2016 Annual Report
AOC-05 Remedial Action
Enhanced Anaerobic Biodegradation of Gasoline-Range Petroleum Hydrocarbons
Boeing Developmental Center
Tukwila, Washington

June 5, 2017

Prepared for

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LIST OF ABBREVIATIONS AND ACRONYMS

AOC .... area of concern
bgs .... below ground surface
Boeing .... The Boeing Company
BTEX .... benzene, toluene, ethylbenzene, and xylenes
DC .... Developmental Center
Ecology .... Washington State Department of Ecology
ft .... feet
LAI .... Landau Associates, Inc.
lbs .... pounds
LLI .... Lancaster Laboratories Environmental
µg/L .... micrograms per liter
mg/L .... milligrams per liter
mg-N/L .... milligrams per liter as nitrogen
NAPL .... non-aqueous phase liquid
ORC .... oxygen release compound
ORP .... oxidation-reduction potential
PCULs .... proposed cleanup levels
redox .... oxidation-reduction
ROIs .... radii of injection
TPH .... total petroleum hydrocarbons
TPH-G .... gasoline-range total petroleum hydrocarbons
UST .... underground storage tank
Work Plan .... Remedial Action Work Plan

1.0 INTRODUCTION

This document presents the 2016 annual report for the anaerobic bioremediation remedial action performed at Area of Concern (AOC)-05 of The Boeing Company's (Boeing) Developmental Center (DC) in Tukwila, Washington (Figure 1). Remedial action is performed to stimulate anaerobic biodegradation of gasoline contamination resulting from a 1985 release from a former leaking underground storage tank (UST) near injection well BDC-103. AOC-05 wells and site features are shown on Figure 2. Anaerobic bioremediation remedial action was performed in general accordance with the Remedial Action Work Plan (Work Plan; Landau Associates, Inc. [LAI] 2007a).

This annual report summarizes the activities and results for April 2016 through February 2017, including the nitrate solution injection to well BDC-103 in December 2016.

Following this introductory section, the report is organized into five main sections. Sections 2 and 3 provide an overview of the remedial approach and a summary of prior work, as context to activities and results in the current reporting period. Section 4 documents activities during the reporting period, and Section 5 presents a discussion of reporting period results. Section 6 provides a summary and describes planned activities.

2.0 OVERVIEW OF REMEDIAL APPROACH

Anaerobic bioremediation at AOC-05 is accomplished through stimulation of micro-organisms present in the aquifer to degrade petroleum hydrocarbons. The addition of nitrate (electron acceptor) allows the native bacteria to utilize petroleum as food (electron donor).

Biodegradation of total petroleum hydrocarbons (TPH) occurs through microbially mediated reactions whereby micro-organisms obtain energy by oxidation-reduction (redox) reactions. TPH are used as the electron donor together with various electron acceptors (oxygen, nitrate, manganese [IV], ferric iron, sulfate, and carbon dioxide). These redox reactions can be compared to the process whereby humans obtain energy through consumption of food (electron donor) and oxygen (electron acceptor). Bacteria obtain the greatest energy yield by using oxygen as an acceptor, as it is highly oxidized and, therefore, can be more easily and more substantially reduced. When oxygen is depleted, bacteria sequentially use the less oxidized electron acceptors in the following order: nitrate, manganese (IV), ferric iron, sulfate, and carbon dioxide.

Biodegradation of petroleum hydrocarbons can occur under both aerobic and anaerobic conditions. Stimulation of anaerobic degradation can be the preferred approach in naturally anaerobic aquifers (such as the one at the DC) where stimulation of aerobic conditions is unlikely to be effective due to high natural demand for oxygen (Wiedemeier et al. 1999). An attempt in 2002 to stimulate aerobic bioremediation of TPH in AOC-05 through injection of oxygen release compound (ORC™) was ineffective due to the naturally anaerobic condition (LAI 2006a). During anaerobic biodegradation of TPH, nitrate (or sulfate) functions as the electron acceptor for microbial degradation of the TPH electron donor. In addition to the work being performed at the Boeing DC, nitrate amendment to enhance anaerobic biodegradation has been successfully implemented on other full-scale remediation projects for gasoline-range and fuel oil-range TPH, both nationally (Lozier and Hicks 2005; Wasserman et. al. 2005) and in Washington State (LAI 2012a).

3.0 SUMMARY OF PREVIOUS WORK

Full-scale anaerobic bioremediation began in 2008 following anaerobic bioremediation pilot testing performed in 2007. The 2007 pilot testing, using a single injection well (BDC-103; LAI 2007b), was expanded to full-scale treatment in 2008 utilizing existing injection well BDC-103 and new injection well BDC-104. Following baseline groundwater monitoring for full-scale treatment, and prior to the current reporting period, nitrate was injected 10 times, as follows:

- three times in 2008 (both wells)
- twice in 2009 (both wells)
- once in 2010 (BDC-103 only)
- twice in 2012 (BDC-103 only)
- once in 2013 (BDC-103 only)
- once in 2016 during the prior reporting period (March, BDC-103 only).

3.1 Pilot Testing

The 2007 bioremediation pilot testing demonstrated degradation of petroleum hydrocarbons resulting from a one-time addition of ammonium nitrate (LAI 2007b). Post-injection monitoring showed that concentrations of TPH in the gasoline range (TPH-G) decreased by about 50 percent compared to baseline over 4 months of post-injection monitoring, while benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds decreased as much as 98 percent (LAI 2007b). As expected, contaminant concentrations rebounded upon depletion of injected nitrate due to groundwater returning to equilibrium with sorbed mass and non-aqueous phase liquid (NAPL) mass remaining in the aquifer.

3.2 Well Installation and Baseline Monitoring

Full-scale implementation of anaerobic bioremediation began in February 2008 with the installation of one additional injection well (BDC-104) and baseline monitoring of all four AOC-05 wells (BDC-101, BDC-102, BDC-103, and BDC-104). The new injection well was installed somewhat upgradient (east) and cross-gradient (north) of existing injection well BDC-103, to enhance treatment coverage during nitrate injections. BDC-103 is located within the tank pit of the former UST. BDC-104 is located near the known upgradient edge of contamination associated with the former UST (LAI 2004). Injection of both wells allowed for groundwater transport of injected nitrate solution to the area of highest contamination. The well locations and their estimated radii of injection (ROIs) are shown relative to the area of groundwater contamination on Figure 2.

Baseline monitoring was performed prior to full-scale treatment to determine starting contaminant concentrations and aquifer redox conditions at the four AOC-05 wells (BDC-101, BDC-102, BDC-103, and BDC-104). Baseline results indicated nitrate- to sulfate-reducing conditions at source zone wells

BDC-103 and BDC-104, nitrate- to iron-reducing conditions at downgradient well BDC-102, and aerobic to nitrate-reducing conditions at downgradient well BDC-101; the same conditions as indicated by pre-pilot test baseline monitoring (LAI 2006b). Prior to full-scale treatment, baseline (February 2008) concentrations of TPH-G were in excess of the preliminary screening level at both source zone wells BDC-103 and BDC-104, and the baseline benzene concentrations exceeded the preliminary screening level at BDC-103. (Preliminary screening levels in use at that time were developed in a prior DC site summary report [LAI 2002].) TPH-G and BTEX were not detected at downgradient wells BDC-101 and BDC-102 during baseline sampling, but had been during prior sampling extending back to 2001. Full results of baseline monitoring are included in the data summary presented in Table 1. Table 1 also includes proposed cleanup levels (PCULs) developed in 2013 (LAI 2013a); contaminant concentrations above PCULs are boxed.

3.3 Prior Full-Scale Nitrate Injections and Performance Results

As indicated above, following baseline groundwater monitoring, nitrate solution was injected 10 times at AOC-05 prior to the current reporting period. Performance monitoring results from 2008 through March 2016 indicated effective treatment of TPH-G and BTEX at source zone wells BDC-103 and BDC-104, while maintaining relatively low or non-detect contaminant levels at downgradient wells BDC-101 and BDC-102. As was observed during the pilot test, following the depletion of injected nitrate, contaminant concentrations demonstrated some degree of rebound at well BDC-103, prompting another nitrate injection. It is understood that rebound will continue to occur as long as contaminant mass remains in the sorbed-phase or as NAPL within the aquifer or in upper portions of the smear zone that are periodically contacted by the water table. The historical remediation timeline is summarized as follows:

- Nitrate solution was injected to wells BDC-103 and BDC-104 three times during 2008 (February, June, and October) and twice during 2009 (June and October).
- After 2009, nitrate injections were only required at BDC-103, as concentrations at BDC-104 had declined below PCULs.
- Following the September 2010 injection, in February 2011 contaminant concentrations at BDC-103 decreased to historical lows.
- Cycles of nitrate depletion and contaminant rebound prompted injections in 2012 (February and October) and 2013 (November). This was followed by a period of slow nitrate consumption, and an additional injection was not required until March 2016.
- Between the November 2013 and March 2016 injections, contaminant concentrations at all wells declined below the PCULs for the first time since treatment began in February 2013, and then below their reporting limits for the first time since treatment began in May 2014.

Periods of substantial TPH rebound were coincident with increased groundwater levels resulting in a higher water table. The higher water table caused groundwater to contact higher portions of the contaminant smear zone not treated by prior injection events and resulted in increased TPH concentration in groundwater.

Detailed analysis of groundwater sampling results for 2008 through February 2015 is presented in previous annual reports (LAI 2009, 2010, 2011, 2012b, 2013b, 2014, 2015, 2016). Cumulative performance monitoring results are presented in Table 1.

In accordance with the work plan (LAI 2007a), nitrate injections initially utilized 6,500 gallons of 1,000 milligrams per liter (mg/L) nitrate solution (225 mg/L as nitrogen [mg-N/L]). As treatment progressed modifications were made to this approach as follows:

- Starting in June 2009, less effective treatment suggested that biodegradation had become nutrient limited. To provide additional nutrients for bacteria, ammonium phosphate was added to the injection solution and the amount of yeast extract was increased from 2 to 4 pounds (lbs) per well. During the June 2009 injection event only, the nitrate concentration injected was decreased by two-thirds to 330 mg/L nitrate (75 mg-N/L) to evaluate the effects of added nutrients.
- Injections conducted beginning in October 2012 used a 50% increased volume (approximately 9,800 gallons total) of 1,000 mg/L nitrate solution.
- The March 2016 injection used a reduced nitrate concentration of 500 mg/L, with the larger injection volume (9,800 gallons).

As indicated in the Work Plan (LAI 2007a), the Washington State Department of Ecology (Ecology) required an action level for nitrate of 10 mg-N/L for the AOC-05 remedial action. Detection of nitrate above the action level at either of the two nearest downgradient wells (BDC-101 or BDC-102) for two consecutive sampling events triggers implementation of additional groundwater monitoring at four wells located farther downgradient (BDC-05-04, MW-17A, MW-18A, and MW-21A). Semiannual monitoring for nitrate is required to continue at these four downgradient wells for 1 year after nitrate at wells BDC-101 and BDC-102 decreases below 10 mg-N/L. Based on continued periodic exceedances of the action level at wells BDC-101 and BDC-102, semiannual nitrate monitoring has been performed at the four downgradient wells since November 2009. Nitrate has not been detected at the four downgradient wells (BDC-05-04, MW-17A, MW-18A, and MW-21A) above the 10 mg-N/L action level since the semiannual monitoring was first triggered. Cumulative downgradient nitrate monitoring results are included in Table 2.

4.0 REMEDIATION ACTIVITIES DURING THIS REPORTING PERIOD

This section describes remediation activities and monitoring events for the current reporting period of April 2016 through February 2017. In this reporting period, nitrate solution was injected once (December 6 and 7) to well BDC-103. Well BDC-104 was not injected because TPH and BTEX concentrations have remained below reporting limits at that well since May 2009, with the exception of low-level detections in February 2013. The reporting period included four quarterly monitoring events, and two semiannual monitoring events for nitrate at downgradient wells.

The December 2016 injection event at BDC-103 consisted of a standard concentration injection (1,000 mg/L nitrate) with a 50 percent increase in volume (9,750 gallons) to extend the ROI and increase the longevity of treatment. Other aspects of the injection were in accordance with the Work Plan (LAI 2007a) and associated 2009 modifications, which added ammonium phosphate and doubled the dose of yeast extract (LAI 2010).

During the December 2016 injection event, as with the previous four injection events, a higher injection flow rate was targeted in an effort to create more mounding of injection fluid above the water table. During injection, injection fluid began to seep from the seams in the concrete pavement about 25 feet (ft) from the injection well. This limited seepage was contained and collected for disposal using a wet-dry shop vacuum. The observed seepage through the pavement confirms the desired mounding above the water table, which is typically present at 11 to 12 ft below ground surface (bgs). Mounding of injection fluid above the water table is intended to contact and treat contamination that may remain in a higher portion of the smear zone, which can contribute to groundwater contaminant rebound during periods of higher groundwater.

The progress of petroleum hydrocarbon biodegradation was evaluated through quarterly performance groundwater monitoring at the four AOC-05 wells (BDC-101 through BDC-104). Monitoring was performed in April, August, and November 2016, and in February 2017. In accordance with the Work Plan (LAI 2007a), samples were analyzed for contaminant concentrations (TPH-G and BTEX) and parameters indicative of aquifer redox conditions (dissolved oxygen [DO], oxidation-reduction potential [ORP], nitrate, ferrous iron, sulfate, and pH). Samples were also analyzed for nitrite. A summary of monitoring results for the four AOC-05 wells (BDC 101 through BDC-104) is presented with cumulative data in Table 1.

Semiannual monitoring for nitrate continued in April and November 2016 at the four monitoring wells located farther downgradient of AOC-05 (MW-17A, MW-18A, MW-21A, and BDC-05-04). These results are presented with cumulative data in Table 2. Semiannual monitoring for nitrate is required to continue at these four downgradient wells for 1 year after nitrate at wells BDC-101 and BDC-102 decreases below 10 mg-N/L.

TPH-G, BTEX, nitrate, nitrite, and sulfate were analyzed in the laboratory, while other parameters (DO, ORP, ferrous iron, and pH) were measured in the field. Laboratory analysis was performed by Eurofins Lancaster Laboratories Environmental (LLI).

5.0 DISCUSSION OF RESULTS DURING THIS REPORTING PERIOD

Performance monitoring results for the current reporting period from April 2016 through February 2017 indicate continued effective treatment of TPH-G and BTEX at AOC-05. Highlights are as follows:

- Contaminant concentrations at BDC-101, BDC-102, and BDC-104 remained below laboratory reporting limits.
- TPH-G concentrations at BDC-103 were below the laboratory reporting limit for two of the four quarters. The TPH-G concentration was above the reporting limit and PCUL in August (1.7 mg/L) and November 2016 (4.5 mg/L). The reporting limit represents a decrease of 99.6 percent from the 2008 baseline concentration of 66 mg/L.
- Similarly, benzene and ethylbenzene were not detected at BDC-103 in April 2016 and February 2017, but were detected above PCULs in August and November 2016. The laboratory reporting limit represents a 99.9 percent contaminant reduction compared to the 2008 baseline concentrations.
- Toluene and total xylenes remained below their PCULs during this reporting period. The laboratory reporting limit represents a 99.9 percent contaminant reduction compared to the 2008 baseline concentrations.
- Nitrate at BDC-103 showed a substantial decrease from April 2016 (102 mg-N/L) to August 2016 (<0.10 mg-N/L), coincident with the increases in TPH-G and BTEX. Nitrate remained below the reporting limit when sampled again in November 2016. The nitrate concentration at BDC-103 recovered in February 2017 to a concentration of 194 mg-N/L following the December 2016 nitrate injection at this well. TPH-G and BTEX concentrations declined below their respective PCULs in February 2017 as a result of the nitrate injection.
- Groundwater elevations in February 2017 were the second highest since treatment began (Figure 3), providing contact of injected nitrate with remaining contaminant mass present in the higher smear zone.
- Per the Work Plan (LAI 2007a), detection of nitrate above the action level of 10 mg-N/L at either BDC-101 or BDC-102 for two consecutive sampling events triggers additional groundwater monitoring at farther downgradient wells MW-17A, MW-18A, MW-21A, and BDC-05-04. Nitrate concentrations at BDC-101 exceeded the action level during April 2016, August 2016, and February 2017 sample events, and was below the action level in November 2016. Nitrate concentrations at well BDC-102 exceeded the action level during the April and August 2016 sampling events, but was below the action level in November 2016 and February 2017. Semiannual nitrate monitoring at four downgradient wells continued during this reporting period. All downgradient detections remained below the 10 mg-N/L action level, with the highest detection occurring at BDC-05-04 (5.5 mg-N/L) in April 2016. Per the Work Plan, semiannual monitoring for nitrate will continue at the four down-gradient wells for 1 year after nitrate at wells BDC-101 and BDC-102 drops below 10 mg-N/L.
- Detection of low levels of nitrite is a result of nitrate reduction. Nitrite is a highly reactive, short-lived compound that is further reduced through nitrous oxide and nitric oxide to nitrogen gas (Environment Agency 2005). Nitrite has been commonly detected at injection wells since the start of full-scale injection activities. The maximum nitrite concentration detected during this reporting period was 0.43 mg-N/L at injection well BDC-103 in April 2016.

Nitrite was not detected at well BDC 104 or at downgradient wells BDC-101 and BDC-102 during this reporting period. This data confirms that nitrite continues to be reduced in the treatment area.

These contaminant and nitrate data at BDC-103 indicate that some contaminant mass remained upon depletion of nitrate between April and August, causing a rebound in contaminant concentrations. Following the December 2016 nitrate injection, treatment resumed and contaminant concentrations declined.

Monitoring results are presented in tables and on figures. Concentrations of TPH-G, benzene, and nitrate at BDC-103 and BDC-104 are plotted against time (from the period of nitrate pilot testing through full-scale treatment) on Figures 4 and 5, respectively. Cumulative monitoring results for wells BDC-101 through BDC-104 are presented on Table 1; results are compared to PCULs (LAI 2013a) and contaminant concentrations above PCULs are boxed. Cumulative monitoring results for downgradient nitrate monitoring are presented in Table 2 and summarized on Figure 6.

6.0 SUMMARY AND PLANNED ACTIVITIES

Data suggest that bioremediation treatment of TPH is nearing completion in AOC-05, as indicated by the slow consumption of nitrate between the November 2013 and March 2016 injection events and repeated periods of contaminant concentrations below PCULs. TPH-G and BTEX have been below PCULs at wells BDC-101, BDC-102, and BDC-104 since 2009. February 2017 monitoring data from the final quarter of this reporting period indicate substantial contaminant concentration reductions of more than 99 percent compared to 2008 baseline conditions. However, some contaminant mass remains in the aquifer, as demonstrated by the rebound of TPH-G and BTEX concentrations at BDC-103 when nitrate was depleted in August 2016.

Additional nitrate injections at AOC-05 will continue, as needed, to treat remaining aqueous-phase, sorbed-phase, and/or NAPL contamination until contaminant concentrations remain consistently below PCULs and it has been demonstrated that substantial rebound of contaminant concentrations will not occur. It is understood that rebound will continue to occur as long as contaminant mass remains in the sorbed-phase or as NAPL within the aquifer. At this stage of treatment, residual mass is expected to be predominantly in the upper portions of the smear zone that are periodically contacted by the water table. Upon depletion of nitrate in the aquifer, groundwater concentrations will return to equilibrium with remaining TPH mass present in non-aqueous phase. Treatment will be complete when rebound no longer occurs upon depletion of injected nitrate.

Following the December 2016 injection event, another injection is not needed at this time; however, additional injections may be scheduled if monitoring results indicate rebound of contaminant concentrations following depletion of nitrate. Modification of the injection approach will be evaluated on an ongoing basis, using the most current monitoring data. Ammonium phosphate (to prevent a nutrient stall), higher injection rates (to achieve mounding for contact with higher portions of the smear zone), and the larger injection volume (to extend the ROI and increase the longevity of treatment) will likely continue to be utilized for future injections, if any.

Groundwater monitoring will continue at the four AOC-05 wells and at the four downgradient wells. AOC-05 groundwater sampling is planned to continue on a quarterly basis to evaluate contaminant treatment and nitrate consumption. The four AOC-05 wells will continue to be sampled for the parameters indicated in the Work Plan and for nitrite. Semiannual monitoring for nitrate only at downgradient wells MW-17A, MW-18A, MW-21A, and BDC-05-04, triggered by nitrate concentrations at wells BDC-101 and BDC-102, will continue per the Work Plan (LAI 2007a).

7.0 USE OF THIS REPORT

This annual evaluation report has been prepared for the exclusive use of The Boeing Company for specific application to the Boeing Developmental Center. 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.

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Washington – Developmental Center

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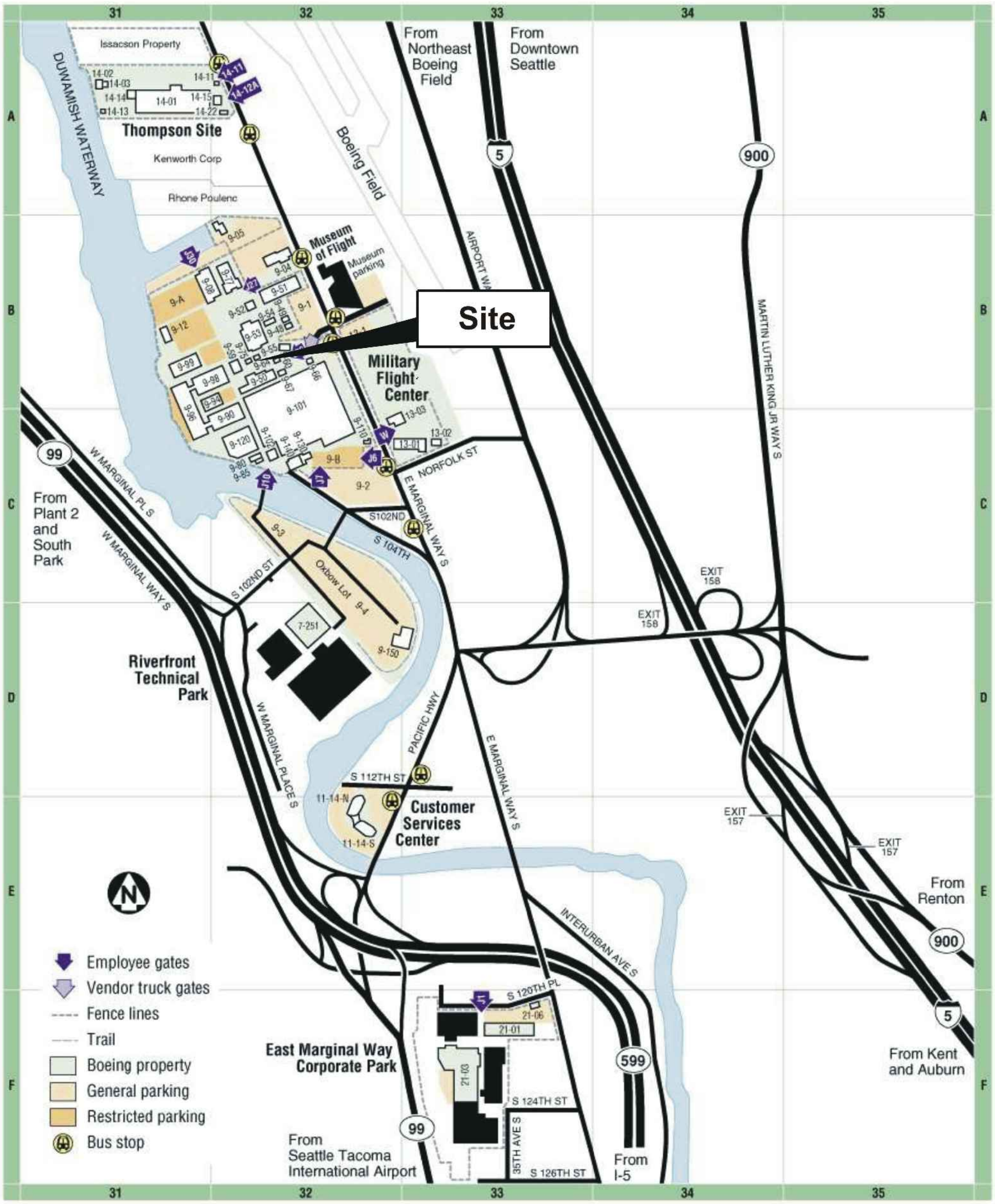

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Map provided by Boeing, March 2000

Not To Scale

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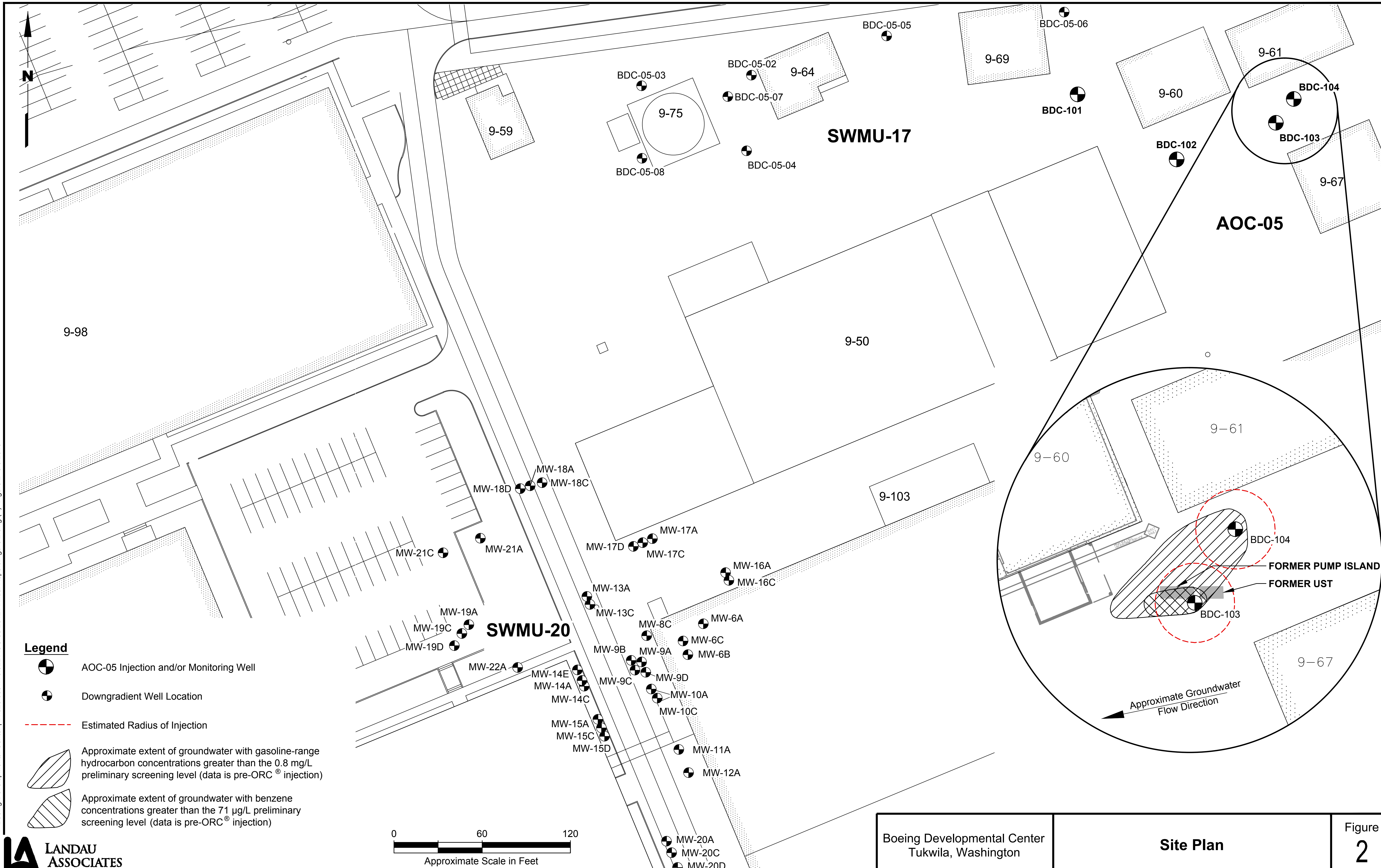
Boeing Development Center Tukwila, Washington	**Site Location Map**	Figure 1

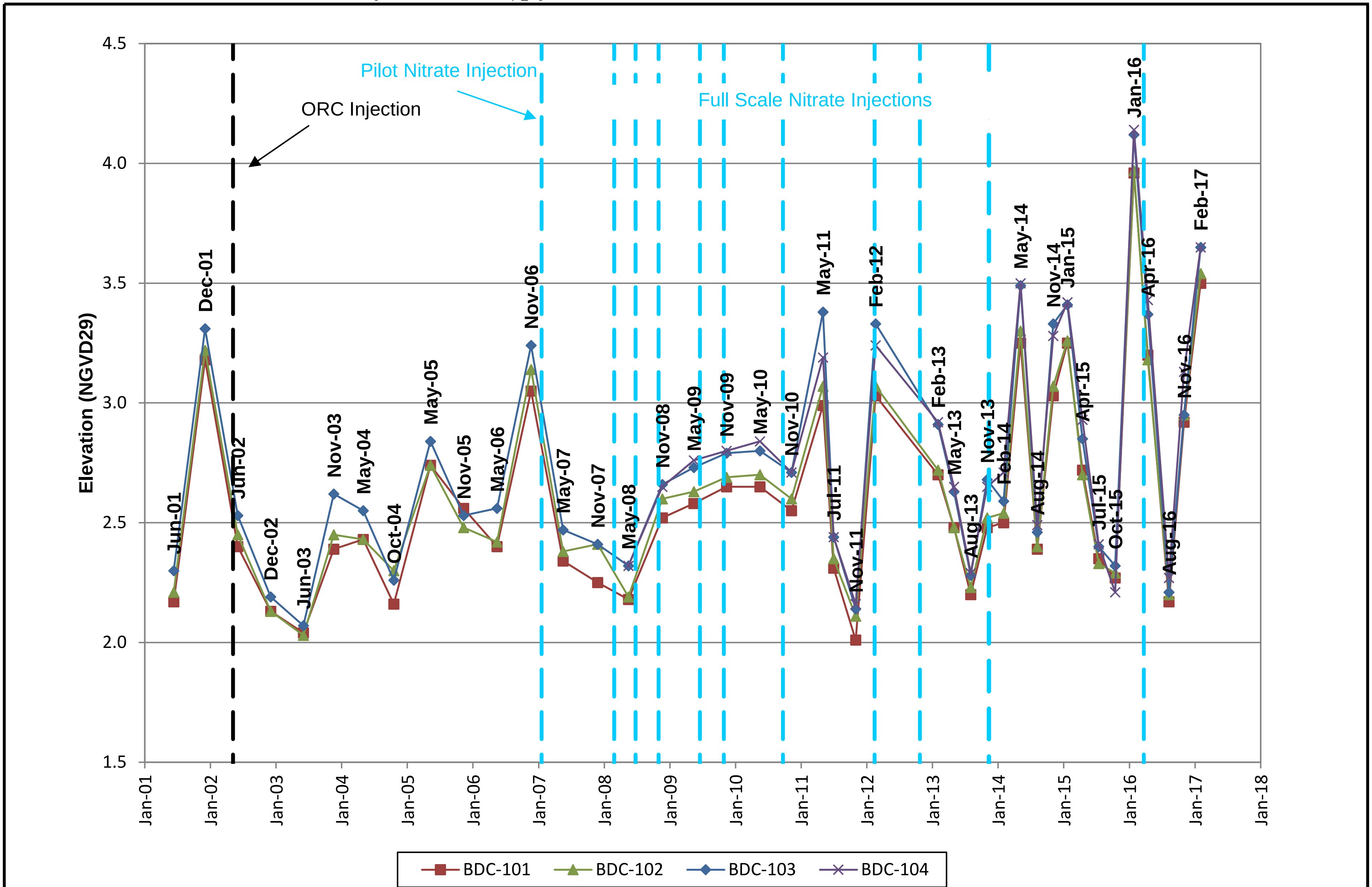


Boeing Developmental Center
Tukwila, Washington

Site Plan

Figure 2

Boeing Developmental Center | V:\025\093\113.022\AOC-05 2012 Annual Report\Figure 2.dwg (A) "Figure 2" 8/9/2013



Boeing Developmental Center
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Groundwater Levels

Figure
3

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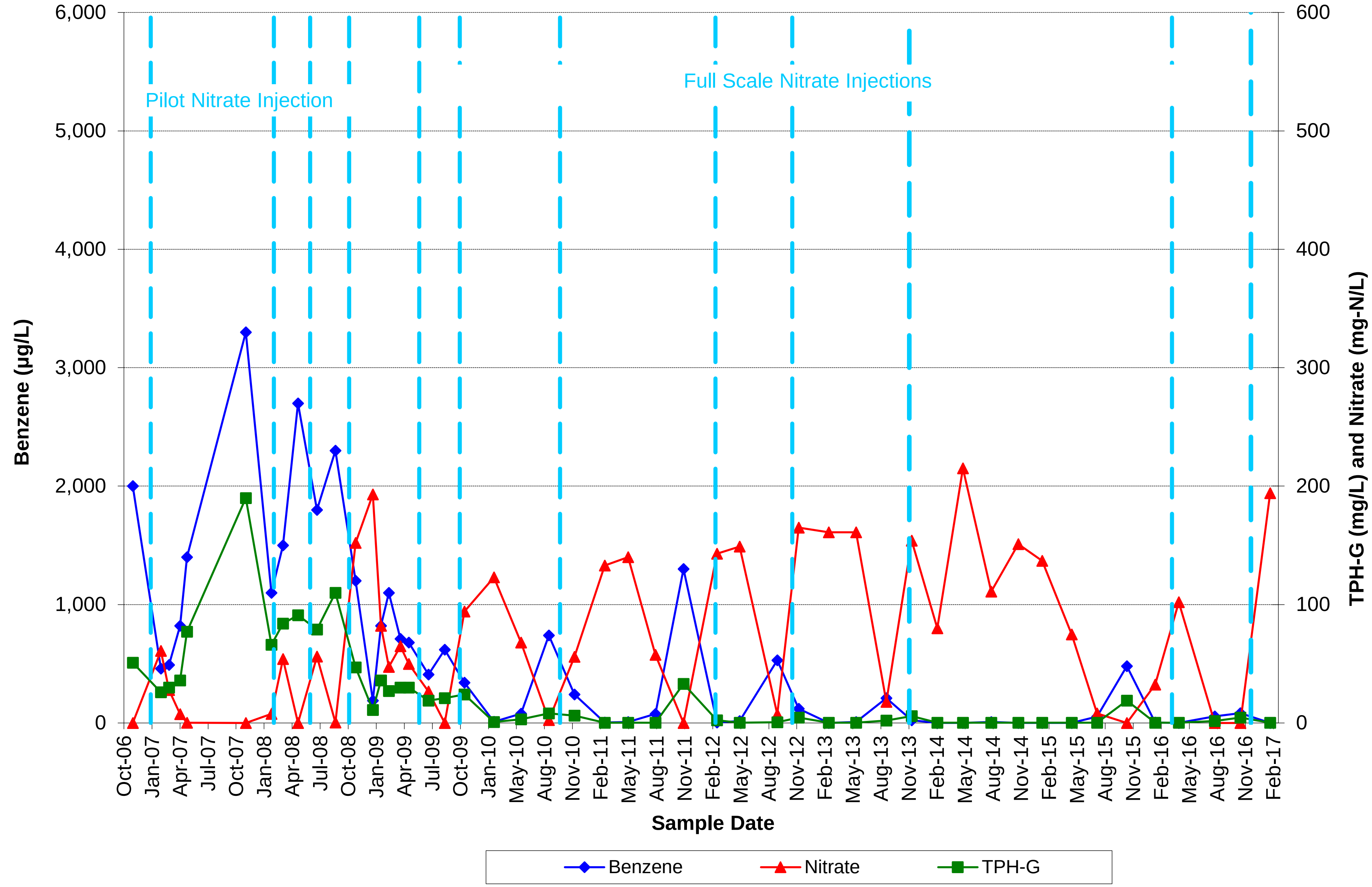

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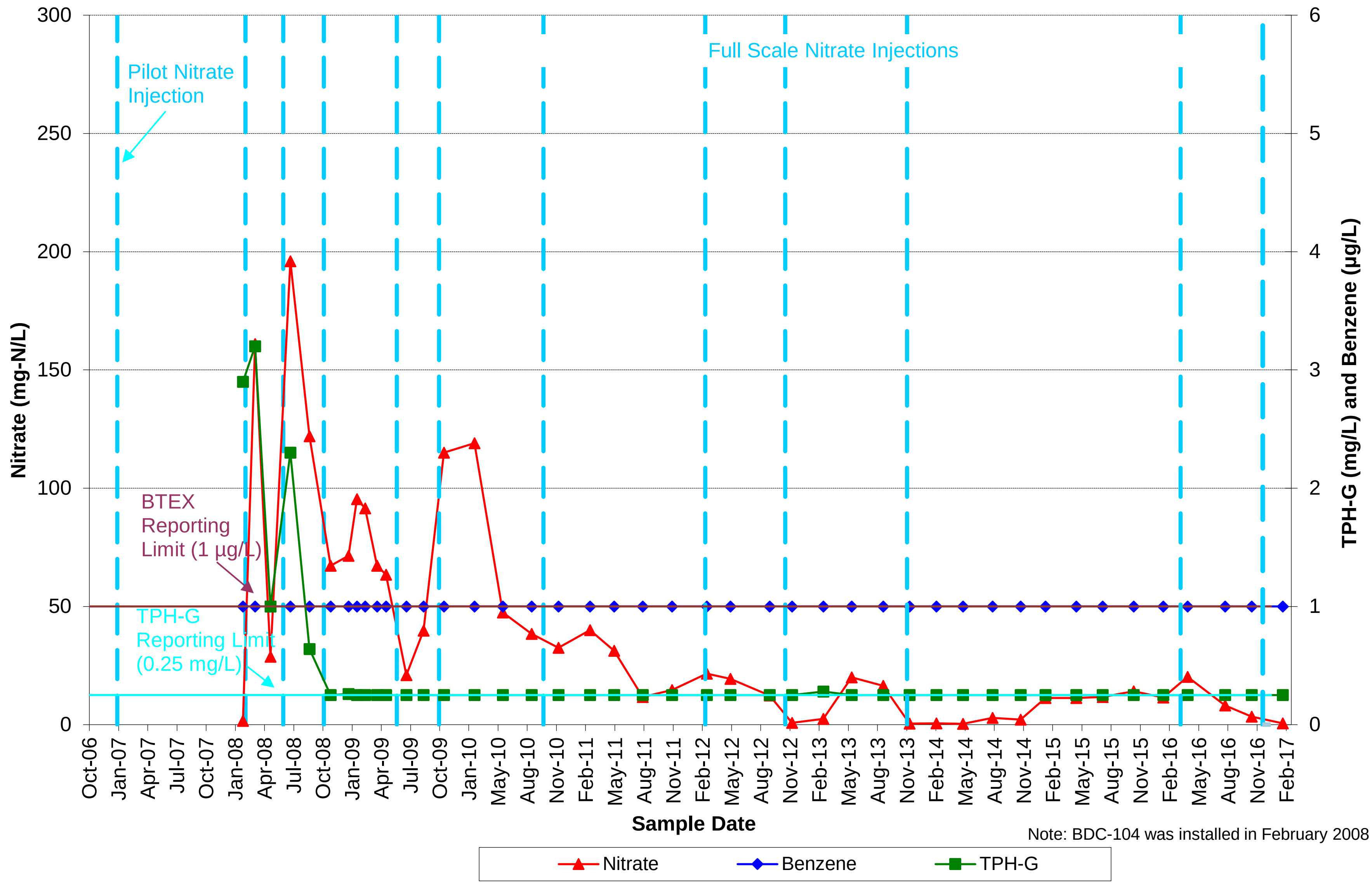
Boeing Developmental Center Tukwila, Washington	**BDC-103 Nitrate, TPH-G, and Benzene Concentrations**	Figure 4



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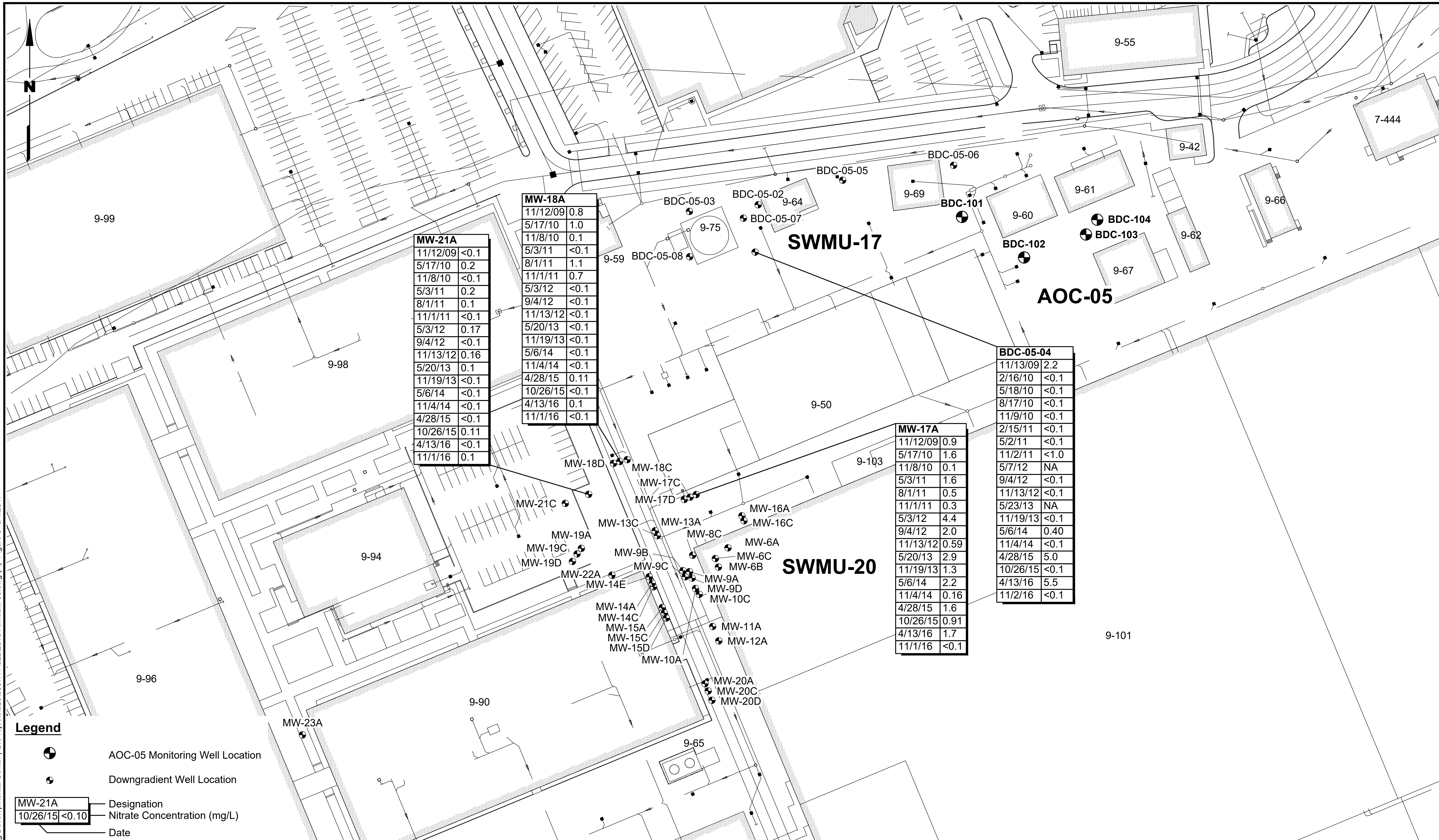
BDC-104 Nitrate, TPH-G, and Benzene Concentrations

Figure 5



MW-21A	
11/12/09	<0.1
5/17/10	0.2
11/8/10	<0.1
5/3/11	0.2
8/1/11	0.1
11/1/11	<0.1
5/3/12	0.17
9/4/12	<0.1
11/13/12	0.16
5/20/13	0.1
11/19/13	<0.1
5/6/14	<0.1
11/4/14	<0.1
4/28/15	<0.1
10/26/15	0.11
4/13/16	<0.1
11/1/16	0.1

MW-18A	
11/12/09	0.8
5/17/10	1.0
11/8/10	0.1
5/3/11	<0.1
8/1/11	1.1
11/1/11	0.7
5/3/12	<0.1
9/4/12	<0.1
11/13/12	<0.1
5/20/13	<0.1
11/19/13	<0.1
5/6/14	<0.1
11/4/14	<0.1
4/28/15	0.11
10/26/15	<0.1
4/13/16	0.1
11/1/16	<0.1

MW-17A	
11/12/09	0.9
5/17/10	1.6
11/8/10	0.1
5/3/11	1.6
8/1/11	0.5
11/1/11	0.3
5/3/12	4.4
9/4/12	2.0
11/13/12	0.59
5/20/13	2.9
11/19/13	1.3
5/6/14	2.2
11/4/14	0.16
4/28/15	1.6
10/26/15	0.91
4/13/16	1.7
11/1/16	<0.1

BDC-05-04	
11/13/09	2.2
2/16/10	<0.1
5/18/10	<0.1
8/17/10	<0.1
11/9/10	<0.1
2/15/11	<0.1
5/2/11	<0.1
11/2/11	<1.0
5/7/12	NA
9/4/12	<0.1
11/13/12	<0.1
5/23/13	NA
11/19/13	<0.1
5/6/14	0.40
11/4/14	<0.1
4/28/15	5.0
10/26/15	<0.1
4/13/16	5.5
11/2/16	<0.1

Legend

AOC-05 Monitoring Well Location

Downgradient Well Location

MW-21A	
10/26/15	<0.10

Designation
Nitrate Concentration (mg/L)
Date

NA = Not Analyzed; Nitrate sampling was inadvertently missed during May 2012 Sampling.

0 100 200
Approximate Scale in Feet

Boeing Developmental Center | G:\Projects\025\093\117\022\2016 Annual\F06.dwg (A) "Figure 6" 6/1/2017

Landau Associates

Boeing Developmental Center
Tukwila, Washington

Nitrate Concentrations at Downgradient Monitoring Locations

Figure 6

TABLE 1
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
															Volatile Organic Compounds (all units in ug/L)							Aquifer Redox Conditions							Donor Indicators		
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546										
BDC-101	6/11/2001														3.0	11.9	<1.0	113.1			109.2										
BDC-101	9/4/2001														5.0	7.13	10.7	50.4			53.8										
BDC-101	12/3/2001														6.5	95	1.6	750			650										
BDC-101	3/13/2002														<0.25	1.4	<1.0	4.4			<1.0										
BDC-101	4/29/2002	-8													<0.25	<1.0	<1.0	2.2	<1.0	<1.0	<1.0										
BDC-101	6/3/2002	27													<0.25	1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	7/1/2002	55													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	8/1/2002	86													<0.25	3.1	<1.0	2.4	<1.0	<1.0	<1.0										
BDC-101	12/2/2002	209													0.61	4.3	<1.0	21	27	6.4	33.4										
BDC-101	3/10/2003	307													<0.25	1.0	<1.0	4.5	3.2	<1.0	3.2										
BDC-101	6/3/2003	392													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/19/2003	561													0.42	13	<1.0	15	35	<1.0	35	0.36	1.1	0.010	0.2	16	240	120.3			
BDC-101	4/28/2004	722													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	10/18/2004	895													0.64	10	<1.0	15	43	<1.0	43										
BDC-101	5/10/2005	1099													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-101	11/10/2005	1283													0.25	7.6	<1.0	2.6	42	<1.0	42	0.96	4.4			34.3		259	2.05		
BDC-101	5/15/2006	1469													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.78	17.8	0.059	0.0	64.1		80			
BDC-101	11/20/2006	1658	-59												1.1	10	<1.0	15	72.0	<1.0	72	0.92	0.122	0.016	2.4	8.7		174			
BDC-101	2/20/2007	1750	33												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.39	15.0	0.047	0.2	50.0		277		6.63	
BDC-101	3/19/2007	1777	60												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.97	8.83	0.037	0.5	38.5		213		6.60	
BDC-101	4/24/2007	1813	96												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.09	9.59	0.041	0.5	34.1		136		6.46	
BDC-101	5/17/2007	1836	119												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.35	9.95	0.046	0.4	35.7		297		6.55	
BDC-101	11/26/2007	2029	312												<0.25	<1.0	<1.0	2.1	6.5	<1.0	6.5	2.30	5.88	0.032	0.0	26.8		287			
BDC-101	2/18/2008	2113	396	-8											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.55	8.10	0.040	0.0	31.5		341		6.29	
BDC-101	3/27/2008	2151	434	30											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.19	9.3	<0.10	0.2	40.0		506			
BDC-101	5/15/2008	2200	483	79	-40										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.57	6.8	<0.10	0.0	24.6		176		6.44	
BDC-101	7/16/2008	2262	545	141	22										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.34	5.3	<0.10	0.0	21.8		-232		6.52	
BDC-101	9/15/2008	2323	606	202	83	-45									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.22	5.33	0.023	0.0	28.7		153			
BDC-101	11/20/2008	2389	672	268	149	21									0.44	1.6	<1.0	<1.0	<1.0	<1.0	<1.0	1.45	2.9	0.1	0.8	17.1		-22		6.65	
BDC-101	1/16/2009	2446	729	325	206	78									<0.25	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	0	4.40	0.042	0.4	29.5		-245		6.50	
BDC-101	2/11/2009	2472	755	351	232	104									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.62	8.5	<0.1	0.4	39.6		-16		6.43	
BDC-101	3/9/2009	2498	781	377	258	130									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.93	9.4	<0.1	0.0	46.8		54		6.54	
BDC-101	4/16/2009	2536	819	415	296	168									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.69	9.0	<0.1	0.0	36.0		131		6.61	
BDC-101	5/14/2009	2564	847	443	324	196	-34								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.00	13.0	<0.1	0.0	44.4		68		6.81	
BDC-101	7/17/2009	2628	911	507	388	260	30								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.80	12.6	<0.1	0.0	49.0		19		7.17	
BDC-101	9/9/2009	2682	965	561	442	314	84	-49							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.25	6.2	<0.1	0.0	31.7		179		6.90	
BDC-101	11/12/2009	2746	1029	625	506	378	148	15							0.35	1.8	<1.0	6.6	16	<1.0	16	1.37	11.3	<0.1	0-0.2	36.7		124		6.53	Very faint iron measurement
BDC-101	2/17/2010	2843	1126	722	603	475	245	112							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.86	13.9	<0.1	0.0	48.7		640		6.55	
BDC-101	5/17/2010	2932	1215	811	692	564	334	201							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.20	20.7	<1.0	0.0	58.7		372		6.86	
BDC-101	8/16/2010	3023	1306	902	783	655	425	292	-37						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.21	15.6	<0.1	0.0	56.9		76		7.21	
BDC-101	11/8/2010	3107	1390	986	867	739	509	376	47						<0.25	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.02	2.2	<0.1	0.4	14.7		145		6.97	
BDC-101	2/16/2011	3207	1490	1086	967	839	609	476	147						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.46	23.9	<0.1	0.0	68.2		161		7.30	
BDC-101	5/3/2011	3283	1566	1162	1043	915	685	552	223						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.57	23.7	<0.1	0.0	66.2		208		6.99	
BDC-101	8/1/2011	3373	1656	1252	1133	1005	775	642	313						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.50	17.9	<0.1	0.0	48.1		150		7.07	
BDC-101	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.69	6.1	<0.1	0.0	24.8		40		7.23	
BDC-101	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5					<0.25	2.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.53	6.6		0.3	27.7		12		6.81	
BDC-101	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.75	15.9		0.0	51.2		263		6.60	
BDC-101	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	-49				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.88	13.8	<0.10	0.0	36.0		154		6.97	
BDC-101	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	21				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.41	10.3	<0.10	0.0	40.4		150		6.90	
BDC-101	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	120				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.55	21.3	<0.10	0.2	68.0		73		6.83	
BDC-101	5/20/2013	4031	2314	1910	1791	1663	1433	1300	971	461	209				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.35	17	<0.10	0.0	52.9		-190		6.72	
BDC-101	8/28/2013	4131	2414	2010	1891	1763	1533	1400	1071	561	309	-76			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	1.99	10.5	<0.10	0.0	41.5		-277		6.46	
BDC-101	11/19/2013	4214	2497	2093	1974	1846	1616	1483	1154	644	392	7			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.53	7.6	<0.10	0.0	28.3		-173		6.67	
BDC-101	2/11/2014	4298	2581	2177	2058	1930	1700	1567	1238	728	476	91			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.65	7.7	<0.10	0.0	29.1		-223		6.80	
BDC-101	5/6/2014	4382	2665	2261	2142	2014	1784	1651	1322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.79	19.6	<0.10	0.0	64.2		-149		6.71	
BDC-101	8/7/2014	4475	2758	2354	2235	2107	1877	1744	1415	905	653	268			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.25	17.2	<0.10	0.0	51.4		71		7.22	
BDC-101	11/4/2014	4564	2847	2443	2324	2196	1966	1833	1504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.22	7.8	<0.10	0.0	29.7		77		6.72	
BDC-101	1/21/2015	4642	2925	2521	2402	2274	2044	1911	1582	1072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.07	21.3	<0.10	0.0	44.6		97		6.29	
BDC-101	4/28/2015	4739	3022	2618	2499	2371	2141	2008	1679	1169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.55	19.1	<0.10	0.0	48.4		82		6.37	
BDC-101	7/20/2015	4822	3105	2701	2582	2454	2224	2091	1762	1252	1000	615			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.96	19.7	<0.10	0.2	57.2		96		6.30	
BDC-101	10/26/2015	4920	3203	2799	2680	2552	2322	2189	1860	1350	1098	713			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.63	8.8	<0.10	0.0	38.6		92		6.64	
BDC-101	1/27/2016	5013	3296	2892	2773	2645	2415	2282	1953	1443	1191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.37	12.3	<0.10	0.0	40.3		102		6.48	
BDC-101	4/13/2016	5090	3373	2969	2850	2722	2492	2359	2030	1520	1268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.94	23.7	<0.10	0.0	65.4		68		6.94	
BDC-101	8/9/2016	5208	3491	3087	2968	2840	2610	2477	2148	1638	1386	1001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.90	16.1	<0.10		45.8		41		6.36	
BDC-101	11/1/2016	5292	3575	3171	3052	2924	2694	2561	2232	1722	1470	1085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	2.3	<0.10		20.0		58		6.45	
BDC-101	2/7/2017	5390	3673	3269	3150	3022	2792	2659	2330	1820	1568	1183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.26	17.1	<0.10		54.3		57		6.58	

TABLE 1
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
															Volatile Organic Compounds (all units in ug/L)							Aquifer Redox Conditions							Donor Indicators		
Proposed Groundwater Cleanup Levels (a)															0.8	2.0	1294	1.7	NA	NA	1546										
BDC-102	6/11/2001														0.55	5.33	<1.0	<1.0			<1.0										
BDC-102	9/4/2001														0.38	1.61	1.89	<1.0			1.87										
BDC-102	12/3/2001														1.6	3.7	<1.0	<1.0			3.49										
BDC-102	3/13/2002														0.50	1.3	<1.0	<1.0			<1.0										
BDC-102	4/29/2002	-8													0.33	2.6	<1.0	<1.0	1.1	<1.0	1.1										
BDC-102	6/3/2002	27													<0.25	4.4	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	7/1/2002	55													0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	8/1/2002	86													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	12/2/2002	209													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	3/10/2003	307													0.26	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	6/3/2003	392													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/19/2003	561													0.99	120	<1.0	8.5	<1.0	<1.0	<1.0	0.38	0.19	0.011	5.5	46	1100	122.2			
BDC-102	4/28/2004	722													0.40	10	<1.0	<1.0	3.0	<1.0	3.0										
BDC-102	10/18/2004	895													0.33	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	5/10/2005	1099													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0										
BDC-102	11/10/2005	1283													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.82	4.4			34.0		122	18.4		
BDC-102	5/15/2006	1469													<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.21	4.72	0.175	2.2	35.7		-11			
BDC-102	11/20/2006	1658	-59												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.25	<0.250	<0.250	2.2	9.2		163			
BDC-102	2/20/2007	1750	33												<0.25	5.8	<1.0	<1.0	<1.0	<1.0	<1.0	0.47	0.749	0.027	3.0	25.3		-145		6.54	
BDC-102	3/19/2007	1777	60												<0.25	18	<1.0	<1.0	32	<1.0	32	0.88	0.938	0.072	3.0	31.0		-98		6.67	
BDC-102	4/24/2007	1813	96												0.53	6.1	<1.0	3.1	100	<1.0	100	1.20	1.94	0.051	2.8	40.4		-93		6.51	
BDC-102	5/17/2007	1836	119												<0.25	1.8	<1.0	<1.0	7.4	<1.0	7.4	0.84	2.78	0.108	2.6	33.9		286		6.52	
BDC-102	11/26/2007	2029	312												<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.29	1.03	0.247	3.0	55.7		46			
BDC-102	2/18/2008	2113	396	-8											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.51	3.91	0.054	2.8	42.8		431		5.97	
BDC-102	3/27/2008	2151	434	30											<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.85	1.3	<0.10	2.5	17.9		233			
BDC-102	5/15/2008	2200	483	79	-40										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.40	3.0	<0.10	3.5	19.2		-115		6.56	
BDC-102	7/16/2008	2262	545	141	22										<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.46	2.5	<0.10	3.2	13.7		-312		6.67	
BDC-102	9/15/2008	2323	606	202	83	-45									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.22	4.28	0.056	3.0	31.6		191			
BDC-102	11/20/2008	2389	672	268	149	21									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	0.40	<0.10	2.0	5.6		-70		6.69	
BDC-102	1/16/2009	2446	729	325	206	78									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.00	<0.100	0.200	2.5	8.3		-235		6.70	
BDC-102	2/11/2009	2472	755	351	232	104									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.65	2.4	<0.1	3.0	20.4		-70		6.61	
BDC-102	3/9/2009	2498	781	377	258	130									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.00	0.9	<0.1	3.0	8.7		-46		6.65	
BDC-102	4/16/2009	2536	819	415	296	168									<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.30	0.6	<0.1	3.0	8.3		-7		6.66	
BDC-102	5/14/2009	2564	847	443	324	196	-34								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.29	0.9	<0.1	3.4	9.8		-35		6.78	
BDC-102	7/17/2009	2628	911	507	388	260	30								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.66	4.9	<0.1	2.2	28.6		-11		6.46	
BDC-102	9/9/2009	2682	965	561	442	314	84	-49							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.91	0.4	<0.1	2.7	5.5		2.8		6.66	
BDC-102	11/12/2009	2746	1029	625	506	378	148	15							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.93	0.2	<0.1	3.2	2.4		-42.0		6.49	
BDC-102	2/17/2010	2843	1126	722	603	475	245	112							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.90	3.4	0.2	2.8	17.2		892		6.56	
BDC-102	5/17/2010	2932	1215	811	692	564	334	201							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.35	8.4	<1.0	3.0	30.1		440		6.61	
BDC-102	8/16/2010	3023	1306	902	783	655	425	292	-37						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.61	8.9	<0.1	3.0	27.8		82		6.60	
BDC-102	11/8/2010	3107	1390	986	867	739	509	376	47						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.34	0.4	<0.1	2.0	6.9		45		7.09	
BDC-102	2/16/2011	3207	1490	1086	967	839	609	476	147						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.68	3.5	<0.1	2.2	43.3		399		6.88	
BDC-102	5/3/2011	3283	1566	1162	1043	915	685	552	223						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.60	12.1	<0.1	2.0	32.4		40		6.70	
BDC-102	8/1/2011	3373	1656	1252	1133	1005	775	642	313						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.01	13.6	<0.1	2.1	28.7		11		6.88	
BDC-102	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.45	9.8	<0.1	1.5	30.9		-48		7.19	
BDC-102	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.25	2.4		1.0	15.4		21		6.60	
BDC-102	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.22	11.3		2.5	40.2		248		6.44	
BDC-102	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	-49				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.20	13.2	<5.0	1.5	39.2		130		6.63	
BDC-102	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	21				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.10	1.7	<0.10	1.6	27.7		48		6.77	
BDC-102	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	120				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.17	18.4	<0.10	1.0	58.5		92		6.60	
BDC-102	5/20/2013	4031	2314	1910	1791	1663	1433	1300	971	461	209				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.49	20	<0.10	1.5	62.2		-280		7.31	
BDC-102	8/28/2013	4131	2414	2010	1891	1763	1533	1400	1071	561	309	-76			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	1.93	12.2	<0.10	1.0	39.1		-341		6.45	
BDC-102	11/19/2013	4214	2497	2093	1974	1846	1616	1483	1154	644	392	7			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	3.89	10.6	<0.10	1.2	43.4		-254		6.54	
BDC-102	2/11/2014	4298	2581	2177	2058	1930	1700	1567	1238	728	476	91			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.16	19.6	<0.10	2.2	63.0		-246		6.67	
BDC-102	5/6/2014	4382	2665	2261	2142	2014	1784	1651	1322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.65	14.8	<0.10	1.6	56.1		-275		6.54	
BDC-102	8/7/2014	4475	2758	2354	2235	2107	1877	1744	1415	905	653	268			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.07	26.7	<0.10	1.4	65.8		-65		7.01	
BDC-102	11/4/2014	4564	2847	2443	2324	2196	1966	1833	1504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.11	22.4	<0.10	1.2	55.9		-15.3		6.47	
BDC-102	1/21/2015	4642	2925	2521	2402	2274	2044	1911	1582	1072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	12.9	<0.10	1.0	49.7		-22		6.14	
BDC-102	4/28/2015	4739	3022	2618	2499	2371	2141	2008	1679	1169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.22	23.1	<0.10	0.6	77.5		28		6.13	
BDC-102	7/20/2015	4822	3105	2701	2582	2454	2224	2091	1762	1252	1000	615			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.33	15.5	<0.10	1.0	63.3		-54		6.18	
BDC-102	10/26/2015	4920	3203	2799	2680	2552	2322	2189	1860	1350	1098	713			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.23	10.9	<0.10	1.0	47.5		-42		6.41	
BDC-102	1/27/2016	5013	3296	2892	2773	2645	2415	2282	1953	1443	1191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.35	0.62	<0.10	1.0	11.9		-124		6.61	
BDC-102	4/13/2016	5090	3373	2969	2850	2722	2492	2359	2030	1520	1268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.70	12.8	<0.10	1.0	43.1		-48		6.61	
BDC-102	8/9/2016	5208	3491	3087	2968	2840	2610	2477	2148	1638	1386	1001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.32	14.0	<0.10		42.6		-79		6.2	
BDC-102	11/1/2016	5292	3575	3171	3052	2924	2694	2561	2232	1722	1470	1085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.56	0.10	<0.10		1.4		-80.8		6.54	
BDC-102	2/7/2017	5390	3673	3269	3150	3022	2792	2659	2330	1820	1568	1183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.19	4.9	<0.10		23.8		12.3		7.78	

TABLE 1
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

Well	Date	ORC Injection BDC-103 Elapsed Time from Injection (days)	Pilot Injection BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 1 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 2 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 3 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 4 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 5 BDC-103/104 Elapsed Time from Injection (days)	Full Scale Injection 6 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 7 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 8 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 9 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 10 BDC-103 Elapsed Time from Injection (days)	Full Scale Injection 11 BDC-103 Elapsed Time from Injection (days)	TPH-G (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylenes (µg/L)	DO (mg/L)	Nitrate (mg-N/L)	Nitrite (mg-N/L)	Iron II (mg/L)	Sulfate (mg/L)	Methane (µg/L)	ORP (mV)	TOC (mg/L)	pH	Comments
															Volatile Organic Compounds (all units in ug/L)							Aquifer Redox Conditions							Donor Indicators		
Proposed Groundwater Cleanup Levels (a)															**0.8**	**2.0**	**1294**	**1.7**	**NA**	**NA**	**1546**										
BDC-103	6/11/2001														177	875	12,010	1,985			11,430										
BDC-103	9/4/2001														123	494	3,760	419			2,636										
BDC-103 (b)	12/3/2001														120	5,100	2,300,000	10,000			3,400,000										
BDC-103	3/13/2002														200	1,700	17,000	4,900			26,400										
BDC-103	4/29/2002	-8													200	980	16,000	5,400	20,000	7,000	27,000										
BDC-103	6/3/2002	27													200	960	17,000	5,100	20,000	7,100	27,100										
BDC-103	7/1/2002	55													240	1,300	16,000	5,200	20,000	6,800	26,800										
BDC-103	8/1/2002	86													270	4,600	18,000	5,200	19,000	6,600	25,600										
BDC-103	12/2/2002	209													250	1,400	15,000	5,000	22,000	6,900	28,900										
BDC-103	3/10/2003	307													180	780	13,000	5,200	20,000	6,700	26,700										
BDC-103	6/3/2003	392													220	900	10,000	5,000	20,000	6,600	26,600										
BDC-103	11/19/2003	561													180	850	8,300	4,500	18,000	5,500	23,500	0.38	0.012	0.011	5.5	53	630	-75.9			
BDC-103	4/28/2004	722													160	1,600	6,600	3,900	16,000	5,100	21,100										
BDC-103	10/18/2004	895													140	2,100	5,500	3,700	15,000	4,400	19,400										
BDC-103	5/10/2005	1099													110	2,200	5,500	3,800	14,000	3,200	17,200										
BDC-103	11/10/2005	1283													90	2,200	3,500	3,700	12,000	2,500	15,000	0.72	<1.0			11.9		147	15.4		
BDC-103	5/15/2006	1469													84	1,600	3,800	3,100	10,000	2,200	12,000	0.92	<0.010	0.054	3.5	15.2		106			
BDC-103	11/20/2006	1658	-59												51	2,000	730	2,200	3,900	1,000	4,900	1.23	<0.10	<0.10	2.4	28.3		202			
BDC-103	2/20/2007	1750	33												26	460	420	140	3,600	1,600	5,200	0.31	60.8	11.1	0.5	99.2		109		6.54	
BDC-103	3/19/2007	1777	60												30	490	88	130	3,500	1,700	5,200	0.63	27.9	8.28	0.4	141		4		6.79	
BDC-103	4/24/2007	1813	96												36	820	440	220	3500	1800	5300	0.84	7.54	3.56	2.4	59.2		-14		6.70	
BDC-103	5/17/2007	1836	119												77	1,400	4,300	1,100	8,300	3,200	11,500	0.61	0.138	0.079	3.6	169		244		6.82	
BDC-103	11/26/2007	2029	312												190	3,300	21,000	4,000	11,000	4,900	15,900	3.37	0.063	0.049	3.6	49.1		-118			
BDC-103	2/18/2008	2113	396	-8											66	1,100	2,600	700	7,500	1,900	9,400	2.06	7.75	0.134	2.8	163		552		5.97	
BDC-103	3/27/2008	2151	434	30											84	1,500	1,900	1,100	9,700	3,000	12,700	1.60	54.1	18	4.0	115.0		182			
BDC-103	5/15/2008	2200	483	79	-40										91	2,700	4,400	1,400	11,000	3,600	14,600	1.38	<0.10	<0.10	3.2	192		-138		7.11	
BDC-103	7/16/2008	2262	545	141	22										79	1,800	440	490	10,000	3,100	13,100	1.61	56.1	16.6	2.8	149		-226		6.72	
BDC-103	9/15/2008	2323	606	202	83	-45									110	2,300	7,600	1,500	10,000	3,600	13,600	0.48	0.330	0.218	3.2	218		189			
BDC-103	11/20/2008	2389	672	268	149	21									47	1,200	260	110	7,000	2,100	9,100	0.21	152	12.5	2.0	120		-1.2		6.66	
BDC-103	1/16/2009	2446	729	325	206	78									11	190	220	12	1,000	480	1,480	0.24	193	2.32	0.6	62.5		-181		6.19	
BDC-103	2/11/2009	2472	755	351	232	104									36	820	510	<100	2,900	1,500	4,400	1.66	82.0	6.7	0.8	178		-65		6.69	
BDC-103	3/9/2009	2498	781	377	258	130									27	1100	440	18	2,400	1,200	3,600	0	47.3	2.4	0.4	192		17		6.80	
BDC-103	4/16/2009	2536	819	415	296	168									30	710	310	<50	2,700	1,200	3,900	0.95	64.8	5.6	0.2-0.4	194		62		6.77	
BDC-103	5/14/2009	2564	847	443	324	196	-34								30	680	320	20	2,400	1,500	3,900	0.48	49.8	4.8	0.8	222		20		6.85	
BDC-103	7/17/2009	2628	911	507	388	260	30								19	410	280	32	630	1,000	1,630	2.60	26.6	2.0	1.0	104		29		6.98	
BDC-103	9/9/2009	2682	965	561	442	314	84	-49							21	620	270	83	700	1200	1,900	0.88	<0.1	<0.1	2.5	134		2.8		7.01	
BDC-103	11/12/2009	2746	1029	625	506	378	148	15							24	340	140	27	1,800	1,200	3,000	1.42	94.1	7.7	0.4	71.7		117		6.11	
BDC-103	2/17/2010	2843	1126	722	603	475	245	112							0.73	10	<1.0	<1.0	3.1	22	25	1.45	123	1.1	0.0	60.3		939		6.22	
BDC-103	5/17/2010	2932	1215	811	692	564	334	201							3.1	79	44	5.2	60	86	146	1.56	67.9	2.6	0.4	71.6		436		6.63	
BDC-103	8/16/2010	3023	1306	902	783	655	425	292	-37						8.0	740	380	110	420	320	740	2.24	2.4	0.1	2.0	72.5		184		6.96	
BDC-103	11/8/2010	3107	1390	986	867	739	509	376	47						6.3	240	11	1.7	180	540	720	7.46	55.8	1.5	0.0	123		199		7.05	
BDC-103	2/16/2011	3207	1490	1086	967	839	609	476	147						0.28	4.6	<1.0	<1.0	<1.0	5.4	5.4	5.18	133	0.6		74.6		508		6.52	
BDC-103	5/3/2011	3283	1566	1162	1043	915	685	552	223						<0.25	9.1	<1.0	<1.0	<1.0	2.2	2.2	2.15	140	0.2	0.0	74.4		393		6.35	
BDC-103	8/1/2011	3373	1656	1252	1133	1005	775	642	313						0.30	76	<1.0	1.8	7.8	2.5	10.3	5.67	57.6	<0.1	0.2	63.2		168		7.09	
BDC-103	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105					33	1300	2200	780	2300	1300	3,600	1.72	<0.1	<0.1	1.2	8.1		-226		7.38	
BDC-103	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5					2.2	5.1	31	19	260	69	329	0.21	143		0.3	57.1		36		6.41	
BDC-103	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79					<0.25	16	1.4	<1.0	3.6	14	17.6	0.11	149	0.83	0.0	56.2		239		6.49	
BDC-103	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	-49				0.72	530	24.0	9.4	40	42	82	0.45	7.2	<0.10	0.4	66.9		146		6.80	
BDC-103	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	21				4.5	120	9.5	3.7	210	380	590	1.02	165	2.8	0.4	93.6		108		6.50	
BDC-103	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	120				<0.25	<1.0	<1.0	<1.0	<2.0	3.4	3.4	0.14	161	0.60	0.2	51.6		109		6.42	
BDC-103	5/20/2013	4031	2314	1910	1791	1663	1433	1300	971	461	209				<0.25	9.3	<1.0	<1.0	4.4	1.8	6.2	0.29	161	<0.10	0.0	47.1		-281		7.47	
BDC-103	8/28/2013	4131	2414	2010	1891	1763	1533	1400	1071	561	309	-76			2	210	56	47	260	91	351	1.60	17.8	0.16	0.6	54.2		-290		6.83	
BDC-103	11/19/2013	4214	2497	2093	1974	1846	1616	1483	1154	644	392	7			5.9	22	37	31	590	350	940	4.42	154	2.6	0.0	51.0		-222		6.48	
BDC-103	2/11/2014	4298	2581	2177	2058	1930	1700	1567	1238	728	476	91			<0.25	<1.0	<1.0	<1.0	4.9	3.6	8.5	2.81	79.9	0.15	0.0	99.2		-254		6.77	
BDC-103	5/6/2014	4382	2665	2261	2142	2014	1784	1651	1322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.19	215	<0.10	0.0	59.8		-233		6.21	
BDC-103	8/7/2014	4475	2758	2354	2235	2107	1877	1744	1415	905	653	268			<0.25	7.8	<1.0	<1.0	2.4	<1.0	2.4	2.67	111	<0.10	0.0	59.7		-46		7.14	
BDC-103	11/4/2014	4564	2847	2443	2324	2196	1966	1833	1504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.27	151	0.68	0.0	66.7		121		6.31	
BDC-103	1/21/2015	4642	2925	2521	2402	2274	2044	1911	1582	1072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	137	0.27	0.0	69.1		118		6.05	
BDC-103	4/28/2015	4739	3022	2618	2499	2371	2141	2008	1679	1169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.16	74.8	<0.10	0.0	90.3		44		6.23	
BDC-103	7/20/2015	4822	3105	2701	2582	2454	2224	2091	1762	1252	1000	615			<0.25	54	1.0	3.7	8.3	2.6	10.9	0.18	8.1	<0.10	0.2	70.9		-22		6.48	
BDC-103	10/26/2015	4920	3203	2799	2680	2552	2322	2189	1860	1350	1098	713			19	480	740	600	1800	850	2650	0.11	<0.10	<0.10	1.0	0.55		-85		6.61	
BDC-103	1/27/2016	5013	3296	2892	2773	2645	2415	2282	1953	1443	1191	806	-56		<0.25	3.9	1.2	3.3	12	7.0	19	0.22	32.5	<0.10	0.0	102		-10		6.56	
BDC-103	4/13/2016	5090	3373	2969	2850	2722	2492	2359	2030	1520	1268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	2.0	2.0	0.46	102	0.43	0.0	51.0		6.7		6.59	
BDC-103	8/9/2016	5208	3491	3087	2968	2840	2610	2477	2148	1638	1386	1001	139		1.7	56	4.9	42	210	51	261	0.0	<0.10	<0.10		31.1		-98.6		6.90	
BDC-103	11/1/2016	5292	3575	3171	3052	2924	2694	2561	2232	1722	1470	1085	223	-35	4.5	83	24	120	360	180	540	0.3	<0.10	<0.10		0.68		-182.9		6.70	
BDC-103	2/7/2017	5390	3673	3269	3150	3022	2792	2659	2330	1820	1568	1183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	2.1	2.1	0.41	194	0.15		47.4		77.2		6.27	

TABLE 1
AOC-05 CLEANUP ACTION SUMMARY
DEVELOPMENTAL CENTER GROUNDWATER MONITORING

		ORC	Pilot	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Full Scale	Volatile Organic Compounds (all units in ug/L)							Aquifer Redox Conditions							Donor Indicators		
		Injection	Injection	Injection 1	Injection 2	Injection 3	Injection 4	Injection 5	Injection 6	Injection 7	Injection 8	Injection 9	Injection 10	Injection 11																	
		BDC-103	BDC-103	BDC-103/104	BDC-103/104	BDC-103/104	BDC-103/104	BDC-103/104	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103	BDC-103																	
		Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	Elapsed Time from Injection (days)	TPH-G	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	Total Xylenes	DO	Nitrate	Nitrite	Iron II	Sulfate	Methane	ORP	TOC	pH	
															(mg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(mg/L)	(mg-N/L)	(mg-N/L)	(mg/L)	(mg/L)	(µg/L)	(mV)	(mg/L)		
Proposed Groundwater Cleanup Levels (a)															**0.8**	**2.0**	**1294**	**1.7**	**NA**	**NA**	**1546**										
Well	Date																														Comments
BDC-104	2/18/2008	2113	396	-8											2.9	<1.0	<1.0	47	180	28	208	2.09	1.63	0.072	3.0	18.7		598			
BDC-104	3/27/2008	2151	434	30											3.2	<1.0	<1.0	22	220	52	272	1.34	161	0.1	0.5	52.2		259			
BDC-104	5/15/2008	2200	483	79	-40										1.0	<1.0	<1.0	7.0	26	22	48	1.24	28.7	0.7	0.4	26.6		94		6.69	
BDC-104	7/16/2008	2262	545	141	22										2.3	<1.0	2.9	3.3	110	50	160	1.56	196	0.4	0.0	74.7		-221		7.17	
BDC-104	9/15/2008	2323	606	202	83	-45									0.64	<1.0	2.6	<1.0	20	16	36	0.06	122	0.729	0.0	38.4		191			
BDC-104	11/20/2008	2389	672	268	149	21									<0.25	<1.0	<1.0	<1.0	1.4	4.1	5.5	0.96	67.2	<0.10	0.2	24.3		-27		7.46	
BDC-104	1/16/2009	2446	729	325	206	78									0.26	<1.0	<1.0	<1.0	<1.0	5.5	5.5	0.05	71.4	0.204	0.6	34.6		-164		6.86	
BDC-104	2/11/2009	2472	755	351	232	104									<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	1.78	95.4 J	0.1	0.2	20.1		-75		6.68	
BDC-104	3/9/2009	2498	781	377	258	130									<0.25	<1.0	<1.0	<1.0	1.3	1.1	2.4	0	91.5	<0.1	0.0	19.2		20		6.67	
BDC-104	4/16/2009	2536	819	415	296	168									<0.25	<1.0	<1.0	<1.0	<1.0	1.6	1.6	0.34	67.2	<0.1	0.0	21.6		67		6.63	
BDC-104	5/14/2009	2564	847	443	324	196	-34								<0.25	<1.0	<1.0	<1.0	<1.0	1.4	1.4	0.51	63.4	<0.1	0.0	20.1		6		6.70	
BDC-104	7/17/2009	2628	911	507	388	260	30								<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.41	21.0	0.5	1.0	30.8		-3		7.30	
BDC-104	9/9/2009	2682	965	561	442	314	84	-49							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.63	39.8	0.1	0.8	41.6		61		7.20	
BDC-104	11/12/2009	2746	1029	625	506	378	148	15							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.99	115	1.4	0.0	24.1		68		6.49	
BDC-104	2/17/2010	2843	1126	722	603	475	245	112							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.73	119	0.1	0.0	111		868		6.93	
BDC-104	5/17/2010	2932	1215	811	692	564	334	201							<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.98	47.4	<1.0	0.6	30.5		482		6.74	
BDC-104	8/16/2010	3023	1306	902	783	655	425	292	-37						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.59	38.4	0.2	2.5	23.6		76		6.92	
BDC-104	11/8/2010	3107	1390	986	867	739	509	376	47						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.87	32.5	<0.1	0.0	18.6		115		7.23	
BDC-104	2/16/2011	3207	1490	1086	967	839	609	476	147						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.48	40.0	<0.1	0.4	24.1		423		6.71	
BDC-104	5/3/2011	3283	1566	1162	1043	915	685	552	223						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.19	31.3	<0.1	1.2	26.8		231		6.63	
BDC-104	8/1/2011	3373	1656	1252	1133	1005	775	642	313						<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.10	11.7	<0.1	0.0	21.2		121		7.20	
BDC-104	11/1/2011	3465	1748	1344	1225	1097	867	734	405	-105					<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.43	14.6	<0.1	0.0	18.7		-53		7.40	
BDC-104	2/19/2012	3575	1858	1454	1335	1207	977	844	515	5					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.26	21.6		0.0	29.2		66		6.23	
BDC-104	5/3/2012	3649	1932	1528	1409	1281	1051	918	589	79					<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.06	19.4		1.5	26.5		207		6.78	
BDC-104	9/4/2012	3773	2056	1652	1533	1405	1175	1042	713	203	-49				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.68	12.3	<0.10	0.5	22.1		130		7.11	
BDC-104	11/13/2012	3843	2126	1722	1603	1475	1245	1112	783	273	21				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.24	0.80	<0.10		5.1		64		7.19	
BDC-104	2/20/2013	3942	2225	1821	1702	1574	1344	1211	882	372	120				0.28	<1.0	6.5	<1.0	17	3.3	20.3	0.44	2.5	<0.10	0.2	3.6		82		6.96	
BDC-104	5/20/2013	4031	2314	1910	1791	1663	1433	1300	971	461	209				<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	2.01	20.0	<0.10	0.0	20.8		-230		7.16	
BDC-104	8/28/2013	4131	2414	2010	1891	1763	1533	1400	1071	561	309	-76			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	0.52	16.4	<0.10	1.0	35.3		-322		6.82	
BDC-104	11/19/2013	4214	2497	2093	1974	1846	1616	1483	1154	644	392	7			<0.25	<1.0	<1.0	<1.0	<2.0	<1.0	<2.0	8.09	0.47	<0.10	0.0	3.1		-35		7.16	
BDC-104	2/11/2014	4298	2581	2177	2058	1930	1700	1567	1238	728	476	91			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.11	0.54	<0.10	0.0	3.4		-135		7.04	
BDC-104	5/6/2014	4382	2665	2261	2142	2014	1784	1651	1322	812	560	175			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	8.49	0.35	<0.10	0.0	4.2		-113		6.82	
BDC-104	8/7/2014	4475	2758	2354	2235	2107	1877	1744	1415	905	653	268			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.04	2.9	<0.10	0.0	4.4		64		7.44	
BDC-104	11/4/2014	4564	2847	2443	2324	2196	1966	1833	1504	994	742	357			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.66	2.1	<0.10	0.0	10.1		39		6.50	
BDC-104	1/21/2015	4642	2925	2521	2402	2274	2044	1911	1582	1072	820	435			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.02	11.3	<0.10	0.0	36.3		135		5.87	
BDC-104	4/28/2015	4739	3022	2618	2499	2371	2141	2008	1679	1169	917	532			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.37	11.3	<0.10	0.0	74.4		85		6.09	
BDC-104	7/20/2015	4822	3105	2701	2582	2454	2224	2091	1762	1252	1000	615			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.18	11.7	<0.10	0.2	74.4		-22		6.48	
BDC-104	10/26/2015	4920	3203	2799	2680	2552	2322	2189	1860	1350	1098	713			<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.20	14.1	<0.10	1.0	84.2		-2.0		6.72	
BDC-104	1/27/2016	5013	3296	2892	2773	2645	2415	2282	1953	1443	1191	806	-56		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.13	11.5	<0.10	0.0	69.1		16.0		6.67	
BDC-104	4/13/2016	5090	3373	2969	2850	2722	2492	2359	2030	1520	1268	883	21		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.65	20.2	<0.10	0.0	96.9		31		6.75	
BDC-104	8/9/2016	5208	3491	3087	2968	2840	2610	2477	2148	1638	1386	1001	139		<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	8.1	<0.10		42.2		-27.2		6.30	
BDC-104	11/1/2016	5292	3575	3171	3052	2924	2694	2561	2232	1722	1470	1085	223	-35	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.91	3.4	<0.10		22.3		-9.8		6.49	
BDC-104	2/7/2017	5390	3673	3269	3150	3022	2792	2659	2330	1820	1568	1183	321	63	<0.25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.03	0.58	<0.10		5.2		69.2		5.93	

TPH-G = total petroleum hydrocarbon-gasoline
DO = dissolved oxygen
µg/L = micrograms per liter
mg/L = milligrams per liter
mV = millivolts
NA = not analyzed
NA = not applicable, not available
ORP = oxidation reduction potential
TOC = total organic carbon

[shaded] = No sample collected or sample not analyzed for specified constituent.
Box = Exceedance of proposed cleanup level

Injection Dates	Months Elapsed	
5/7/2002		ORC
1/18/2007	57	Pilot -scale nitrate
2/26/2008	13	1st full scale injection
6/24/2008	4	2nd full scale injection
10/30/2008	4	3rd full scale injection
6/17/2009	8	4th full scale injection (start ammonium phosphate, 1/3 ammonium nitrate dose to both wells)
10/28/2009	4	5th full scale injection (103 full dose, 104 half dose)
9/22/2010	11	6th full scale injection (103 only full dose)
2/14/2012	17	7th full scale injection (103 only full dose)
10/23/2012	8	8th full scale injection (103 only 1.5x volume dose)
11/12/2013	13	9th full scale injection (103 only 1.5x volume dose)
3/23/2016	29	10th full scale injection (103 only 1.5x volume, half concentration dose)
12/6/2016	9	11th full scale injection (103 only 1.5x volume dose)

(a) Proposed Cleanup Standards and Comparison to Site Data, Boeing Developmental Center, Tukwila,Washington (Landau Associates, 5/7/13).
(b) BTEX data questionable for this event. Concentrations inconsistent with TPH-G data for indicated event and BTEX data from other events.

TABLE 2
NITRATE CONCENTRATIONS AT DOWNGRADIENT MONITORING LOCATIONS
AOC-05 ANAEROBIC BIOREMEDIATION REMEDIAL ACTION
BOEING DEVELOPMENTAL CENTER

				Aquifer Redox Conditions					
				DO	**Nitrate**	Iron II	Sulfate	Methane	ORP
Area	Well	Date		(mg/L)	**(mg-N/L)**	(mg/L)	(mg/L)	(mg/L)	(mV)
SWMU-17	BDC-05-04	5/15/2006	Natural Redox Baseline		**12.3**	2.6	33.4		
SWMU-17	BDC-05-04	10/23/2008		2.45	**7.6**	0.1	31.0	0.29	73.5
SWMU-17	BDC-05-04	11/2/2008		0.59	**4.5**	0.8	25,2	0.05	-16
SWMU-17	BDC-05-04	12/16/2008		0.55	**5.5**	1.0	30.4	1.61	-98
SWMU-17	BDC-05-04	1/16/2009		0.06	**4.3**	1.0	21.8	1.48	-192
SWMU-17	BDC-05-04	2/11/2009		2.45	**5.9**	1.0	31.8	1.06	-54
SWMU-17	BDC-05-04	3/9/2009		0.27	**4.8**	1.5	30.1	0.20	35
SWMU-17	BDC-05-04	4/16/2009		1.48	**5.9**	1.4	33.6	<0.0007	68
SWMU-17	BDC-05-04	5/13/2009		0.33	**4.5**	1.6	26.6	0.37	49
SWMU-17	BDC-05-04	8/16/2009		0.86	**5.4**	2.2	30.6	<0.0007	93
SWMU-17	BDC-05-04	11/13/2009	Downgradient Monitoring Triggered	0.56	**2.2**	3.0	18.4	2.44	109
SWMU-17	BDC-05-04	2/16/2010		0.88	**<0.1**	3.3	24.6	1.49	899
SWMU-17	BDC-05-04	5/18/2010		0.75	**<0.1**	3.0	25.4	1.32	473
SWMU-17	BDC-05-04	8/17/2010		1.00	**<0.1**	2.8	17.1	3.53	108
SWMU-17	BDC-05-04	11/9/2010		2.21	**<0.1**	2.2	21.3	3.00	101
SWMU-17	BDC-05-04	2/15/2011		2.50	**<0.1**	2.4	19.4	4.46	93
SWMU-17	BDC-05-04	5/2/2011		1.69	**<0.1**	2.2	18.0	1.75	49
SWMU-17	BDC-05-04	11/2/2011		1.52	**<1.0**	1.2	<1.0		-3
SWMU-17	BDC-05-04	5/7/2012		0.16		2.0	21.5		98
SWMU-17	BDC-05-04	9/4/2012		0.21	**<0.10**		16.6		96
SWMU-17	BDC-05-04	11/13/2012		0.03	**<0.10**	1.8	16.9		64
SWMU-17	BDC-05-04	5/23/2013		0.49		1.5	13.7		-310
SWMU-17	BDC-05-04	11/19/2013		2.56	**<0.10**	1.0	13.2		-259
SWMU-17	BDC-05-04	5/6/2014		3.49	**0.40**		14.4		-299
SWMU-17	BDC-05-04	11/4/2014		0.05	**<0.10**	1.6	<1.0		-126
SWMU-17	BDC-05-04	4/28/2015		0.11	**5.0**	0.4	13.5		74
SWMU-17	BDC-05-04	10/26/2015		0.08	**<0.10**	1.5	<1.0		-101
SWMU-17	BDC-05-04	4/13/2016		0.57	**5.5**		13.9		46
SWMU-17	BDC-05-04	11/2/2016		0.39	**<0.10**		0.75		-140.5
SWMU-20	MW-17A	05/15/2006	Natural Redox Baseline		**1.37**	0.0	27.0		
SWMU-20	MW-17A	11/12/2009	Downgradient Monitoring Triggered		**0.9**				
SWMU-20	MW-17A	5/17/2010			**1.6**	0.2	21.0		
SWMU-20	MW-17A	11/8/2010			**0.1**	2.1	15.7		
SWMU-20	MW-17A	5/3/2011			**1.6**	0.0	19.8		
SWMU-20	MW-17A	8/1/2011			**0.5**	0.0	20.5		
SWMU-20	MW-17A	11/1/2011			**0.3**	0.0	23.2		
SWMU-20	MW-17A	5/3/2012			**4.4**	0.0			
SWMU-20	MW-17A	9/4/2012			**2.0**		26.8		
SWMU-20	MW-17A	11/13/2012			**0.59**	0.0	22.9		
SWMU-20	MW-17A	5/20/2013			**2.9**		26.8		
SWMU-20	MW-17A	11/19/2013			**1.3**	0.4	23.9		
SWMU-20	MW-17A	5/6/2014			**2.2**	0.0	23.7		
SWMU-20	MW-17A	11/4/2014			**0.16**	0.4	26.0		
SWMU-20	MW-17A	4/28/2015			**1.6**	0.0	26.3		
SWMU-20	MW-17A	10/26/2015		0.17	**0.91**	0.0	29.0		-11.1
SWMU-20	MW-17A	4/13/2016		0.31	**1.7**	1.8	0.90		-175
SWMU-20	MW-17A	11/1/2016		0.41	**<0.10**	1.4			-215.9
SWMU-20	MW-18A	05/15/2006	Natural Redox Baseline		**0.154**	0.4	64.8		
SWMU-20	MW-18A	11/12/2009	Downgradient Monitoring Triggered		**0.8**				
SWMU-20	MW-18A	05/17/2010			**1.0**	0.4	32.2		
SWMU-20	MW-18A	11/08/2010			**0.1**	0.0	14.2		
SWMU-20	MW-18A	5/3/2011			**<0.1**	0.0	31.5		
SWMU-20	MW-18A	8/1/2011			**1.1**	0.0	42.2		
SWMU-20	MW-18A	11/1/2011			**0.7**	0.0	93.3		
SWMU-20	MW-18A	5/3/2012			**<0.10**	0.0			
SWMU-20	MW-18A	9/4/2012			**<0.10**		19.5		
SWMU-20	MW-18A	11/13/2012			**<0.10**	0.0	21.5		
SWMU-20	MW-18A	5/20/2013			**<0.10**		19.6		
SWMU-20	MW-18A	11/19/2013			**<0.10**	0.6	15.0		
SWMU-20	MW-18A	5/6/2014			**<0.10**	0.0	26.1		
SWMU-20	MW-18A	11/4/2014			**<0.10**	0.4	21.0		
SWMU-20	MW-18A	4/28/2015			**0.11**	0.0	19.1		
SWMU-20	MW-18A	10/26/2015		0.10	**<0.10**	0.6	23.4		-7.1
SWMU-20	MW-18A	4/13/2016		0.76	**0.10**	0.0	42.8		38
SWMU-20	MW-18A	11/1/2016		0.26	**<0.10**	0.4			-8.5

TABLE 2
NITRATE CONCENTRATIONS AT DOWNGRADIENT MONITORING LOCATIONS
AOC-05 ANAEROBIC BIOREMEDIATION REMEDIAL ACTION
BOEING DEVELOPMENTAL CENTER

				Aquifer Redox Conditions					
				DO	**Nitrate**	Iron II	Sulfate	Methane	ORP
Area	Well	Date		(mg/L)	**(mg-N/L)**	(mg/L)	(mg/L)	(mg/L)	(mV)
SWMU-20	MW-21A	05/15/2006	Natural Redox Baseline		**0.136**	0.4	54.9		
SWMU-20	MW-21A	11/12/2009	Downgradient Monitoring Triggered		**<0.1**				
SWMU-20	MW-21A	05/17/2010			**0.2**	0.0	11.9		
SWMU-20	MW-21A	11/08/2010			**<0.1**	0.0	5.9		
SWMU-20	MW-21A	5/3/2011			**0.2**	0.0	52.1		
SWMU-20	MW-21A	8/1/2011			**0.1**	0.0	26.7		
SWMU-20	MW-21A	11/1/2011			**<0.1**	0.0	9.3		
SWMU-20	MW-21A	5/3/2012			**0.17**	0.0			
SWMU-20	MW-21A	9/4/2012			**<0.10**		6.7		
SWMU-20	MW-21A	11/13/2012			**0.16**	0.0	18.5		
SWMU-20	MW-21A	5/20/2013			**0.10**	0.5	13.5		
SWMU-20	MW-21A	11/19/2013			**<0.10**	0.0	15.6		
SWMU-20	MW-21A	5/6/2014			**<0.10**	0.0	7.6		
SWMU-20	MW-21A	11/4/2014			**<0.10**	0.0	5.1		
SWMU-20	MW-21A	4/28/2015			**<0.10**	0.0	5.3		
SWMU-20	MW-21A	10/26/2015		0.33	**0.11**	0.0	3.9		10.3
SWMU-20	MW-21A	4/13/2016		2.08	**<0.10**	0.0	4.9		56
SWMU-20	MW-21A	11/1/2016		1.71	**0.10**	0.2			78

DO = dissolved oxygen
mg/L = milligrams per liter
mg-N/L = milligrams nitrogen per liter
mV = millivolt
ORP = oxidation reduction potential
Nitrate column bolded for emphasis of target compound. Other results included for aquifer redox evaluation.
[shaded cell] = not analyzed