oregon	Former Degreaser Source Area Bioremediation Injection Wells	Figure 13
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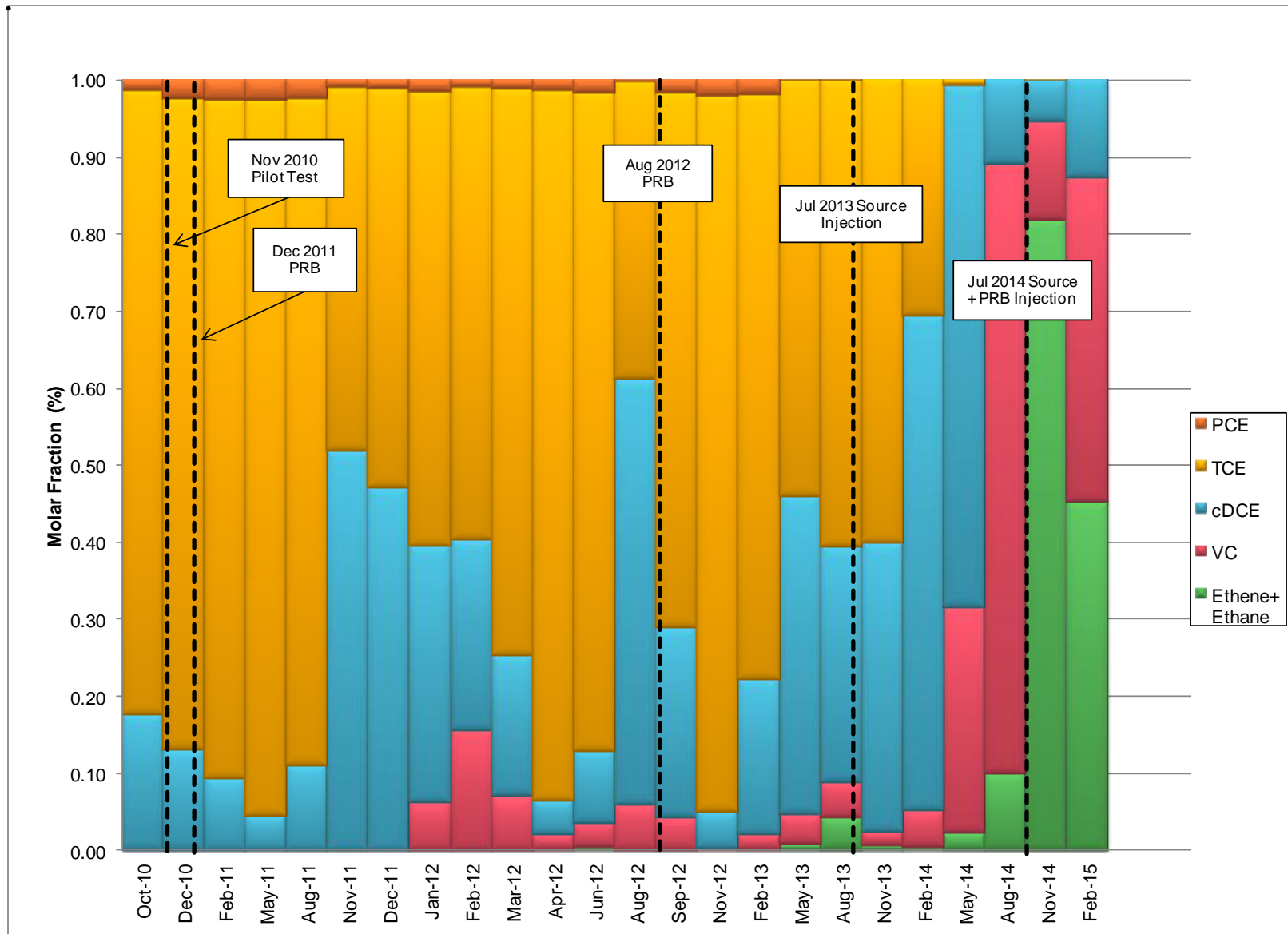


Boeing Portland
Gresham, Oregon

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

Figure
14





**TABLE 1
GROUNDWATER PERFORMANCE MONITORING PROGRAM (a)**

Aquifer and Well Use	Location	Sampling Frequency July - December 2014		Sampling Frequency Proposed	
		Groundwater Elevation	Groundwater Quality	Groundwater Elevation	Groundwater Quality
TGA Well	BOP-16(i)	S	Q	S	Q
TGA Well	BOP-57(ia)	S	S	S	S
TGA Well	BOP-57(ib)	S	S	S	S
TGA Extraction Well	E-5	Q	A	Q	A
TGA Extraction Well	E-11	Q	Q	Q	Q
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	Q	A	Q	A
TGA Extraction Well	E-7	Q	A	Q	A
TGA Extraction Well	DP-1	Q	Q	Q	Q
Upper TSA Well	BOP-65(ds) (b)	S	S	A	A
East Yard					
TGA Well	BOP-48(i)	S	A	S	A
TGA Extraction Well	E-9	Q	A	Q	A
Upper TSA Well	BOP-61(ds) (b)	S	S	S	S
East Area					
TGA Extraction Well	E-8	Q	A	Q	A
Southwest Area					
TGA Well	BOP-9(i)	S	S	S	S
Upper TSA Well	BOP-62(ds) (b)	S	A	S	A
Downgradient Area					
TGA Well	BOP-7(i)	S	Q	S	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	Q	Q	Q	Q
TGA Extraction Well	E-3	Q	Q	Q	Q
TGA Extraction Well	E-4	Q	Q	Q	Q
TGA Extraction Well	E-12	Q	Q	Q	Q
TGA Extraction Well	E-13	Q	Q	Q	Q
Upper TSA Well	BOP-22R(ds) (b)	A	A	A	A

**TABLE 1
GROUNDWATER PERFORMANCE MONITORING PROGRAM (a)**

Aquifer and Well Use	Location	Sampling Frequency July - December 2014		Sampling Frequency Proposed	
		Groundwater Elevation	Groundwater Quality	Groundwater Elevation	Groundwater Quality
Former Degreaser Source Control Area					
	BOP-72(i)	Q	Q	Q	Q
	BOP-73(i)	Q	Q	Q	Q
	BOP-74(i)	Q	Q	Q	Q
	BOP-75(i)	Q	Q	Q	Q
	BOP-76(i)	Q	Q	Q	Q
	BOP-77(i)	Q	Q	Q	Q
	BOP-78(i)	Q	Q	Q	Q
	BOP-79(i)	Q	Q	Q	Q
	BOP-80(i)	Q	Q	Q	Q
	BOP-81(i)	Q	Q	Q	Q
	BOP-82(i)	Q	Q	Q	Q
	BOP-83(i)	Q	Q	Q	Q
	BOP-84(i)	Q	Q	Q	Q
	BOP-85(i)	Q	Q	Q	Q
	BOP-86(i)	Q	Q	Q	Q
	BOP-87(i)	Q	Q	Q	Q
	BOP-88(i)	Q	Q	Q	Q
Coolant Release					
	LAI-1	Q	C-A	A	C-A
	LAI-2	Q	C-A	A	C-A
	LAI-3	Q	C-A	A	C-A
	LAI-4	Q	S/C-S	S	S/C-S
	LAI-5	Q	C-A	A	C-A
	LAI-6	Q	C-A	A	C-A
	LAI-7	Q	S/C-S	S	S/C-S
	LAI-8	Q	S/C-S	S	S/C-S

S = Semiannual; Q = Quarterly; A = Annual; -- = No Data; C = Coolant
S/C-S = Well sampled for multiple purposes. First abbreviation indicates sampling frequency for VOC remedy/second abbreviation indicates sampling frequency for coolant release.
Red colored text indicates proposed modification to monitoring frequency.
TGA = Troutdale Gravel Aquifer
TSA = Troutdale Sandstone Aquifer

- (a) From Table 3-3 of Five-Year Performance Evaluation, January 2001 through December 2005 (Landau Associates 2006), based on Phase 2 Corrective Measures Study (Landau Associates 1996).
- (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.

TABLE 2
GROUNDWATER QUALITY SUMMARY
TGA AND SELECT TSA WELLS
JULY 1 THROUGH DECEMBER 31, 2014

Area	Location	Sample Type	Date	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	1,1,1-TCA	PCE	TCE	Vinyl chloride
MCL Cleanup Level:				7	70	70	200	5	5	2
<u>East Area-TGA</u>										
	E-8	Grab	8/14/2014	0.3	1.0	ND	ND	5.3	7.0	ND
<u>East Yard-TGA</u>										
	BOP-48(i)	Purge	8/5/2014	ND	ND	ND	ND	ND	0.4	ND
	E-9	Grab	8/14/2014	ND	ND	ND	ND	0.5	0.5	0.7
<u>Central Area-TGA</u>										
	BOP-10(i)	Purge	8/5/2014	ND	1.8	ND	ND	7.8	14	ND
	BOP-56(i)	Purge	8/18/2014	0.3	2.9	ND	ND	3.7	23	ND
	BOP-59(i)	Purge	8/5/2014	ND	2.3	ND	ND	5.5	9.4	ND
	BOP-59(i)-Dup	Purge	8/5/2014	ND	2.3	ND	ND	5.4	9.3	ND
	E-6	Grab	8/12/2014	0.2	8.2	ND	ND	17	17	ND
	E-7	Grab	8/12/2014	0.3	8.6	1.2	ND	ND	19	ND
	DP-1	Grab	8/12/2014	0.4	68	0.7	ND	21	24	ND
	DP-1	Grab	11/5/2014	0.4	57	1.7	ND	16	18	ND
<u>West Area-TGA</u>										
	BOP-16(i)	Purge	8/12/2014	0.5	1.6	ND	ND	ND	6.2	3.7
	BOP-16(i)	Purge	11/11/2014	0.4	1.4	ND	ND	ND	6.3	2.4
	BOP-57(ia) (a)	Purge	8/5/2014	1.7	3.8	ND	0.6	1.9	18	ND
	BOP-57(ib) (a)	Purge	8/5/2014	35	9.1	ND	20	0.8	34	0.2
	E-5	Grab	8/12/2014	0.5	0.9	ND	ND	0.4	5.2	0.4
	E-11	Grab	8/12/2014	0.3	7.6	ND	ND	ND	0.2	ND
	E-11	Grab	11/5/2014	ND	3.0	ND	ND	ND	ND	ND
	E-15	Grab	8/13/2014	0.2	2.4	ND	ND	ND	0.5	2.5
	E-15	Grab	11/5/2014	0.3	1.7	ND	ND	ND	ND	5.4
	E-16	Grab	8/13/2014	0.6	2.4	ND	ND	3.0	13	ND
	E-16	Grab	11/5/2014	0.5	1.7	ND	ND	2.4	13	ND
<u>Southwest Area - TGA</u>										
	BOP-9(i)	Purge	8/5/2014	1.8	13	ND	0.6	3.8	50	ND
<u>Downgradient Area TGA</u>										
	BOP-7(i)	Purge	8/14/2014	13	9.6	ND	3.0	4.4	190	ND
	BOP-7(i)-Dup	Purge	8/14/2014	15	10	ND	3.4	5.2	160	ND
	BOP-7(i)	Purge	11/7/2014	17 J	15	ND	2.8 J	3.9 J	250	ND
	BOP-7(i)-Dup	Purge	11/7/2014	22 J	18	0.3	3.6 J	6.8 J	240	ND
	D-7(i)	Purge	8/4/2014	0.3	ND	ND	ND	ND	1.3	ND
	D-8(i)	Purge	8/4/2014	1.8	1.0	ND	ND	0.8	25	ND
	D-11(i)	Purge	8/4/2014	ND	ND	ND	ND	ND	0.6	ND
	D-12(i)	Purge	8/4/2014	0.6	ND	ND	ND	ND	2.7	ND
	E-2	Grab	8/14/2014	0.5	0.7	ND	ND	0.4	2.4	0.4
	E-2	Grab	11/3/2014	0.7	0.9	ND	ND	0.5	2.7 J	0.4
	E-2-Dup	Grab	11/3/2014	0.6	0.8	ND	ND	0.4	2.2 J	0.4
	E-3	Grab	8/14/2014	1.3	2.5	ND	ND	0.7	10	1.2
	E-3	Grab	11/3/2014	2.0	4.0	ND	ND	0.7	15	1.5
	E-4	Grab	8/14/2014	5.1	1.0	ND	ND	1.3	25	ND
	E-4	Grab	11/5/2014	6.3	1.5	ND	ND	1.5	28	ND

**TABLE 2
GROUNDWATER QUALITY SUMMARY
TGA AND SELECT TSA WELLS
JULY 1 THROUGH DECEMBER 31, 2014**

Area	Location	Sample Type	Date	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	1,1,1-TCA	PCE	TCE	Vinyl chloride
MCL Cleanup Level:				7	70	70	200	5	5	2
	E-12	Grab	8/14/2014	1.3	0.8	ND	ND	0.4	11	ND
	E-12	Grab	11/11/2014	1.1	0.5	ND	ND	0.4	9.4	ND
	E-13	Grab	8/14/2014	1.7	0.9	ND	ND	0.4	8.4	ND
	E-13	Grab	11/5/2014	2.3	1.4	ND	ND	0.4	12	ND
GWTS Influent/Effluent										
	Tower Influent	Grab	8/5/2014	0.8	13	ND	ND	4.0	10	0.3
	Tower Influent Dup	Grab	8/5/2014	0.8	15	ND	ND	4.7	11	0.3
	Tower Influent	Grab	11/5/2014	2.0	1.6	ND	ND	0.5	8.8	ND
	Tower Influent Dup	Grab	11/5/2014	2.4	1.7	ND	ND	0.5	11	ND
	Tower Effluent	Grab	8/5/2014	ND	ND	ND	ND	ND	ND	ND
	Tower Effluent Dup	Grab	8/5/2014	ND	ND	ND	ND	ND	ND	ND
	Tower Effluent	Grab	11/5/2014	ND	ND	ND	ND	ND	ND	ND
	Tower Effluent Dup	Grab	11/5/2014	ND	ND	ND	ND	ND	ND	ND
Upper TSA Monitoring Wells										
	BOP-22R(ds)	DBS	8/6/2014	ND	ND	ND	ND	ND	ND	ND
	BOP-60R(ds)	DBS	8/12/2014	ND	ND	ND	ND	ND	ND	ND
	BOP-61(ds)	Purge	8/12/2014	ND	0.6	ND	ND	0.3	6.2	ND
	BOP-62(ds)	Purge	8/12/2014	ND	ND	ND	ND	ND	0.4	ND
	BOP-65(ds)	Purge	8/12/2014	ND	0.6	ND	ND	ND	2.1	ND
	BOP-66(ds)	Purge	8/12/2014	ND	ND	ND	ND	0.2	3.3	ND
Coolant Release Wells										
	LAI-4	Purge	8/18/2014	ND	0.5	ND	ND	ND	0.7	ND
	LAI-7	Purge	8/18/2014	ND	2.1	ND	ND	9.7	6.8	ND
Former Degreaser Source Control Area										
	BOP-72(i)	DBS	8/13/2014	ND	0.2	ND	ND	ND	ND	1.1
	BOP-72(i)	DBS	11/6/2014	ND	0.3	ND	ND	ND	ND	1.9
	BOP-73(i)	DBS	8/13/2014	4.9	2800	190	ND	ND	ND	13000
	BOP-73(i)	DBS	11/6/2014	ND	47	4.3	ND	ND	1.7	73
	BOP-74(i)	DBS	11/6/2014	0.3	11	ND	ND	ND	0.3	2.1
	BOP-75(i)	DBS	8/13/2014	0.9	9.5	0.3	ND	ND	6.2	10
	BOP-75(i)	DBS	11/5/2014	0.4	4.3	ND	ND	ND	ND	11
	BOP-76(i)	DBS	8/13/2014	0.7	24	0.2	ND	0.3	13	4.1
	BOP-76(i)	DBS	11/6/2014	0.6	9.5	ND	ND	ND	1.4	2.1
	BOP-77(i)	DBS	8/13/2014	ND	81	0.7	ND	ND	0.6	17
	BOP-77(i)	DBS	11/6/2014	0.3	200	1.0	ND	ND	2.7	24
	BOP-78 (i)	DBS	11/5/2014	ND	23	1.4	ND	ND	1.7	2.6
	BOP-79(i)	DBS	11/7/2014	ND	21	1.3	ND	ND	1.5	5.6
	BOP-80(i)	DBS	8/14/2014	ND	1.1	0.9	ND	ND	0.5	3.1
	BOP-80(i)	DBS	11/6/2014	10	360	3.9	ND	0.8	65	63
	BOP-81(i)	DBS	8/14/2014	ND	ND	0.5	ND	ND	ND	0.4
	BOP-81(i)	DBS	11/6/2014	ND	ND	0.3	ND	ND	ND	0.3
	BOP-82(i)	DBS	8/14/2014	0.7	0.6	0.2	ND	1.0	12	ND
	BOP-82(i)	DBS	11/7/2014	0.7	2.7	ND	ND	0.6	8.1	0.7

TABLE 2
GROUNDWATER QUALITY SUMMARY
TGA AND SELECT TSA WELLS
JULY 1 THROUGH DECEMBER 31, 2014

Area	Location	Sample Type	Date	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	1,1,1-TCA	PCE	TCE	Vinyl chloride
MCL Cleanup Level:				7	70	70	200	5	5	2
	BOP-83(i)	DBS	8/14/2014	ND	ND	ND	ND	ND	2.2	ND
	BOP-83(i)	DBS	11/11/2014	ND	ND	ND	ND	ND	2.1	ND
	BOP-84(i)	DBS	11/7/2014	ND	8.0	0.9	ND	ND	ND	2.9
	BOP-85(i)	DBS	11/5/2014	0.2	3.4	2.2	ND	ND	1.6	0.4
	BOP-86(i)	DBS	11/5/2014	ND	4.6	3.5	ND	ND	0.6	3.0
	BOP-87(i)	DBS	11/5/2014	ND	1.5	2.7	ND	ND	0.6	0.8
	BOP-88(i)	DBS	11/11/2014	0.2	30	1.6	ND	ND	1.9	4.2

MCL = Maximum Contaminant Level

DCE = dichloroethene

TCA = trichloroethane

PCE = tetrachloroethene

TCE = trichloroethene

DBS = Diffusion Bag Sampler Type.

ND = Not detected.

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 cleanup level.

(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).

Notes:

1. TSA water quality data collected as part of the TGA remedy implementation.
2. Data are parts per billion (µg/L).
3. Box indicates exceedance of MCL Cleanup Level.

TABLE 3
WATER ANALYTICAL RESULTS
TPH-Dx AND FIELD PARAMETERS
COOLANT RELEASE INVESTIGATION, 2014
BOEING PORTLAND FACILITY

		NWTPH-Dx (mg/L) (a)			Field Parameters		
		Diesel	Motor Oil	Total TPH-Dx	pH	Dissolved Oxygen (mg/L)	ORP (mV)
TGA Wells							
LAI-1	8/18/2014	0.38	2.4	2.78	5.59	4.54	-39.0
LAI-2	8/18/2014	0.097 U	0.24 U	ND	5.83	2.32	-246.2
LAI-3	8/18/2014	0.12	0.24 U	0.12	6.57	2.75	-328.7
LAI-4	8/18/2014	1.80	4.1	5.9	5.94	1.16	-237.1
LAI-5	8/18/2014	0.096 U	0.24 U	ND	5.97	4.80	-218.7
LAI-6	8/18/2014	0.096 U	0.24 U	ND	5.98	5.64	-215.3
LAI-7	8/18/2014	0.10 U	0.25 U	ND	5.67	2.02	-129.6
LAI-8	8/18/2014	Dry in August 2014					
Cleanup Level (b)				1.35			

TPH-Dx = total petroleum hydrocarbons-diesel range

ORP = oxygen reduction potential

mg/L = milligrams per liter

mV = millivolts

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

ND = Not detected.

DEQ = Oregon Department of Environmental Quality

Box = Exceedance of Cleanup Level.

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

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

TABLE 4
GROUNDWATER ELEVATION DATA
TGA MONITORING WELLS
JULY 1 THROUGH DECEMBER 31, 2013

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
<u>TGA WELLS</u>					
BOP-7(i)	8/4/2014	11:35	83.08	61.77	21.31
BOP-9(i)	8/4/2014	11:28	114.74	81.60	33.14
BOP-10(i)	8/4/2014	11:17	109.19	37.90	71.29
BOP-16(i)	8/4/2014	11:32	89.08	60.06	29.02
BOP-48(i)	8/4/2014	10:00	94.17	12.66	81.51
BOP-56(i)	8/4/2014	16:25	99.07	58.83	40.24
BOP-57(ia) (b)	8/4/2014	11:07	95.45	61.84	33.61
BOP-57(ib) (b)	8/4/2014	11:02	94.57	61.32	33.25
BOP-59(i)	8/4/2014	11:21	110.20	39.16	71.04
D-7(i)	8/4/2014	12:55	45.38	32.22	13.16
D-8(i)	8/4/2014	13:05	29.30	16.45	12.85
D-11(i)	8/4/2014	13:25	77.11	63.10	14.01
D-12(i)	8/4/2014	13:15	33.51	20.70	12.81
<u>COOLANT RELEASE WELLS</u>					
LAI-1	8/4/2014	9:23	109.86	25.41	84.45
LAI-2	8/4/2014	9:19	109.89	21.95	87.94
LAI-3	8/4/2014	9:13	109.85	17.11	92.74
LAI-4	8/4/2014	9:35	110.71	17.48	93.23
LAI-5	8/4/2014	9:38	110.56	17.22	93.34
LAI-6	8/4/2014	9:41	110.65	17.39	93.26
LAI-7	8/4/2014	9:26	109.90	25.98	83.92
LAI-8	8/4/2014	9:29	110.59	Dry	Dry
<u>TSA WELLS</u>					
BOP-13(ds)	7/7/2014	12:15	128.94	115.87	13.07
BOP-13(ds)	8/4/2014	10:37	128.94	119.20	9.74
BOP-13(ds)	11/3/2014	8:02	128.94	120.60	8.34
BOP-13(dg)	7/7/2014	13:35	128.71	115.60	13.11
BOP-13(dg)	8/4/2014	10:32	128.71	119.76	8.95
BOP-20(ds)	8/4/2014	10:35	77.45	64.58	12.87
BOP-20(ds)	11/3/2014	16:21	77.45	65.40	12.05
BOP-20(dg)	8/4/2014	10:43	77.32	64.49	12.83
BOP-20(dg)	11/3/2014	16:19	77.32	65.39	11.93
BOP-21(ds)	8/4/2014	11:43	78.02	64.93	13.09
BOP-21(ds)	11/3/2014	16:43	78.02	65.86	12.16
BOP-22R(ds)	8/4/2014	10:00	82.91	69.55	13.36
BOP-22R(ds)	11/3/2014	12:22	82.91	70.59	12.32
BOP-22(dg)	8/4/2014	10:15	81.05	66.88	14.17
BOP-22(dg)	11/3/2014	12:24	81.05	67.90	13.15
BOP-23(dg)	8/4/2014	10:42	76.96	64.42	12.54
BOP-31(ds)	7/7/2014	18:20	99.04	84.74	14.30
BOP-31(ds)	8/4/2014	10:38	99.04	86.17	12.87
BOP-31(ds)	11/3/2014	16:04	99.04	87.82	11.22
BOP-31(dg)	7/7/2014	17:40	98.51	84.25	14.26
BOP-31(dg)	8/4/2014	10:39	98.51	85.70	12.81
BOP-42(ds)	8/4/2014	10:26	130.74	116.92	13.82
BOP-42(dg)	8/4/2014	10:25	130.71	117.35	13.36

TABLE 4
GROUNDWATER ELEVATION DATA
TGA MONITORING WELLS
JULY 1 THROUGH DECEMBER 31, 2013

	Date	Time	Reference Elev. (a) (ft, MSL)	Depth to Water (ft)	Groundwater Elevation (ft)
BOP-60R(ds)	8/4/2014	15:18	82.80	69.51	13.29
BOP-60R(ds)	11/3/2014	15:04	82.80	70.66	12.14
BOP-60(dg)	8/4/2014	10:59	93.59	80.74	12.85
BOP-61(ds)	8/4/2014	10:06	94.64	83.60	11.04
BOP-61(dg)	8/4/2014	10:03	94.43	83.42	11.01
BOP-62(ds)	8/4/2014	10:53	112.29	99.41	12.88
BOP-65(ds)	8/4/2014	10:50	104.22	91.11	13.11
BOP-66(ds)	8/4/2014	9:46	102.97	90.11	12.86

FORMER VAPOR DEGREASER AREA WELLS

BOP-72(i)	8/4/2014	14:07	83.64	46.60	37.04
BOP-72(i)	11/3/2014	17:38	83.64	45.71	37.93
BOP-73(i)	8/4/2014	14:22	83.65	47.88	35.77
BOP-73(i)	11/3/2014	17:29	83.65	47.05	36.60
BOP-74(i)	8/4/2014	15:40	83.69	51.80	31.89
BOP-74(i)	11/3/2014	17:41	83.69	49.55	34.14
BOP-75(i)	8/4/2014	14:12	83.70	45.61	38.09
BOP-75(i)	11/3/2014	17:10	83.70	44.27	39.43
BOP-76(i)	8/4/2014	14:17	83.65	47.19	36.46
BOP-76(i)	11/3/2014	17:25	83.65	44.91	38.74
BOP-77(i)	8/4/2014	14:29	83.68	47.61	36.07
BOP-77(i)	11/3/2014	17:33	83.68	48.61	35.07
BOP-78(i)	11/3/2014	15:00	83.16	47.13	36.03
BOP-78(i)	8/4/2014	15:47	83.16	48.17	34.99
BOP-79(i)	11/3/2014	14:30	83.34	47.91	35.43
BOP-79(i)	8/4/2014	15:52	83.34	48.21	35.13
BOP-80(i)	8/4/2014	15:08	83.60	52.28	31.32
BOP-80(i)	11/3/2014	16:53	83.60	53.97	29.63
BOP-81(i)	8/4/2014	15:05	83.57	52.60	30.97
BOP-81(i)	11/3/2014	16:57	83.57	54.40	29.17
BOP-82(i)	8/4/2014	15:00	81.10	53.68	27.42
BOP-82(i)	11/3/2014	16:35	81.10	56.55	24.55
BOP-83(i)	8/4/2014	14:52	80.42	53.15	27.27
BOP-83(i)	11/3/2014	16:29	80.42	54.68	25.74
BOP-84(i)	8/4/2014	15:26	83.67	51.94	31.73
BOP-84(i)	11/3/2014	16:45	83.67	52.70	30.97
BOP-85(i)	8/4/2014	16:10	83.69	46.60	37.09
BOP-85(i)	11/3/2014	17:14	83.69	44.96	38.73
BOP-86(i)	11/3/2014	10:45	83.70	48.11	35.59
BOP-86(i)	8/4/2014	16:16	83.70	47.80	35.90
BOP-87(i)	8/4/2014	16:00	83.68	46.92	36.76
BOP-87(i)	11/3/2014	17:17	83.68	44.35	39.33
BOP-88(i)	8/4/2014	15:56	83.67	47.00	36.67
BOP-88(i)	11/3/2014	17:21	83.67	46.27	37.40

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

VOLATILES (Method TO-15)														
Location	Lab ID	Date Collected	Days since startup	Days of Shutdown	Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	cis-DCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)	VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
VOW-16	1408092-11A	8/5/2014	687		3.0 U	4.7 U	37	4.7 U	340	41	NA			
VOW-16	1411150-11A	11/4/2014	778		3.0 U	4.6 U	27	4.6 U	250	56	NA			
VOW-17	1408092-12A	8/5/2014	687		3.0 U	4.6 U	11	4.6 U	300	100	NA			
VOW-17	1411150-12A	11/4/2014	778		3.0 U	4.7 U	10	4.7 U	980	220	NA			
VOW-18	1408092-13A	8/5/2014	687		3.0 U	4.6 U	77	9.5	360	200	NA			
VOW-18	1411150-13A	11/4/2014	778		3.0 U	4.7 U	100	11	440	230	NA			
BOP-78(i)	1408092-04A	8/5/2014	687	(b)	3.1 U	4.8 U	6.6 U	4.8 U	48	40	NA	Off	54	Off
BOP-78(i)	1411150-04A	11/4/2014	778	(b)	3.0 U	4.6 U	30	4.6 U	81	40	NA	Off	0	Off

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

		VOLATILES (Method TO-15)												
Location	Lab ID	Date Collected	Days since startup	Days of Shutdown	Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	cis-DCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)	VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
BOP-79(i)	1408092-05A	8/5/2014	687	(b)	3.1 U	4.8 U	12	4.8 U	28	23	NA	Off	54	Off
BOP-79(i)	1411150-05A	11/4/2014	778	(b)	3.0 U	4.6 U	23	4.6 U	63	22	NA	Off	0	Off
BOP-84(i)	1408092-06A	8/5/2014	687	(b)	3.0 U	4.6 U	6.4 U	4.6 U	140	86	NA	Off	54	Off
BOP-84(i)	1411150-06A	11/4/2014	778	(b)	12 U	19 U	26 U	19 U	5700	280	NA	Off	0	Off
BOP-85(i)	1408092-07A	8/5/2014	687	(b)	3.0 U	4.7 U	180	4.7 U	58	140	NA	Off	54	Off
BOP-85(i)	1411150-07A	11/4/2014	778	(b)	3.0 U	4.6 U	41	4.6 U	20	44	NA	Off	0	Off
BOP-86(i)	1408092-08A	8/5/2014	687	(b)	29 U	46 U	63 U	46 U	62 U	78 U	NA	Off	54	Off
BOP-86(i)	1411150-08A	11/4/2014	778	(b)	2.8 U	4.3 U	18	4.3 U	50	71	NA	Off	0	Off

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

VOLATILES (Method TO-15)

Location	Lab ID	Date Collected	Days since startup	Days of Shutdown	Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	cis-DCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)	1,1-DCA (µg/m3)	VOC Removal Rate (lbs/day)	Operational Days (since previous sample collection)	Mass Removal (lbs)
		Screening Level (a)			2,800	880,000	22,000,000		2,900	47,000				
BOP-87(i)	1408092-09A	8/5/2014	687	(b)	62	96	190	96	140	160	NA	Off	54	Off
BOP-87(i)	1411150-09A	11/4/2014	778	(b)	10 U	15 U	320	15 U	140	62	NA	Off	0	Off
BOP-88(i)	1408092-10A	8/5/2014	687	(b)	3.1 U	4.8 U	140	4.8 U	30	45	NA	Off	54	Off
BOP-88(i)	1411150-10A	11/4/2014	778	(b)	2.9 U	4.6 U	190	4.6 U	43	26	NA	Off	0	Off

Cumulative VOC Mass Removed (lbs) 6.90

NA = Not analyzed

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

Bold = Detection

Boxed results are greater than the screening level.

(a) Soil gas screening levels were developed by the Oregon Department of Environmental Quality (DEQ) 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 shut down on 7/2/2014 at 3:00 pm with DEQ approval.

TABLE 6
SUB-SLAB VAPOR WELL ANALYTICAL RESULTS
FORMER VAPOR DEGREASER SOURCE AREA
BOEING PORTLAND

VOLATILES (Method TO-15)

Location	Date Collected	Vinyl Chloride (µg/m3)	1,1-DCE (µg/m3)	1,1,1-TCA (µg/m3)	cis-DCE (µg/m3)	TCE (µg/m3)	PCE (µg/m3)
	Screening Level (a)	2,800	880,000	22,000,000		2,900	47,000
VP-1	Baseline	29 U	44 U	61 U	44 U	15,000	NA
VP-1	8/5/2014	2.9 U	4.4 U	6.9	4.4 U	250	89
VP-1	11/4/2014	15 U	24 U	33 U	24 U	9,000	270
VP-2	Baseline	200 U	310 U	NA	1100	280,000	NA
VP-2	8/5/2014	30 U	46 U	63 U	55	19,000	200
VP-2	11/4/2014	160 U	250 U	340 U	580	180,000	2700
VP-3	Baseline	14 U	90	4700	27	7,400	NA
VP-3	8/5/2014	3.0 U	4.6 U	510	4.6 U	230	83
VP-3	11/4/2014	3.0 U	4.6 U	890	4.6 U	240	84
VP-4	Baseline	290 U	440 U	610 U	660	170,000	NA
VP-4	8/5/2014	3.0 U	4.7 U	8.9	4.7 U	130	180
VP-4	11/4/2014	3.2 U	4.9 U	10	4.9 U	280	140
VP-5	Baseline	1100	1700	2400	3800	850,000	NA
VP-5	8/5/2014	12 U	18 U	99	18 U	7,400	150
VP-5	11/4/2014	310 U	480 U	660 U	570	260,000	4300
VP-6	Baseline	13 U	59	7600	160	3,200	NA
VP-6	8/5/2014	13 U	59	7600	160	3,200	NA
VP-6	11/4/2014	3.1 U	4.8 U	830	15	1,200	170
VP-7	Baseline	30 U	3200	NA	1900	5,200	NA
VP-7	8/5/2014	10 U	190	7200	160	500	170
VP-7	11/4/2014	6.0 U	100	3600	95	260	100
VP-8	Baseline	100 U	14273	190975	7414	20,743	NA
VP-8	8/5/2014	40 U	780	30000	310	2,200	340
VP-8	11/4/2014	40 U	1000	26000	450	1,600	290
VP-9	Baseline	100 U	103 U	186	103 U	8,007	NA
VP-9	8/5/2014	2.9 U	4.5 U	58	4.5 U	440	210
VP-9	11/4/2014	2.9 U	4.6 U	41	4.6 U	250	120

µg/m3 = micrograms per cubic meter

NA = Not analyzed

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

Boxed results are greater than the screening level.

(a) Soil gas screening levels were developed by the Oregon Department of Environmental Quality (DEQ) by multiplying the Concentration for air in an occupational setting by an attenuation factor of 1,000 to account for vapor intrusion through Screening levels updated June 7, 2012.

(b) Total VOC concentration reduction percentages are developed from baseline concentrations.

**TABLE 7
EXTRACTION WELL SUMMARY
GROUNDWATER TREATMENT SYSTEM**

Location	July 2014				August 2014				September 2014			
	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)
E-2	528,750	42,300	12.50	11.84	445,536	24,480	18.20	10.31	263,520	14,400	18.30	6.10
E-3	71,910	42,300	1.70	1.61	129,744	24,480	5.30	3.00	76,320	14,400	5.30	1.77
E-4	46,530	42,300	1.10	1.04	26,928	24,480	1.10	0.62	2,160	7,200	0.30	0.05
E-5	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-6	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-7	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-8	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-9	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-11	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-12	304,560	42,300	7.20	6.82	117,404	24,480	4.80	2.72	34,560	7,200	4.80	0.80
E-13	4,050,540	35,100	115.40	90.74	1,824,768	17,280	105.60	42.24	1,284,489	14,400	89.20	29.73
E-15	27,495	42,300	0.65	0.62	12,240	24,480	0.50	0.28	2,736	2,880	0.95	0.06
E-16	71,910	42,300	1.70	1.61	36,720	24,480	1.50	0.85	75,600	14,400	5.25	1.75
EW-3	124,023	0	0.00	2.78	0	0	0.00	0.00	0	0	0.00	0.00
EW-13	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
DP-1	148,050	42,300	3.50	3.32	63,648	24,480	2.60	1.47	22,329	7,200	3.10	0.52
Total	5,373,768				2,656,988				1,761,714			

**TABLE 7
EXTRACTION WELL SUMMARY
GROUNDWATER TREATMENT SYSTEM**

Location	October 2014				November 2014				December 2014			
	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)	Gallons Pumped	Run Time Operational Minutes	Pump Rate (gpm)	Avg. Yield (gpm)
E-2	764,870	40,320	18.97	17.71	824,256	38,880	21.20	19.08	655,260	40,200	16.30	14.68
E-3	231,504	41,340	5.60	5.36	159,408	38,880	4.10	3.69	88,440	40,200	2.20	1.98
E-4	36,792	41,340	0.89	0.85	42,768	38,880	1.10	0.99	44,220	40,200	1.10	0.99
E-5	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-6	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-7	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-8	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-9	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-11	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
E-12	100,947	39,900	2.53	2.34	103,680	28,800	3.60	2.40	100,500	40,200	2.50	2.25
E-13	2,475,852	41,340	59.89	57.31	2,336,688	38,880	60.10	54.09	2,576,820	40,200	64.10	57.72
E-15	19,950	39,900	0.50	0.46	18,720	37,440	0.50	0.43	2,325	38,760	0.06	0.05
E-16	99,750	39,900	2.50	2.31	42,768	38,880	1.10	0.99	36,180	40,200	0.90	0.81
EW-3	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
EW-13	0	0	0.00	0.00	0	0	0.00	0.00	0	0	0.00	0.00
DP-1	113,685	41,340	2.75	2.63	108,864	38,880	2.80	2.52	104,520	40,200	2.60	2.34
Total	3,843,350				3,637,152				3,608,265			

Notes:

1. Average yield reflects total gallons pumped divided by total minutes for the measuring period.
2. Well E-1 was decommissioned in June 2004 and is no longer shown.
3. EW-3 and EW-13 are TSA extraction wells.
4. Wells E-5 through E-9 and E-11 were not operated this quarter except for sampling.
5. Well E-10 was decommissioned on 3/29/10 and is no longer shown.
6. Well E-14 was decommissioned on 4/1/10 and is no longer shown.
7. DEQ approved the pilot shutdown of EW-3. The pump was shut off on 12/12/09. The well will remain in pilot shutdown.
8. DEQ approved the pilot shutdown of EW-13. The pump was shut off on 11/25/09. The well will remain in pilot shutdown.
9. Well EW-22 was converted to a monitoring well, decommissioned on 3/26/10, and is no longer shown.

**TABLE 8
BIOREMEDIATION SUMMARY
FORMER VAPOR DEGREASER SOURCE AREA
BOEING OF 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)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions						Donor Indicators		Molar Fraction										
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (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)	Methane (mg/L)	TOC (mg/L)	pH	PCE	TCE	CIS	VC	Ethene	Ethane	Total
BOP-72(i) Monitoring Well	10/19/2010	-16					3.1	28	10	<1.0	<1.0	<2.0	--	--	1.2	--	--	--	12.9	--	0.106	1.77		0.06	0.64	0.31	0.00	0.00	0.00	1.00	
	12/6/2010	32					<2.0	3.6	<2.0	<2.0	25	5.4	--	2.81	-26.2	<5.0	3.2	--	<5.0	--	0.849	3020	6.88	0.00	0.02	0.00	0.00	0.81	0.16	1.00	
	2/2/2011	90					<2.0	<2.0	<2.0	<2.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	0.00	--	--	0.00	
	5/5/2011	182					<1.0	<1.0	6.3	<1.0	--	--	--	0.21	163	--	--	--	--	--	--	--	6.79	0.00	0.00	1.00	0.00	--	--	1.00	
	8/10/2011	279					<1.0	<1.0	10	<1.0	<1.1	<1.2	<1.1	0.26	-151.6	<0.1	2.4	--	1.5	--	7.7	263	6.77	0.00	0.00	1.00	0.00	0.00	0.00	1.00	
	11/3/2011	364	-55				<1.0	<1.0	3.0	6.8	--	--	--	0.09	-138.8	--	--	--	--	--	--	--	6.71	0.00	0.00	0.22	0.78	--	--	1.00	
	2/8/2012	461	42				<2.0	<2.0	<2.0	7.5	--	--	--	0.31	-317.5	--	--	--	--	--	--	--	7.46	0.00	0.00	0.00	1.00	--	--	1.00	
	5/4/2012	547	128				<2.0	<2.0	<2.0	9.0	--	--	--	0.86	-65.7	--	--	--	--	--	--	--	6.69	0.00	0.00	0.00	1.00	--	--	1.00	
	8/9/2012	644	225	-7			<1.0	<1.0	<1.0	10	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	1.00	--	--	1.00	
	11/8/2012	735	316	84			<0.2	<0.2	0.2	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.02	0.98	--	--	1.00	
	2/5/2013	824	405	173			<0.2	<0.2	0.3	3.4	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.05	0.95	--	--	1.00	
	5/2/2013	910	491	259	-68		<0.2	<0.2	0.2	3.3	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.04	0.96	--	--	1.00	
	8/6/2013	1006	587	355	28		<0.2	<0.2	0.7	2.7	5.0	<5.0	<5.0	0.58	-148.8	<0.10	3.0	--	<5.0	--	13	47.4	6.66	0.00	0.00	0.03	0.19	0.78	0.00	1.00	
	11/7/2013	1099	680	448	121		<0.2	<0.2	0.3	1.9	<5.0	<5.0	<5.0	0.62	-113.4	<0.10	2.5	--	<1.0	--	11	41.7	6.68	0.00	0.00	0.09	0.91	0.00	0.00	1.00	
	2/5/2014	1189	770	538	211		<0.2	<0.2	0.2	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.06	0.94	--	--	1.00	
5/7/2014	1280	861	629	302	-70	<0.2	<0.2	<0.2	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	1.00	--	--	1.00		
8/13/2014	1378	959	727	400	28	<0.2	<0.2	0.2	1.1	<5.0	<5.0	<5.0	0.43	68.2	<0.10	3.0	--	<1.0	--	14	36.6	6.12	0.00	0.00	0.10	0.90	0.00	0.00	1.00		
11/6/2014	1463	1044	812	485	113	<0.2	<0.2	0.3	1.9	<5.0	<5.0	<5.0	0.26	-147.7	<0.10	3.0	9.75	9.38	2.8	<2.0	14	13.6	6.56	0.00	0.00	0.09	0.91	0.00	0.00	1.00	
BOP-73(i) Monitoring Well	10/19/2010	-16					12	560	90	<1.0	<1.0	<2.0	--	--	0.7	--	--	--	11	--	0.0599	1.6		0.01	0.81	0.18	0.00	0.00	0.00	1.00	
	12/6/2010	32					19	520	59	<2.0	<2.0	<5.0	--	3.20	14.6	1.0	2.8	--	10.3	--	--	2.24	6.94	0.02	0.85	0.13	0.00	0.00	0.00	1.00	
	2/2/2011	90					37	1000	78	<1.0	--	--	--	0.45	-14.8	--	--	--	--	--	--	--	6.37	0.03	0.88	0.09	0.00	--	--	1.00	
	5/5/2011	182					43	1200	42	<3.0	--	--	--	0.64	15.6	--	--	--	--	--	--	--	6.29	0.03	0.93	0.04	0.00	--	--	1.00	
	8/10/2011	279					18	510	48	<1.0	<1.1	<1.2	<1.1	0.54	-24.9	1.0	2.4	--	11.8	--	1.01	1.88	6.30	0.02	0.87	0.11	0.00	0.00	0.00	1.00	
	11/3/2011	364					4.7	160	130	<1.0	--	--	--	0.10	-42.9	--	--	--	--	--	--	--	6.33	0.01	0.47	0.52	0.00	--	--	1.00	
	12/1/2011	392	-27				5.0	180	120	<1.0	<1.1	<1.2	<1.1	--	--	--	--	--	9.5	--	0.759	1.93	6.71	0.01	0.52	0.47	0.00	0.00	0.00	1.00	
	1/19/2012	441	22				7.8	240	100	12	--	--	--	0.41	249	0.3	1.8	--	8.8	--	--	9.26	7.04	0.02	0.59	0.33	0.06	--	--	1.00	
	2/16/2012	469	50				4.0	190	59	24	<1.1	<1.2	<1.1	0.66	-235.3	0.3	2.2	--	11.5	--	1.35	<1.50	7.74	0.01	0.59	0.25	0.16	0.00	0.00	1.00	
	3/15/2012	497	78				6.4	290	53	13	<1.1	<1.2	<1.1	0.80	-220	0.8	1.9	--	11.2	--	0.535	2.14	6.90	0.01	0.74	0.18	0.07	0.00	0.00	1.00	
	4/17/2012	530	111				26	1400	50	14	<1.1	<1.2	<1.1	1.23	-244.1	1.0	1.5	--	10.7	--	0.438	<1.50	7.66	0.01	0.92	0.04	0.02	0.00	0.00	1.00	
	6/12/2012	586	167				72	2700	220	45	2.8	<1.2	<1.1	0.70	28.3	0.9	2.0	--	9.7	--	0.787	1.61	6.37	0.02	0.85	0.09	0.03	0.00	0.00	1.00	
	8/9/2012	644	225	-7			2.2	180	190	13	--	--	--	--	--	--	--	--	--	--	--	--	219	--	0.00	0.39	0.55	0.06	--	--	1.00
	9/18/2012	684	265	33			41	1300	340	38	<5.0	<5.0	<5.0	0.45	-119	0.28	1.6	--	8.4	--	1.6	5.2	6.31	0.02	0.69	0.25	0.04	0.00	0.00	1.00	
	11/14/2012	741	322	90			83	2900	110	2.6	<5.0	<5.0	<5.0	0.83	122.5	0.89	0.5	--	10.2	--	3.2	<1.0	6.57	0.02	0.93	0.05	0.00	0.00	0.00	1.00	
2/6/2013	825	406	174			13	390	77	4.7	<5.0	<5.0	<5.0	0.52	56.4	0.11	0.5	--	8.9	--	1.4	--	6.26	0.02	0.76	0.20	0.02	0.00	0.00	1.00		
5/7/2013	915	496	264	-63		16	11000	6200	380	29	<5.0	<5.0	2.75	-28.6	<0.10	2.0	--	7.8	--	2.8	--	6.39	0.00	0.54	0.41	0.04	0.01	0.00	1.00		
8/6/2013	1006	587	355	28		6.5	1800	670	65	27	<5.0	<5.0	0.52	-120.5	<0.10	1.5	--	10.2	--	4.8	2.4	6.18	0.00	0.60	0.31	0.05	0.04	0.00	1.00		
11/7/2013	1099	680	448	121		<4.0	17000	7800	250	30	<5.0	<5.0	1.13	-75.5	<0.10	3.0	--	8.6	--	1.9	2.0	6.41	0.00	0.60	0.37	0.02	0.00	0.00	1.00		
2/20/2014	1204	785	553	226		<4.0	8400	13000	610	21	<5.0	<5.0	1.23	23.0	<0.10	4.0	--	6.9	--	2.6	1.5	6.54	0.00	0.31	0.64	0.05	0.00	0.00	1.00		
5/8/2014	1281	862	630	303		<2.0	340	20000	5600	180	<5.0	<5.0	0.50	-43.5	<0.10	2.5	--	<1.0	--	3.4	7.2	6.92	0.00	0.01	0.68	0.29	0.02	0.00	1.00		
8/13/2014	1378	959	727	400	28	<2.0	<2.0	2800	13000	730	<5.0	<5.0	1.14	17.3	<0.10	4.5	--	1.4	--	4.8	32.9	5.87	0.00	0.00	0.11	0.79	0.10	0.00	1.00		
11/6/2014	1463	1044	812	485	113	<0.2	1.7	47	73	210	<5.0	<5.0	0.15	-108.1	<0.10	3.0	16.4	16.1	4.1	<2.0	5.6	11.9	6.41	0.00	0.00	0.05	0.13	0.82	0.00	1.00	
BOP-74(i) PRB Well	10/19/2010	-16					1.0	38	8.0	<1.0	<1.0	<2.0	--	--	0.9	--	--	--	9.1	--	0.1	<1.50		0.02	0.77	0.22	0.00	0.00	0.00	1.00	
	12/6/2010	32					<1.0	24	6.5	<1.0	<1.0	<2.0	--	3.07	53.3	0.2	0.2	--	--	--	--	2.79	6.61	0.00	0.73	0.27	0.00	--	--	1.00	
	2/2/2011	90					2.6	44	3.8	<1.0	--	--	--																		

**TABLE 8
 BIOREMEDIATION SUMMARY
 FORMER VAPOR DEGREASER SOURCE AREA
 BOEING OF 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)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions						Donor Indicators		Molar Fraction										
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	PCE (ug/L)	TCE (ug/L)	CIS (ug/L)	VC (ug/L)	Ethene (ug/L)	Ethane (ug/L)	Acetylene (ug/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)	Methane (mg/L)	TOC (mg/L)	pH	PCE	TCE	CIS	VC	Ethene	Ethane	Total
BOP-74(i) PRB Well	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	--	21	128	6.04	0.00	0.35	0.32	0.33	0.00	0.00	1.00
	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	--	26	669	5.07	0.00	0.02	0.52	0.47	0.00	0.00	1.00
	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	--	17	330	6.05	0.00	0.00	0.11	0.08	0.81	0.00	1.00
	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	--	22	66.2	6.37	0.00	0.00	0.12	0.07	0.00	0.81	1.00
	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	--	19	32.8	6.58	0.00	0.00	0.10	0.18	0.72	0.00	1.00
	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	21	2860	4.16	0.00	0.02	0.76	0.22	0.00	0.00	1.00
BOP-75(i) Upgradient Well	2/2/2011	90					2.5	87	11	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.84	0.14	0.00	--	--	1.00	
	5/5/2011	182					1.1	52	11	<1.0	--	--	--	--	--	--	--	--	13.5	--	--	--	4.77	--	0.01	0.77	0.22	0.00	--	--	1.00
	8/10/2011	279					1.6	59	11	<1.0	<1.1	<1.2	<1.1	1.76	-16.3	1.1	2.4	--	--	--	--	<0.0007	--	6.24	0.02	0.78	0.20	0.00	0.00	0.00	1.00
	11/3/2011	364	-55				1.2	58	10	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.80	0.19	0.00	--	--	1.00
	2/8/2012	461	42				1.3	55	9.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.80	0.19	0.00	--	--	1.00
	5/4/2012	547	128				<1.0	52	10	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.79	0.21	0.00	--	--	1.00
	8/9/2012	644	225	-7			1.6	39	7.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.78	0.20	0.00	--	--	1.00
	11/8/2012	735	316	84			1.0	35	6.9	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.78	0.21	0.00	--	--	1.00
	2/5/2013	824	405	173			1.0	54	9.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.80	0.19	0.00	--	--	1.00
	5/2/2013	910	491	259			0.8	42	7.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.80	0.19	0.00	--	--	1.00
	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	--	<0.005	2.3	6.25	0.01	0.72	0.27	0.00	0.00	0.00	1.00
	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	--	0.39	51.3	6.43	0.00	0.02	0.96	0.01	0.00	0.00	1.00
	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	--	12	5.5	6.55	0.00	0.04	0.06	0.91	0.00	0.00	1.00
	2/5/2014	1189	770	538	211		<0.2	2.6	1.3	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.06	0.04	0.90	--	--	1.00
5/7/2014	1280	861	629	302	-70	<0.2	7.4	2.7	14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.18	0.09	0.73	--	--	1.00	
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	--	9.9	258	5.38	0.00	0.15	0.32	0.52	0.00	0.00	1.00	
11/5/2014	1462	1043	811	484	112	<0.2	<0.2	4.3	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.20	0.80	--	--	1.00	
BOP-76(i) Monitoring Well	2/2/2011	90					1.7	8.5	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.14	0.86	0.00	0.00	--	--	1.00
	5/5/2011	182					<1.0	6.8	1.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.81	0.19	0.00	--	--	1.00
	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	--	<0.0007	2.37	6.20	0.05	0.64	0.31	0.00	0.00	0.00	1.00
	11/3/2011	364	-55				1.4	27	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.89	0.07	0.00	--	--	1.00
	2/8/2012	461	42				<1.0	2.1	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	1.00	0.00	0.00	--	--	1.00
	5/4/2012	547	128				<1.0	9.2	1.5	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.82	0.18	0.00	--	--	1.00
	8/9/2012	644	225	-7			1.1	33	2.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.90	0.08	0.00	--	--	1.00
	11/8/2012	735	316	84			0.8	9.8	1.7	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.77	0.18	0.00	--	--	1.00
	2/5/2013	824	405	173			0.8	11	1.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.80	0.15	0.00	--	--	1.00
	5/2/2013	910	491	259			1.4	22	1.7	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.87	0.09	0.00	--	--	1.00
	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	--	<0.005	1.6	6.18	0.03	0.88	0.09	0.00	0.00	0.00	1.00
	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	--	3.4	111	6.14	0.00	0.01	0.88	0.11	0.00	0.00	1.00
	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	--	11.0	6.9	6.44	0.01	0.50	0.18	0.31	0.00	0.00	1.00
	2/5/2014	1189	770	538	211		1.0	45	5.8	8.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.63	0.11	0.25	--	--	1.00
5/7/2014	1280	861	629	302	-70	<0.2	7.2	1.2	4.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.39	0.09	0.52	--	--	1.00	
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	--	7.6	170	5.27	0.00	0.24	0.60	0.16	0.00	0.00	1.00	
11/6/2014	1463	1044	812	485	113	<0.2	1.4	9.5	2.1	15	<5.0	<5.0	<5.0	0.20	-104.7	0.20	1.5	14.4	14.5	3.2	<2.0	21	51.2	5.88	0.00	0.02	0.14	0.05	0.79	0.00	1.00
BOP-77(i) Monitoring Well	2/2/2011	90					1.7	88	2.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.95	0.04	0.00	--	--	1.00
	5/5/2011	182					<1.0	41	3.8	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.89	0.11	0.00	--	--	1.00
	8/10/2011	279					1.8	17	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.83	0.11	0.00	--	--	1.00
	11/3/2011	364					<1.0	11	6.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.55	0.45	0.00	--	--	1.00
	12/1/2011	392	-27				1.1	32	7.1																						

**TABLE 8
 BIOREMEDIATION SUMMARY
 FORMER VAPOR DEGREASER SOURCE AREA
 BOEING OF 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)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions						Donor Indicators		Molar Fraction										
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (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)	Methane (mg/L)	TOC (mg/L)	pH	PCE	TCE	CIS	VC	Ethene	Ethane	Total
BOP-77(i) Monitoring Well	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	--	17	888	5.38	0.00	0.01	0.217	0.313	0.46	0.00	1.00
	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	--	20	111	6.21	0.00	0.00	0.083	0.256	0.66	0.00	1.00
	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	--	19	40	6.29	0.00	0.02	0.064	0.123	0.79	0.00	1.00
	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	--	23	36.4	6.41	0.00	0.00	0.021	0.088	0.81	0.08	1.00
	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	--	15	10100	4.32	0.00	0.00	0.425	0.138	0.435	0.00	1.00
	11/6/2014	1463	1044	812	485	113	<0.2	2.7	200	24	63	<5.0	<5.0	0.17	-165.8	<0.50	7.0	961	981	1850	11.3	22	4920	4.13	0.00	0.00	0.438	0.081	0.476	0.00	1.00
BOP-78(i) Injection Well	11/21/2011	382	-37				1.7	37	6.1	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.79	0.18	0.00	--	--	1.00	
	8/9/2012	644	225	-7			1.1	30	9.3	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.69	0.29	0.00	--	--	1.00	
	11/8/2012	735	316	84			<0.2	0.3	7.2	51	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.08	0.91	--	--	1.00	
	2/6/2013	825	406	174			<0.2	0.3	11	78	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.08	0.92	--	--	1.00	
	5/2/2013	910	491	259	-68		<0.2	0.3	0.6	19	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.01	0.02	0.97	--	--	1.00	
	8/7/2013	1007	588	356	29		0.2	5.5	120	98	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.01	0.43	0.55	--	--	1.00	
	11/8/2013	1100	681	449	122		<0.2	<0.2	1.1	17	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.04	0.96	--	--	1.00	
	2/5/2014	1189	770	538	211		<0.2	1.0	1.3	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.11	0.19	0.70	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	<0.2	3.6	2.7	1.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.33	0.34	0.33	--	--	1.00	
	11/5/2014	1462	1043	811	484	112	<0.2	1.7	23	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.04	0.81	0.14	--	--	1.00	
BOP-79(i) Injection Well	11/21/2011	382	-37				1.8	42	5.0	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.84	0.13	0.00	--	--	1.00	
	8/9/2012	644	225	-7			2.2	95	12	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.84	0.14	0.00	--	--	1.00	
	11/8/2012	735	316	84			<0.2	0.2	3.7	68	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.03	0.96	--	--	1.00	
	2/6/2013	825	406	174			<0.2	0.2	0.6	5.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.02	0.06	0.92	--	--	1.00	
	5/2/2013	910	491	259	-68		<0.2	0.4	24	41	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.27	0.72	--	--	1.00	
	8/7/2013	1007	588	356	29		<0.2	1.0	37	20	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.01	0.54	0.45	--	--	1.00	
	11/8/2013	1100	681	449	122		<0.2	1.9	13	16	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.04	0.33	0.63	--	--	1.00	
	2/5/2014	1189	770	538	211		<0.2	3.4	17	7.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.08	0.55	0.36	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	0.9	58	43	15	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.39	0.39	0.21	--	--	1.00	
	11/7/2014	1464	1045	813	486		<0.2	1.5	21	5.6	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.04	0.68	0.28	--	--	1.00	
BOP-80(i) Downgradient Well	11/21/2011	382					<1.0	2.4	7.0	7.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.09	0.36	0.55	--	--	1.00	
	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	--	3.97	2.43	6.74	0.00	0.31	0.17	0.23	0.28	0.00	1.00
	1/9/2012	431	12				<1.0	<1.0	<1.0	1.4	--	--	--	0.15	-255	0.2	1.7	--	--	0.4	--	--	4.93	6.80	0.00	0.00	0.00	1.00	--	--	1.00
	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	--	7.44	3.28	7.14	0.00	0.00	0.00	0.00	0.00	1.00	1.00
	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	--	7.98	4.72	6.99	0.00	0.00	0.00	0.17	0.35	0.49	1.00
	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	--	12.8	2.89	7.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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	--	10.4	2.50	6.01	0.00	0.00	0.00	0.10	0.37	0.53	1.00
	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	--	14	13.9	6.35	0.01	0.59	0.18	0.11	0.00	0.12	1.00
	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	--	7.5	1.5	6.48	0.00	0.59	0.31	0.07	0.00	0.03	1.00
	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	--	23	1.2	6.44	0.00	0.06	0.00	0.03	0.00	0.91	1.00
	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	--	20	1.3	6.31	0.00	0.01	0.00	0.03	0.00	0.96	1.00
	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	--	17	1.5	5.53	0.00	0.00	0.00	0.02	0.00	0.98	1.00
	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	--	22	1.4	5.99	0.00	0.00	0.00	0.01	0.00	0.99	1.00
	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	--	0.45	2.6	6.59	0.08	0.90	0.02	0.00	0.00	0.00	1.00
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	--	16	3.8	6.73	0.00	0.03	0.00	0.00	0.00	0.97	1.00	
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	--	13	909	5.28	0.00	0.01	0.03	0.14	0.00	0.82	1.00	
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	2.9	1.4	6.82	0.00	0.09	0.71	0.19	0.00	0.00	1.00	
BOP-81(i) Downgradient Well	11/21/2011	382					<1.0	<1.0	1.6	6.2	--	--	--	--																	

**TABLE 8
 BIOREMEDIATION SUMMARY
 FORMER VAPOR DEGREASER SOURCE AREA
 BOEING OF 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)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions						Donor Indicators		Molar Fraction											
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (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)	Methane (mg/L)	TOC (mg/L)	pH	PCE	TCE	CIS	VC	Ethene	Ethane	Total	
BOP-81(i) Downgradient Well	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	--	20.0	1.2	6.04	0.00	0.00	0.00	0.02	0.00	0.98	1.00	
	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	--	0.33	1.4	6.14	0.44	0.56	0.00	0.00	0.00	0.00	1.00	
	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	--	24.0	2.0	6.73	0.00	0.01	0.00	0.00	0.00	0.99	1.00	
	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	--	12.0	225	5.76	0.00	0.00	0.00	0.03	0.00	0.97	1.00	
	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	25.0	1.5	6.33	0.00	0.00	0.00	0.01	0.00	0.99	1.00	
BOP-82(i) Downgradient Well	11/21/2011	382					4.6	91	1.6	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.94	0.02	0.00	--	--	1.00		
	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	--	<0.0007	<1.50	6.36	0.04	0.93	0.03	0.00	0.00	0.00	1.00	
	12/28/2011	419	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.12	--	--	--	--	--	--	0.00		
	1/9/2012	431	12				2.6	47	1.0	<1.0	--	--	--	0.31	-238.8	<0.2	2.1	--	--	7.3	--	--	9.81	6.74	0.04	0.93	0.03	0.00	--	--	1.00	
	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	--	0.0144	4.85	6.94	0.03	0.78	0.19	0.00	0.00	0.00	1.00	
	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	--	<0.0007	3.25	6.97	0.03	0.69	0.28	0.00	0.00	0.00	1.00	
	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	--	<0.0007	2.46	6.78	0.03	0.80	0.17	0.00	0.00	0.00	1.00	
	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	--	<0.0007	2.56	5.54	0.04	0.84	0.12	0.00	0.00	0.00	1.00	
	8/16/2012	651	232	0			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.6	--	--	--	--	--	--	0.00		
	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	--	<0.015	1.4	6.45	0.03	0.83	0.09	0.05	0.00	0.00	0.00	1.00
	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	--	0.036	<1.0	6.61	0.05	0.86	0.08	0.02	0.00	0.00	1.00	
	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	--	0.036	<1.0	6.50	0.06	0.77	0.13	0.04	0.00	0.00	1.00	
	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	--	0.48	<1.0	6.26	0.04	0.86	0.06	0.03	0.00	0.00	1.00	
	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	--	0.11	<1.0	6.24	0.05	0.91	0.03	0.00	0.00	0.00	1.00	
	11/7/2013	1099	680	448	121		1.1	17	0.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.92	0.04	0.00	--	--	1.00	
	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	--	--	2.5	6.08	0.05	0.91	0.04	0.00	0.00	0.00	1.00	
	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	--	1.0	1.9	6.25	0.04	0.91	0.05	0.00	0.00	0.00	1.00	
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	--	1.5	36.4	5.82	0.06	0.88	0.06	0.00	0.00	0.00	1.00		
11/7/2014	1464	1045	813	486	114	0.6	8.1	2.7	0.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.59	0.27	0.11	--	--	1.00		
BOP-83(i) Downgradient Well	11/21/2011	382					<1.0	31	<1.0	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	1.00	0.00	0.00	--	--	1.00		
	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	--	<0.0007	<1.50	6.73	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
	12/28/2011	419	0				--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.87	--	--	--	--	--	--	0.00		
	1/9/2012	431	12				1.8	36	<1.0	<1.0	--	--	--	6.18	-200.7	7.2	0.1	--	--	19.7	--	--	<1.5	6.70	0.04	0.96	0.00	0.00	--	--	1.00	
	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	--	<0.0007	2.73	7.10	0.03	0.91	0.05	0.00	0.00	0.00	1.00	
	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	--	<0.0007	1.90	6.87	0.04	0.96	0.00	0.00	0.00	0.00	1.00	
	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	--	<0.0007	<1.50	6.34	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
	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	--	<0.015	<1.50	5.98	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
	8/16/2012	651	232	0			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<1.0	--	--	--	--	--	--	0.00		
	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	--	<0.015	1.2	6.07	0.04	0.92	0.04	0.00	0.00	0.00	1.00	
	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	--	0.0064	<1.0	6.69	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
	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	--	<0.005	<1.0	6.63	0.04	0.91	0.05	0.00	0.00	0.00	1.00	
	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	--	<0.005	<1.0	6.32	0.04	0.91	0.05	0.00	0.00	0.00	1.00	
	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	--	<0.005	<1.0	6.35	0.00	1.00	0.00	0.00	0.00	0.00	1.00	
	11/7/2013	1099	680	448	121		<0.2	2.4	<0.2	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	1.00	0.00	0.00	--	--	1.00	
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	--	<0.005	<1.0	6.33	0.00	1.00	0.00	0.00	0.00	0.00	1.00		
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	--	0.19	1.2	6.43	0.05	0.87	0.08	0.00	0.00	0.00	1.00		
8/14/2014	1379	960	728	401	29	<0.2	2.2																									

**TABLE 8
 BIOREMEDIATION SUMMARY
 FORMER VAPOR DEGREASER SOURCE AREA
 BOEING OF 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)	Volatile Organic Compounds Analytical Results						Aquifer Redox Conditions						Donor Indicators		Molar Fraction										
		Pilot Injection	PRB 1st Injection	PRB 2nd Injection	Source Zone Wells 1st Injection	Source Zone Wells + PRB Injection	PCE (µg/L)	TCE (µg/L)	CIS (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)	Methane (mg/L)	TOC (mg/L)	pH	PCE	TCE	CIS	VC	Ethene	Ethane	Total
BOP-85(i) Injection Well	2/8/2012	461	42				1.6	33	6.5	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.77	0.20	0.00	--	--	1.00	
	5/4/2012	547	128				<1.0	29	6.5	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.77	0.23	0.00	--	--	1.00	
	8/9/2012	644	225	-7			1.2	32	5.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.79	0.19	0.00	--	--	1.00	
	11/8/2012	735	316	84			0.9	20	4.3	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.75	0.22	0.00	--	--	1.00	
	2/6/2013	825	406	174			0.8	37	7.0	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.79	0.20	0.00	--	--	1.00	
	5/2/2013	910	491	259	-68		1.1	30	5.8	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.77	0.20	0.00	--	--	1.00	
	8/7/2013	1007	588	356	29		0.5	1.5	22	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.04	0.89	0.05	--	--	1.00	
	11/8/2013	1100	681	449	122		<0.2	0.2	2.4	2.1	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.03	0.41	0.56	--	--	1.00	
	2/5/2014	1189	770	538	211		<0.2	<0.2	<0.2	1.3	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	1.00	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	<0.2	<0.2	<0.2	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.00	1.00	--	--	1.00	
	11/5/2014	1462	1043	811	484	112	<0.2	1.6	3.4	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.23	0.65	0.12	--	--	1.00	
BOP-86(i) Injection Well	2/8/2012	461	42				1.2	21	17	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.47	0.51	0.00	--	--	1.00	
	5/4/2012	547	128				<1.0	28	5.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.80	0.20	0.00	--	--	1.00	
	8/9/2012	644	225	-7			1.0	39	7.7	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.78	0.21	0.00	--	--	1.00	
	11/8/2012	735	316	84			0.9	20	4.6	0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.71	0.22	0.04	--	--	1.00	
	2/6/2013	825	406	174			0.6	31	6.2	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.78	0.21	0.00	--	--	1.00	
	5/2/2013	910	491	259	-68		0.7	35	7.4	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.77	0.22	0.00	--	--	1.00	
	8/7/2013	1007	588	356	29		0.6	9.1	15	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.28	0.64	0.07	--	--	1.00	
	11/8/2013	1100	681	449	122		<0.2	1.4	2.0	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.15	0.28	0.57	--	--	1.00	
	2/5/2014	1189	770	538	211		0.3	0.4	0.4	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	0.10	0.16	0.22	0.52	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	<0.2	0.4	1.3	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.10	0.46	0.44	--	--	1.00	
	11/5/2014	1462	1043	811	484	112	<0.2	0.6	4.6	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.05	0.47	0.48	--	--	1.00	
BOP-87(i) Injection Well	2/8/2012	461	42				1.3	14	1.8	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.06	0.80	0.14	0.00	--	--	1.00	
	5/4/2012	547	128				<1.0	24	1.4	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.93	0.07	0.00	--	--	1.00	
	8/9/2012	644	225	-7			2.2	52	2.6	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.91	0.06	0.00	--	--	1.00	
	11/8/2012	735	316	84			1.2	9.7	1.6	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.76	0.17	0.00	--	--	1.00	
	2/6/2013	825	406	174			0.4	8.5	1.2	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.03	0.81	0.16	0.00	--	--	1.00	
	5/2/2013	910	491	259	-68		0.2	7.1	1.2	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.80	0.18	0.00	--	--	1.00	
	8/7/2013	1007	588	356	29		0.7	21	6.3	0.3	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.68	0.28	0.02	--	--	1.00	
	11/8/2013	1100	681	449	122		<0.2	0.6	6.2	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.06	0.82	0.12	--	--	1.00	
	2/5/2014	1189	770	538	211		<0.2	0.3	1.2	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.07	0.40	0.52	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	<0.2	<0.2	0.3	0.5	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.00	0.28	0.72	--	--	1.00	
	11/5/2014	1462	1043	811	484	112	<0.2	0.6	1.5	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.14	0.47	0.39	--	--	1.00	
BOP-88(i) Injection Well	2/8/2012	461	42				2.0	26	2.2	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.85	0.10	0.00	--	--	1.00	
	5/4/2012	547	128				<1.0	19	2.5	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.85	0.15	0.00	--	--	1.00	
	8/9/2012	644	225	-7			2.8	130	8.9	<1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.90	0.08	0.00	--	--	1.00	
	11/8/2012	735	316	84			1.2	11	1.5	<0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.07	0.79	0.15	0.00	--	--	1.00	
	2/6/2013	825	406	174			0.9	11	1.4	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.78	0.14	0.03	--	--	1.00	
	5/2/2013	910	491	259	-68		0.6	14	2.2	1.2	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.70	0.15	0.13	--	--	1.00	
	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	--	1.9	294	5.88	0.03	0.33	0.63	0.02	0.00	0.00	1.00
	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	--	17.0	458	6.20	0.00	0.00	0.93	0.07	0.00	0.00	1.00
	2/5/2014	1189	770	538	211		<0.2	0.9	3.0	27	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.01	0.07	0.92	--	--	1.00	
	5/7/2014	1280	861	629	302	-70	<0.2	1.0	3.5	7.7	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00	0.05	0.22	0.74	--	--	1.00	
	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	13.0	3150	4.56	0.00	0.04	0.79	0.17	0.00	0.00	1.00

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: Perform Permeable Reactive Barrier (PRB) injection at BOP-74(i). Injected 15 drums of LactOil, Newman Zone vegetable oil emulsion, and Wilclear sodium lactate with 15,000 gal of water. Injection rates were between 70 to 80 ppm.
 c) August 18, 2012: Conducted PRB injection at BOP-74(i) with 30,000 gal of LactOil and water mixture.
 d) July 2-9, 2013: Conducted gravity feed injection at 7 source area zone injection wells (BOP-78, 79, 84, 85, 86, 87, 88). Injection consisted of 540 gal 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 feed to 7 multipurpose injection wells. Injection consisted of 50,000 gallon mixture of water, LactOil, Textrol BR, glycerin, and ferrous sulfate.

Notes:
 -- Data not collected or analyzed
 Blue highlighted values indicate the compound with the highest micromoles per event