

# Other Area 12 Enhanced Reductive Dechlorination Interim Measure – Third Semiannual Report

**Boeing Plant 2  
Seattle/Tukwila, Washington**

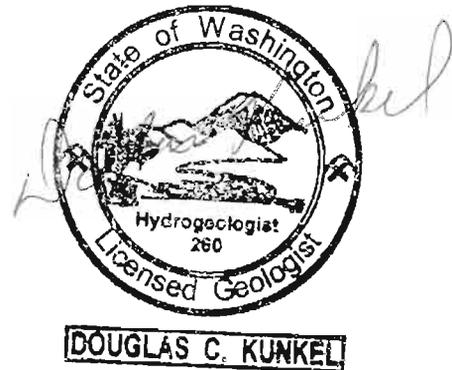
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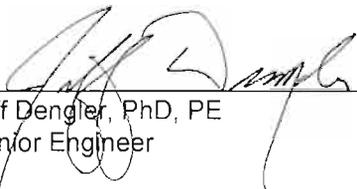
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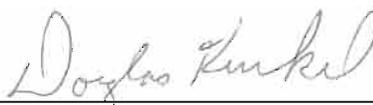
April 16, 2010

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## ACRONYMS

Br	bromide ion
cells/ml	halorespirer (dehalogenating) bacteria cells per milliliter
COC	contaminant of concern
°C	degrees Celsius
DCE	dichloroethene
DO	dissolved oxygen
EMF	Electrical Manufacturing Facility
EPA	United States Environmental Protection Agency
EPI	Environmental Partners, Inc.
ERD	enhanced reductive dechlorination
IM	Interim Measure
µg/L	micrograms per liter
mg/L	milligrams per liter
mS/cm	milliSiemens/centimeter
mV	millivolt
NO <sub>3</sub>	nitrate ion
NTU	nephelometric turbidity units
OA	Other Area
ORP	oxidation-reduction potential
PCE	tetrachloroethene
PPM	priority pollutant metals
SAP	Sampling and Analysis Plan
SO <sub>4</sub>	sulfate ion
TCE	trichloroethene
TOC	total organic carbon
VC	vinyl chloride
VOC	volatile organic compound

## 1.0 INTRODUCTION

This Third Semiannual Report presents information and data from the sixth and seventh rounds of groundwater performance monitoring for the pilot-scale Interim Measure (IM) at Other Area 12 (OA-12) located in the 2-60s Area of Plant 2. The report covers data generated during the period from July 2009 through December 2009.

In a letter dated February 19, 2008 from the United States Environmental Protection Agency Region X (EPA) to Boeing, EPA approved the *Interim Measure Work Plan for Other Area 12 Plume 2-60s Area* (Environmental Partners, Inc. [EPI], 2007). This work plan presented methods and rationale for a pilot-scale groundwater remediation project to be performed on the chlorinated volatile organic compounds (VOCs) at OA-12. Figure 1 presents a general vicinity map showing the location of Plant 2. Figure 2 is a site representation showing the OA-12 IM location at Plant 2.

Data from the *2-60s Area Data Gap Investigation Report* (EPI/Golder, 2006) indicated that groundwater at OA-12 is impacted by several contaminants of concern (COCs) including tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (DCE), and vinyl chloride (VC). PCE, TCE, DCE, and VC plumes exist in portions of the A and B levels of the aquifer at OA-12. Figure 3 presents a simplified schematic showing the approximate chlorinated VOC plume location and shape, and wells located within the plume. Detailed drawings showing the locations of the three contaminant plumes are presented in the *2-60s Area Data Gap Investigation Report*.

Enhanced reductive dechlorination (ERD) was selected as the OA-12 IM remedial technology for contaminant mass reduction. ERD uses *in situ* nutrient substrate applications to modify the subsurface geochemical environment to promote the growth of certain bacteria that are effective in the reductive degradation of chlorinated VOCs. Under proper conditions dehalogenating bacteria can metabolize chlorinated VOCs by successively removing chlorine atoms from the ethene backbone until only ethene or ethane gas remains. At the OA-12 IM, ERD was initiated as a pilot-scale test by injecting a nutrient substrate solution into three pairs of upgradient injection wells.

The OA-12 IM is being performed as a pilot-scale remedy because ERD has not yet been tried or proven in the shallower, more aerobic A level of the aquifer at Plant 2. If the pilot-scale demonstration is successful, the ERD remedy may be refined and expanded as a full-scale IM remedy for the remaining OA-12 chlorinated VOC plume.

## **2.0 INTERIM MEASURE IMPLEMENTATION**

The OA-12 IM was designed as a pilot-scale application of ERD and is intended to provide the data necessary to make decisions regarding full-scale application of ERD for this chlorinated VOC plume at Plant 2. To expedite data collection, the OA-12 IM injection and monitoring well network was designed to be compact, covering only the center portion of the OA-12 plume. Monitoring well locations downgradient of the injection wells are spaced closer to injection wells than would be typical for a full-scale application to decrease the time frame necessary to observe results. In addition, groundwater sampling intervals for the onset of the OA-12 IM were shortened from standard quarterly intervals to two-month intervals.

### **2.1 Well Installation**

Six injection wells and three monitoring wells were installed at OA-12 from May 19 to May 22, 2008. The paired injection wells, OA12-01A, OA12-01B, OA12-02A, OA12-02B, OA12-03A, and OA12-03B, were installed in the A and B levels of the aquifer. The paired wells are spaced approximately 50 feet apart in a line approximately perpendicular to the groundwater flow direction. Three new monitoring wells, OA12-04A, OA12-04B, and OA12-05B, were installed downgradient of the injection wells in the A and B levels of the aquifer. The new monitoring wells are located approximately 150 and 250 feet downgradient of the line of injection wells. The approximate locations of new and existing monitoring wells are indicated in Figure 3. New well construction data and geologic logs were included in the *Other Area 12 Interim Measure – First Semiannual Report* (EPI, 2009a).

### **2.2 Baseline Sampling**

Baseline sampling was conducted from June 2 to June 4, 2008 to provide an indication of groundwater quality and subsurface geochemical and bacterial population conditions before initiation of IM remedial actions. Baseline sampling results and discussion are presented in the First Semiannual Report (EPI, 2009a).

### **2.3 Nutrient Substrate Injection**

A nutrient substrate provided by a local vendor and consisting of a carbohydrate solution of waste beverages was pumped into the six new injection wells. The target sugar concentration for the nutrient substrate was 6 percent but varied from 3.5 percent to 10.5 percent because the nutrient solution, being a recycled feedstock, was not uniform.

The nutrient substrate was injected into the A level of the aquifer in mid-July 2008 and into the B level of the aquifer in early August 2008. Because the majority of the chlorinated VOC contamination at OA-12 is in the A level and because the B level is naturally more anaerobic than the A level, the injections were designed to add more solution and sugar into the A level. Approximately 21,000 gallons of nutrient substrate solution (average sugar content of 8.1 percent and equaling about 14,500 pounds of sugar) were injected into the A level and 15,000 gallons of nutrient substrate solution (average sugar content of 4.5 percent and equaling about 5,600

pounds of sugar) were injected into the B level. Details of the nutrient substrate injection were presented in the First Semiannual Report (EPI, 2009a).

#### **2.4 Performance Monitoring**

Bimonthly performance monitoring was begun October 2008 to assess geochemical responses in the subsurface and ERD progress by following concentration trends of COCs and ERD-related parameters. Results from previous rounds of performance monitoring were reported in the First and Second Semiannual Reports (EPI, 2009a and EPI, 2009b).

### 3.0 PERFORMANCE MONITORING METHODOLOGY

Performance monitoring is done to evaluate the effect and degree of success of the ERD remedial treatment. Performance monitoring results are compared to baseline and previous performance monitoring results to evaluate reductions in contaminant concentrations and trends in biological indicators and subsurface geochemistry. Performance monitoring procedures are described below.

Groundwater samples were collected from OA-12 IM monitoring network wells in the A and B levels of the aquifer listed below and shown in Figure 3.

- OA12-01A
- OA12-01B
- OA12-02A
- OA12-02B
- OA12-03A
- OA12-03B
- PL2-315A
- PL2-315B
- PL2-330A
- PL2-330B
- OA12-04A
- OA12-04B
- OA12-05B

Groundwater samples were collected using the methods and procedures presented in the Sampling and Analysis Plan (SAP) that is Attachment A of the IM Work Plan (EPI, 2007). Groundwater samples were analyzed for VOCs by EPA Method 8260B and for total organic carbon (TOC) by EPA Method 415.1. Select samples were also analyzed for dissolved gases (methane, ethane, and ethene) by Method RSK-175, ferrous iron by Method 3500-FED, anions (bromide, nitrate, and sulfate) by EPA Method 300, organic (volatile fatty) acids by ion chromatography, priority pollutant metals (PPM) by EPA Method Series 6020/7471, and bacterial census of halorespirers by the Bio-Dechlor Census Test RT-PCR.

Prior to sampling, the water level in each monitoring well was measured. During well purging prior to sampling groundwater, the following field parameters were measured and recorded: pH, specific conductivity, turbidity, dissolved oxygen (DO), temperature, and oxidation-reduction potential (ORP).

## 4.0 PERFORMANCE MONITORING RESULTS

Results of the sixth and seventh rounds of performance monitoring are presented and discussed in Sections 4.1 and 4.2, respectively. Sixth round groundwater sample analytical results are presented in Table 1 and seventh round results are presented in Table 2. Tables 3a and 3b present all OA-12 IM analytical data for all sampling events for the A level and B level, respectively. Field parameter measurements and field notes made during sampling are presented in Tables 4a and 4b for the A level and B level, respectively, and in Attachment A. Full metals data for Round 6 and Round 7 are presented in Attachment B. All VOC detections for Rounds 6 and 7 are given in Attachment C. Data validation results are presented in Attachment D. Trend plots of VOC data are presented in Attachment E. Section 4.3 discusses observed data trends.

### 4.1 Round 6

The sixth round of performance sampling took place on August 3 and 4, 2009. Matrix interference problems with VOC analyses for some samples from injection wells increased detection limits for the affected samples. The matrix interference was not as pronounced as in previous sampling rounds. Analytical interferences are decreasing as groundwater dispersion and advection spreads the injected nutrient substrate downgradient.

As indicated in Table 1, chlorinated VOC concentrations generally remain higher in the A level than in the B level. The largest VOC concentrations were for DCE, with the greatest DCE concentration of 29 micrograms per liter ( $\mu\text{g/L}$ ) in the sample from OA12-01A. PCE, TCE, and VC concentrations are generally less than DCE concentrations. The greatest PCE concentration was 3.2  $\mu\text{g/L}$  and the greatest TCE concentration was 12  $\mu\text{g/L}$ , both in the sample from downgradient well PL2-330A. The greatest VC concentration was 2.9  $\mu\text{g/L}$  in the sample from injection well OA12-02A. In reviewing VOC data for all sampling rounds in Tables 3a and 3b, upward and/or downward concentration trends were noted for DCE at OA12-01A, OA12-02A, OA12-04A, and OA12-01B. Trends of VOC concentrations were not apparent for other compounds and at other wells because matrix interference problems during analysis raised detection limits at some wells, concentrations were too low to be distinguished from data variability, and/or the ERD impact at downgradient wells was limited. Section 4.3 presents more discussion of these trends. (Refer to Attachment C for all VOC detections for the sixth round.)

Groundwater TOC concentrations, representative of current nutrient substrate concentrations, were greater than 100 milligrams per liter ( $\text{mg/L}$ ) for all injection wells and generally decreased to less than 10  $\text{mg/L}$  at downgradient wells due to consumption by bacteria and dispersion. Two exceptions were at OA12-03A and PL2-315B. The TOC concentration of 8,450  $\text{mg/L}$  in the sample from OA12-03A is atypical relative to samples from the other two A level injection wells. This condition may be due to minor variations in aquifer permeability, which first became apparent during nutrient solution injections. EPI field staff noted slower injection rates into OA12-03A relative to the other two A level injection wells. The TOC concentration in the sample from PL2-315B was greater than 500  $\text{mg/L}$ , possibly indicating a preferential flow path. Tables 3a and 3b indicate that all other downgradient wells have experienced minimal TOC increases.

Significant TOC concentration increases are not expected in wells 100 to 250 feet downgradient of the injection wells based on Electrical Manufacturing Facility (EMF) plume data. Other observations regarding the OA-12 IM groundwater monitoring data are summarized in the following bullets:

- Colored water and elevated turbidity noted in purge water from wells OA12-02B and OA12-03B is likely due to high bacterial populations in groundwater and residual nutrient substrate at these injection wells. Bacterial census data from OA12-02B indicate enhanced bacterial populations; OA12-03B is not sampled for bacterial census. Turbidity measurements have been consistently elevated in purge water from these two wells during previous sampling events.
- Concentrations of the dissolved gas methane were high at injection wells OA12-02A and OA12-02B and are generally increasing over time in samples from A and B level wells 50, 100, and 150 feet downgradient of the injection line.
- Ethane and ethene dissolved gases, the end products of reductive dechlorination, were not detected in any well.
- Ferrous iron and anion concentration data at injection wells OA12-02A and OA12-02B indicated reducing geochemical conditions.
- Low nitrate ( $\text{NO}_3$ ) and sulfate ( $\text{SO}_4$ ) anion concentrations were observed for injection wells OA12-02A and OA12-02B and for downgradient wells PL2-315B and PL2-330B.
- Manganese concentrations increased in samples from injection wells OA12-02A and OA12-02B and at PL2-315B, which is 50 feet downgradient from the injection line. Field parameter data indicate that geochemical conditions at these wells are strongly reducing.
- Arsenic concentrations are less than the Plant 2 screening level of 8  $\mu\text{g/L}$ , with the greatest concentration being 5.5  $\mu\text{g/L}$  at OA12-02A. (Refer to Attachment B full metals data.)
- Organic acids were detected in groundwater samples from the six wells sampled for these compounds; injection wells OA12-02A and OA12-02B and in downgradient wells OA12-04A, OA12-04B, PL2-315A, and PL2-315B. Bacterial census for dehalogenating bacteria indicated populations in groundwater samples at the same six wells. Only OA12-04A indicated an increase in these two analytes from previous rounds, while data from all other wells indicated no appreciable change.
- Field parameter measurements indicated near neutral pH values in all wells. Measured ORP and DO values remain low in all injection wells, but increased slightly in downgradient A level wells. ORP was mostly unchanged or slightly decreased for most wells from the fifth to the sixth round except for downgradient A level wells, in which ORP slightly increased.

## 4.2 Round 7

The seventh round of performance sampling occurred October 7, 8, and 9, 2009. Matrix interference problems for VOC analyses have generally disappeared.

As indicated in Table 2, chlorinated VOC concentrations generally remained higher in the A level than in the B level. The largest VOC concentrations were for DCE with the greatest being 22 µg/L in the sample from OA12-01A, as was the case for Round 6. The largest PCE concentration was 3.4 µg/L and the largest TCE concentration was 15 µg/L; both concentrations were in the sample from downgradient well PL2-330A. The largest VC concentration was 6.0 µg/L in the sample from injection well OA12-02A. The VOC trends noted in Section 4.1 for Round 6 continued for Round 7 data. Section 4.3 presents more discussion of these trends. (Refer to Attachment C for all VOC detections for the seventh round.)

Groundwater TOC concentrations for Round 7 have generally remained the same as Round 6 data or have slightly decreased for most wells. TOC concentrations increased at OA12-02A and continue to increase at PL2-315B. The notable exception continues to be the TOC concentration at OA12-03A of 7,460 mg/L. As noted in Section 4.1, there is likely slower dispersion at this well, possibly as a result of lower groundwater flow at this location that has kept much of the nutrient solution near the injection well. TOC concentrations at other downgradient wells in both A and B levels are less than 12 mg/L with an overall slight downward concentration trend.

Other observations regarding the OA-12 IM groundwater monitoring data are summarized in the following bullets:

- Colored water and elevated turbidity noted in purge water from wells OA12-02B and OA12-03B is likely due to high bacterial populations in groundwater and residual nutrient substrate at these injection wells. Turbidity measurements have been consistently elevated in purge water from these two wells during previous sampling events.
- Methane dissolved gas concentrations in samples from all injection and downgradient wells sampled for dissolved gases remain large. Large increases in methane concentrations were noted in samples from wells PL2-330B and OA12-04A, 100 and 150 feet downgradient, respectively.
- Ethane and ethene dissolved gases were not detected in samples from any well.
- Ferrous iron concentrations in samples from injection wells OA12-02A and OA12-02B indicated reducing conditions but were inconclusive at downgradient wells.
- Low nitrate (NO<sub>3</sub>) and sulfate (SO<sub>4</sub>) anion concentrations were observed for injection wells OA12-02A and OA12-02B and for downgradient wells PL2-315B and PL2-330B.

- Manganese concentrations for Round 7 groundwater samples decreased at injection wells OA12-02A and OA12-02B and increased at downgradient well PL2-315B. Concentrations at other sampled wells were a few hundred micrograms per liter.
- All arsenic concentrations remained less than the 8.0 µg/L screening level.
- Organic acids were detected in groundwater samples from the six wells sampled for these compounds; injection wells OA12-02A and OA12-02B and downgradient wells OA12-04A, OA12-04B, PL2-315A, and PL2-315B. Bacterial census for dehalogenating bacteria indicated populations in groundwater samples at the same wells. Seventh round data for these two analytes were similar to sixth round data.
- Field parameter measurements again indicated near neutral pH at all wells. Routine pH monitoring will continue during sampling events to verify that pH values remain in the neutral range. For the seventh round ORP values slightly decreased at most wells. DO concentrations increased at all wells with most indicating DO concentrations near or greater than 1 mg/L.

#### **4.3 Data Trend Analysis**

The most definitive VOC concentration trends are in data from wells OA12-01A and OA12-02A. Trend plots of chlorinated VOC data for wells OA12-01A and OA12-02A from baseline through Round 7 sampling are presented in Figure 4. VOC concentration trend plots for other wells in the OA-12 IM monitoring network are presented in Attachment E.

The most significant feature of trend plots in Figure 4 is the decrease of PCE and TCE concentrations and increase of DCE and VC concentrations. These concentration trends are prototypical of the reductive dechlorination model. As chlorine atoms are removed from the ethene backbone by microbiological activity, PCE is converted to TCE, which in turn is converted to DCE, which is converted to VC, which is ultimately converted to ethene and ethane. Thus, chlorinated VOC compounds undergoing ERD initially increase in concentration and then decrease in concentration as remediation progresses. This progression is indicated by the TCE and DCE curves in Figure 4. The peak of the DCE curve also necessarily lags behind the peak of the TCE curve. At OA12-02A the VC curve rises during the sixth and seventh rounds as VC is produced from DCE. Continued reductive dechlorination at OA12-02A is expected to cause the VC concentration to decrease. An increase in VC concentration at OA12-01A is not evident, but may occur at the next sampling round as a result of the declining DCE concentration indicated in the figure.

DCE concentrations appear to be decreasing in samples from OA12-01B but low baseline VOC concentrations and matrix interference issues make interpretation of ERD progression difficult. Chlorinated VOC concentrations at other OA-12 wells do not show the reductive progression because reducing conditions are not sufficiently strong to drive dechlorination and/or VOC concentrations are so low that data interpretation is impossible due to data variability. Conditions at downgradient wells are not sufficiently reducing and VOC concentrations in many B level wells are too small and intermittent to interpret for possible trends.

TOC concentrations at injection wells have decreased to a few hundred mg/L in all injection wells. (OA12-03A with a TOC concentration of 7,460 mg/L is an exception to this statement due to a suspected low permeability/low flow condition in the vicinity of this well.) TOC concentrations at downgradient wells are equal to or less than 12 mg/L, except for PL2-315B with a TOC concentration of 888 mg/L. Downgradient well TOC concentrations appear to be steady or decreasing.

DO and ORP, the two most direct measures of reducing conditions, appear to be increasing in most wells, indicating a trend toward a more oxidized state. Both of these parameters are field measured and are difficult to measure accurately, thus, both have a degree of variability. Nevertheless, measured DO for the seventh round is higher for every well relative to first round measurements. Recent ORP data for most A level wells are positive, indicating a more oxidized state, which is not favorable for continued reductive dechlorination.

The combination of decreasing TOC concentrations and increasing DO and ORP measurements following earlier conditions conducive to ERD indicates that another round of nutrient substrate injection is warranted at the OA-12 IM pilot. EPI has prepared an addendum to the OA-12 IM Work Plan to inject a solution of procured sugar, potable water, and sodium bicarbonate, which serves as a buffer, into the six OA-12 IM injection wells. This work plan addendum will be submitted to EPA in March 2010.

## 5.0 RESULTS AND RECOMMENDATIONS

A discussion of the status of the OA-12 IM is presented in Section 5.1 followed by recommendations for future action in Section 5.2.

### 5.1 Results

Approximately 15 months have passed since the initial injection of nutrient substrate into the line of six A and B level injection wells. Previous reports indicated the establishment of reducing conditions and the development of a dehalogenating bacteria population at the injection wells and select downgradient wells. According to the data, the nutrient substrate injection appears to have influenced monitoring wells at least 150 feet downgradient from the injection line. However, data do not yet indicate if the nutrient injection has affected geochemical conditions at the sampling location 250 feet downgradient.

Data indicate that the ERD process has successfully reduced chlorinated VOC concentrations in samples from two A level injection wells, OA12-01A and OA12-02A. These data demonstrate that the nutrient substrate injection successfully initiated ERD in the A level of the aquifer. Trend plots in Figure 4 demonstrate that PCE and TCE have been dechlorinated to DCE and VC. Continued ERD treatment, including a second nutrient substrate injection, is necessary to maintain the ERD process and further dechlorinate DCE and VC to ethane and ethene. The anticipated reductions in DCE and VC concentrations in samples from OA12-01A and OA12-02A are necessary to further demonstrate that ERD processes effectively dechlorinate PCE and TCE to ethane and ethene in the A level of the aquifer. Due to initial low VOC concentrations, data variability, and/or the development of insufficient reducing conditions, data from other A and B level wells are difficult to interpret or have not undergone appreciable dechlorination.

The B level of the shallow aquifer at Plant 2 is known to be somewhat more naturally reduced than the A level because it is deeper and undergoes less air exchange with the surface. Data from the most recent sampling rounds indicate that both levels of the aquifer have similar reducing geochemical characteristics, despite the fact that the B level received only about 40 percent of the nutrient substrate volume that the A level received during nutrient substrate injection. Methane dissolved gas concentrations for both levels indicate similar reducing conditions at OA12-04A and OA12-04B; both wells are 150 feet downgradient of the injection wells. However, reductions of chlorinated VOC concentrations at downgradient A and B level wells are not apparent or measurable. As noted in the previous paragraph another round of nutrient substrate injections is required to further facilitate decreases in chlorinated VOC concentrations in downgradient A and B level wells.

DO concentrations are trending upward in most A and B level wells. TOC concentrations at most wells appear steady or are slightly decreasing. ORP results are mixed. The ERD process that was initiated by the nutrient substrate injection in 2008 has stagnated and appears to be reverting to a more oxidized state, especially in the A level of the aquifer where the target contaminants are concentrated.

## 5.2 Recommendations

The following recommendations are made for the OA-12 ERD IM based on the results of this report:

- A second nutrient substrate injection is proposed to reinforce existing reduced conditions at OA-12 and to prevent the subsurface returning to an oxidized state. This second injection will enhance the reducing conditions in the subsurface and, based on results to date, will produce additional decreases in chlorinated VOC concentrations. Specifically, the nutrient injections is necessary to maintain the ERD process and further dechlorinate DCE and VC to ethane and ethene in the A level of the aquifer and also to promote measurable decreases in chlorinated VOC concentrations in downgradient B level wells, as noted in Section 5.1. The proposed second injection would be performed in May or June 2010.
- The nutrient substrate used for the second injection will not be the recycled material that was used for the first injection. The recycled material used for the first injection consisted primarily of carbonated, fermented, and citric beverages, which produced low pH conditions around the injection wells, confounded analytical processes, and probably contributed to the mobilization of some metals in discrete, localized areas. This condition led to increased monitoring and buffer addition requirements to raise the low pH. In addition, the recycled material was a dark reddish-brown color, varied in sugar content, and contained particulate matter that required extensive filtering during injection.
- A dissolved sugar solution will be used as the nutrient substrate for the second injection. This nutrient substrate will be a clear solution, have no particulate matter, and will contain sodium bicarbonate buffer to maintain favorable pH conditions during the ERD process. The sugar and buffer solution will be prepared on-site and will be mixed to have a uniform 6 percent sugar content. This same nutrient substrate was used for the 2-66 ERD IM, which did not have a low pH response or require filtering for injection. A Work Plan amendment will be submitted discussing the proposed second injection for EPA review, comment, and approval. The amendment will provide specifications and a description of the second nutrient substrate preparation, injection, and subsequent monitoring. The Work Plan amendment will be submitted in March 2010 and proposed for implementation in May or June 2010.
- Prior to the second nutrient substrate injection, the six injection wells will be redeveloped to improve functionality. Current groundwater samples contain considerable particulate matter that should be eliminated or reduced by redevelopment so as to facilitate future monitoring activity and improve analytical results.
- Although data trends indicate that ERD at OA-12 as a pilot has been successfully enhanced in the A and B levels of the aquifer, expansion to a full scale ERD IM does not presently appear warranted. Relatively low baseline VOC concentrations over the larger areal extent of the OA-12 plume and the corresponding difficulty in measuring constituent degradation in such circumstances make implementation of full scale ERD at this time

inappropriate. Maintaining ERD conditions using a better quality nutrient source should allow more effective monitoring of the changes in individual VOC constituents. Full scale ERD implementation will be reevaluated following this next pilot phase and after slab and source removal actions have been completed in the wider area in conjunction with the planned demolition work in the south part of Plant 2.

## 6.0 SCHEDULE

This report presents results for the third six-month period in the implementation of the pilot-scale OA-12 ERD IM remediation. The report covers performance monitoring events 14 and 16 months after the initial nutrient substrate injection.

As reported in the Second Semiannual Report, the performance monitoring schedule will be lengthened to quarterly with continued semiannual reporting. The updated quarterly sampling schedule beginning in October 2009 is presented below:

**Quarterly Sampling and Reporting Schedule for OA-12 ERD IM**

7 <sup>th</sup> Round	October 2009 (completed)	Performance Monitoring
8 <sup>th</sup> Round	January 2010	Performance Monitoring
Injection Plan	March 2010	Work Plan Amendment Submitted
Reporting	March 2010 (Rounds 6 and 7)	3 <sup>rd</sup> Semiannual Report
9 <sup>th</sup> Round	April 2010	Performance Monitoring
Injection	May/June 2010	Second Nutrient Substrate Injection
10 <sup>th</sup> Round	July 2010	Performance Monitoring
Reporting	September 2010 (Rounds 8 and 9)	4 <sup>th</sup> Semiannual Report
11 <sup>th</sup> Round	October 2010	Performance Monitoring
12 <sup>th</sup> Round	January 2011	Performance Monitoring

## 7.0 REFERENCES

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## **TABLES**

**Table 1. OA-12 ERD IM Sixth Round Groundwater Performance Monitoring Analytical Results (August 2009)**

Well	Date	VOCs (µg/L)				TOC (mg/L)	Dissolved Gases (µg/L)			Ferrous Iron (mg/L)	Anions (mg/L)			Metals (µg/L)		pH	Organic Acids (mg/L)					Bacterial Census (cells/ml)
		PCE	TCE	DCE	VC		Methane	Ethane	Ethene		Br	NO <sub>3</sub>	SO <sub>4</sub>	Arsenic	Manganese		Pyruvic	Lactic	Acetic	Propionic	Butyric	
OA12-01A	8/4/09	<1.0	<1.0	29	<1.0	134	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.46	NS	NS	NS	NS	NS	NS
OA12-01B	8/4/09	<0.6	<0.6	1	<0.6	384	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.48	NS	NS	NS	NS	NS	NS
OA12-02A	8/4/09	<0.2	<0.2	15.2	2.9	236	15,900	<1.2	<1.1	192	1.4	<0.5	0.7	5.5	6,220	7.42	<10	13.0 J	2100	69	100	1,720
OA12-02B	8/4/09	<1.0	<1.0	1.2	<1.0	1,260	19,500	<1.2	<1.1	138	4.7	<0.5	<0.5	0.9	6,160	6.97	<10	100	2,300	220	210	55.8
OA12-03A	8/4/09	<0.6	4.7	3.7	<0.6	8,450	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.41	NS	NS	NS	NS	NS	NS
OA12-03B	8/4/09	<1.0	<1.0	<1.0	<1.0	330	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.16	NS	NS	NS	NS	NS	NS
PL2-315A	8/3/09	2.2	7.6	9.8	0.6	13.1	10,900	<1.2	<1.1	NS	0.7	6	165	1.1	118	7.41	<10	<25	7.4	<1	0.5 J	1.30
PL2-315B	8/3/09	<0.2	<0.2	0.3	0.9	522	17,800	<1.2	<1.1	NS	<1.0	<1.0	0.2	<0.5	2,730	8.01	<10	8.1 J	730	25	77	14.2
PL2-315B (dup)	8/3/09	<0.2	<0.2	0.4	0.8	546	15,600	<1.2	<1.1	NS	<1.0	<1.0	0.2	<0.5	2,690	8.01	<10	<25	850	26	78	30.9
PL2-330A	8/3/09	3.2	12	12.8	<0.2	9.59	8,760	<1.2	<1.1	<0.04	0.4	2.6	106	0.7	88	7.31	NS	NS	NS	NS	NS	NS
PL2-330B	8/3/09	<0.2	<0.2	0.6	<0.2	9.33	12	<1.2	<1.1	0.244	0.5	<0.1	48.3	0.4	341	7.58	NS	NS	NS	NS	NS	NS
OA12-04A	8/3/09	1.6	11	10.4	<0.2	5.80	6,580	<1.2	<1.1	NS	<0.1	4.5	79.8	0.9	87	6.97	2.9 J	19	8.1	<1	<1	1
OA12-04B	8/3/09	<0.2	<0.2	15.5	0.4	5.66	697	<1.2	<1.1	NS	0.3	<0.1	146	<0.5	184	7.06	41	130	120	5.6	3.4	26.8
OA12-05B	8/3/09	<0.2	<0.2	18.4	0.5	7.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.68	NS	NS	NS	NS	NS	NS
OA12-05B (dup)	8/3/09	<0.2	<0.2	18.4	0.5	7.07	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.68	NS	NS	NS	NS	NS	NS

**Notes:**

< = not detected at the indicated reporting limit  
 J = estimated value below calculated reporting limit  
 NS = no sample submitted for this analysis

µg/L = micrograms per liter  
 mg/L = milligrams per liter  
 ml = milliliter

DCE = sum of cis-1,2, trans-1,2, and 1,1-dichloroethene  
 PCE = tetrachloroethene  
 TCE = trichloroethene  
 TOC = total organic carbon  
 VC = vinyl chloride  
 VOCs = volatile organic compounds

Br = bromide ion  
 NO<sub>3</sub> = nitrate ion  
 SO<sub>4</sub> = sulfate ion

Table 2. OA-12 ERD IM Seventh Round Groundwater Performance Monitoring Analytical Results (October 2009)

Well	Date	VOCs (µg/L)				TOC (mg/L)	Dissolved Gases (µg/L)			Ferrous Iron (mg/L)	Anions (mg/L)			Metals (µg/L)		pH	Organic Acids (mg/L)					Bacterial Census (cells/ml)
		PCE	TCE	DCE	VC		Methane	Ethane	Ethene		Br	NO <sub>3</sub>	SO <sub>4</sub>	Arsenic	Manganese		Pyruvic	Lactic	Acetic	Propionic	Butyric	
OA12-01A	10/9/09	<2.0	<2.0	22	<2.0	101	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.52	NS	NS	NS	NS	NS	NS
OA12-01B	10/9/09	<0.6	<0.6	0.9	<0.6	328	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.73	NS	NS	NS	NS	NS	NS
OA12-02A	10/8/09	<0.2	<0.2	5.8	6.0	778	16,300	<1.2	<1.1	272	<1.0	<0.5	2.4	5.5	3,890	6.83	10 M	4.90 M	1,100 M	92 M	110 M	1,840
OA12-02B	10/8/09	<0.2	<0.2	1.0	<0.2	710	15,800	<1.2	<1.1	146	1.6	<0.5	>0.5	1.5	3,900	6.78	19 M	<10 M	620 M	230 M	48 M	60.8
OA12-02B (dup)	10/8/09	<0.2	<0.2	1.0	<0.2	718	15,500	<1.2	<1.1	120	1.5	<0.5	<0.5	1.7	3,950	6.78	20 M	<10 M	630 M	240 M	57 M	15.7
OA12-03A	10/9/09	<0.2	4.1	3.9	0.2	7,460	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.60	NS	NS	NS	NS	NS	NS
OA12-03B	10/9/09	<2.0	<2.0	<2.0	<2.0	197	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.99	NS	NS	NS	NS	NS	NS
PL2-315A	10/8/09	2.7	10	12.5	0.7	12.0	8,200	<1.2	<1.1	NS	0.4	2.1	177	4.0	147	6.16	<0.07 M	0.087 M	0.059 M	1.30 M	<0.07 M	0.80
PL2-315B	10/8/09	<0.2	<0.2	0.8	1.8	888	20,300	<1.2	<1.1	NS	<0.5	<0.5	<0.5	0.4	4,130	6.42	28 M	<10 M	860 M	78 M	300 M	3.20
PL2-330A	10/7/09	3.4	15	13.7	<0.2	7.79	8,750	<1.2	<1.1	<0.04	0.3	2.2	128	1.0	101	6.33	NS	NS	NS	NS	NS	NS
PL2-330B	10/8/09	<0.2	<0.2	1.5	2.6	8.92	11,900	<1.2	<1.1	3.02	0.5	<0.1	13.1	0.6	587	6.80	NS	NS	NS	NS	NS	NS
OA12-04A	10/7/09	2.0	13	9.1	0.2	4.64	9,620	<1.2	<1.1	NS	0.1	4.1	58.2	1.4	111	6.27	<0.07	<0.1	<0.07	<0.07	<0.07	1.80
OA12-04A (dup)	10/7/09	2.0	13	9.8	0.2	4.70	8,340	<1.2	<1.1	NS	0.1	3.7	54.9	1.4	109	6.27	<0.07	<0.1	0.53	<0.07	<0.07	4.20
OA12-04B	10/7/09	<0.2	<0.2	17.5	0.6	5.18	3,110	<1.2	<1.1	NS	0.4	<0.1	167	<0.5	214	6.60	<0.07	<0.1	0.08	0.15	<0.07	72.7
OA12-05B	10/7/09	<0.2	<0.2	21.4	0.5	6.28	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.31	NS	NS	NS	NS	NS	NS

**Notes:**

< = not detected at the indicated reporting limit  
 NS = no sample submitted for this analysis  
 M = Recovery/RPD poor for MS/MSD or sample

µg/L = micrograms per liter  
 mg/L = milligrams per liter  
 ml = milliliter

DCE = sum of cis-1,2, trans-1,2, and 1,1-dichloroethene  
 PCE = tetrachloroethene  
 TCE = trichloroethene  
 TOC = total organic carbon  
 VC = vinyl chloride  
 VOCs = volatile organic compounds

Br = bromide ion  
 NO<sub>3</sub> = nitrate ion  
 SO<sub>4</sub> = sulfate ion

**Table 3a. OA-12 ERD IM Groundwater Performance Monitoring Analytical Data Summary—A Level**

Location/Event	Well	Date	VOCs (µg/L)				TOC (mg/L)	Dissolved Gases (µg/L)			Ferrous Iron (mg/L)	Anions (mg/L)			Metals (µg/L)		pH	Organic Acids (mg/L)						Bacterial Census (cells/ml)		
			PCE	TCE	DCE	VC		Methane	Ethane	Ethene		Br	NO <sub>3</sub>	SO <sub>4</sub>	Arsenic	Manganese		Pyruvic	Lactic	Formic	Acetic	Propionic	Butyric			
<b>Injection Line</b>																										
Baseline	OA12-01A	6/2/08	0.7	5.1	13.5	0.2	6.10	8.0	<1.2	<1.1	2.06	0.3	<0.1	94.4	0.6	239	6.44	<4	<1	<1	<1	<1	<1	<1	<1	NS
1st Round	OA12-01A	9/29/08	0.6	<0.2	9.1	<0.2	4,060	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.26	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-01A	12/3/08	<5.0	14	55	<5.0	885	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.02	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-01A	2/2/09	1.1	4.2	59.4	<1.0	398	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.96	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-01A (dup)	2/2/09	1.1	4.2	59.5	<1.0	402	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.96	NS	NS	NS	NS	NS	NS	NS	NS	
4th Round	OA12-01A	4/7/09	<1.0	1.8	56.6	<1.0	169	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.25	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	OA12-01A	6/9/09	<0.2	0.3	57.4	0.6	105	NS	NS	NS	NS	NS	NS	NS	NS	NS	8.01	NS	NS	NS	NS	NS	NS	NS	NS	
6th Round	OA12-01A	8/4/09	<1.0	<1.0	29	<1.0	134	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.46	NS	NS	NS	NS	NS	NS	NS	NS	
7th Round	OA12-01A	10/9/09	<2.0	<2.0	22	<2.0	101	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.52	NS	NS	NS	NS	NS	NS	NS	NS	
Baseline	OA12-02A	6/2/08	1.4	4.9	9.2	0.2	5.47	9.3	<1.2	<1.1	0.040	0.5	32.7	216	<0.5	922	6.30	<4	<1	<1	<1	<1	<1	<1	<1	4.28
Baseline	OA12-02A (dup)	6/2/08	1.5	5.3	8.7	0.2	5.58	10.6	<1.2	<1.1	0.044	0.5	32.6	220	0.5	932	6.30	<4	<1	<1	<1	<1	<1	<1	<1	NS
1st Round	OA12-02A	9/29/08	<10	<10	<10	<10	12,600	NS	NS	NS	NS	<2.0	<2.0	74.3	NS	NS	2.90	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-02A	12/4/08	4.1	8.1	11	<1.0	1,040	NS	NS	NS	NS	2.9	<1.0	227	NS	NS	0.89	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-02A	2/2/09	1.2	3.6	18	<1.0	710	12,900	<1.2	<1.1	84.5	<5.0	<5.0	191	4.6	1,610	5.10	<4	<1	<1	<1	1,281	78.7	122	1.00 J	
4th Round	OA12-02A	4/7/09	<1.0	<1.0	21	<1.0	185	9,360	<1.2	<1.1	8.48	<1.0	<1.0	11.6	5.3	1,030	6.34	<4	<1	<1	<1	276	7.2	3.5	7.50	
5th Round	OA12-02A	6/9/09	<0.2	0.4	18.3	0.2	516	16,200	<1.2	<1.1	48.7	<0.5	<0.5	2.0	5.7	3,780	8.36	<10	<25	<1	850	36	96	7.80		
5th Round	OA12-02A (dup)	6/9/09	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	8.36	NS	NS	NS	NS	NS	NS	NS	7.70	
6th Round	OA12-02A	8/4/09	<0.2	<0.2	15.2	2.9	236	15,900	<1.2	<1.1	192	1.4	<0.5	0.7	5.5	6,220	7.42	<10	13.0 J	NS	2,100	69	100	1,720		
7th Round	OA12-02A	10/8/09	<0.2	<0.2	5.8	6.0	778	16,300	<1.2	<1.1	272	<1.0	<0.5	2.4	5.5	3,890	6.83	12 M	4.9 JM	53 BM	1,100 M	92 M	110 M	1,840		
Baseline	OA12-03A	6/3/08	<0.2	3.5	2.5	<0.2	7.80	8.0	<1.2	<1.1	0.115	0.3	4.4	102	2.0	138	6.10	<4	<1	<1	<1	<1	<1	<1	NS	
1st Round	OA12-03A	9/30/08	<10	<10	<10	<10	15,500	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.88	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-03A	12/4/08	<10	<10	<10	<10	13,500	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.44	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-03A	2/2/09	<1.0	3.7	<1.0	<1.0	11,000	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.55	NS	NS	NS	NS	NS	NS	NS	NS	
4th Round	OA12-03A	4/7/09	<1.0	4.4	<1.0	<1.0	8,440	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.55	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	OA12-03A	6/9/09	<6.0	<6.0	<6.0	<6.0	8,320	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.60	NS	NS	NS	NS	NS	NS	NS	NS	
6th Round	OA12-03A	8/4/09	<0.6	4.7	3.7	<0.6	8,450	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.41	NS	NS	NS	NS	NS	NS	NS	NS	
7th Round	OA12-03A	10/9/09	<0.2	4.1	3.8	0.2	7,460	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.60	NS	NS	NS	NS	NS	NS	NS	NS	
<b>50 Feet Downgradient</b>																										
Baseline	PL2-315A	6/4/08	2.6	10	12.5	<0.2	7.11	<0.7	<1.2	<1.1	<0.040	0.4	22.5	172	<0.5	120	5.94	<4	<1	<1	<1	<1	<1	<1	<1	0.492 J
Baseline	PL2-315A (dup)	6/4/08	2.7	11	12.4	<0.2	7.01	<0.7	<1.2	<1.1	<0.040	0.4	22.1	163	0.6	117	5.94	<4	<1	<1	<1	<1	<1	<1	<1	NS
1st Round	PL2-315A	9/30/08	<10	13	10	<10	8.91	NS	NS	NS	NS	<0.5	5.1	172	NS	NS	5.63	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	PL2-315A	12/4/08	3.2	14	18.7	<0.2	7.78	NS	NS	NS	NS	<1.0	3.8	173	NS	NS	5.98	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	PL2-315A	2/4/09	3.4	12	14.7	<0.2	8.85	153	<1.2	<1.1	NS	0.3	7.7	168	1.4	138	5.64	<4	<1	<1	<1	<1	<1	<1	0.70	
4th Round	PL2-315A	4/7/09	3.6	10	13.6	<0.2	9.64	7,360	<1.2	<1.1	NS	1.4	9.9	198	1.0	108	6.00	<4	<1	<1	<1	<1	<1	<1	3.20	
5th Round	PL2-315A	6/9/09	3.1	11	12.5	0.2	9.82	7,370	<1.2	<1.1	NS	0.4	4.6	154	1.4	112	6.87	<10	<25	<1	<1	<1	<1	<1	<0.50	
6th Round	PL2-315A	8/3/09	2.2	7.6	9.8	0.6	13.1	10,900	<1.2	<1.1	NS	0.7	6.0	165	1.1	118	7.41	<10	<25	NS	7.4	<1	<1	0.5 J	1.30	
7th Round	PL2-315A	10/8/09	2.7	10	12.5	0.7	12.0	8,200	<1.2	<1.1	NS	0.4	2.1	177	4.0	147	6.16	<0.07 M	0.087 JM	0.20 BM	0.059 JM	1.30 M	<0.07 M	0.80		
<b>100 Feet Downgradient</b>																										
Baseline	PL2-330A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1st Round	PL2-330A	10/1/08	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.2	6.7	142	NS	NS	6.14	NS	NS	NS	NS	NS	NS	NS	NS	NS
2nd Round	PL2-330A	12/5/08	5.4	15	15.7	<0.2	7.14	NS	NS	NS	NS	0.3	6.0	133	NS	NS	6.04	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	PL2-330A	2/4/09	3.8	13	13.3	<0.2	8.42	<0.7	<1.2	<1.1	<0.04	0.3	3.9	146	1.4	66	5.02	NS	NS	NS	NS	NS	NS	NS	NS	
4th Round	PL2-330A	4/6/09	4.7	16	15	<0.2	8.28	57.4	<1.2	<1.1	<0.04	0.3	2.9	169	<0.5	87	5.06	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	PL2-330A	6/8/09	4.2	15	16.8	<0.2	7.94	4,870	<1.2	<1.1	<0.04	0.3	2.6	134	0.8	99	6.47	NS	NS	NS	NS	NS	NS	NS	NS	
6th Round	PL2-330A	8/3/09	3.2	12	12.8	<0.2	9.59	8,760	<1.2	<1.1	<0.04	0.4	2.6	106	0.7	88	7.31	NS	NS	NS	NS	NS	NS	NS	NS	
7th Round	PL2-330A	10/7/09	3.4	15	13.7	<0.2	7.79	8,750	<1.2	<1.1	<0.04	0.3	2.2	128	1.0	101	6.33	NS	NS	NS	NS	NS	NS	NS	NS	
<b>150 Feet Downgradient</b>																										
Baseline	OA12-04A	6/4/08	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.15	NS	NS	NS	NS	NS	NS	NS	NS	0.475 J
1st Round	OA12-04A	9/30/08	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.5	2.2	92.8	NS	NS	6.06	NS	NS	NS	NS	NS	NS	NS	NS	
1st Round	OA12-04A (dup)	9/30/08	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.5	2.1	94.9	NS	NS	6.06	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-04A	12/5/08	2.4	15	23.1	<0.2	5.12	NS	NS	NS	NS	0.2	1.6	119	NS	NS	6.01	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-04A (dup)	12/5/08	2.3	16	22.1	<0.2	5.14	NS	NS	NS	NS	0.2	1.6	109	NS	NS	6.01	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-04A	2/4/09	2.0	13	15.9	<0.2	5.79	11.8	<1.2	<1.1	NS	0.1	1.4	93.0	0.8	360	5.36	<4	<1	<1	<1	<1				

**Table 3b. OA-12 ERD IM Groundwater Performance Monitoring Analytical Data Summary—B Level**

Location/Event	Well	Date	VOCs (µg/L)				TOC (mg/L)	Dissolved Gases (µg/L)			Ferrous Iron (mg/L)	Anions (mg/L)			Metals (µg/L)		pH	Organic Acids (mg/L)						Bacterial Census (cells/ml)		
			PCE	TCE	DCE	VC		Methane	Ethane	Ethene		Br	NO <sub>3</sub>	SO <sub>4</sub>	Arsenic	Manganese		Pyruvic	Lactic	Formic	Acetic	Propionic	Butyric			
<b>Injection Line</b>																										
Baseline	OA12-01B	6/2/08	<0.2	<0.2	<0.2	<0.2	2.19	0.9	<1.2	<1.1	0.338	<0.1	<0.1	12.8	0.6	135	7.31	<4	<1	<1	<1	<1	<1	<1	NS	
1st Round	OA12-01B	9/29/08	<0.2	<0.2	<0.2	<0.2	14,000	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.76	NS	NS	NS	NS	NS	NS	NS		
1st Round	OA12-01B (dup)	9/29/08	<10	<10	<10	<10	15,200	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.76	NS	NS	NS	NS	NS	NS	NS		
2nd Round	OA12-01B	12/3/08	<1.0	1.3	4.2	1.1	5,360	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.16	NS	NS	NS	NS	NS	NS	NS		
3rd Round	OA12-01B	2/2/09	<0.6	0.8	2.9	<0.6	2,360	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.22	NS	NS	NS	NS	NS	NS	NS		
4th Round	OA12-01B	4/7/09	<1.0	<1.0	2.7	<1.0	610	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.87	NS	NS	NS	NS	NS	NS	NS		
5th Round	OA12-01B	6/9/09	<1.0	<1.0	2.6	<1.0	494	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.87	NS	NS	NS	NS	NS	NS	NS		
6th Round	OA12-01B	8/4/09	<0.6	<0.6	1.0	<0.6	384	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.48	NS	NS	NS	NS	NS	NS	NS		
7th Round	OA12-01B	10/9/09	<0.6	<0.6	0.9	<0.6	328	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.73	NS	NS	NS	NS	NS	NS	NS		
Baseline	OA12-02B	6/3/08	<0.2	<0.2	0.2	1.6	6.74	131	<1.2	<1.1	5.40	0.7	<0.1	164	<0.5	825	6.57	<4	<1	<1	<1	<1	<1	<1	14.5	
1st Round	OA12-02B	9/29/08	<10	<10	<10	<10	3,570	NS	NS	NS	NS	<2.0	<2.0	19.0	NS	NS	3.03	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-02B	12/4/08	<1.0	<1.0	1.0	1.2	2,830	NS	NS	NS	NS	<1.0	<1.0	11.2	NS	NS	6.05	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-02B	2/2/09	<1.0	<1.0	<1.0	<1.0	2,420	12,500	<1.2	<1.1	107	<5.0	<5.0	<5.0	0.2	2,080	5.45	<4	2.8	2.1	1,807	457	1,017	0.60 J	NS	
4th Round	OA12-02B	4/7/09	<1.0	<1.0	2.1	1.4	2,580	7,030	<1.2	<1.1	131	<2.5	<2.5	<2.5	0.9	4,200	5.99	<4	<1	2.1	1,911	246	1,353	40.8	NS	
4th Round	OA12-02B (dup)	4/7/09	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.99	NS	NS	NS	NS	NS	NS	NS	49.4	
5th Round	OA12-02B	6/9/09	<0.2	<0.2	1.3	0.4	1,750	15,600	<1.2	<1.1	110	<2.0	<2.0	<2.0	2.9	4,940	8.58	<100	230	<1	1,400	230	660	30.5	NS	
6th Round	OA12-02B	8/4/09	<1.0	<1.0	1.2	<1.0	1,260	19,500	<1.2	<1.1	138	4.7	<0.5	<0.5	0.9	6,160	6.97	<10	100	NS	2,300	220	210	55.8	NS	
7th Round	OA12-02B	10/8/09	<0.2	<0.2	1.0	<0.2	710	15,800	<1.2	<1.1	146	1.6	<0.5	<0.5	1.5	3,900	6.78	19 M	<10 M	18 BM	620 M	230 M	48 M	60.8		
7th Round	OA12-02B (dup)	10/8/09	<0.2	<0.2	1.0	<0.2	718	15,500	<1.2	<1.1	120	1.5	<0.5	<0.5	1.7	3,950	6.78	20 M	<10 M	18 BM	630 M	240 M	57 M	15.7		
Baseline	OA12-03B	6/3/08	<0.2	<0.2	<0.2	1.6	12.1	232	<1.2	<1.1	4.58	0.8	<0.1	54.0	1.1	452	6.88	<4	<1	<1	<1	<1	<1	<1	NS	
Baseline	OA12-03B (dup)	6/3/08	<0.2	<0.2	<0.2	1.8	11.9	19.9	<1.2	<1.1	4.58	0.8	<0.1	53.3	1.1	439	6.88	<4	<1	<1	<1	<1	<1	<1	NS	
1st Round	OA12-03B	9/30/08	<10	<10	<10	<10	13,000	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.98	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	OA12-03B	12/4/08	<1.0	<1.0	1.1	1.9	2,470	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.86	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	OA12-03B	2/2/09	<0.6	<0.6	1.5	1.3	2,930	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.45	NS	NS	NS	NS	NS	NS	NS	NS	
4th Round	OA12-03B	4/7/09	<10	<10	<10	<10	2,940	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.87	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	OA12-03B	6/9/09	<1.0	<1.0	1.1	<1.0	890	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.28	NS	NS	NS	NS	NS	NS	NS	NS	
6th Round	OA12-03B	8/4/09	<1.0	<1.0	<1.0	<1.0	330	NS	NS	NS	NS	NS	NS	NS	NS	NS	7.16	NS	NS	NS	NS	NS	NS	NS	NS	
7th Round	OA12-03B	10/9/09	<2.0	<2.0	<2.0	<2.0	197	NS	NS	NS	NS	NS	NS	NS	NS	NS	6.99	NS	NS	NS	NS	NS	NS	NS	NS	
<b>50 Feet Downgradient</b>																										
Baseline	PL2-315B	6/3/08	<0.2	<0.2	0.2	1.4	7.04	1,070	<1.2	<1.1	21.3	1.3	<0.1	103	<0.5	975	6.46	<4	<1	<1	<1	<1	<1	<1	1.48	
1st Round	PL2-315B	9/30/08	<10	<10	<10	<10	7.05	NS	NS	NS	NS	1.0	<0.5	162	NS	NS	5.43	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	PL2-315B	12/4/08	<0.2	<0.2	0.2	1.1	6.05	NS	NS	NS	NS	0.8	<1.0	193	NS	NS	6.47	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	PL2-315B	2/4/09	<0.2	<0.2	0.3	1.3	6.73	2,040	<1.2	<1.1	NS	1.2	<0.1	130	<0.5	892	5.11	<4	<1	<1	<1	<1	<1	<1	61.5	
3rd Round	PL2-315B (dup)	2/4/09	<0.2	<0.2	0.2	1.3	7.36	1,030	<1.2	<1.1	NS	<0.1	0.8	130	<0.5	889	5.11	<4	<1	<1	<1	<1	<1	<1	NS	
4th Round	PL2-315B	4/7/09	<0.2	<0.2	0.3	<0.2	36.5	883	<1.2	<1.1	NS	1.8	<1.0	227	<0.5	963	6.32	<4	<1	<1	67.3	2.1	<1	<1	7.10	
4th Round	PL2-315B (dup)	4/7/09	<0.2	<0.2	0.2	0.5	36.5	922	<1.2	<1.1	NS	1.5	<1.0	228	<0.5	979	6.32	<4	<1	<1	65.8	2.2	<1	<1	NS	
5th Round	PL2-315B	6/8/09	<0.2	<0.2	0.4	0.7	22.7	7,190	<1.2	<1.1	NS	0.8	<0.1	10.8	<0.5	807	7.96	<10	<25	<1	13	<1	1.2	15.7		
6th Round	PL2-315B	8/3/09	<0.2	<0.2	0.3	0.9	522	17,800	<1.2	<1.1	NS	<1.0	<1.0	0.2	<0.5	2,730	8.01	<10	8.1 J	NS	730	25	77	14.2		
6th Round	PL2-315B (dup)	8/3/09	<0.2	<0.2	0.4	0.8	546	15,600	<1.2	<1.1	NS	<1.0	<1.0	0.2	<0.5	2,690	8.01	<10	<25	NS	850	26	78	30.9		
7th Round	PL2-315B	10/8/09	<0.2	<0.2	0.8	1.8	888	20,300	<1.2	<1.1	NS	<0.5	<0.5	<0.5	0.4	4,130	6.42	28 M	<10 M	70 BM	860 M	78 M	300 M	3.20		
<b>100 Feet Downgradient</b>																										
Baseline	PL2-330B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1st Round	PL2-330B	10/1/08	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.5	<0.5	58.8	NS	NS	6.82	NS	NS	NS	NS	NS	NS	NS	
2nd Round	PL2-330B	12/5/08	<0.2	<0.2	1.0	3.0	6.20	NS	NS	NS	NS	0.5	<0.1	48.5	NS	NS	6.69	NS	NS	NS	NS	NS	NS	NS	NS	
2nd Round	PL2-330B (dup)	12/5/08	<0.2	<0.2	1.0	2.8	6.50	NS	NS	NS	NS	0.5	<0.1	47.9	NS	NS	6.69	NS	NS	NS	NS	NS	NS	NS	NS	
3rd Round	PL2-330B	2/4/09	<0.2	<0.2	1.0	2.2	7.35	1,470	<1.2	<1.1	1.11	0.5	<0.1	57.6	<0.5	439	5.58	NS	NS	NS	NS	NS	NS	NS	NS	
4th Round	PL2-330B	4/6/09	<0.2	<0.2	1.3	1.9	8.08	435	<1.2	<1.1	1.61	0.4	<0.1	67.1	0.3	434	5.68	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	PL2-330B	6/8/09	0.3	<0.2	1.3	2.6	7.64	302	<1.2	<1.1	2.04	0.3	<0.1	67.3	<0.5	452	6.98	NS	NS	NS	NS	NS	NS	NS	NS	
5th Round	PL2-330B (dup)	6/8/09	0.2	<0.2	1.3	2.6	8.17	307	<1.2	<1.1	2.06	0.3	<0.1	67.0	0.6	445	6.98	NS	NS	NS	NS	NS	NS	NS	NS	
6th Round	PL2-330B	8/3/09	<0.2	<0.2	0.6	<0.2	9.33	12.3	<1.2	<1.1	0.244	0.5	<0.1	48.3	0.4	341	7.58	NS	NS	NS	NS	NS	NS	NS	NS	
7th Round	PL2-330B	10/8/09	<0.2	<0.2	1.5	2.6	8.92	11,900	<1.2	<1.1	3.02	0.5	<0.1	13.1	0.4	587	6.80	NS	NS	NS	NS	NS	NS	NS	NS	
<b>150 Feet Downgradient</b>																										
Baseline	OA12-04B	6/4/08	NS																							

**Table 4a. OA-12 ERD IM Groundwater Field Parameter Summary—A Level**

Location / Event	Well	Date	Time	Depth to Water (feet)	Total Volume Purged (gallons)	pH	Specific Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)	Comments
<b>Injection Line</b>												
Baseline	OA12-01A	6/2/08	10:00	10.96	5.7	6.44	0.662	13.0	0.15	14.8	-18.8	clear
1st Round	OA12-01A	9/29/08	10:20	11.34	4.9	3.26	0.615	6.35	0.17	17.4	129	clear, smelly
2nd Round	OA12-01A	12/3/08	13:33	11.00	3.5	2.02	3.001	30.9	0.20	15.0	-119	gray-clear
3rd Round	OA12-01A	2/2/09	10:24	10.91	5.5	4.96	1.706	36.7	0.33	14.5	-221	gray
4th Round	OA12-01A	4/7/09	13:25	10.89	6.2	6.25	2.085	19.9	0.06	14.8	-263	gray, odor
5th Round	OA12-01A	6/9/09	13:38	10.81	3.3	8.01	1.144	29.2	0.39	15.1	-130	clear black/brown
6th Round	OA12-01A	8/4/09	12:05	11.15	1.7	7.46	1.317	14.6	0.09	15.6	-79	coffee-color, clear
7th Round	OA12-01A	10/9/09	11:40	11.44	4.5	6.52	1.400	25.1	0.31	16.4	-120	clear, brown
<b>Injection Line</b>												
Baseline	OA12-02A	6/2/08	14:00	10.79	5.0	6.30	1.061	6.04	0.53	15.3	40.9	clear
1st Round	OA12-02A	9/29/08	15:02	11.14	2.8	2.90	3.335	20.3	0.17	18.6	124	cloudy, smelly
2nd Round	OA12-02A	12/4/08	9:44	10.82	6.5	0.89	5.490	17.4	0.12	15.6	-144	clear
3rd Round	OA12-02A	2/2/09	11:32	10.69	3.0	5.10	2.664	21.6	0.36	15.7	-190	black/gray
4th Round	OA12-02A	4/7/09	12:40	10.70	5.8	6.34	2.487	8.8	0.08	16.0	-201	brown, odor
5th Round	OA12-02A	6/9/09	11:11	10.59	6.0	8.36	3.314	5.8	0.45	15.3	-174	slightly gray
6th Round	OA12-02A	8/4/09	10:01	10.94	2.3	7.42	3.639	18.9	0.15	15.5	-177	clearing
7th Round	OA12-02A	10/8/09	13:40	11.24	3.1	6.83	4.500	27.0	0.88	16.7	-207	gray, clear, odor
<b>Injection Line</b>												
Baseline	OA12-03A	6/3/08	12:10	10.85	2.0	6.10	0.560	1.59	0.50	14.5	51.6	clear
1st Round	OA12-03A	9/30/08	9:32	NM	4.5	2.88	4.473	116	0.16	17.0	99.7	cloudy, yellow, smelly
2nd Round	OA12-03A	12/4/08	12:52	10.98	5.0	5.44	10.31	181	0.17	16.7	-27.2	yellow, cloudy
3rd Round	OA12-03A	2/2/09	14:43	10.46	1.8	4.55	4.084	38.9	0.51	16.2	-41.8	clear, fizzing
4th Round	OA12-03A	4/7/09	15:17	10.84	4.6	4.55	6.072	9.4	0.13	16.6	-28.3	clear, odor
5th Round	OA12-03A	6/9/09	15:03	10.75	3.4	4.60	5.261	17.8	0.53	16.3	39.9	clear
6th Round	OA12-03A	8/4/09	8:30	11.09	1.7	5.41	4.719	16.0	0.18	15.6	22.3	clear
7th Round	OA12-03A	10/9/09	9:05	11.38	2.8	4.60	4.670	18.2	0.93	15.9	53	clear, sour fruit odor
<b>50 Feet Downgradient</b>												
Baseline	PL2-315A	6/4/08	8:30	10.72	2.2	5.94	0.767	4.37	1.00	14.2	111	clear
1st Round	PL2-315A	9/30/08	14:18	11.18	2.0	5.63	0.671	0.00	0.22	16.7	-0.8	clear
2nd Round	PL2-315A	12/4/08	14:08	10.87	2.0	5.98	0.681	1.92	0.09	16.2	-17.1	clear
3rd Round	PL2-315A	2/4/09	8:50	10.83	3.5	5.64	0.619	1.78	2.97	15.2	-27.8	clear, colorless
4th Round	PL2-315A	4/7/09	8:40	10.80	2.5	6.00	0.946	3.61	0.16	14.7	25.0	clear
5th Round	PL2-315A	6/9/09	10:10	10.67	4.8	6.87	1.173	1.69	0.46	16.1	20.6	clear
6th Round	PL2-315A	8/3/09	13:41	10.99	1.7	7.41	0.928	0.86	0.23	17.4	7.2	clear
7th Round	PL2-315A	10/8/09	10:30	11.30	2.0	6.16	0.879	6.11	0.92	17.5	36	clear, colorless
<b>100 Feet Downgradient</b>												
Baseline	PL2-330A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1st Round	PL2-330A	10/1/08	12:02	11.40	2.0	6.14	0.597	0.00	0.20	16.8	39.7	clear
2nd Round	PL2-330A	12/5/08	10:41	11.14	1.5	6.04	0.582	1.14	0.11	15.9	9.3	clear
3rd Round	PL2-330A	2/4/09	10:40	11.20	3.8	5.02	0.475	1.07	2.67	15.5	-53.8	clear
4th Round	PL2-330A	4/6/09	14:00	11.00	2.0	5.06	0.665	0.38	0.21	16.0	30.0	clear
5th Round	PL2-330A	6/8/09	13:13	10.83	5.3	6.47	0.738	2.48	0.20	16.1	49.3	clear
6th Round	PL2-330A	8/3/09	10:54	11.15	1.4	7.31	0.631	0.75	0.27	16.8	12.1	clear
7th Round	PL2-330A	10/7/09	16:04	11.48	4.5	6.33	0.666	4.33	1.25	17.2	120	clear
<b>150 Feet Downgradient</b>												
Baseline	OA12-04A	6/4/08	11:30	11.17	2.0	6.15	0.498	3.05	0.63	14.8	-4.2	clear
1st Round	OA12-04A	9/30/08	15:44	11.69	2.3	6.06	0.517	0.42	0.19	16.4	19.3	clear
2nd Round	OA12-04A	12/5/08	9:00	11.42	2.0	6.01	0.538	3.24	0.20	15.6	49.5	clear
3rd Round	OA12-04A	2/4/09	12:45	11.34	3.0	5.36	0.409	7.29	3.88	15.8	-44.6	clear
4th Round	OA12-04A	4/6/09	12:30	11.29	2.0	5.10	0.425	3.32	0.31	15.6	18.8	clear
5th Round	OA12-04A	6/8/09	10:55	11.08	1.9	6.21	0.477	5.16	0.19	15.7	59.1	clear
6th Round	OA12-04A	8/3/09	10:02	11.38	1.9	6.97	0.531	2.01	0.23	16.5	25.3	clear
7th Round	OA12-04A	10/7/09	14:35	11.74	4.0	6.27	0.571	7.43	1.11	17.0	65	clear

**Notes:**

NS = not sampled

°C = degrees Celsius

mg/L - milligrams per liter

mS/cm = milliSiemens per centimeter

mV = millivolts

NTU = nephelometric turbidity units

**Table 4b. OA-12 ERD IM Groundwater Field Parameter Summary—B Level**

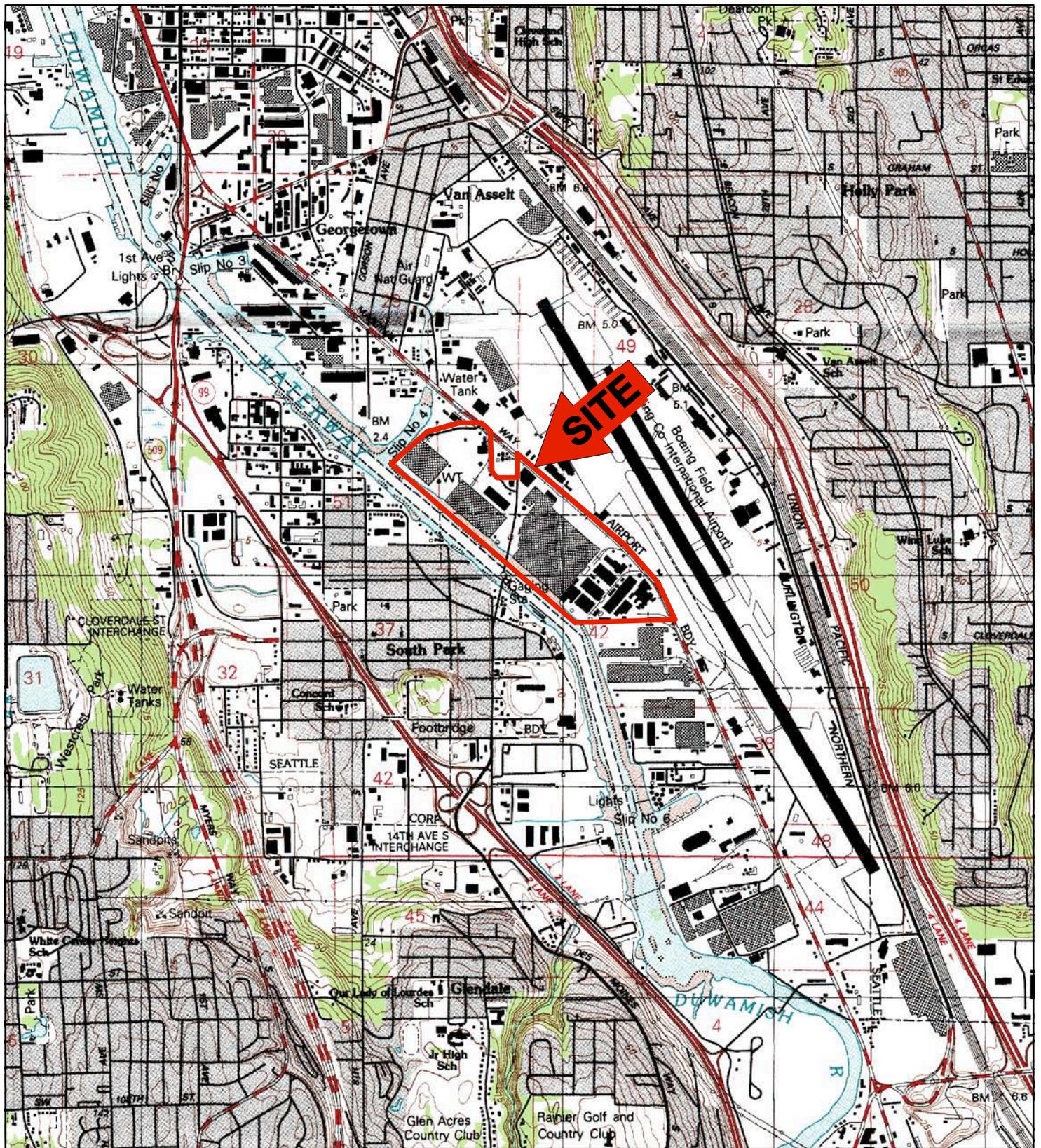
Location / Event	Well	Date	Time	Depth to Water (feet)	Total Volume Purged (gallons)	pH	Specific Conductivity (mS/cm)	Turbidity (NTUs)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)	Comments
<b>Injection Line</b>												
Baseline	OA12-01B	6/2/08	11:20	10.96	3.0	7.31	0.364	20.2	2.39	14.8	-13.3	clear
1st Round	OA12-01B	9/29/08	11:43	11.18	3.9	2.76	0.995	21.4	0.12	18.3	98.1	mostly clear, smelly
2nd Round	OA12-01B	12/3/08	14:08	11.01	5.0	4.16	5.432	NM	0.14	16.1	-5.9	clearing
3rd Round	OA12-01B	2/2/09	10:47	10.81	2.6	5.22	6.556	70.6	0.35	14.6	-213	gray, clearing
4th Round	OA12-01B	4/7/09	13:57	10.85	2.3	5.87	4.458	13.6	0.11	15.3	-164	clear
5th Round	OA12-01B	6/9/09	14:17	10.84	3.5	7.87	4.171	31.4	0.36	15.7	-173	clear brown
6th Round	OA12-01B	8/4/09	11:27	11.02	2.0	7.48	3.544	9.2	0.16	15.8	-118	coffee, clear
7th Round	OA12-01B	10/9/09	10:42	11.34	2.5	6.73	3.730	13.9	0.91	16.2	-163	clear, coffee color
Baseline	OA12-02B	6/3/08	10:50	10.71	6.2	6.57	1.105	10.5	0.25	15.2	-93.9	clear
1st Round	OA12-02B	9/29/08	13:46	11.13	3.5	3.03	1.194	25.2	0.23	18.2	107	cloudy, smelly
2nd Round	OA12-02B	12/4/08	10:27	10.99	6.0	6.05	7.305	29.1	0.15	15.8	-65.2	mostly clear
3rd Round	OA12-02B	2/2/09	12:25	10.60	5.0	5.45	8.141	27.8	0.38	15.7	-200	grayish, clear
4th Round	OA12-02B	4/7/09	10:45	10.95	2.0	5.99	8.965	22.0	0.16	15.7	-172	odor, light gray
5th Round	OA12-02B	6/9/09	12:37	10.92	2.8	8.58	6.424	30.4	0.54	15.7	-157	brownish yellow
6th Round	OA12-02B	8/4/09	9:03	11.01	1.0	6.97	5.493	37.9	0.24	15.7	-145	cloudy
7th Round	OA12-02B	10/8/09	11:45	11.34	3.8	6.78	5.310	48.2	0.85	16.6	-209	odor, slightly gray, cloudy
Baseline	OA12-03B	6/3/08	14:28	10.73	4.8	6.88	1.066	17.59	0.21	15.4	-139	clear
1st Round	OA12-03B	9/30/08	10:55	11.14	3.8	1.98	3.372	53.3	0.11	18.9	53.4	cloudy, yellow, smelly
2nd Round	OA12-03B	12/4/08	13:14	10.96	4.0	5.86	7.380	47.1	0.10	16.0	-54.4	cloudy due to bubbles
3rd Round	OA12-03B	2/2/09	15:07	10.72	2.0	5.45	9.640	39.7	0.39	15.7	-217	black/gray
4th Round	OA12-03B	4/7/09	14:25	10.90	1.8	5.87	9.249	16.1	0.10	16.2	-182	black with odor
5th Round	OA12-03B	6/9/09	15:34	10.79	2.6	7.28	6.255	50.1	0.39	16.5	-201	clear with black
6th Round	OA12-03B	8/4/09	7:55	11.00	1.4	7.16	4.905	80.5	0.43	15.8	-155	cloudy
7th Round	OA12-03B	10/9/09	9:54	11.12	3.3	6.99	4.720	59.5	0.61	16.0	-203	dark brown, cloudy
<b>50 Feet Downgradient</b>												
Baseline	PL2-315B	6/3/08	16:15	11.18	3.5	6.46	1.339	6.97	0.28	16.0	-127	clear
1st Round	PL2-315B	9/30/08	12:55	11.42	3.3	5.43	1.268	0.00	0.15	16.4	-23.5	clear
2nd Round	PL2-315B	12/4/08	14:43	11.13	3.0	6.47	1.316	1.44	0.06	15.1	-12.3	clear
3rd Round	PL2-315B	2/4/09	9:10	11.14	2.5	5.11	0.999	1.61	2.84	15.2	-136	clear
4th Round	PL2-315B	4/7/09	9:30	11.20	1.8	6.32	1.331	3.54	0.10	15.8	-173	clear
5th Round	PL2-315B	6/8/09	14:55	10.85	3.6	7.96	1.692	9.20	0.14	16.3	-324	clear
6th Round	PL2-315B	8/3/09	12:30	11.13	2.7	8.01	2.094	1.45	0.15	16.7	-103	clear
7th Round	PL2-315B	10/8/09	9:28	12.50	4.2	6.42	2.560	6.22	0.47	16.0	-222	clear, slight odor
<b>100 Feet Downgradient</b>												
Baseline	PL2-330B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1st Round	PL2-330B	10/1/08	12:52	11.56	1.9	6.82	0.978	7.53	0.16	16.5	50.7	clear
2nd Round	PL2-330B	12/5/08	10:10	11.43	2.2	6.69	0.993	5.41	0.14	15.1	39.0	clear
3rd Round	PL2-330B	2/4/09	11:03	11.31	2.5	5.58	0.692	2.95	2.63	15.4	-118	clear
4th Round	PL2-330B	4/6/09	13:20	11.34	2.0	5.68	0.827	7.45	0.14	16.0	-99.4	clear
5th Round	PL2-330B	6/8/09	13:57	11.02	2.2	6.98	0.869	3.78	0.10	16.4	-57.9	clear
6th Round	PL2-330B	8/3/09	11:26	11.29	1.3	7.58	0.810	4.25	0.16	16.8	15.8	clear
7th Round	PL2-330B	10/8/09	8:35	11.70	1.6	6.80	0.980	5.72	0.77	16.1	-112	clear
<b>150 Feet Downgradient</b>												
Baseline	OA12-04B	6/4/08	10:12	11.14	2.8	6.35	0.715	1.90	0.44	15.2	-79.7	clear
1st Round	OA12-04B	10/1/08	9:39	11.69	2.5	6.13	0.725	3.86	0.18	15.9	68.8	clear
2nd Round	OA12-04B	12/5/08	9:31	11.54	0.9	6.34	0.637	5.58	0.22	14.9	52.0	clear
3rd Round	OA12-04B	2/4/09	13:15	11.37	3.5	5.61	0.520	2.50	2.05	15.7	-86.2	clear
4th Round	OA12-04B	4/6/09	11:30	11.40	1.5	5.81	0.664	4.31	0.14	16.1	-49.7	clear
5th Round	OA12-04B	6/8/09	11:48	11.09	1.8	6.61	0.720	8.80	0.22	16.1	-9.0	clear, colorless
6th Round	OA12-04B	8/3/09	10:02	11.38	1.9	6.97	0.531	2.01	0.23	16.5	25.3	clear
7th Round	OA12-04B	10/7/09	13:40	11.77	1.9	6.60	0.801	5.59	0.99	16.5	-56.0	clear
<b>250 Feet Downgradient</b>												
Baseline	OA12-05B	6/4/08	12:30	11.35	2.0	6.11	0.977	3.93	0.57	15.8	-54.3	clear
1st Round	OA12-05B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
2nd Round	OA12-05B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
3rd Round	OA12-05B	2/4/09	13:41	11.35	2.0	5.46	0.634	2.37	1.82	16.1	-78.0	clear
4th Round	OA12-05B	4/6/09	10:55	11.45	2.4	5.68	0.805	8.48	0.18	16.0	-26.2	clear
5th Round	OA12-05B	6/8/09	10:20	10.96	4.4	6.23	0.746	19.4	0.31	16.0	9.6	clear
6th Round	OA12-05B	8/3/09	8:28	11.21	1.6	6.68	0.757	7.48	0.55	16.3	17.0	clear
7th Round	OA12-05B	10/7/09	13:00	11.64	2.6	6.31	0.814	6.94	1.09	16.4	-42.0	clear

**Notes:**

NS = not sampled  
 °C = degrees Celsius  
 mg/L - milligrams per liter

mS/cm = milliSiemens per centimeter  
 mV = millivolts  
 NTU = nephelometric turbidity units

## FIGURES



KEY:

SOURCE: USGS 7.5 MINUTE QUADRANGLE  
(TOPOGRAPHIC)

SEATTLE SOUTH  
1983

SCALE = 1:25,000

**ept** ENVIRONMENTAL PARTNERS INC  
295 NE Gilman Boulevard, Suite 201  
Issaquah, Washington 98027

FIGURE 1

BOEING PLANT 2  
GENERAL LOCATION

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b>	<b>DRAWN BY</b>	<b>REVIEWED BY</b>	<b>DATE</b>
1 of 1	ARM	JLD	02/02/10



KEY:

— APPROXIMATE OA-12 PILOT TEST LOCATION

— PLANT 2 BOUNDARY

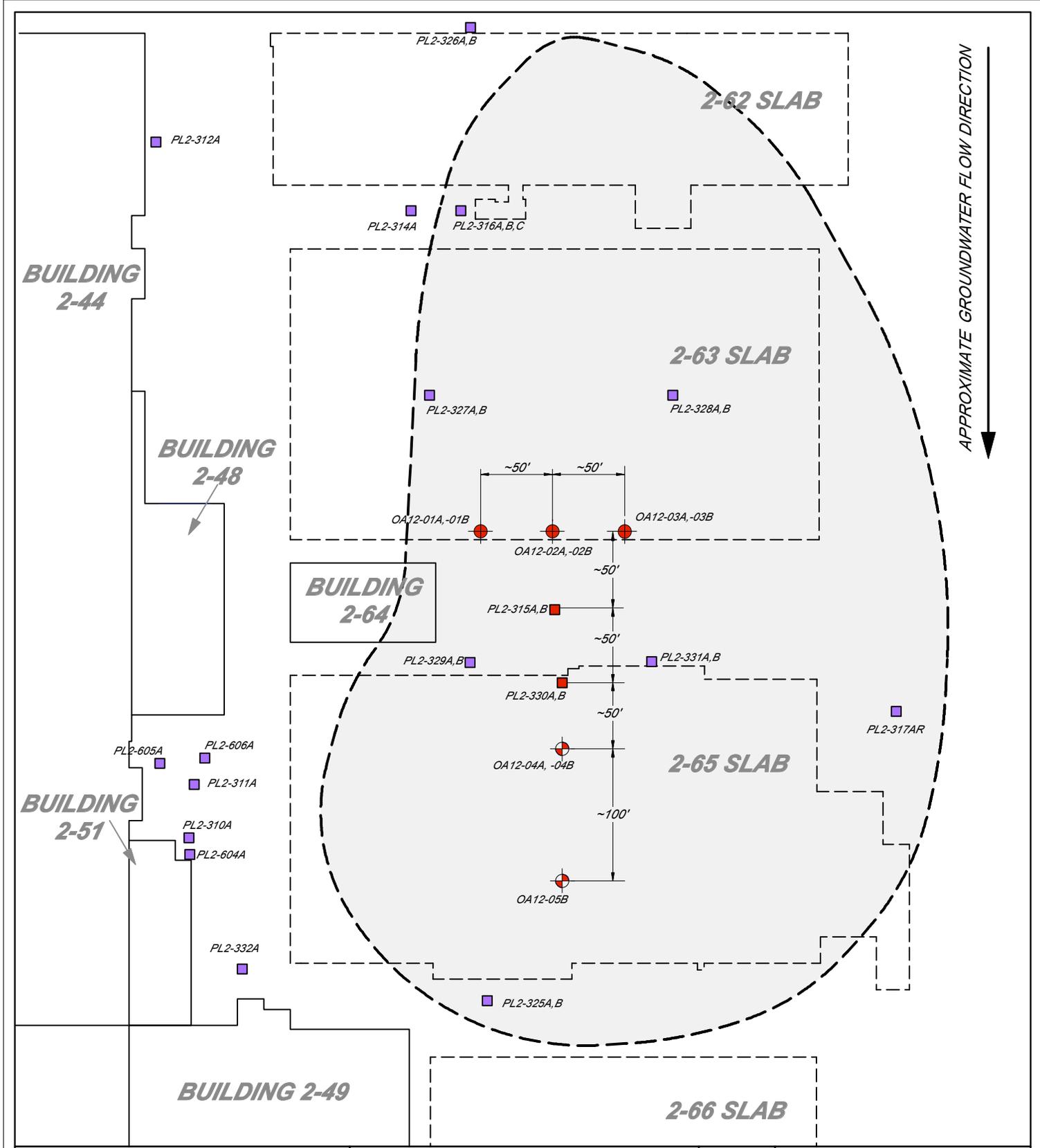
APPROXIMATE SCALE: 1" = 400'

**ENVIRONMENTAL PARTNERS INC**  
 295 NE Gilman Boulevard, Suite 201  
 Issaquah, Washington 98027

**FIGURE 2**

**SITE REPRESENTATION**

<b>PROJECT</b>	OA-12 IN SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> ARM	<b>REVIEWED BY</b> JLD	<b>DATE</b> 08/17/10



KEY:

-  OA-12 IM INJECTION WELL
-  OA-12 IM PROJECT MONITORING WELL
-  EXISTING MONITORING WELL
-  EXISTING MONITORING WELL LOCATION (NOT SAMPLED)

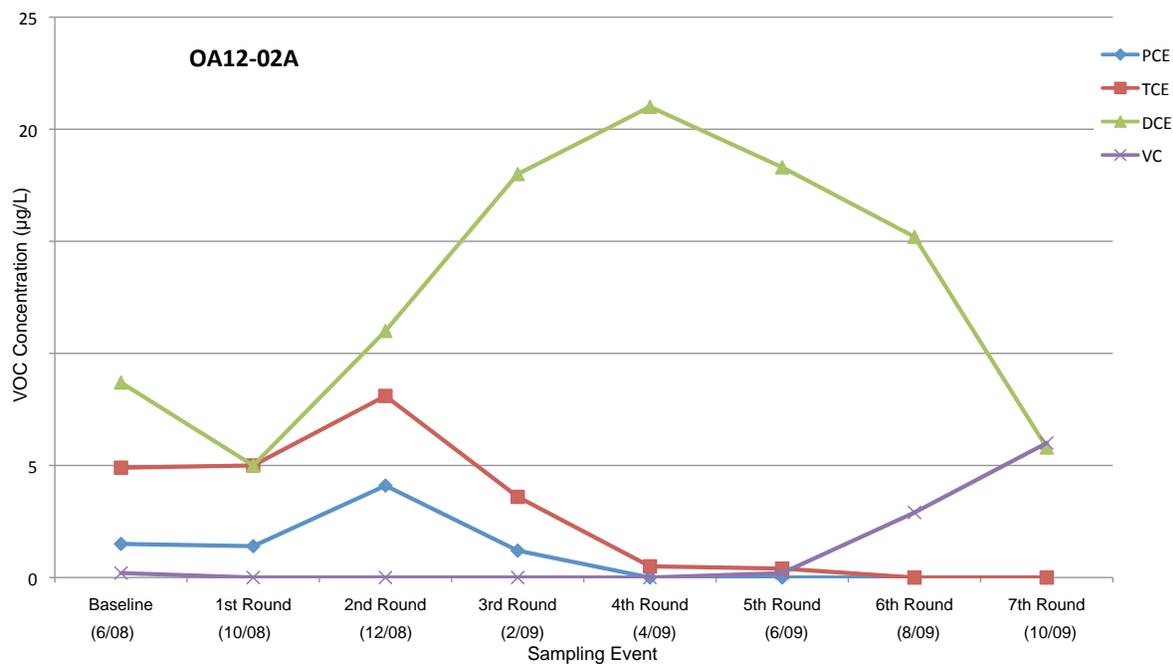
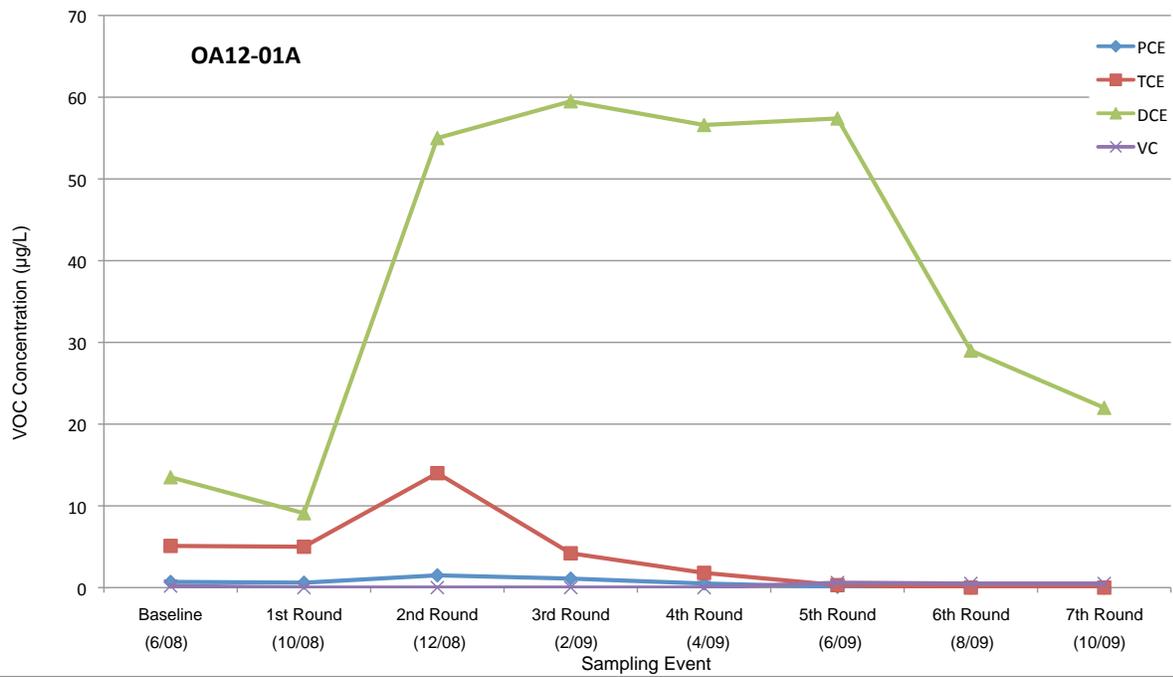




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 Issaquah, Washington 98027

FIGURE 3  
 OA-12 INTERIM MEASURES  
 INJECTION AND MONITORING WELLS

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b>	<b>DRAWN BY</b>	<b>REVIEWED BY</b>	<b>DATE</b>
1 of 1	ARM	DCK	02/03/10



**KEY:**

- ◆— Tetrachloroethene
  - Trichloroethene
  - ▲— Dichloroethene
  - ×— Vinyl chloride
- µg/L = micrograms per liter



**FIGURE 4**

VOC TREND PLOTS FOR  
OA12-01A AND OA12-02A

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 12/30/09

**ATTACHMENT A**  
**FIELD PARAMETER DATA AND FIELD NOTES**

**Table A1. OA-12 ERD IM Performance Monitoring - 6th Round Field Parameter Measurements (8/2009)**

Well ID	pH	Dissolved Oxygen (mg/L)	ORP (mV)	Temperature (°C)	Turbidity (NTU)	Specific Conductance (mS/cm)	Depth to Water (ft)
OA12-01A	7.46	0.1	-79	15.6	14.6	1.32	11.15
OA12-01B	7.48	0.2	-118	15.8	9.2	3.54	11.02
OA12-02A	7.42	0.2	-177	15.5	18.9	3.64	10.94
OA12-02B	6.97	0.2	-145	15.7	37.9	5.49	11.01
OA12-03A	5.41	0.2	22	15.6	16.0	4.72	11.09
OA12-03B	7.16	0.4	-155	15.8	80.5	4.91	11.00
PL2-315A	7.41	0.2	7	17.4	0.9	0.93	10.99
PL2-315B	8.01	0.2	-103	16.7	1.5	2.09	11.03
PL2-330A	7.31	0.3	12	16.8	0.8	0.63	11.15
PL2-330B	7.58	0.2	16	16.8	4.3	0.81	11.29
OA12-04A	6.97	0.2	25	16.5	2.0	0.53	11.38
OA12-04B	7.06	0.3	0	115.9	3.5	0.71	11.37
OA12-05B	6.68	0.6	17	16.3	7.5	0.76	11.21

**Notes:**

°C = degrees Celsius

mg/L = milligrams per liter

mS/cm = milliSiemens per centimeter

mV = millivolt

NTU = nephelometric turbidity units

ORP = oxidation-reduction potential

**Table A2. OA-12 ERD IM Performance Monitoring - 7th Round Field Parameter Measurements (10/2009)**

Well ID	pH	Dissolved Oxygen (mg/L)	ORP (mV)	Temperature (°C)	Turbidity (NTU)	Specific Conductance (mS/cm)	Depth to Water (ft)
OA12-01A	6.52	0.3	-120	16.4	25.1	1.40	11.44
OA12-01B	6.73	0.9	-163	16.2	13.9	3.73	11.34
OA12-02A	6.83	0.9	-207	16.7	27.0	4.50	11.24
OA12-02B	6.78	0.9	-209	16.6	48.2	5.31	11.34
OA12-03A	4.60	0.9	53	15.9	18.2	4.67	11.38
OA12-03B	6.99	0.6	-203	16.0	59.5	4.72	11.12
PL2-315A	6.16	0.9	36	17.5	6.1	0.88	11.30
PL2-315B	6.42	0.5	-222	16.0	6.2	2.56	12.50
PL2-330A	6.33	1.3	120	17.2	4.3	0.67	11.48
PL2-330B	6.80	0.8	-112	16.1	5.7	0.98	11.70
OA12-04A	6.27	1.1	65	17.0	7.4	0.57	11.74
OA12-04B	6.60	1.0	-56	15.5	5.6	0.80	11.77
OA12-05B	6.31	1.1	-42	16.4	6.9	0.81	11.64

**Notes:**

°C = degrees Celsius

mg/L = milligrams per liter

mS/cm = milliSiemens per centimeter

mV = millivolt

NTU = nephelometric turbidity units

ORP = oxidation-reduction potential

Boeing-Plant 2 8/3/09  
OA-12 IM 12 month (6<sup>th</sup> Rd)

GW Sampling Sunny

- 0600 Gather equipment
- 0620 Leave for Boeing Plant 2
- 0655 K. Addis onsite
- 0700 M. Mogg onsite
- 0703 Health + Safety Meeting
- 0710 K. Addis to pick-up bottles at ARI.  
M. Mogg will stay onsite + measure water levels.
- 0735 K. Addis onsite
- 0740 Calibrate equipment (YSI, turbidity)  
See sampling booklet.
- 0803 Begin purge at OA12-05B, see booklet
- 0834 Last sample taken.  
All samples were immediately double bagged and placed in iced cooler.  
All equipment was decontam using alconox + tap water. All purgewater was transferred to treatment tank in 2-49 building.
- 1430 K. Addis to ARI with samples  
M. Mogg offsite
- 1530 K. Addis @ office.

~~K. Addis~~  
K. Addis  
8/3/09

Location: Boeing Plant 2 Date 8/4/09 15

Project: OA12- IM 12 month (6<sup>th</sup> Round)

GW Sampling Cloudy, Breezy

- 0700 K. Addis + M. Mogg onsite
- 0720 Calibrate YSI + Turbidity meter
- 0735 Begin purge at OA12-03B  
See Sampling Booklet for details.
- 1001 GW-090804-OA12-02A-0 MS/MSD  
\*Only 1 sample taken for gDHC  
250 mL filtered  
All dissolved metals are Field Filtered
- 1205 Last sample collected  
All samples were immediately double bagged and placed in an iced cooler.  
All equipment was decontam using alconox and tap water, with distilled water rinse. All purgewater was transferred to treatment tank in 2-49 building
- 1300 K. Addis + M. Mogg offsite.
- 1305 K. Addis at ARI to deliver samples.
- 1315 K. Addis leaves ARI
- 1350 K. Addis @ storage shed - Unload equipment
- 1410 Fill van with gas
- 1425 At EPI. Unload remaining equip.
- 1500 K. Addis finished.

K. Addis  
8/4/09

Location Boeing-OA1Z 4<sup>th</sup> Quarter 10/7/09

Project/Client Boeing Plant 2

Partly Cloudy, Breezy

- 1130 K. Addis finished with 2-31 gw sampling. Begin preparation for OA1Z gw sampling.
- 1200 Calibration for Horiba was completed in morning for 2-31 sampling.
- 1210 Mary Holder on-site; J. Bernthal offsite. Open wells
- 1227 Begin water levels
- |      | W.L. in feet |
|------|--------------|
| 05B  | 11.64        |
| 04B  | 11.77        |
| 04A  | 11.74        |
| 330B | 11.70        |
| 330A | 11.48        |
| 315B | 12.50        |
| 315A | 11.30        |
| 03B  | 11.12        |
| 03A  | 11.38        |
| 02B  | 11.34        |
| 02A  | 11.24        |
| 01B  | 11.34        |
| 01A  | 11.44        |

Location Boeing-OA1Z 4<sup>th</sup> Qtr GWSampling 10/7/09

Project/Client Boeing-Plant 2 IM Sampling

Partly Cloudy, Breezy

- 1227 Begin purge @ OA1Z-05B
- 1300 Sample
- 1320 Begin purge @ OA1Z-04B
- 1340 Sample
- 1409 Begin purge @ OA1Z-04A
- 1435 Sample
- 1526 Begin purge @ PL2-330A
- 1604 Sample
- 1650 All equipment decontaminated at end of day. All purgewater was emptied into 2-49 treatment tank. Deliver samples to lab.
- 1715 M. Holder, K. Addis offsite
- 1800 At office.

~~Kristin A. Addis  
10/7/09~~

Location Boeing Plant Z  
 Project/Client Boeing OAIZ IM 4<sup>th</sup> Qtr Sampling  
 Cold, Sunny

10/8/09

- 0730 K. Addis, M. Holder onsite  
 0740 Review Health + Safety  
 0745 Calibration  
 Horiba (11W)  
 SN 001876 Aurical Autocal 6886  
 Lot Exp. 2-20-2010  
 pH - 3.59  
 Cond 0.459 S/m  
 DO = 10.62  
 Temp. 10.7°C  
 ORP 303 mV  
 LcMotte 2020c  
 O = 0.00 IO = 9.89
- 0815 Begin purge @ PL2-330A  
 0835 Sample  
 0855 Begin purge @ PL2-315B  
 0928 Sample  
 1005 Begin purge @ PL2-315A  
 1030 Sample  
 1100 Begin purge @ OAIZ-02B  
 1145 Sample  
 Census filters only able to filter  
 25 ml before clogging. Microbial  
 Insights can accept 2 filters  
 per sample if low water volume.

Location Boeing Plant Z  
 Project/Client Boeing OAIZ 4<sup>th</sup> Qtr IM GW Sampling

Date 10/8/09

- In an effort to stay consistent  
 with water volume of previous samples  
 2 filters were collected.  
 Duplicate sample also 25ml each  
 of water filtered.
- 1300 End Sampling  
 1310 Begin purge @ OAIZ-02A  
 1340 Sample - MS/MSD except  
 census filters.  
 1400 40 mL filtered for Census  
 2 filters collected for  
 one sample.  
 1427 End Sampling  
 1440 All equipment was decontaminated  
 at end of day. All purgewater +  
 decon water was emptied into  
 2-49 treatment tank.  
 1503 Samples delivered to lab  
 1540 K. Addis + M. Holder offsite  
 1630 At office - Bed Traffic !!

~~Kristin Z. Addis  
 10/8/09~~

Location Boeing-Plant 2

Date 10/9/09

Project / Client Boeing OA12 4<sup>th</sup> Qtr GW Sampling

Partly Cloudy, cool

- 0730 K. Addis, M. Holder onsite  
 0745 Health + Safety Review  
 See Sampling Booklet for  
 Calibration information  
 0800  
 0829 Begin purge @ OA12-03A  
 0905 Sample - Non-preserved VOAs  
 0915 Begin purge @ OA12-03B  
 0954 Sample - Non-preserved VOAs  
 10~~4~~6 Begin purge @ OA12-01B  
 1042 Sample - Non-preserved VOAs  
 1051 Begin purge @ OA12-01A  
 1140 Sample - Non-preserved VOAs  
 1200 Decontaminate all equipment, buckets  
 All Decon water + purge water was  
 emptied into 2-49 treatment tank  
 See sampling booklet for all  
 gw parameters + sampling details.  
 Deliver samples to lab  
 1300 K. Addis + M. Holder offsite.  
 1330 K. Addis at INW to return equipment  
 + pick up YSI (Boeing).  
 1400 At office.

~~Kush Z Addis 10/9/09~~





# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	OA12-04A	Date	9/3/09
Sample: ID	GW-090803-OA12-04A-0	Field Team: (Initials)	KA MM
Field Conditions	Sunny, cool, breezy		

## Purge Information

Well Diameter (in.)	2	Purge Method (circle) :	Submersible pump
Well Depth (ft.)	25.06		Bladder Pump
Initial Depth to Water (ft.)	11.38		<u>Peristaltic Pump</u>
Depth of Water Column	13.68	Other: :	
3 Casing Volumes	6.0	Start Time	0925
1 Casing Volume	2.2	End Time	1019
		Total Gallons Purged	1.9

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
0933	0.5	6.95	0.548	mS/cm <sup>2</sup>	10.04	0.72	15.89	25.5	Clear
0938	0.7	6.95	0.536	mS/cm <sup>2</sup>	ERR1	0.73	15.79	25.9	Clear
0939	0.8	6.95	0.528	mS/cm <sup>2</sup>	ERR1	0.29	16.03	26.1	Clear
0942	1.0	6.93	0.528	mS/cm <sup>2</sup>	-	0.32	16.13	26.1	Clear
0945	1.2	6.94	0.528	mS/cm <sup>2</sup>	-	0.30	16.25	25.9	Clear
0954	1.7	6.95	0.533	mS/cm <sup>2</sup>	1.81	0.24	16.43	25.2	Clear
0957	1.8	6.96	0.533	mS/cm <sup>2</sup>	2.30	0.24	16.47	25.3	Clear
1000	1.9	6.97	0.531	mS/cm <sup>2</sup>	2.01	0.23	16.51	25.3	Clear

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	100Z	3x40mL VOA	HCl	
TOC	100Z	1x250mL AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases		3x40mL VOA	—	
Ferrous Iron	—			
Anions	100Z	1x500mL HDPE	—	
Organic Acids	100Z	2x60mL VOA	—	
Dissolved Metals (PP plus Mn)	100Z	1x500mL HDPE	HNO <sub>3</sub>	field filtered
Bio-Dechlor Census Test	100Z	1 filter	—	1 liter

End Time 1019

Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

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Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	PL2-330A	Date	8/3/09
Sample: ID	GM-090803 PL2-330A-0	Field Team: (Initials)	KA MM
Field Conditions	Sunny, cool, breezy		

## Purge Information

Well Diameter (in.)	2	Purge Method (circle) :	Submersible pump
Well Depth (ft.)	17.48		Bladder Pump
Initial Depth to Water (ft.)	11.15		<u>Peristaltic Pump</u>
Depth of Water Column	6.33	Other: :	
3 Casing Volumes	3.0	Start Time	1028
1 Casing Volume	1.0	End Time	1107
		Total Gallons Purged	1.4

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1037	0.5	7.43	0.593	mS/cm <sup>2</sup>	0.62	0.55	16.74	7.4	Clear
1040	0.7	7.39	0.604	mS/cm <sup>2</sup>	1.05	0.47	16.73	9.3	Clear
1043	0.9	7.35	0.610	mS/cm <sup>2</sup>	0.62	0.38	16.72	10.5	clear
1046	1.0	7.32	0.621	mS/cm <sup>2</sup>	0.46	0.33	16.74	11.3	Clear
1049	1.2	7.31	0.629	mS/cm <sup>2</sup>	0.75	0.29	16.80	11.6	Clear
1052	1.4	7.31	0.631	mS/cm <sup>2</sup>	0.75	0.27	16.82	12.1	clear

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1054	3x40mL VDA	HCl	
TOC	1054	1x250mL AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases	1054	3x40mL VDA	—	
Ferrous Iron	1054	1x250mL AG	HCl	
Anions	1054	1x500mL HDPE	—	
Organic Acids				
Dissolved Metals (PP plus Mn)	1054	1x500mL HDPE	HNO <sub>3</sub>	field filtered
Bio-Dechlor Census Test				

End Time 1107

### Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.



# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	PL2-315B	Date	8/13/09
Sample: ID	GW-090803-PL2-315B-047	Field Team: (Initials)	
Field Conditions	Sunny, warm		GW-090803-PL2-315B-1

## Purge Information

Well Diameter (in.)	2
Well Depth (ft.)	49.45
Initial Depth to Water (ft.)	11.13
Depth of Water Column	38.32
3 Casing Volumes	18.3
1 Casing Volume	6.1

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: \_\_\_\_\_

Start Time	1152
End Time	1315
Total Gallons Purged	2.7

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1159	0.5	8.56	1.884	ms/cm <sup>2</sup>	0.14	0.26	16.91	-176.6	Clear
1202	0.7	8.49	2.006	ms/cm <sup>2</sup>	3.24	0.38	16.77	-156.5	Clear
1205	0.9	8.39	2.049	ms/cm <sup>2</sup>	0.38	0.48	16.72	-143.7	Clear
1208	1.1	8.29	2.070	ms/cm <sup>2</sup>	1.56	0.29	16.76	-135.4	Clear
1211	1.3	8.23	2.083	ms/cm <sup>2</sup>	0.88	0.21	16.75	-128.1	Clear
1214	1.5	8.17	2.092	ms/cm <sup>2</sup>	0.88	0.18	16.78	-121.6	Clear
1217	1.7	8.12	2.098	ms/cm <sup>2</sup>	0.78	0.17	16.69	-115.4	Clear
1220	1.9	8.08	2.100	ms/cm <sup>2</sup>	1.30	0.16	16.71	-108.6	Clear
1223	2.1	8.04	2.097	ms/cm <sup>2</sup>	1.82	0.16	16.71	-105.7	Clear
1226	2.3	8.01	2.094	ms/cm <sup>2</sup>	1.45	0.15	16.69	-102.5	Clear

## Sample Information

Sample Method(s) (circle) Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1230	3x40mL VOA	HCl	Dupl.
TOC	1230	1x250mL AG	H <sub>2</sub> SO <sub>4</sub>	Dupl.
Dissolved Gases	1230	3x40mL VOA	—	Dupl.
Ferrous Iron	—	—	—	—
Anions	1230	1x800mL HDPE	—	Dupl.
Organic Acids	1230	2x60mL VOA	—	Dupl.
Dissolved Metals (PP plus Mn)	1230	1x500mL HDPE	HNO <sub>3</sub>	Dupl. field filtered
Bio-Dechlor Census Test	1230	1 filter	—	1 liter - Dupl.

End Time 1315

### Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.





# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	DA12-03A	Date	8/14/09
Sample: ID	GW-090804-OA12-03A-0	Field Team: (Initials)	KA MM
Field Conditions	cloudy, cool, breezy		

## Purge Information

Well Diameter (in.)	4
Well Depth (ft.)	29.88
Initial Depth to Water (ft.)	11.09
Depth of Water Column	13.79
3 Casing Volumes	13.2
1 Casing Volume	4.4

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: \_\_\_\_\_

Start Time 0802

End Time 0835

Total Gallons Purged 1.7

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
0810	0.4	5.48	4.765	mS/cm <sup>2</sup>	12.6	0.28	15.68	43.0	Slightly cloudy
0813	0.6	5.46	4.737	mS/cm <sup>2</sup>	15.2	0.21	15.64	36.5	clearing
0816	0.8	5.44	4.728	mS/cm <sup>2</sup>	18.2	0.20	15.61	32.4	clearing
0819	1.0	5.42	4.725	mS/cm <sup>2</sup>	19.2	0.19	15.59	28.6	clearing
0822	1.2	5.41	4.720	mS/cm <sup>2</sup>	16.4	0.18	15.59	26.0	clearing
0825	1.4	5.40	4.720	mS/cm <sup>2</sup>	17.3	0.18	15.58	23.9	clear
0828	1.6	5.41	4.719	mS/cm <sup>2</sup>	16.0	0.18	15.57	22.3	clear

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	0830	3x40ml VOA	—	
TOC	0830	1x250ml AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases				
Ferrous Iron				
Anions				
Organic Acids				
Dissolved Metals (PP plus Mn)				
Bio-Dechlor Census Test				

End Time 0835

### Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

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Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.





# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	GA-12-01B	Date	8/4/09
Sample: ID	GW-090804-OA12-01B-0	Field Team: (Initials)	KA MM
Field Conditions	cloudy, cool breezy		

## Purge Information

Well Diameter (in.)	4"	Purge Method (circle) :	Submersible pump
Well Depth (ft.)	45.16		Bladder Pump
Initial Depth to Water (ft.)	11.02		<u>Peristaltic Pump</u>
Depth of Water Column	34.14	Other: :	
3 Casing Volumes	32.9	Start Time	1056
1 Casing Volume	10.9	End Time	1132
		Total Gallons Purged	2.0

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1104	0.4	7.37	3.561	mS/cm	9.43	0.19	15.84	-136.0	Root Beer, clearing
1107	0.6	7.40	3.557	mS/cm	9.47	0.16	15.82	-133.6	Black - Root beer
1110	0.8	7.44	3.555	mS/cm	9.61	0.15	15.78	-134.7	Black - Root beer
1113	1.0	7.46	3.552	mS/cm	9.30	0.15	15.76	-124.4	Root beer - coffee
1116	1.2	7.47	3.552	mS/cm	9.18	0.15	15.76	-115.3	Coffee, clear
1119	1.4	7.49	3.547	mS/cm	9.20	0.16	15.77	-126.1	Coffee, clear
1122	1.5	7.48	3.548	mS/cm	9.50	0.17	15.81	-120.2	Coffee, clear
1125	1.7	7.48	3.544	mS/cm	9.16	0.16	15.82	-118.4	Coffee, clear

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1127	3-40mL VOA	Non-preserved	
TOC	1127	1-250mL Amber	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases				
Ferrous Iron				
Anions				
Organic Acids				
Dissolved Metals (PP plus Mn)				
Bio-Dechlor Census Test				

End Time 1132

### Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.



# Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number: _____		Turn-around Requested: Standard		Page: 1 of 1				<b>Analytical Resources, Incorporated</b> Analytical Chemists and Consultants 4611 South 134th Place, Suite 100 Tukwila, WA 98168 206-695-6200 206-695-6201 (fax)									
ARI Client Company: <b>Boeing</b>		Phone: _____		Date: 8/3/09								Ice Present? <input checked="" type="checkbox"/>					
Client Contact: <b>Will Ernst</b>				No. of Coolers: 2								Cooler Temps: 5.0, 5.8					
Client Project Name: <b>OA-12 IM Performance Sampling</b>																	
Client Project #: <b>EPI # 17511.2 OA-12</b>		Samplers: <b>K. Addis, M. Mogg</b>		Analysis Requested								Notes/Comments					
Sample ID	Date	Time	Matrix	Number of Containers	VOCs EPA 8260	TOC EPA 415.1	MEE RSK-175	Ferrous Iron 3500-FED	PPM Metals (dissolved)** +Fe, Mn, V	(Br, NO <sub>3</sub> , & SO <sub>4</sub> )	Anions EPA 300.0	organic acids (by MI)	VFA	bacterial census (by MI)	qDHC		
GW-090803-OA12-05B-0	8/3/09	0828	GW	4	X	X											
GW-090803-OA12-05B-1		0828		4	X	X											
GW-090803-OA12-04B-0		0902		12	X	X	X		X	X	X	X	X				
GW-090803-OA12-04A-0		1002		12	X	X	X		X	X	X	X	X				
GW-090803-PL2-330A-0		1054		10	X	X	X	X	X	X							
GW-090803-PL2-330B-0		1126		10	X	X	X	X	X	X							
GW-090803-PL2-315B-0		1230		12	X	X	X		X	X	X	X	X				
GW-090803-PL2-315B-1		1230		12	X	X	X		X	X	X	X	X				
GW-090803-PL2-315A-0	↓	1341	↓	12	X	X	X		X	X	X	X	X				
Trip Blank	-	-	-	2	X												
Comments/Special Instructions <b>More VFA &amp; CENSUS sample to follow.</b>		Relinquished by: (Signature) <i>Kristin Addis</i>		Received by: (Signature) <i>A. Volgardsen</i>		Relinquished by: (Signature)		Received by: (Signature)									
		Printed Name: <b>Kristin Addis</b>		Printed Name: <b>A. Volgardsen</b>		Printed Name:		Printed Name:									
		Company: <b>EPI</b>		Company: <b>ARI</b>		Company:		Company:									
		Date & Time: <b>8/3/09 1445</b>		Date & Time: <b>8/3/09 1445</b>		Date & Time:		Date & Time:									

**Limits of Liability:** ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, notwithstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

**Sample Retention Policy:** Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

hair Cus y R d & ora An is F est

ARI Assigned Number:	Turn-around Requested: Standard	Page: 1 of 1
ARI Client Company: <b>Boeing</b>	Phone:	Date: 8/4/09
Client Contact: <b>Will Ernst</b>		Ice Present?
		No. of Coolers:
		Cooler Temps:



**Analytical Resources, Incorporated**  
 Analytical Chemists and Consultants  
 4611 South 134th Place, Suite 100  
 Tukwila, WA 98168  
 206-695-6200 206-695-6201 (fax)

Client Project Name: <b>OA-12 IM Performance Sampling</b>					Analysis Requested								Notes/Comments	
Client Project #:		Samplers:			EPA 8260B/C VOCs 50	EPA 415.1 TOC	MSK-175 MEE	Ferroous Iron 3500-FED	PPM Metals (dissolved)** +Fe, Mn, V	(Br, NO <sub>3</sub> , & SO <sub>4</sub> ) EPA 300.0 Anions	organic acids (by MI) VFA	bacterial census (by MI)	qDHC	
EPI #	175112	OA12												
Sample ID	Date	Time	Matrix	Number of Containers										
GW-090804-OA12-03B-0	8/4/09	0755	GW	4	X	X								
GW-090804-OA12-03A-0		0830		4	X	X								
GW-090804-OA12-02B-0		0903		13	X	X	X	X	X	X	X	X		
GW-090804-OA12-02A-0		1001		40	X	X	X	X	X	X	X	X	MS/MSD <sup>1</sup>	
GW-090804-OA12-03B-0		1127		4	X	X								
GW-090804-OA12-01A-0	↓	1205	↓	4	X	X								
Trip Blank	-	-	-	2	X									
Comments/Special Instructions ① Used 40mL VOA's for VFA samples.					Relinquished by: (Signature) <i>Kristin L. Addis</i>			Received by: (Signature) <i>G. Peterson</i>			Relinquished by: (Signature)			Received by: (Signature)
					Printed Name: <i>Kristin L. Addis</i>			Printed Name: <i>G. Peterson</i>			Printed Name:			Printed Name:
					Company: <i>EPI</i>			Company: <i>ARI</i>			Company:			Company:
					Date & Time: 8/4/09 1310			Date & Time: 8/4/09 1310			Date & Time:			Date & Time:

**Limits of Liability:** ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, notwithstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

**Sample Retention Policy:** Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

-05B

# OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station	OA-12-05B	Date	10/7/09
Sample ID	GW-091007-OA12-05B-0	Field Team: (Initials)	KA, MA
Field Conditions	Partly cloudy, Breezy ~60°F		

## Purge Information

Well Diameter (In.)	2.11
Well Depth (ft.)	45.36
Initial Depth to Water (ft.)	11.64
Depth of Water Column	33.72
3 Casing Volumes	16.2
1 Casing Volume	5.4

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: :

Start Time	1229
End Time	1306
Total Gallons Purged	2.6

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1243	1.5	6.29	80.7	ms/cm	7.97	1.84	16.5	-33	clear
1246	1.7	6.31	81.2	ms/cm	7.89	1.44	16.5	-36	clear
1249	1.9	6.31	82.1	ms/cm	7.69	1.29	16.5	-39	clear
1252	2.1	6.31	82.0	ms/cm	6.97	1.19	16.5	-40	clear
1255	2.3	6.31	81.4	ms/cm	6.82	1.10	16.4	-41	clear
1258	2.6	6.31	81.4	ms/cm	6.94	1.09	16.4	-42	clear

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1300	3 40mL VOA	HCl	
TOC	1300	1-250mL AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases				MnH
Ferrous Iron				MnH
Anions				MnH
Organic Acids				MnH
Dissolved Metals (PP plus Mn)				MnH
Bio-Dechlor Census Test				MnH

End Time 1306

## Comments / Exceptions:

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

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Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.



04A

**OA-12 IM Groundwater Sampling Field Data**

Boeing Plant 2, Seattle/Tukwila, Washington

Station: OA-12-04A Date: 10/7/09  
 Sample ID: GW-091007-OA12-04A-0 Field Team: (Initials) KA, MH  
 Field Conditions: Partly Sunny, Windy \* GW-091007-OA12-04A-1

**Purge Information**

Well Diameter (in.): 2"  
 Well Depth (ft.): 25.06  
 Initial Depth to Water (ft.): 11.74  
 Depth of Water Column: 13.32  
 3 Casing Volumes: 6.3  
 1 Casing Volume: 2.1

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: :

Start Time: 1409  
 End Time: 1517  
 Total Gallons Purged: 4.0

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1415	0.5	6.31	56.1	mS/m	8.52	1.63	17.0	74	clear
1418	0.7	6.24	56.4	mS/m	8.43	1.41	17.0	77	clear
1421	0.9	6.21	55.9	mS/m	8.39	1.29	17.0	77	clear
1424	1.1	6.21	56.5	mS/m	7.57	1.22	17.0	76	clear
1427	1.3	6.22	57.1	mS/m	7.32	1.16	17.0	71	clear
1430	1.5	6.24	57.4	mS/m	7.81	1.15	17.0	70	clear
1433	1.7	6.27	57.1	mS/m	7.43	1.11	17.0	65	clear

**Sample Information**

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1435	3-40mL VOAs	HCl	Duplicate
TOC	1435	1-250mL AG	H <sub>2</sub> SO <sub>4</sub>	Duplicate
Dissolved Gases	1435	3-40mL VOAs	HCl	Duplicate
Ferrous Iron	—		—	
Anions	1435	1-500mL HDPE	NA	Duplicate
Organic Acids	1435	2-40mL VOA	NA	Duplicate
Dissolved Metals (PP plus Mn)	1435	1-500mL HDPE	HNO <sub>3</sub>	Duplicate
Bio-Dechlor Census Test	1435	1-filter	NA	Duplicate 1 Liter filtered

End Time: 1517

**Comments / Exceptions:**

Presence of floating product? YES / NO Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

330A

OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

⊙ PL2-330A  
GW-091007-PL2-330A-C  
SUNNY

Date: 10/7/09  
Field Team: (Initials) KA+MH

Purge Information

Well Diameter (in.) 2"  
Well Depth (ft.) 17.48  
Initial Depth to Water (ft.) 11.48'  
Depth of Water Column 6  
3 Casing Volumes 2.88  
1 Casing Volume 0.96

Purge Method (circle) : Submersible pump  
Bladder Pump  
Peristaltic Pump  
Other: :

Start Time 1526  
End Time 1645  
Total Gallons Purged 4.5

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1532	1.2	6.34	68.7	ms/m	4.04	2.49	17.2	144	clear
1537	1.8	6.33	68.3		5.17	2.04	17.2	138	"
1541	2.0	6.33	67.5		3.91	1.81	17.1	134	"
1544	2.3	6.33	67.0		4.05	1.61	17.2	130	"
1548	3.0	6.33	66.8		4.37	1.49	17.2	127	"
⊙1554	3.5	6.34	66.3		4.47	1.35	17.2	123	"
1557	4.0	6.34	66.6		4.50	1.29	17.2	121	"
1600	4.3	6.33	66.6	↓	4.33	1.25	17.2	120	"

Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1404	3-40ml VOAs	HCl	
TOC	1404	1-250ml AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases	1404	3-40ml VOAs	HCl	
Ferrous Iron	1404	1-250ml AG	HCl	
Anions	1404	1-500 HDPE	-	
Organic Acids	MNH			
Dissolved Metals (PP plus Mn)	1404	1-500ml HDPE	HNO <sub>3</sub>	Field filtered
Bio-Dechlor. Census Test	MNH			

End Time 1645

Comments / Exceptions:

Presence of floating product? YES (NO) Presence of sinking product? YES (NO)

Time: 1404 should be 1604

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.



315B

OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

PL2-315B  
GW-041008-PL2-315B-0  
sunny cold

Date  
Field Team: (Initials)

10/8/09  
KAO MH

Purge Information

Well Diameter (in.)  
Well Depth (ft.)  
Initial Depth to Water (ft.)  
Depth of Water Column  
3 Casing Volumes  
1 Casing Volume

2"  
49.45  
12.50'  
36.95  
17.9  
5.9

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: :

Start Time 0835

End Time 1000

Total Gallons Purged 4.2

maybe a sulfur-like smell

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
0902	0.8	6.56	0.190	mS/m	5.59	0.77	15.9	-154	clear
0905	1.3	6.47	0.215		6.28	0.63	15.9	-183	"
0908	1.5	6.45	0.231		5.48	0.59	15.9	-194	"
0911	1.8	6.43	0.238		5.84	0.56	16.0	-208	"
0914	2.1	6.42	0.242		5.95	0.53	16.0	-213	"
0917	2.4	6.41	0.249		5.25	0.52	16.0	-214	"
0922	2.8	6.41	0.255		5.98	0.49	16.0	-215	"
0925	3.2	6.42	0.256	↓	6.22	0.47	16.0	-222	"
									smells like a sweet wet dog

Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	0928	3-40mL VOA	HCl	
TOC	0928	1-250mL HDPE	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases	0928	3-40mL VOA	HCl	
<del>Ferrous Iron</del>				<del>MnH</del>
Anions	0928	1-500mL HDPE	—	
Organic Acids	0928	2-40mL VOA	—	
Dissolved Metals (PP plus Mn)	0928	1-500mL HDPE	HNO <sub>3</sub> filtered	
Bio-Dechlor Census Test	0928	1 filter	—	1 Liter Filtered

End Time 1000

Comments / Exceptions:

Presence of floating product? YES / NO Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

315A

OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

PL2-315A  
GW-091008-PL2-315A-0  
Sunny

Date 10/8/09  
Field Team: (Initials) KA MH

Purge Information

Well Diameter (in.)  
Well Depth (ft.)  
Initial Depth to Water (ft.)  
Depth of Water Column  
3 Casing Volumes  
1 Casing Volume

2.4  
17.96  
11.30  
6.66  
3.3  
1.1

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: \_\_\_\_\_

Start Time 1005

End Time 1057

Total Gallons Purged 2.0

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1010	0.5	6.26	91.1	mS/m	6.56	1.35	17.5	15	clear, colorless
1013	0.6	6.21	89.8	mS/m	7.18	1.20	17.5	23	clear, colorless
1016	0.8	6.20	89.5	mS/m	6.52	1.14	17.4	26	clear, colorless
1019	1.0	6.17	88.7	mS/m	6.35	1.01	17.4	31	clear, colorless
1022	1.2	6.16	88.7	mS/m	8.51	0.99	17.5	33	clear, colorless
1025	1.4	6.15	87.9	mS/m	6.82	0.95	17.5	36	clear, colorless
1028	1.6	6.16	87.9	mS/m	6.11	0.92	17.5	36	clear, colorless

Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1030	3-40mL VOA	HCl	
TOC	1030	1-250mL AG	H <sub>2</sub> SO <sub>4</sub>	
Dissolved Gases	1030	3-40mL VOA	HCl	
Ferrous Iron	—	—	—	
Anions	1030	1-500mL HDPE	—	
Organic Acids	1030	2-40mL VOA	—	
Dissolved Metals (PP plus Mn)	1030	1-500mL HDPE	HNO <sub>3</sub> / filtered	
Bio-Dechlor Census Test	1030	1 filter	—	1 Liter filtered

End Time 1057

Comments / Exceptions:

Presence of floating product? YES / (NO) Presence of sinking product? YES / (NO)

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

# 02B OA-12 IM Groundwater Sampling Field Data

Boeing Plant 2, Seattle/Tukwila, Washington

Station: OA-12-02B Date: 10/8/09  
 Sample ID: GW-091008-OA12-02B-02 Field Team: (Initials) KA MH  
 Field Conditions: Sunny GW-091008-OA12-02B-1

## Purge Information

Well Diameter (in.): 4.11  
 Well Depth (ft.): 45.07  
 Initial Depth to Water (ft.): 11.2 11.34'  
 Depth of Water Column: 33.73  
 3 Casing Volumes: 16.269.7  
 1 Casing Volume: 5.421.9

Purge Method (circle): Submersible pump

Bladder Pump

Peristaltic Pump

Other: \_\_\_\_\_

Start Time: 1100  
 End Time: 1300  
 Total Gallons Purged: 3.8

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1107	0.6	6.75	0.453	S/m	48.3	1.10	16.7	-199	Slightly gray, cloudy
1122	2.0	6.78	0.504	S/m	48.1	0.82	16.5	-205	Moderate odor, cloudy
1125	2.3	6.78	0.510	S/m	50.5	0.82	16.4	-207	odor, gray, cloudy
1128	2.6	6.79	0.513	S/m	51.2	0.82	16.4	-208	odor, sl. gray, cloudy
1131	2.8	6.79	0.517	S/m	50.0	0.81	16.5	-208	odor, sl. gray, cloudy
1134	3.0	6.79	0.518	S/m	48.9	0.82	16.5	-209	odor, sl. gray, cloudy
1137	3.2	6.79	0.532	S/m	47.6	0.83	16.6	-209	odor, sl. gray, cloudy
1140	3.5	6.79	0.531	S/m	48.4	0.84	16.6	-209	odor, sl. gray, cloudy
1143	3.8	6.78	0.531	S/m	48.2	0.85	16.6	-207	odor, sl. gray, cloudy

## Sample Information

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1145	3-40 mL VOA	Non-preserved	Duplicate
TOC	1145	1-250 mL AG	H <sub>2</sub> SO <sub>4</sub>	Duplicate
Dissolved Gases	1145	3-40 mL VOA	Non-preserved	Duplicate
Ferrous Iron	1145	1-250 mL AG	HCl	Duplicate
Anions	1145	1-500 mL HDPE	-	Duplicate
Organic Acids	1145	2-40 mL VOA	-	Duplicate
Dissolved Metals (PP plus Mn)	1145	1-500 mL HDPE	Non-Preserved / Non-filtered / HNO <sub>3</sub> / Filtered	Duplicate - Non-preserved / Non-filtered
Bio-Dechlor Census Test	1145	2 Filters		Duplicate / Filter filtered 25 ml each

End Time: 1300

## Comments / Exceptions:

Presence of floating product? YES / NO Presence of sinking product? YES / NO  
Moderate odor

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

Duplicate same bottles as above

02A

**OA-12 IM Groundwater Sampling Field Data**

Boeing Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

OA-12-02A  
GW-091008-OA12-02A-0  
and GW-091008-OA12-02A-4

Date: 10/8/09  
Field Team: (Initials) KA MH

**Purge Information**

Well Diameter (in.) 4"  
Well Depth (ft.) 25.06'  
Initial Depth to Water (ft.) 11.24'  
Depth of Water Column 13.82'  
3 Casing Volumes (KA) 6.46 26.95  
1 Casing Volume 2.2 8.98

Purge Method (circle) : Submersible pump

Bladder Pump  
Peristaltic Pump  
Other: :

Start Time 1310  
End Time 1427  
Total Gallons Purged 3.1

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1317	1.0	6.80	0.453	S/m	20.3	2.78	16.6	-186	Gray, cloudy, odor
1320	1.3	6.80	0.452	S/m	30.6	1.37	16.6	-196	Gray, clearing, odor
1323	1.6	6.80	0.449	S/m	57.7	1.19	16.6	-200	Gray, clearing, odor
1326	1.9	6.81	0.451	S/m	27.0	1.08	16.7	-203	Gray, clear, odor
1329	2.2	6.83	0.453	S/m	26.8	0.97	16.8	-206	Gray, clear, odor
1332	2.5	6.83	0.453	S/m	26.8	0.92	16.8	-206	Gray, clear, odor
1335	2.8	6.83	0.450	S/m	27.7	0.90	16.7	-207	Gray, clear, odor
1338	3.1	6.83	0.450	S/m	27.0	0.88	16.7	-207	Gray, clear, odor

**Sample Information**

Sample Method(s) (circle) Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1340	3-40 mL VOA	Non-preserved	MS/MSD
TOC	1340	1-250 mL AG	H <sub>2</sub> SO <sub>4</sub>	MS/MSD
Dissolved Gases	1340	3-40 mL VOA	Non-preserved	MS/MSD
Ferrous Iron	1340	1-250 mL AG	HCl	MS/MSD
Anions	1340	1-500 mL HDPE	—	MS/MSD
Organic Acids	1340	2-40 mL VOA	Non-preserved	MS/MSD
Dissolved Metals (PP plus Mn)	1340	1-500 mL HDPE	not preserved not filtered	MS/MSD
Bio-Dechlor Census Test	1340	2 Filters	—	NO MS/MSD 90ml filtered each

End Time 1427

Comments / Exceptions:  
Presence of floating product? YES (NO) Presence of sinking product? YES (NO)

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

03A

**OA-12 IM Groundwater Sampling Field Data**

Bosong Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

OA-12-03A  
GU-091009-OA12-03A-0  
cool clear

Date: 10/9/09  
Field Team: (Initials) KA & MH

**Purge Information**

Well Diameter (in.) 4.11  
Well Depth (ft.) 24.88  
Initial Depth to Water (ft.) 11.38  
Depth of Water Column 13.5  
3 Casing Volumes ICA 6.48 26.3  
1 Casing Volume ICA 2.16 8.8

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: .

Start Time 0829  
End Time 0835  
Total Gallons Purged 2.8

smelly!!  
Appearance

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
0838	0.8	4.53	0.473		21.2	1.77	15.4	80	clear
0842	1.2	4.58	0.469		18.6	1.30	15.8	68	"
0846	1.5	4.60	0.468		24.4	1.15	15.8	63	"
0850	1.8	4.60	0.467		24.1	1.08	15.8	59	"
0853	2.2	4.60	0.467		17.1	1.02	15.9	57	"
0857	2.5	4.60	0.467		17.1	0.97	15.9	55	"
0900	2.8	4.60	0.467		18.2	0.93	15.9	53	"

**Sample Information**

Sample Method(s) (circle): Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	0905	3-40ml VOCs	unpreserved	
TOC	0905	1-250ml AG	H <sub>2</sub> SO <sub>4</sub>	
<del>Dissolved Gases</del>				
<del>Ferrous Iron</del>				
<del>Anions</del>				
<del>Organic Acids</del>				
<del>Dissolved Metals (PP plus Mn)</del>				
<del>Bio-Dechlor Census Test</del>				

End Time 0835

**Comments / Exceptions:**

Presence of floating product? YES / NO Presence of sinking product? YES / NO  
Strong odor, Sour fruit juice smell

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

0825 10/9/09  
calibrate Horiba  
pH 4.00  
Cond 0.452 S/m  
DO 10.35 mg/L  
Temp 12.7°C  
ORP 284

calibrate LaMotte  
0.00  
9.00 for 10.0 std





OIA

**OA-12 IM Groundwater Sampling Field Data**

Boeing Plant 2, Seattle/Tukwila, Washington

Station  
Sample: ID  
Field Conditions

OA-12-OIA  
GW-091009-OA12-OIA-0  
Sunny (KA) Partly Cloudy

Date: 10/9/09  
Field Team: (Initials) KA MT

**Purge Information**

Well Diameter (in.)  
Well Depth (ft.)  
Initial Depth to Water (ft.)  
Depth of Water Column  
3 Casing Volumes  
1 Casing Volume

4"  
25.10  
11.44  
13.66  
6.6 26.6  
2.2 8.88

Purge Method (circle) : Submersible pump

Bladder Pump

Peristaltic Pump

Other: \_\_\_\_\_

Start Time: 1051  
End Time: 1145  
Total Gallons Purged: 4.5

Time	Gallons	pH	Cond	Units	NTU	DO	Temp.	ORP	Appearance
1101	1.0	6.47	0.142	S/m	16.7	0.84	15.6	-84	brown, clear
1104	1.3	6.43	0.140	S/m	17.3	0.77	15.7	-88	brown, clear
1107	1.6	6.43	0.139	S/m	17.9	0.64	15.9	-96	brown, clear
1110	1.9	6.43	0.138	S/m	17.9	0.60	15.8	-99	brown, clear
1113	2.2	6.44	0.146	S/m	20.1	0.59	15.8	-102	brown, clear
1116	2.5	6.46	0.140	S/m	20.7	0.54	16.1	-105	brown, clear
1119	2.8	6.47	0.139	S/m	22.6	0.49	16.3	-109	brown, clear
1122	3.1	6.50	0.140	S/m	23.5	0.46	16.2	-112	brown, clear
1125	3.3	6.51	0.140	S/m	23.7	0.44	16.1	-114	brown, clear
1128	3.5	6.52	0.140	S/m	25.5	0.41	16.1	-116	brown, clear
1131	3.8	6.52	0.140	S/m	25.2	0.37	16.3	-118	brown, clear
1134	4.1	6.51	0.140	S/m	25.0	0.34	16.4	-118	brown, clear
1137	4.4	6.52	0.140	S/m	25.1	0.31	16.4	-120	brown, clear

**Sample Information**

Sample Method(s) (circle) Peristaltic pump / Submersible pump / Bladder Pump / Other

Analysis	Time	Bottle Type	Preservative/Filtration	Comments
VOCs	1140	3-40 mL VOA	None	
TOC	1140	1-250 mL AG	H <sub>2</sub> SO <sub>4</sub>	
<del>Dissolved Gases</del>				
<del>Ferrous Iron</del>				
<del>Anions</del>				
<del>Organic Acids</del>				
<del>Dissolved Metals (PP plus Mn)</del>				
<del>Bio-Dechlor Census Test</del>				

End Time: 1145

**Comments / Exceptions:**

Presence of floating product? YES / NO      Presence of sinking product? YES / NO

Notes: Where multiple visits are required to complete sampling, parameters are to be checked prior to sampling for each visit. Enter data under field comments.

# Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around Requested: Standard	Page:   of
ARI Client Company: <b>Boeing</b>	Phone:	Date: 10/7/09
Client Contact: <b>Will Ernst</b>		Ice Present?
		No. of Coolers:
		Cooler Temps:



**Analytical Resources, Incorporated**  
 Analytical Chemists and Consultants  
 4611 South 134th Place, Suite 100  
 Tukwila, WA 98168  
 206-695-6200 206-695-6201 (fax)

Client Project Name: <b>OA-12 IM Performance Sampling</b>					Analysis Requested								Notes/Comments			
Client Project #: 17511.2 OA-12		Samplers: K. Addis, M. Holder			VOCs EPA 8260C	TOC EPA 415.1	MEE RSK-175	Ferrous Iron 3500-FED	PPM Metals (dissolved)** +Fe, Mn, V	(Br, NO <sub>3</sub> , & SO <sub>4</sub> )	Anions EPA 300.0	organic acids (by MM)	VFA	bacterial census (by MM)	qDHC	** dissolved metals are field filtered
Sample ID	Date	Time	Matrix	Number of Containers												
GW-091007-0A12-05B-0	10/7/09	1300	GW	4	X	X										
GW-091007-0A12-04B-0		1340		12	X	X	X	X	X	X	X	X	X			
GW-091007-0A12-04A-0		1435		12	X	X	X	X	X	X	X	X	X			
GW-091007-0A12-04A-1		1435		12	X	X	X	X	X	X	X	X	X			
GW-091007-02-330A-0		1404	↓	10	X	X	X	X	X	X						
Trip Blank		-	-	2												
Comments/Special Instructions More VFA + qDHC samples to follow on 10/8/09					Relinquished by: (Signature) <i>Kristin L. Addis</i>	Received by: (Signature) <i>J. Peterson</i>				Relinquished by: (Signature)	Received by: (Signature)					
					Printed Name: Kristin L. Addis	Printed Name: J. Peterson				Printed Name:	Printed Name:					
					Company: EPI	Company: ARI				Company:	Company:					
					Date & Time: 10/7/09 1650	Date & Time: 10/7/09 1650				Date & Time:	Date & Time:					

**Limits of Liability:** ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the Invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, notwithstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

**Sample Retention Policy:** Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

# Chain of Custody Record & Laboratory Analysis Request

ARI Assigned Number:	Turn-around Requested: Standard	Page: 1 of 1
ARI Client Company: <b>Boeing</b>	Phone:	Date: 10/8/2009
Client Contact: <b>Will Ernst</b>		Ice Present? <input checked="" type="checkbox"/>
		No. of Coolers: 3
		Cooler Temps: 09.81



**Analytical Resources, Incorporated**  
 Analytical Chemists and Consultants  
 4611 South 134th Place, Suite 100  
 Tukwila, WA 98168  
 206-695-6200 206-695-6201 (fax)

Client Project Name: <b>OA-12 IM Performance Sampling</b>					Analysis Requested								Notes/Comments
Client Project #: 17511.2		Samplers: K. Addis/M. Holder			VOCs EPA 8260C	TOC EPA 415.1	MEE RSK-175	Ferrous Iron 3500-FED	PPM Metals (dissolved) ** +Fe, Mn, V	Anions EPA 300.0 (Br, NO <sub>3</sub> , & SO <sub>4</sub> )	organic acids (VFA)	qDHC bacterial census (by MI)	** dissolved metals are field filtered
Sample ID	Date	Time	Matrix	Number of Containers									
GW-091008-PL2-330B-0	10/8/09	0835	water	10	X	X	X	X	X	X			
GW-091008-PL2-315B-0	10/8/09	0928	water	12	X	X	X	X	X	X	X		
GW-091008-PL2-315A-0		1030		12	X	X	X	X	X	X	X		
GW-091008-OA12-02B-0		1145		14	X	X	X	X	X	X	X		metals not filtered & no preservative
GW-091008-OA12-02B-1		1145		14	X	X	X	X	X	X	X		
GW-091008-OA12-02A-0		1340		14	X	X	X	X	X	X	X		VOCs/MEE no preservative
GW-091008-OA12-02A-4	✓	1340	✓	28	X	X	X	X	X	X	X		
Trip Blank	10/8/09	-	-	2	X								
Comments/Special Instructions					Relinquished by: (Signature) Kristin L. Addis	Received by: (Signature) A. Volgardsen			Relinquished by: (Signature)	Received by: (Signature)			
					Printed Name: Kristin L. Addis	Printed Name: A. Volgardsen			Printed Name:	Printed Name:			
					Company: EPF	Company: ARI			Company:	Company:			
					Date & Time: 10/8/09 1503	Date & Time: 10/8/09 1503			Date & Time:	Date & Time:			

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**Sample Retention Policy:** Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

Chain of Custody, Record & Laboratory Analysis Request

7<sup>th</sup> QUARTER (3/3)

ARI Assigned Number: **PS15**  
 Turn-around Requested: **Standard**  
 ARI Client Company: **Boeing** Phone:  
 Client Contact: **Will Ernst**

Page: **1** of **1**  
 Date: **10/9/09**  
 Ice Present:   
 No. of Coolers:  Cables:  Lamps:



**Analytical Resources, Incorporated**  
 Analytical Chemists and Consultants  
 4611 South 134th Place, Suite 100  
 Tukwila, WA 98168  
 206-695-6200 206-695-6201 (fax)

Client Project Name: **OA-12 IM Performance Sampling**  
 Client Project #: **17511.2 OA-12**  
 Samplers: **K. Addis, M. Holder**

Analysis Requested										Notes/Comments
EPA 8260C VOCS	EPA 415.1 TOC	MEE RSK-175	Ferrous Iron 3500-FED	PPM Metals (dissolved)** +Fe, Mn, V	EPA 300.0 (Br, NO <sub>3</sub> , & SO <sub>4</sub> )	Anions EPA 300.0 (by MI)	VFA organic acids (by MI)	qDHC bacterial census (by MI)		** dissolved metals are field filtered  ⊗ = Non-preserved VOAS
⊗	X									
⊗	X									
⊗	X									
⊗	X									
X										

Comments/Special Instructions	Relinquished by: (Signature) <i>Kristin Z. Addis</i>	Received by: (Signature) <i>A. Volgardsen</i>	Relinquished by: (Signature)	Received by: (Signature)
	Printed Name: <b>Kristin Z. Addis</b>	Printed Name: <b>A. Volgardsen</b>	Printed Name:	Printed Name:
	Company: <b>EPT</b>	Company: <b>ARI</b>	Company:	Company:
	Date & Time: <b>10/9/09 1250</b>	Date & Time: <b>10/9/09 1250</b>	Date & Time:	Date & Time:

**Limits of Liability:** ARI will perform all requested services in accordance with appropriate methodology following ARI Standard Operating Procedures and the ARI Quality Assurance Program. This program meets standards for the industry. The total liability of ARI, its officers, agents, employees, or successors, arising out of or in connection with the requested services, shall not exceed the invoiced amount for said services. The acceptance by the client of a proposal for services by ARI release ARI from any liability in excess thereof, not withstanding any provision to the contrary in any contract, purchase order or co-signed agreement between ARI and the Client.

**Sample Retention Policy:** Unless specified by workorder or contract, all water/soil samples submitted to ARI will be discarded or returned, no sooner than 90 days after receipt or 60 days after submission of hardcopy data, whichever is longer. Sediment samples submitted under PSDDA/PSEP/SMS protocol will be stored frozen for up to one year and then discarded.

**ATTACHMENT B**  
**PRIORITY POLLUTANT METALS DATA**

**Table B1. OA-12 ERD IM Performance Monitoring Analytical Results - Metals in Groundwater, 6th Round**

Well	pH	Dissolved Metals (µg/L)												
		Antimony	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
OA12-01A	7.46	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-01B	7.48	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-02A	7.42	100 U	2 U	4 U	10 U	4 U	1 U	0.1 U	20 U	2 U	6 U	0.2 U	6 U	20 U
OA12-02B	6.97	100 U	2 U	4 U	10 U	5	1 U	0.4 U	20 U	2	6 U	0.2 U	53	20 U
OA12-03A	5.41	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-03B	7.16	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PL2-315A	7.41	50 U	1 U	2 U	5 U	12	1 U	0.1 U	10 U	2 U	3 U	0.2 U	18	10 U
PL2-315B	8.01	50 U	1 U	2 U	5 U	2 U	1 U	0.1 U	10 U	2 U	3 U	0.2 U	4	10 U
PL2-315B (dup)	8.01	50 U	1 U	2 U	5 U	2 U	1 U	0.1 U	10 U	2 U	3 U	0.2 U	4	10 U
PL2-330A	7.31	50 U	1 U	2 U	5 U	10	1 U	0.1 U	10 U	1.0	3 U	0.2 U	27	10 U
PL2-330B	7.58	50 U	1 U	2 U	5 U	4	1 U	0.1 U	10 U	0.9	3 U	0.2 U	4	10 U
OA12-04A	6.97	50 U	1 U	2 U	5 U	6	1 U	0.1 U	10 U	0.9	3 U	0.2 U	21	10 U
OA12-04B	7.06	50 U	1 U	2 U	5 U	2 U	1 U	0.1 U	10 U	2 U	3 U	0.2 U	3 U	10 U
OA12-05B	6.68	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

**Notes:**

dup = duplicate sample

NS = not sampled

U = non-detect, result below indicated detection limit

µg/L = micrograms per liter

**Table B2. OA-12 ERD IM Performance Monitoring Analytical Results - Metals in Groundwater, 7th Round**

Well	pH	Dissolved Metals (µg/L)												
		Antimony	Beryllium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
OA12-01A	6.52	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-01B	6.73	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-02A	6.83	50 U	1 U	2 U	8	3	1 U	0.1 U	10 U	2 U	3 U	0.2 U	3 U	10 U
OA12-02B	6.78	50 U	1 U	2 U	10	2 U	1 U	0.1 U	10 U	4	3 U	0.2 U	26	10 U
OA12-02B (dup)	6.78	50 U	1 U	2 U	9	2 U	1 U	0.1 U	10 U	5	3 U	0.2 U	25	10 U
OA12-03A	4.60	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OA12-03B	6.99	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PL2-315A	6.16	50 U	1 U	2 U	7	14	1 U	0.1 U	10 U	1.9	3 U	0.2 U	21	10 U
PL2-315B	6.42	50 U	1 U	2 U	7	2 U	1 U	0.1 U	10 U	1.1	3 U	0.2 U	5	10 U
PL2-330A	6.33	50 U	1 U	2 U	5 U	11	1 U	0.1 U	10 U	2 U	3 U	0.2 U	54	10 U
PL2-330B	6.80	50 U	1 U	2 U	5	2 U	1 U	0.1 U	10 U	1.7	3 U	0.2 U	3 U	10 U
OA12-04A	6.27	50 U	1 U	2 U	5 U	5	1 U	0.1 U	10 U	0.9	3 U	0.2 U	25	10 U
OA12-04A (dup)	6.27	50 U	1 U	2 U	5 U	5	1 U	0.1 U	10 U	1.0	3 U	0.2 U	25	10 U
OA12-04B	6.60	50 U	1 U	2 U	5 U	2 U	1 U	0.1 U	10 U	2 U	3 U	0.2 U	3 U	10 U
OA12-05B	6.31	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

**Notes:**

dup = duplicate sample

NS = not sampled

U = non-detect, result below indicated detection limit

µg/L = micrograms per liter

**ATTACHMENT C**  
**GROUNDWATER VOC ANALYTICAL DATA – ALL DETECTIONS**

**Table C1. OA-12 ERD IM Performance Monitoring Analytical Results - VOC (all detections, µg/L) in Groundwater, 6th Round (8/2009)**

Constituent	Analytical Method	2004 Screening Level	Laboratory Reporting Limit	OA12-01A 8/4/2009	OA12-01B 8/4/2009	OA12-02A 8/4/2009	OA12-02B 8/4/2009	OA12-03A 8/4/2009	OA12-03B 8/4/2009	PL2-315A 8/3/2009	PL2-315B 8/3/2009
<b>Volatile Organic Compounds (VOCs)</b>											
Toluene	EPA 8260B	NA	0.2	<1.0	0.6	0.3	<1.0	4.0	<1.0	<0.2	<0.2
Ethylbenzene	EPA 8260B	2,100	0.2	1.9	1.3	0.9	<1.0	1.0	<1.0	<0.2	<0.2
Vinyl chloride	EPA 8260B	0.731	0.2	<1.0	<0.6	2.9	<1.0	<0.6	<1.0	0.6	0.9
Methylene chloride	EPA 8260B	NA	0.5	<2.5	<1.5	<0.5	<2.5	<1.5	<2.5	<0.5	<0.5
Acetone	EPA 8260B	NA	2.5	49	83	770	830	120 M	410	<5.0	67
Carbon disulfide	EPA 8260B	34,300	0.2	<1.0	<0.6	<0.2	1.0	0.6	<1.0	<0.2	<0.2
trans-1,2-Dichloroethene	EPA 8260B	NA	0.2	<1.0	<0.6	0.2 M	<1.0	<0.6	<1.0	0.4	<0.2
cis-1,2-Dichloroethene	EPA 8260B	1,550	0.2	29	1.0	15	1.2	3.7	<1.0	9.4	0.3
2-Butanone	EPA 8260B	NA	2.5	<25	190	680	2,200	720	1,800	<5.0	200
Trichloroethene	EPA 8260B	0.302	0.2	<1.0	<0.6	<0.2	<1.0	4.7	<1.0	7.6	<0.2
Tetrachloroethene	EPA 8260B	0.822	0.2	<1.0	<0.6	<0.2	<1.0	<0.6	<1.0	2.2	<0.2
Styrene	EPA 8260B	NA	0.2	<1.0	<0.6	<0.2	<1.0	12	<1.0	<0.2	<0.2

Constituent	Analytical Method	2004 Screening Level	Laboratory Reporting Limit	PL2-315B (dup) 8/3/2009	PL2-330A 8/3/2009	PL2-330B 8/3/2009	OA12-04A 8/3/2009	OA12-04B 8/3/2009	OA12-05B 8/3/2009	OA12-05B (dup) 8/3/2009
<b>Volatile Organic Compounds (VOCs)</b>										
Toluene	EPA 8260B	NA	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	EPA 8260B	2,100	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vinyl chloride	EPA 8260B	0.731	0.2	0.8	<0.2	<0.2	<0.2	0.4	0.5	0.5
Methylene chloride	EPA 8260B	NA	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acetone	EPA 8260B	NA	2.5	70	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon disulfide	EPA 8260B	34,300	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
trans-1,2-Dichloroethene	EPA 8260B	NA	0.2	<0.2	0.8	<0.2	0.6	0.5	0.4	0.4
cis-1,2-Dichloroethene	EPA 8260B	1,550	0.2	0.4	12	0.6	9.8	15	18	18
2-Butanone	EPA 8260B	NA	2.5	210	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethene	EPA 8260B	0.302	0.2	<0.2	12	<0.2	11	<0.2	<0.2	<0.2
Tetrachloroethene	EPA 8260B	0.822	0.2	<0.2	3.2	<0.2	1.6	<0.2	<0.2	<0.2
Styrene	EPA 8260B	NA	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

**Notes:**

< = not detected at the listed reporting limit

µg/L= micrograms per liter

NA = not applicable

**Table C2. OA-12 ERD IM Performance Monitoring Analytical Results - VOCs (all detections, µg/L) in Groundwater, 7th Round (10/2009)**

Constituent	Analytical Method	2004 Screening Level	Laboratory Reporting Limit	OA12-01A 10/9/2009	OA12-01B 10/9/2009	OA12-02A 10/8/2009	OA12-02B 10/8/2009	OA12-02B (dup) 10/8/2009	OA12-03A 10/9/2009	OA12-03B 10/9/2009	PL2-315A 10/8/2009
<b>Volatile Organic Compounds (VOCs)</b>											
Benzene	EPA 8260B	4.48	0.2	<2.0	<0.6	<0.2	<0.2	<0.2	<0.2	<2.0	<0.2
Toluene	EPA 8260B	NA	0.2	<2.0	0.6	0.3	0.2	0.2	3.2	<2.0	<0.2
Ethylbenzene	EPA 8260B	2,100	0.2	2	1.0	1.0	0.5	0.5	0.9	<2.0	<0.2
Vinyl chloride	EPA 8260B	0.731	0.2	<2.0	<0.6	6.0	<0.2	<0.2	0.2	<2.0	0.7
Methylene chloride	EPA 8260B	NA	0.5	<5.0	<1.5	<0.5	<0.5	<0.5	<0.5	<5.0	1.4
Acetone	EPA 8260B	NA	2.5	<50	75	1,200	730	760	160	<50	<5.0
Carbon disulfide	EPA 8260B	34,300	0.2	<2.0	<0.6	<0.2	0.7	0.6	0.4	<2.0	<0.2
trans-1,2-Dichloroethene	EPA 8260B	NA	0.2	<2.0	<0.6	<0.2	<0.2	<0.2	<0.2	<2.0	0.5
cis-1,2-Dichloroethene	EPA 8260B	1,550	0.2	22	0.9	5.8	1.0	1.0	3.9	<2.0	12
2-Butanone	EPA 8260B	NA	2.5	<50	150	910	2,100	2,200	650	62	<5.0
Trichloroethene	EPA 8260B	0.302	0.2	<2.0	<0.6	<0.2	<0.2	<0.2	4.1	<2.0	10
Tetrachloroethene	EPA 8260B	0.822	0.2	<2.0	<0.6	<0.2	<0.2	<0.2	<0.2	<2.0	2.7
Styrene	EPA 8260B	NA	0.2	<2.0	<0.6	<0.2	<0.2	<0.2	8.5	<2.0	<0.2

Constituent	Analytical Method	2004 Screening Level	Laboratory Reporting Limit	PL2-315B 10/8/2009	PL2-330A 10/7/2009	PL2-330B 10/8/2009	OA12-04A 10/7/2009	OA12-04A (dup) 10/7/2009	OA12-04B 10/7/2009	OA12-05B 10/7/2009
<b>Volatile Organic Compounds (VOCs)</b>										
Benzene	EPA 8260B	4.48	0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2
Toluene	EPA 8260B	NA	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Ethylbenzene	EPA 8260B	2,100	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Vinyl chloride	EPA 8260B	0.731	0.2	1.6	<0.2	2.6	0.2	0.2	0.6	0.5
Methylene chloride	EPA 8260B	NA	0.5	1.6	0.8	1.4	1.0	1.0	0.9	1.1
Acetone	EPA 8260B	NA	2.5	120	6.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon disulfide	EPA 8260B	34,300	0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
trans-1,2-Dichloroethene	EPA 8260B	NA	0.2	<0.2	0.7	<0.2	0.6	0.6	0.5	0.4
cis-1,2-Dichloroethene	EPA 8260B	1,550	0.2	0.8	13	1.5	8.5	9.2	17	21
2-Butanone	EPA 8260B	NA	2.5	490	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Trichloroethene	EPA 8260B	0.302	0.2	<0.2	15	<0.2	13	13	<0.2	<0.2
Tetrachloroethene	EPA 8260B	0.822	0.2	<0.2	3.4	<0.2	2.0	2.0	<0.2	<0.2
Styrene	EPA 8260B	NA	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

**Notes:**

< = not detected at the listed reporting limit

µg/L= micrograms per liter

NA = not applicable

**ATTACHMENT D**  
**DATA VALIDATION REPORTS**



## TECHNICAL MEMORANDUM

**Date:** 10/16/2009

**Project No.:** 013-1646-009.300.06

**To:** Will Ernst

**Company:** The Boeing Company

**From:** Jill Lamberts, Staff Environmental Scientist  
Kent Angelos, Principal and Project Director

**cc:** Doug Kunkel, Jeff Dengler, EPI

**Email:** jill\_lamberts@golder.com

**RE: BOEING PLANT 2 – INTERIM MEASURE GROUNDWATER PERFORMANCE MONITORING FOR OTHER AREA 12 (OA 12) PLUME 2-60S AREA DATA VALIDATION QA/QC REVIEW**

### 1.0 INTRODUCTION

A total of 17 water samples (including 2 field duplicates and 2 trip blanks) were collected August 3 and 4, 2009 as part of the Boeing Plant 2 Groundwater Interim Measures Work Plan for Other Area 12 (OA 12) (November, 2007). Samples were analyzed by Analytical Resources Incorporated (ARI) of Tukwila, Washington and Microbial Insights of Rockford, Tennessee for the following parameters:

- Volatile Organic Compounds (VOCs) by EPA Method 8260C
- Total Organic Carbon (TOC) by EPA 415.1
- Dissolved Gases (Methane, Ethane, and Ethene – MEE) by Modified RSK 175
- Dissolved Metals (Priority Pollutant Metals - Silver, Arsenic, Beryllium, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Antimony, Selenium, Thallium, and Zinc. Additional metals – Iron, Vanadium, and Manganese) by EPA Methods 200.8, 6010B, and 7470A
- Ferrous Iron by SM 3500 FeD
- Anions (Bromide, N-Nitrate, and Sulfate) by EPA 300.0
- Organic Volatile Fatty Acids (VFAs) (Pyruvic, Lactic, Formic, Acetic, Propionic, and Butyric Acids) by ion chromatography by Microbial Insights
- Bio-Dechlor Bacterial Census by qDHC (RT-PCR) – dehalococcoides by Microbial Insights

With the exception of the metabolic acids analysis, samples were analyzed in accordance with procedures described in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW-846, 3rd edition) 8260C, 6010B, metals, EPA Method 200.8, Revision 5.5; Determination of Trace Elements in Water and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Standard Methods for the Examination of Water and Wastewater (20th Edition). Methods SM3500 Fe-D, RSK 175, 415.1 and 300.0.*

The bacterial and metabolic acids analyses were analyzed in accordance with the *Microbial Insights Standard Operating Procedures*.

### 2.0 SAMPLE DELIVERY GROUPS, SAMPLES AND ANALYSES

Samples were analyzed and results reported by the laboratory in batch numbers as summarized below:

**PI98, 006GH (VOCs, TOC, MEE, Ferrous Iron, Anions, VFAs, Dissolved Metals, and Bacterial Census):**

GW-090803-OA12-05B-0

GW-090803-OA12-04A-0

GW-090803-PL2-315B-0

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GW-090803-OA12-05B-1	GW-090803-PL2-330A-0	GW-090803-PL2-315B-1
GW-090803-OA12-04B-0	GW-090803-PL2-330B-0	GW-090803-PL2-315A-0
Trip Blank		

**PJ05, 031GF (VOCs, TOC, MEE, Ferrous Iron, Anions, VFAs, Dissolved Metals, and Bacterial Census):**

GW-090804-OA12-03B-0	GW-090804-OA12-02B-0	GW-090804-OA12-01B-0
GW-090804-OA12-03A-0	GW-090804-OA12-02A-0	GW-090804-OA12-01A-0
Trip Blank		

Quality assurance/quality control (QA/QC) reviews of laboratory data were performed in the laboratory in accordance with the laboratory quality assurance program plan. The data validation QA/QC review focused primarily on laboratory result summary sheets and quality control summary sheets to ensure that work plan data quality objectives were met for the project.

Data validation was conducted in accordance with the criteria outlined in the National Functional Guidelines for Organic Data Review (EPA 1999) and the National Functional Guidelines for Inorganic Data Review (EPA, 2004), modified to include method specific requirements of the laboratory analytical methods. Raw data sheets were reviewed as necessary to confirm conditions reported and to support application of qualifiers to analytical results.

The validation level for the data is Level 1, as described in the QAPP (EPI, 2008). The following is a summary of quality control elements associated with each analytical fraction and the status of that element as a result of the data validation process.

### 3.0 SAMPLING, DOCUMENTATION AND REPORTING

Sample acknowledgements, chain-of-custody, request forms and data package completeness were evaluated with the following noted:

- SDG PI98 and PJ05: Formic Acid results reported as "NA". Unable to determine if it means < RL or if it was not analyzed. Microbial Insights was contacted. The response on 10/6/2009 determined that Formic Acid was not analyzed as it is not part of the lactate breakdown process and is not required. It was analyzed inadvertently in earlier sampling efforts and will not be run for future events. No further action.
- SDGs PI98: Cooler receipt form indicates that the VOC vials for sample GW-090803-PL2-3135A-0 had one large bubble in one of the vials. No action was required since the samples were all analyzed within 7 days and the other two vials were ok.
- SDG PJ05: ARI sample receiving noted that there were small to large bubbles in 7 of 8 VOA vials for GW-090804-OA12-02B-0. No action was taken other than to note since the samples were analyzed in < 7days.
- Results for volatile organic compound 1, 1, 2-trichloro-1, 2, 2-trifluoroethane are reported in a truncated format (1, 1, 2-trichloro-1, 2, 2-trifluoro) due to ARI report format. No action was taken.

### 4.0 VOLATILE ORGANIC COMPOUNDS

Level 1 summary data packages were provided for the VOC analysis. The items reviewed during validation are summarized below.

#### 4.1 Analytical Methods – *acceptable*

Samples for VOC analysis were analyzed by gas chromatography/mass spectrometry (GC/MS) using EPA SW846 Method 8260C. The QAPP lists the method for VOCs as 8260B. ARI recently updated their methods due to a NELAP audit and a memo dated 6/1/2009 was sent to Boeing, EPI, and Golder Project Managers informing them of the change.

## 4.2 Sample Holding Times and Preservations – *acceptable*

All samples were prepared and analyzed within 14 days of sample collection (preserved water samples) or within 7 days of sample collection (unpreserved water samples) with the following exceptions:

- SDG PI98: ARI sample receiving noted that there was a large bubble in one of the three HCl VOA vials for GW-090803-PL2-315A-0. No action was taken other than to note since the other two vials were ok and the samples were analyzed in < 7days.
- SDG PJ05: ARI sample receiving noted that there were small to large bubbles in 7 of 8 VOA vials for GW-090804-OA12-02B-0. No action was taken other than to note since the samples were analyzed in < 7days.
- SDG PJ05: The Chain of Custody indicated that all samples for VOCs were submitted unpreserved. No action was required since all samples were analyzed within 7 days.

## 4.3 Laboratory Reporting Limits

The laboratory achieved the reporting limits (RLs) required by the approved quality assurance project plan (EPI, 2007) with the following exceptions:

- Quality assurance project plan (QAPP) reporting limits were not met for nine compounds. A review of current ARI detection limits shows that both method and reporting limits were recently updated (as of 6/1/2009). Compounds that do not meet QAPP stipulated reporting levels (RLs) are identified in the following table:

**TABLE 1**  
**OA12 Reporting Limits**

Compound	QAPP Table 5 RLs (µg/L)	Lab Reported RLs (µg/L)
Chloromethane	0.2	0.5
Bromomethane	0.2	0.5
Methylene Chloride	0.3	0.5
Acetone	3	5.0
2-Butanone	1.0	5.0
Vinyl Acetate	0.5	1.0
2-Chloroethylvinylether	0.5	1.0
4-Methyl-2-Pentanone	1.0	5.0
2-Hexanone	1.0	5.0

- No action was taken; this change in the RLs was sent by ARI to Boeing, EPI, and Golder Project Managers on June 1, 2009 and subsequently approved and implemented as part of the June 2009 QAPP compendium (Golder, 2009).
- Trichloroethene is listed twice in QAPP Table 5. No action was taken.
- The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds.

## 4.4 Instrument Calibration

Calibration review is not required under the QAPP; however, the lab provided information on the calibration performance in the case narratives. All of the calibration criteria were met with the following exceptions:

- SDG PI98: The case narrative listed that the CCAL from 8/6/2009 was out of control low for Bromomethane. The lab qualifies detects as “Q” (%D > 20%). All results for Bromomethane from 8/6/09 were qualified as estimated (J/UJ) due to possible low bias.
- SDG PJ05: The case narrative listed that the CCAL from 8/8/2009 was out of control low for Bromomethane. The lab qualifies detects as “Q” (%D > 20%). All results for Bromomethane from 8/8/09 were qualified as estimated (J/UJ) due to possible low bias.

#### 4.5 Blank Contamination – *acceptable*

The method blanks and trip blanks were free of contamination with the following exceptions:

- SDG PI98: The Trip Blank contained Methylene Chloride above the RL. No action was required since all other associated samples had no detections for Methylene Chloride.

#### 4.6 Surrogate Recovery – *acceptable*

All surrogate recoveries were within control limits.

#### 4.7 Matrix Spike Compound Recovery

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) analysis was performed on GW-090804-OA12-02A-0 in SDG PJ05. In SDGs where MS/MSD data are not available refer to LCS/LCSD and field duplicate data for precision and accuracy information. All MS/MSD recoveries and relative percent differences (RPDs) were acceptable with the following exceptions:

- SDG PI98: MS/MSD analysis was not performed in this SDG. Please refer to LCS/LCSD and field duplicate data for precision and accuracy information.
- SDG PJ05: The MS and MSD percent recoveries were out of control low for acetone. The parent sample (GW-090804-OA12-02A-0) was qualified as estimated (J) due to a possible low bias from matrix effects.
- SDG PJ05: The MS percent recovery was out of control high for styrene. No action was taken since the MSD and LCS/LCSD recoveries were in control and styrene was not detected in the parent sample.

Refer to Laboratory Control Sample data and field duplicate data for additional precision and accuracy information.

#### 4.8 Laboratory Control Sample Recovery

Laboratory control samples (LCS) were evaluated using control limits listed in Table 4 of the QAPP (EPI, 2008) and recently updated CLs on the ARI website. All LCS/LCSD recoveries and relative percent differences (RPDs) were acceptable with the following exceptions:

- SDG PI98: The case narrative noted that the LCS % recoveries for the 8/6/09 analysis were out of control low for Bromomethane. The LCSD % recovery was in control. All associated samples for the 8/6/09 analysis were qualified as estimated (UJ/J) for Bromomethane due to a low bias and associated poor ccal performance.

#### 4.9 Field Duplicate Sample Analysis

Field duplicate samples were collected and analyzed as follows:

**TABLE 2**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PI98	GW-090803-PL2-315B-0	GW-090803-PL2-315B-1
PI98	GW-090803-OA12-05B-0	GW-090803-OA12-05B-1

Field duplicate analysis criteria were met.

## 5.0 METHANE, ETHANE, AND ETHENE (MEE)

The laboratory provided summary forms for compounds methane, ethane, and ethene. The items reviewed during validation are summarized below.

### 5.1 Analytical Methods – *acceptable*

Samples for MEE parameters were analyzed using EPA Method RSK-175 (Modified).

### 5.2 Sample Holding Times – *acceptable*

All samples were prepared and analyzed within the recommended holding times 14 days from collection to analysis. Please note that the QAPP stipulates that the hold time for MEE is 7 days. The lab was contacted to verify the hold time 5/11/2009. The lab responded that the QAPP was incorrect and the true hold time is 14 days. No action required other than to note.

### 5.3 Laboratory Reporting Limits – *acceptable*

The laboratory achieved the reporting limits (RLs) required by the QA Plan with the following exception:

- Table 5 of the QAPP stipulates a reporting level of 1.0 µg/L for methane, ethane, and ethene. The ARI reporting level for methane was 0.7 µg/L, 1.2 µg/L for ethane, and 1.1 µg/L for ethene. EPI's project manager was contacted and approved the slightly higher limits [personal comm. J. Dengler]. No further action was taken other than to note this.

### 5.4 Blank Contamination – *acceptable*

The method and equipment blanks were free of target compounds.

### 5.5 Surrogate Recovery – *acceptable*

All surrogate recoveries were within control limits.

### 5.6 Matrix Spike Compound Recovery – *acceptable*

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) analysis was performed on GW-090804-OA12-02A-0 in SDG PJ05. In SDGs where MS/MSD data are not available refer to LCS/LCSD and field duplicate data for precision and accuracy information. All MS/MSD recoveries and relative percent differences (RPDs) were acceptable with the following exceptions:

- SDG PI98: MS/MSD analysis was not performed in this SDG. Please refer to LCS/LCSD and field duplicate data for precision and accuracy information.
- SDG PJ05: The MS/MSD recoveries were out of control low for methane. No action was taken since the spike amount was less than 4 times the sample result.

## 5.7 Laboratory Control Sample Recovery – *acceptable*

Laboratory control samples (LCS) were evaluated and were within the control limits listed in the QAPP (EPI, 2008).

## 5.8 Field Duplicate Sample Analysis – *acceptable*

Field duplicate samples were collected and analyzed as follows:

**TABLE 3**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PI98	GW-090803-PL2-315B-0	GW-090803-PL2-315B-1

Field duplicate analysis criteria were met.

## 6.0 INORGANICS – DISSOLVED METALS

The laboratory provided a provided a summary data package for review of metals analyses and the items reviewed during validation are summarized below.

### 6.1 Analytical Methods – *acceptable*

Samples for dissolved metals analysis were prepared using EPA Methods 3010A and 7000 Series. Metals analysis was completed by EPA Methods 6010B and 200.8, and mercury by EPA Method 7470A. No sampling, documentation, and reporting discrepancies were noted.

### 6.2 Sample Holding Times and Preservation – *acceptable*

All samples were prepared and analyzed within the recommended holding period from the date of collection; 180 days for metals and 28 days for mercury. All holding time criteria were met but the following observations were noted:

- SDG PJ05: Samples GW-090804-OA12-02A-0 and GW-090804-OA12-02B-0 were submitted with a preservation greater than a pH of 2. The lab preserved the samples upon receipt. No further action was required.

### 6.3 Laboratory Reporting Limits

All metals listed in the Phase II Sampling Plan (2005) QAPP were analyzed for and requested reporting levels were met with the following exceptions:

**TABLE 4**  
**Laboratory Reporting Limit Differences**

Compound	QAPP Table C-1B RLS (µg/L)	Lab Reported RLS (µg/L)
Arsenic	0.5	0.2
Copper	0.5	2
Nickel	0.5	10
Selenium	50	0.5
Silver	0.5	3
Zinc	6	10

The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds. No action was taken.

No action was taken for the discrepancies listed above as the RL increases have been documented in the June 2009 QAPP Compendium (Golder, 2009)

#### 6.4 Blank Contamination – *acceptable*

The method blanks were free of target compounds.

#### 6.5 Laboratory Control Sample Recovery

LCS recoveries were within QC limits of 80 to 120 percent with the following exceptions:

- PI98: The LCS percent recovery was out of control high for mercury. All sample results were qualified as estimated (UJ/J).

#### 6.6 Matrix Spike/Matrix Spike Duplicate Analysis – *acceptable*

Matrix Spike (MS) analysis was performed on GW-090803-OA12-04B-0 in SDG PI98 and on GW-090804-OA12-02A-0 in SDG PJ05. In SDGs where MS data are not available refer to LCS, matrix duplicate, and field duplicate data for precision and accuracy information. All MS recoveries were acceptable with the following comments:

- SDG PJ05: The MS recoveries were out of control low for lead. No action was taken since the spike amount was less than 4 times the sample result.

#### 6.7 Duplicate Analysis – *acceptable*

Laboratory duplicate analysis was performed on the same selected samples as for the MS analysis listed in the previous section. Duplicate analysis criteria were met with the following comments:

- SDG PJ05: The duplicate RPD was out of control high for silver. No action was required because the sample results were < 5X the RL.

#### 6.8 Field Duplicate Sample Analysis

Field duplicate samples were collected and analyzed as follows:

**TABLE 5**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PI98	GW-090803-PL2-315B-0	GW-090803-PL2-315B-1

Field duplicate analysis criteria were met.

### 7.0 GENERAL CHEMISTRY - TOTAL ORGANIC CARBON, FERROUS IRON, ANIONS, VOLATILE FATTY ACIDS, AND BACTERIAL CENSUS

The laboratory (ARI) provided a Level I data package for analysis TOC, ferrous iron, and anions; the items reviewed during validation are summarized below. Microbial Insights provided a Level I data package for analysis of the organic volatile fatty acids (VFAs) and bacterial census.

## 7.1 Analytical Methods and Reporting – *acceptable*

The anions (Bromide, N-Nitrate, and Sulfate) were analyzed using EPA method 300.0. Total Organic Carbon was analyzed by EPA Method 415.1. Ferrous Iron was analyzed by Standard Method 3500 FeD. Organic Volatile Fatty Acids (VFAs) (Pyruvic, Lactic, Acetic, Propionic, and Butyric) were analyzed by ion chromatography at Microbial Insights. The Bio-Dechlor Bacterial Census was analyzed by qDHC (RT-PCR) – dehalococcoides by Microbial Insights. All methods and reporting requirements were met with the following observations:

- All SDGs: Formic Acid results were reported as “NA”. Microbial Insights was contacted to determine if “NA” meant “not detected” or “not available”. An email response dated October 6, 2009 from Poonam Sheth stated the following “Formic acid was not analyzed. The formic acid is not part of the lactate breakdown products and should not have been included originally in the VFA suite. Hence we no longer run this analyte.” No further action was taken other than to note.

## 7.2 Sample Holding Times and Preservation

All samples were prepared and analyzed within the recommended holding period from the date of collection to analysis. Sample preservations met the QAPP requirements with the following exceptions:

- SDG PI98: Preservations failed for TOC for a few samples upon receipt. The lab documented adjusting the pH to the correct level during the receiving process.
- SDG PI98: The holding time of 48 hours was exceeded for the qDHC analysis based on the reported data sheets. Upon further review of the electronic data package, it was determined that the samples were extracted within the 48 hour hold time. No action was required.
- SDGs PI98 and PJ05: The holding time of 7 days was exceeded for the VFA analysis. All samples were qualified as estimated (J/UJ).

## 7.3 Laboratory Reporting Limits – *acceptable*

The laboratory achieved the reporting limits (RLs) required by the approved QAPP (EPI, 2007) with the following comments:

- The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds. No action was taken.
- SDGs PI98 and PJ05: RLs for Lactic and Pyruvic Acid were elevated at 25 and 10 mg/L, respectively instead of the 1 mg/L listed in the QAPP. No action was taken other than to note as the purpose of this analysis is qualitative rather than quantitative and results are examined how they change over time.

## 7.4 Blank Contamination – *acceptable*

The calibration blanks and/or method blanks were free of target compounds.

## 7.5 Laboratory Control Spike and/or Standard Reference Material Recovery – *acceptable*

A standard reference material (SRM) sample was analyzed for bromide, N-nitrate, sulfate and total organic carbon for each analytical batch. All SRM recoveries were acceptable.

An LCS was analyzed for Ferrous Iron and the recoveries were in control.

No LCS or SRMs were analyzed for VFAs and qDHC. No action was taken other than to note.

## 7.6 Matrix Spike/Matrix Spike Duplicate Analysis

Matrix Spike (MS) analysis was performed on GW-090803-OA12-05B-0 for TOC, on GW-090803-PL2-330A-0 for Ferrous Iron, and on GW-090803-PI2-330B-0 for bromide, N-nitrate, and sulfate in SDG PI98 and on GW-090804-OA12-02A-0 for bromide, N-nitrate, sulfate, TOC, and VFAs in SDG PJ05. In SDGs where MS data are not available refer to LCS, matrix duplicate, and field duplicate data for precision and accuracy information. All MS recoveries were acceptable with the following comments:

- SDG PI98 and PJ05: An MS/MSD was performed on sample GW-090804-OA12-02A-0 for VFA analysis. The spike amount was not reported by the lab, so the lab was contacted and it was determined that the samples had been spiked with 100 mg/L of VFAs. Percent recoveries were calculated (see Table 6) and it was determined that all of the MS/MSD percent recoveries were out of control low or high except for Propionic and Butyric acid. No further action was required since all VFA samples had already been qualified as estimated (J/UJ) due to a holding time exceedance.

**TABLE 6**  
**MS/MSD Percent Recovery Calculations**

Compound	Result (mg/L)	Spike Amount (mg/L)	LCL%	UCL%	MS Result (mg/L)	%Rec	MSD Result (mg/L)	%Rec	%RPD
Pyruvic	<10	100	75	125	9.6	9.6	3.4	3.4	95.4
Lactic	13	100	75	125	30	17.0	25	12.0	34.5
Acetic	2100	100	75	125	870	n/a	920	n/a	4.1
Propionic	69	100	75	125	160	91.0	180	111.0	19.8
Butyric	100	100	75	125	190	90.0	210	110.0	20.0

- SDG PI98: An MS was performed on sample GW-090803-OA12-05B-0 for TOC and the percent recovery was found to be out of control high for TOC. Sample GW-090803-OA12-05B-0 was qualified as estimated (J) due to a possible high bias due to matrix effects. The SRM was in control.

## 7.7 Duplicate Analysis

Laboratory duplicate analysis was performed on the same selected samples as for the MS analysis listed in the previous section. Duplicate analysis criteria were met with the following comments:

- SDG PJ05: The MS/MSD RPD was out of control for pyruvic acid. No action was required because the sample results were < 5X the RL.
- SDG PJ98: The duplicate for Bromide was out of control. All samples were qualified as estimated (J/UJ) for a poor RPD.

## 7.8 Field Duplicate Sample Analysis

Field duplicate samples were collected and analyzed as follows:

**TABLE 7**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PI98	GW-090803-PL2-315B-0	GW-090803-PL2-315B-1
PI98	GW-090803-OA12-05B-0	GW-090803-OA12-05B-1

Field duplicate analysis criteria were met with the following exceptions:

- PI98: The RPD for qDHC for the field duplicate samples GW-090803-PL2-315B-0 and GW-090803-PL2-315B-1 was out of control high at 74% RPD. No action was taken other than to note.

## 8.0 DATA QUALIFIERS

Data qualifiers applied by the laboratory have been removed from the data summary report sheets and superseded by data validation qualifiers as follows:

The following qualifiers were used to modify the data quality and usefulness of individual analytical results.

- U – The constituent was analyzed for, but was not detected above the reported sample quantitation limit.
- J – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result is less than the quantitation limit or quality control criteria were not met.
- J+ – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result may be biased high.
- J- – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result may be biased low.
- UJ – The constituent was not detected; the associated quantitation limit is an estimated value because quality control criteria were not met.
- R – Data are rejected due to significant exceedence of quality control criteria. The analyte may or may not be present. Additional sampling and analysis may be required to determine the presence or absence of the constituent. For statistical reasons, rejected values are not included in the database.
- UR – The constituent is rejected at the reported quantitation limit.
- Y – The reporting limit is elevated due to interference. The result is not detected.

## 9.0 DATA ASSESSMENT

Data review and validation was performed by an experienced quality assurance chemist independent of the analytical laboratory and not directly involved in the project. This is to certify that I have examined the analytical data and based on the information provided to me by the laboratory, in my professional judgment, the data are acceptable for use except where indicated by data qualifiers, which may modify the usefulness of those individual values.

  
\_\_\_\_\_  
Jill Lamberts  
Staff Environmental Scientist, Golder

October 16, 2009  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
Kent Angelos

October 21, 2009  
\_\_\_\_\_  
Date

Principal & Project Director, Golder

## 10.0 REFERENCES

EPA 1999, USEPA Contract Laboratory Program, National Functional Guidelines for Organic Data Review, EPA-540/R-99/008, October, 1999.

EPA 2004, USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review, EPA-540-R-02-003, October, 2004

EPI, 2008, Interim Measure Work Plan for 2-66 Sheetpile, Boeing Plant 2, Seattle/Tukwila, Washington, Prepared by Environmental Partners, Inc. (EPI), July 2008.

EPI 2007, Interim Measure Work Plan For Other Area 12 Plume 2-60s Area, Boeing Plant 2, Seattle/Tukwila, Washington, Prepared by Environmental Partners, Inc. (EPI), November 2007.

Golder Associates Inc. (Golder), 2009, Compendium of Sampling and Analysis Plans and Quality Assurance Plans for Boeing Plant 2, Prepared for The Boeing Company by Golder Associates Inc. (Golder) and Environmental Partners, Inc. (EPI), June of 2009.



# TECHNICAL MEMORANDUM

**Date:** 12/15/2009 **Project No.:** 013-1646-009.300.06  
**To:** Will Ernst **Company:** The Boeing Company  
**From:** Kent Angelos, Principal Environmental Scientist  
**cc:** Doug Kunkel, Jeff Dengler, EPI **Email:** kmangelos@golder.com  
**RE: BOEING PLANT 2 – OA12 IM DATA VALIDATION REVIEW, OCT09 SAMPLE EVENT**

## 1.0 INTRODUCTION

A total of 19 water samples (including 2 field duplicates and 2 trip blanks) were collected October 7-9, 2009 as part of the Boeing Plant 2 Groundwater Interim Measures Work Plan for Other Area 12 (OA 12) (November, 2007). Samples were analyzed by Analytical Resources Incorporated (ARI) of Tukwila, Washington, Microbial Insights of Rockford, Tennessee and Microseeps of Pittsburgh, PA for the following parameters:

- Volatile Organic Compounds (VOCs) by EPA Method 8260C
- Total Organic Carbon (TOC) by EPA 415.1
- Dissolved Gases (Methane, Ethane, and Ethene – MEE) by Modified RSK 175
- Dissolved Metals (Priority Pollutant Metals - Silver, Arsenic, Beryllium, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Antimony, Selenium, Thallium, and Zinc. Additional metals – Iron, Vanadium, and Manganese) by EPA Methods 200.8, 6010B, and 7470A
- Ferrous Iron by SM 3500 FeD
- Anions (Bromide, N-Nitrate, and Sulfate) by EPA 300.0
- Organic Volatile Fatty Acids (VFAs) (Pyruvic, Lactic, Formic, Acetic, Propionic, and Butyric Acids) by ion chromatography by Microbial Insights
- Bio-Dechlor Bacterial Census by qDHC (RT-PCR) – dehalococcoides by Microbial Insights

With the exception of the metabolic acids analysis, samples were analyzed in accordance with procedures described in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW-846, 3rd edition) 8260C, 6010B, metals, EPA Method 200.8, Revision 5.5; Determination of Trace Elements in Water and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Standard Methods for the Examination of Water and Wastewater (20th Edition). Methods SM3500 Fe-D, RSK 175, 415.1 and 300.0.*

The bacterial and metabolic acids analyses were analyzed in accordance with the *Microbial Insights Standard Operating Procedures* and *Microseeps Standard Operating Procedures*.

## 2.0 SAMPLE DELIVERY GROUPS, SAMPLES AND ANALYSES

Samples were analyzed and results reported by the laboratory in batch numbers as summarized below:

### SDG: PS01 (VOCs, TOC, MEE, Ferrous Iron, Metals, Anions, VFA, qDHC)

GW-091008-PL2-330B-0	GW-091008-PL2-315B-0	GW-091008-PL2-315A-0
GW-091008-OA12-02B-0	GW-091008- OA12-02B-1	GW-091008-OA12-02A-0

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Golder Associates Inc.  
18300 NE Union Hill Road, Suite 200  
Redmond, WA 98052 USA  
Tel: (425) 883-0777 Fax: (425) 882-5498 www.golder.com

GW-091008-OA12-02A-4	TRIP BLANK	
<b>SDG: PR78/PS02 (VOCs, TOC, MEE, Ferrous Iron, Metals, Anions, VFA, qDHC)</b>		
GW-091007-OA12-05B-0	GW-091007-OA12-04B-0	GW-091007-OA12-04A-0
GW-091007-OA12-04A-1	GW-091007-PL2-330A-0	TRIP BLANK
<b>SDG: PS15 (VOCs, TOC, MEE, Ferrous Iron, Metals, Anions, VFA, qDHC)</b>		
GW-091009-OA12-03A-0	GW-091007-OA12-03B-0	GW-091007-OA12-01B-0
GW-091007-OA12-01A-0	TRIP BLANK	

Quality assurance/quality control (QA/QC) reviews of laboratory data were performed in the laboratory in accordance with the laboratory quality assurance program plan. The data validation QA/QC review focused primarily on laboratory result summary sheets and quality control summary sheets to ensure that work plan data quality objectives were met for the project.

Data validation was conducted in accordance with the criteria outlined in the National Functional Guidelines for Organic Data Review (EPA 1999) and the National Functional Guidelines for Inorganic Data Review (EPA, 2004), modified to include method specific requirements of the laboratory analytical methods. Raw data sheets were reviewed as necessary to confirm conditions reported and to support application of qualifiers to analytical results.

The validation level for the data is Level 1, as described in the QAPP (EPI, 2008). The following is a summary of quality control elements associated with each analytical fraction and the status of that element as a result of the data validation process.

### 3.0 SAMPLING, DOCUMENTATION AND REPORTING

Sample acknowledgements, chain-of-custody, request forms and data package completeness were evaluated with the following noted:

- PS01 – small and pea-sized bubbles in samples from ..315B, 02B and 02A locations, no action taken. Metals preservation for 315B and 02A/B samples was insufficient, pH adjusted in lab, no action taken.

### 4.0 VOLATILE ORGANIC COMPOUNDS

Level 1 summary data packages were provided for the VOC analysis. The items reviewed during validation are summarized below.

#### 4.1 Analytical Methods – *acceptable*

Samples for VOC analysis were analyzed by gas chromatography/mass spectrometry (GC/MS) using EPA SW846 Method 8260C. The QAPP lists the method for VOCs as 8260B. ARI recently updated their methods due to a NELAP audit and a memo dated 6/1/2009 was sent to Boeing, EPI, and Golder Project Managers informing them of the change.

#### 4.2 Sample Holding Times and Preservations – *acceptable*

All samples were prepared and analyzed within 14 days of sample collection (preserved water samples) or within 7 days of sample collection (unpreserved water samples).

#### 4.3 Laboratory Reporting Limits

The laboratory achieved the reporting limits (RLs) required by the approved quality assurance project plan (EPI, 2007) with the following exceptions:

- Quality assurance project plan (QAPP) reporting limits were not met for nine compounds. A review of current ARI detection limits shows that both method and reporting limits were

recently updated (as of 6/1/2009). Compounds that do not meet QAPP stipulated reporting levels (RLs) are identified in the following table:

**TABLE 1**  
**OA12 Reporting Limits**

Compound	QAPP Table 5 RLs (µg/L)	Lab Reported RLs (µg/L)
Chloromethane	0.2	0.5
Bromomethane	0.2	0.5
Methylene Chloride	0.3	0.5
Acetone	3	5.0
2-Butanone	1.0	5.0
Vinyl Acetate	0.5	1.0
2-Chloroethylvinylether	0.5	1.0
4-Methyl-2-Pentanone	1.0	5.0
2-Hexanone	1.0	5.0

- No action was taken; this change in the RLs was sent by ARI to Boeing, EPI, and Golder Project Managers on June 1, 2009 and subsequently approved and implemented as part of the June 2009 QAPP compendium (Golder, 2009).
- Trichloroethene is listed twice in QAPP Table 5. No action was taken.
- The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds.

#### 4.4 Instrument Calibration

Calibration review is not required under the QAPP; however, the lab provided information on the calibration performance in the case narratives. All of the calibration criteria were met.

#### 4.5 Blank Contamination – *acceptable*

The method blanks and trip blanks were free of contamination.

#### 4.6 Surrogate Recovery – *acceptable*

All surrogate recoveries were within control limits.

#### 4.7 Matrix Spike Compound Recovery

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) analysis was performed on ...02A-4 in SDG PS01. In SDGs where MS/MSD data are not available refer to LCS/LCSD and field duplicate data for precision and accuracy information. All MS/MSD recoveries and relative percent differences (RPDs) were acceptable with the following exceptions:

- PS01: Bromomethane, vinyl acetate low MS recovery – no action; MIBK and 2-hexanone high MS/MSD recovery – no action.

Refer to Laboratory Control Sample data and field duplicate data for additional precision and accuracy information.

#### 4.8 Laboratory Control Sample Recovery - *acceptable*

Laboratory control samples (LCS) were evaluated using control limits listed in Table 4 of the QAPP (EPI, 2008) and recently updated CLs on the ARI website. All LCS/LSCD recoveries and relative percent differences (RPDs) were acceptable.

#### 4.9 Field Duplicate Sample Analysis - *acceptable*

Field duplicate samples were collected and analyzed as follows:

**TABLE 2**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PS01	GW-091008-OA12-02B-0	GW-091008- OA12-02B-1
PR78	GW-091007-OA12-04A-0	GW-091007-OA12-04A-1

Field duplicate analysis results were acceptable.

#### 5.0 METHANE, ETHANE, AND ETHENE (MEE)

The laboratory provided summary forms for compounds methane, ethane, and ethene. The items reviewed during validation are summarized below.

##### 5.1 Analytical Methods – *acceptable*

Samples for MEE parameters were analyzed using EPA Method RSK-175 (Modified).

##### 5.2 Sample Holding Times – *acceptable*

All samples were prepared and analyzed within the recommended holding times 14 days from collection to analysis. Please note that the QAPP stipulates that the hold time for MEE is 7 days, which is incorrect the correct holding time requirement for MEE analyses is 14 days.

##### 5.3 Laboratory Reporting Limits – *acceptable*

The laboratory achieved the reporting limits (RLs) required by the QA Plan with the following exception:

- Table 5 of the QAPP stipulates a reporting level of 1.0 µg/L for methane, ethane, and ethene. The ARI reporting level for methane was 0.7 µg/L, 1.2 µg/L for ethane, and 1.1 µg/L for ethane. No further action was taken other than to note this.

##### 5.4 Blank Contamination – *acceptable*

The method and equipment blanks were free of target compounds.

##### 5.5 Surrogate Recovery – *acceptable*

All surrogate recoveries were within control limits.

##### 5.6 Matrix Spike Compound Recovery – *acceptable*

Matrix Spike (MS) and Matrix Spike Duplicate (MSD) analysis was performed on ...02A-4 in SDG PS01. In SDGs where MS/MSD data are not available refer to LCS/LCSD and field duplicate data for precision and accuracy information. All MS/MSD recoveries and relative percent differences (RPDs) were acceptable.

## 5.7 Laboratory Control Sample Recovery – *acceptable*

Laboratory control samples (LCS) were evaluated and were within the control limits listed in the QAPP (EPI, 2008).

## 5.8 Field Duplicate Sample Analysis – *acceptable*

Field duplicate samples were collected and analyzed as follows:

**TABLE 3**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PS01	GW-091008-OA12-02B-0	GW-091008- OA12-02B-1
PR78	GW-091007-OA12-04A-0	GW-091007-OA12-04A-1

Field duplicate analysis criteria were met.

## 6.0 INORGANICS – DISSOLVED METALS

The laboratory provided a provided a summary data package for review of metals analyses and the items reviewed during validation are summarized below.

### 6.1 Analytical Methods – *acceptable*

Samples for dissolved metals analysis were prepared using EPA Methods 3010A and 7000 Series. Metals analysis was completed by EPA Methods 6010B and 200.8, and mercury by EPA Method 7470A. No sampling, documentation, and reporting discrepancies were noted.

### 6.2 Sample Holding Times and Preservation – *acceptable*

All samples were prepared and analyzed within the recommended holding period from the date of collection; 180 days for metals and 28 days for mercury. All holding time and preservation criteria were met but the following observations were noted:

- PS01: metals samples preservation for ..315B, ...02B and ...02A did not pass the pH <2 check upon receipt and were readjusted at the laboratory.

### 6.3 Laboratory Reporting Limits

All metals listed in the Phase II Sampling Plan (2005) QAPP were analyzed for and requested reporting levels were met with the following exceptions:

**TABLE 4**  
**Laboratory Reporting Limit Differences**

Compound	QAPP Table C-1B RLS (µg/L)	Lab Reported RLS (µg/L)
Arsenic	0.5	0.2
Copper	0.5	2
Nickel	0.5	10
Selenium	50	0.5
Silver	0.5	3
Zinc	6	10

The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds. No action was taken.

No action was taken for the discrepancies listed above as the RL increases have been documented in the June 2009 QAPP Compendium (Golder, 2009)

#### 6.4 Blank Contamination – *acceptable*

The method blanks were free of target compounds.

#### 6.5 Laboratory Control Sample Recovery - *acceptable*

LCS recoveries were within QC limits of 80 to 120 percent.

#### 6.6 Matrix Spike/Matrix Spike Duplicate Analysis – *acceptable*

Matrix Spike (MS) analysis was performed on ...02A-4 in SDG PS01. In SDGs where MS data are not available refer to LCS, matrix duplicate, and field duplicate data for precision and accuracy information. All MS recoveries were acceptable.

#### 6.7 Duplicate Analysis – *acceptable*

Laboratory duplicate analysis was performed on the same selected samples as for the MS analysis listed in the previous section. Duplicate analysis criteria were met.

#### 6.8 Field Duplicate Sample Analysis – *acceptable*

Field duplicate samples were collected and analyzed as follows:

**TABLE 5**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PS01	GW-091008-OA12-02B-0	GW-091008- OA12-02B-1
PR78	GW-091007-OA12-04A-0	GW-091007-OA12-04A-1

Field duplicate analysis criteria were met.

### 7.0 GENERAL CHEMISTRY - TOTAL ORGANIC CARBON, FERROUS IRON, ANIONS, VOLATILE FATTY ACIDS, AND BACTERIAL CENSUS

The laboratory (ARI) provided a Level I data package for analysis TOC, ferrous iron, and anions; the items reviewed during validation are summarized below. Microbial Insights provided a Level I data package for analysis of the organic volatile fatty acids (VFAs) and bacterial census.

#### 7.1 Analytical Methods and Reporting – *acceptable*

The anions (Bromide, N-Nitrate, and Sulfate) were analyzed using EPA method 300.0. Total Organic Carbon was analyzed by EPA Method 415.1. Ferrous Iron was analyzed by Standard Method 3500 FeD. Organic Volatile Fatty Acids (VFAs) (Pyruvic, Lactic, Acetic, Propionic, and Butyric) were analyzed by ion chromatography at Microbial Insights. The Bio-Dechlor Bacterial Census was analyzed by qDHC (RT-PCR) – dehalococcoides by Microbial Insights. All methods and reporting requirements were met.

## 7.2 Sample Holding Times and Preservation - *acceptable*

All samples were prepared and analyzed within the recommended holding period from the date of collection to analysis. Sample holding times and preservations met the QAPP requirements.

## 7.3 Laboratory Reporting Limits - *acceptable*

The laboratory achieved the reporting limits (RLs) required by the approved QAPP (EPI, 2007) with the following comments:

- The reporting limits were not met in cases in which the samples were analyzed at dilutions due to high concentrations of target compounds. No action was taken.
- SDG PS02: The RL for Lactic Acid was elevated at 10 mg/L, instead of the 1 mg/L listed in the QAPP. No action was taken other than to note as the purpose of this analysis is qualitative rather than quantitative and results are examined how they change over time.

## 7.4 Blank Contamination – *acceptable*

The calibration blanks and/or method blanks were free of target compounds.

## 7.5 Laboratory Control Spike and/or Standard Reference Material Recovery – *acceptable*

A standard reference material (SRM) sample was analyzed for bromide, N-nitrate, sulfate and total organic carbon for each analytical batch. All SRM recoveries were acceptable.

An LCS was analyzed for Ferrous Iron and the recoveries were in control.

No LCS or SRMs were analyzed for VFAs and qDHC. No action was taken other than to note.

## 7.6 Matrix Spike/Matrix Spike Duplicate Analysis - *acceptable*

Matrix Spike (MS) analysis was performed for anions, TOC and VFA, recoveries were acceptable.

## 7.7 Duplicate Analysis - *acceptable*

Laboratory duplicate analysis was performed for TOC, Ferrous Iron and Anions. Duplicate analysis criteria were met.

## 7.8 Field Duplicate Sample Analysis - *acceptable*

Field duplicate samples were collected and analyzed as follows:

**TABLE 7**  
**Field Duplicates**

Laboratory SDG	Sample	Field Duplicate Sample
PS01	GW-091008-OA12-02B-0	GW-091008- OA12-02B-1
PR78	GW-091007-OA12-04A-0	GW-091007-OA12-04A-1

Field duplicate analysis criteria were met.

## 8.0 DATA QUALIFIERS

Data qualifiers applied by the laboratory have been removed from the data summary report sheets and superseded by data validation qualifiers as follows:

The following qualifiers were used to modify the data quality and usefulness of individual analytical results.

- U – The constituent was analyzed for, but was not detected above the reported sample quantitation limit.
- J – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result is less than the quantitation limit or quality control criteria were not met.
- J+ – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result may be biased high.
- J- – The constituent was positively identified and detected; however, the concentration reported is an estimated value because the result may be biased low.
- UJ – The constituent was not detected; the associated quantitation limit is an estimated value because quality control criteria were not met.
- R – Data are rejected due to significant exceedence of quality control criteria. The analyte may or may not be present. Additional sampling and analysis may be required to determine the presence or absence of the constituent. For statistical reasons, rejected values are not included in the database.
- UR – The constituent is rejected at the reported quantitation limit.
- Y – The reporting limit is elevated due to interference. The result is not detected.

## 9.0 DATA ASSESSMENT

Data review and validation was performed by an experienced quality assurance chemist independent of the analytical laboratory and not directly involved in the project. This is to certify that I have examined the analytical data and based on the information provided to me by the laboratory, in my professional judgment, the data are acceptable for use except where indicated by data qualifiers, which may modify the usefulness of those individual values.



Kent Angelos  
Principal Environmental Scientist

December 15, 2009  
Date

## 10.0 REFERENCES

EPA 1999, USEPA Contract Laboratory Program, National Functional Guidelines for Organic Data Review, EPA-540/R-99/008, October, 1999.

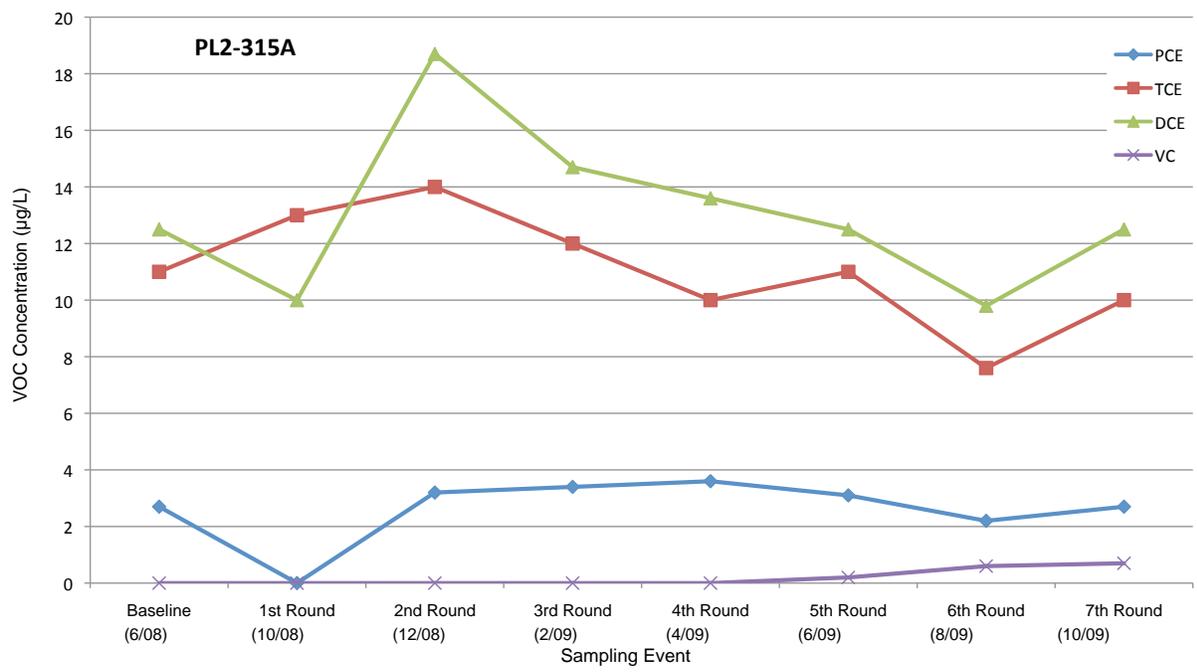
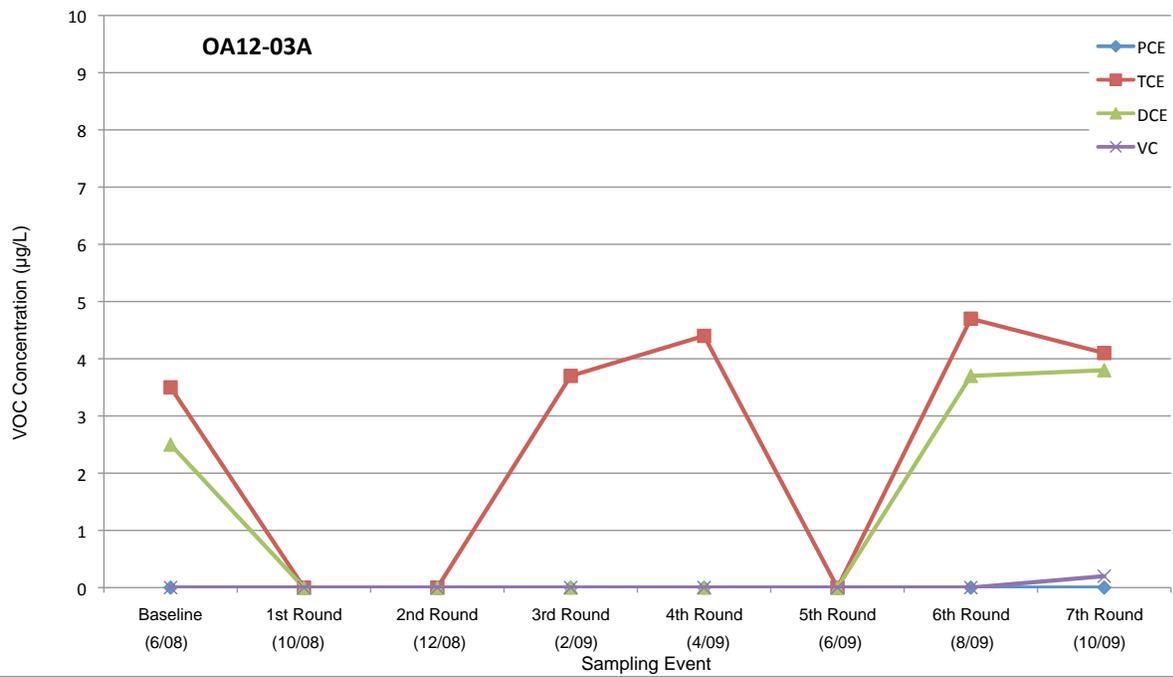
EPA 2004, USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review, EPA-540-R-02-003, October, 2004

EPI, 2008, Interim Measure Work Plan for 2-66 Sheetpile, Boeing Plant 2, Seattle/Tukwila, Washington, Prepared by Environmental Partners, Inc. (EPI), July 2008.

EPI 2007, Interim Measure Work Plan For Other Area 12 Plume 2-60s Area, Boeing Plant 2, Seattle/Tukwila, Washington, Prepared by Environmental Partners, Inc. (EPI), November 2007.

Golder Associates Inc. (Golder), 2009, Compendium of Sampling and Analysis Plans and Quality Assurance Plans for Boeing Plant 2, Prepared for The Boeing Company by Golder Associates Inc. (Golder) and Environmental Partners, Inc. (EPI), June of 2009.

**ATTACHMENT E**  
**VOC TREND PLOTS**



**KEY:**

- ◆— Tetrachloroethene
- Trichloroethene
- ▲— Dichloroethene
- ×— Vinyl chloride

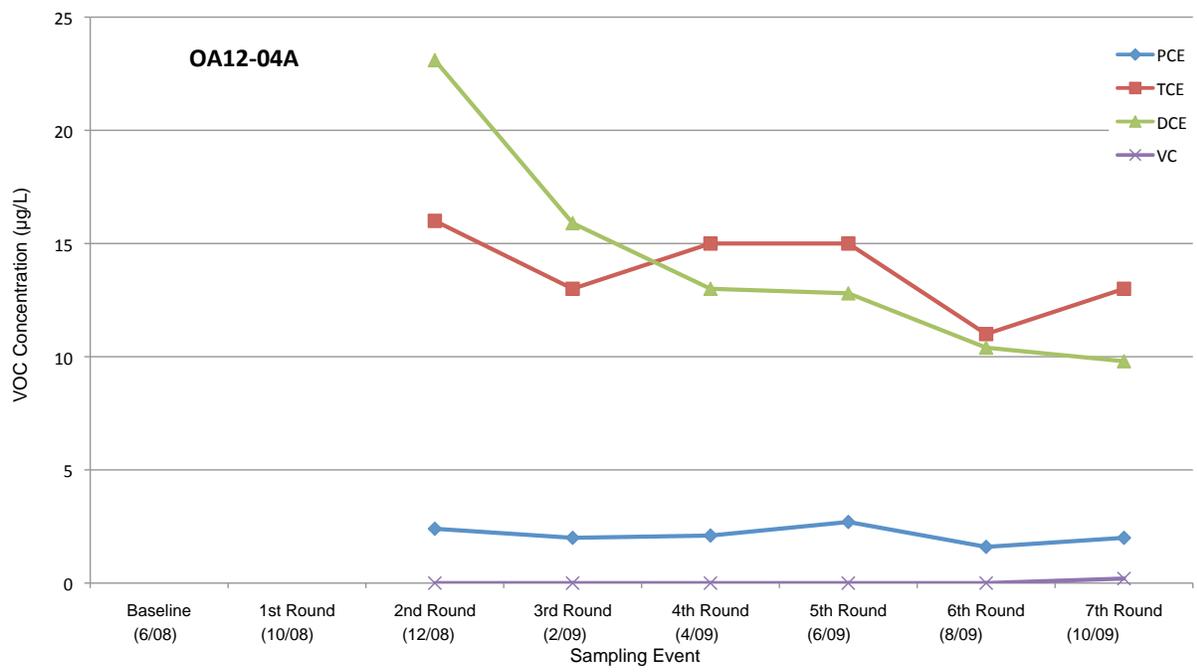
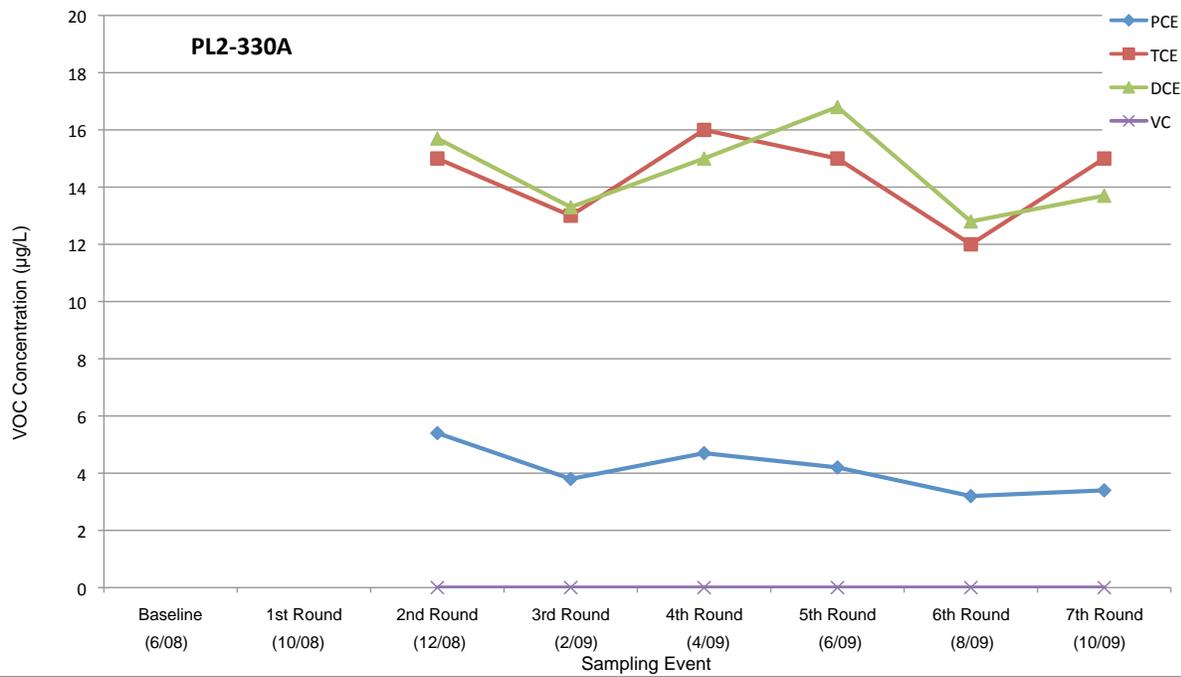
µg/L = micrograms per liter



**FIGURE E1**

VOC TREND PLOTS FOR  
OA12-03A AND PL2-315A

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10



**KEY:**

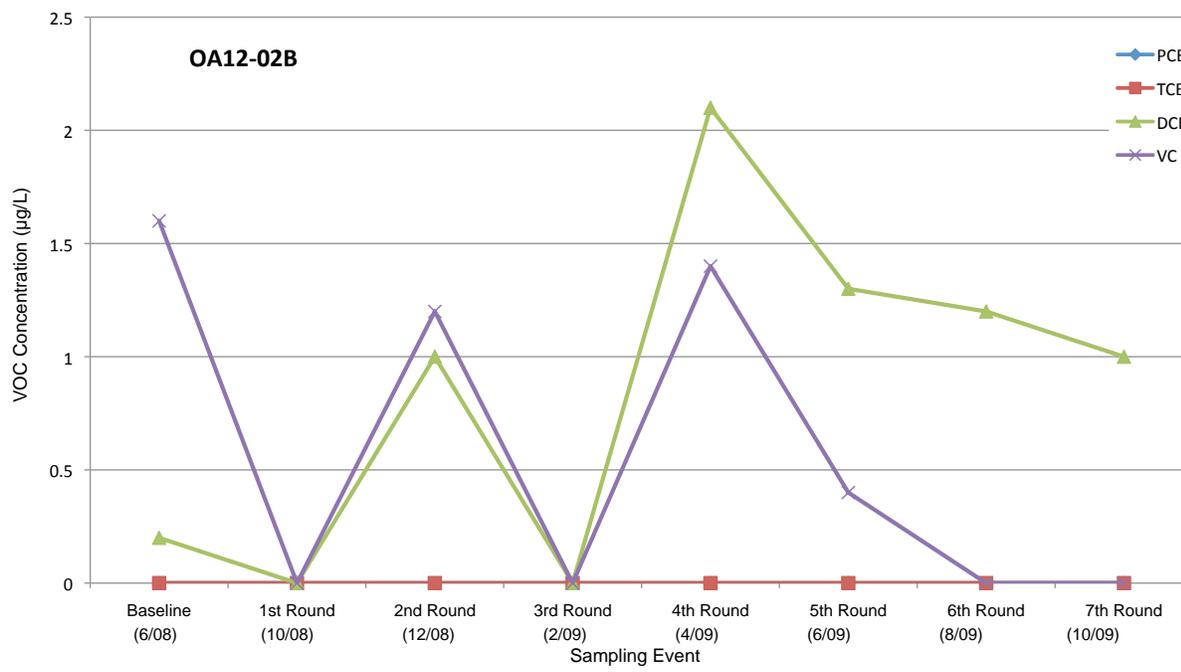
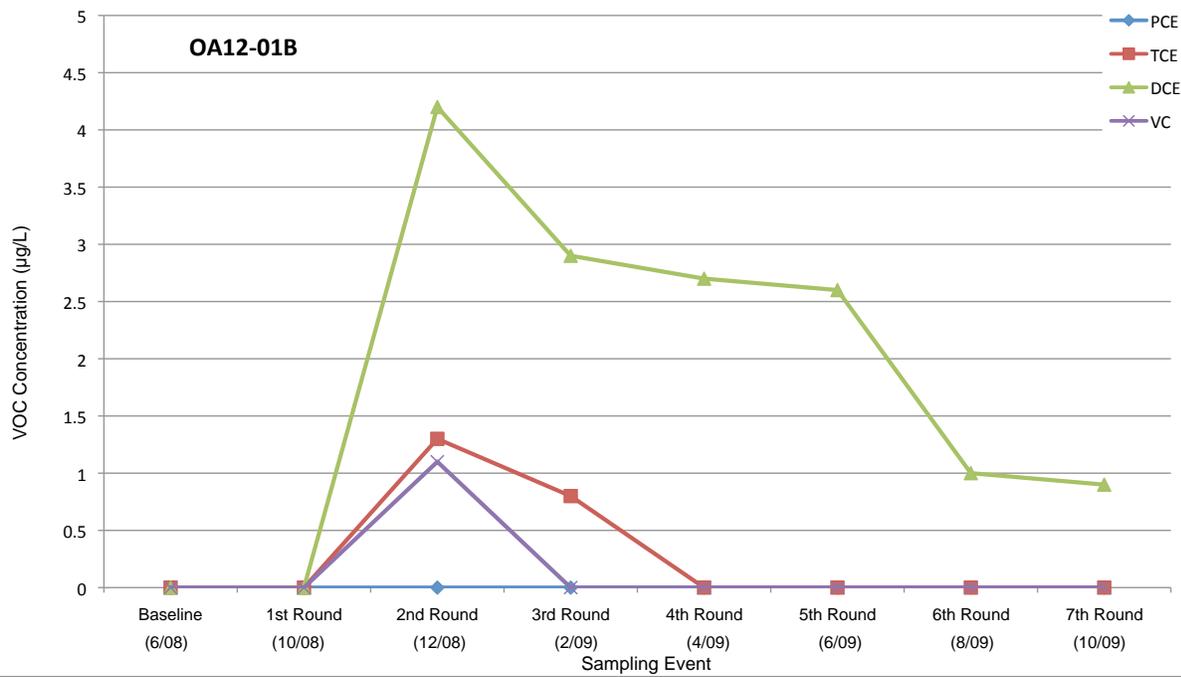
- Tetrachloroethene
- Trichloroethene
- Dichloroethene
- Vinyl chloride

µg/L = micrograms per liter



**FIGURE E2**  
VOC TREND PLOTS FOR  
PL2-330A AND OA12-04A

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10



**KEY:**

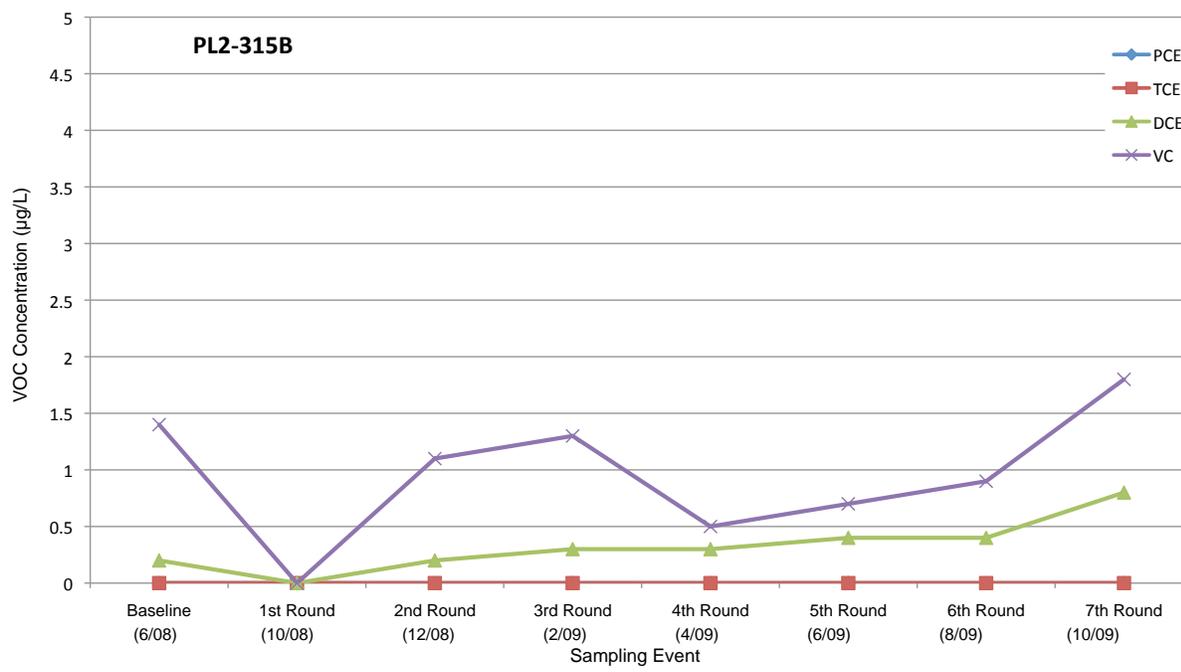
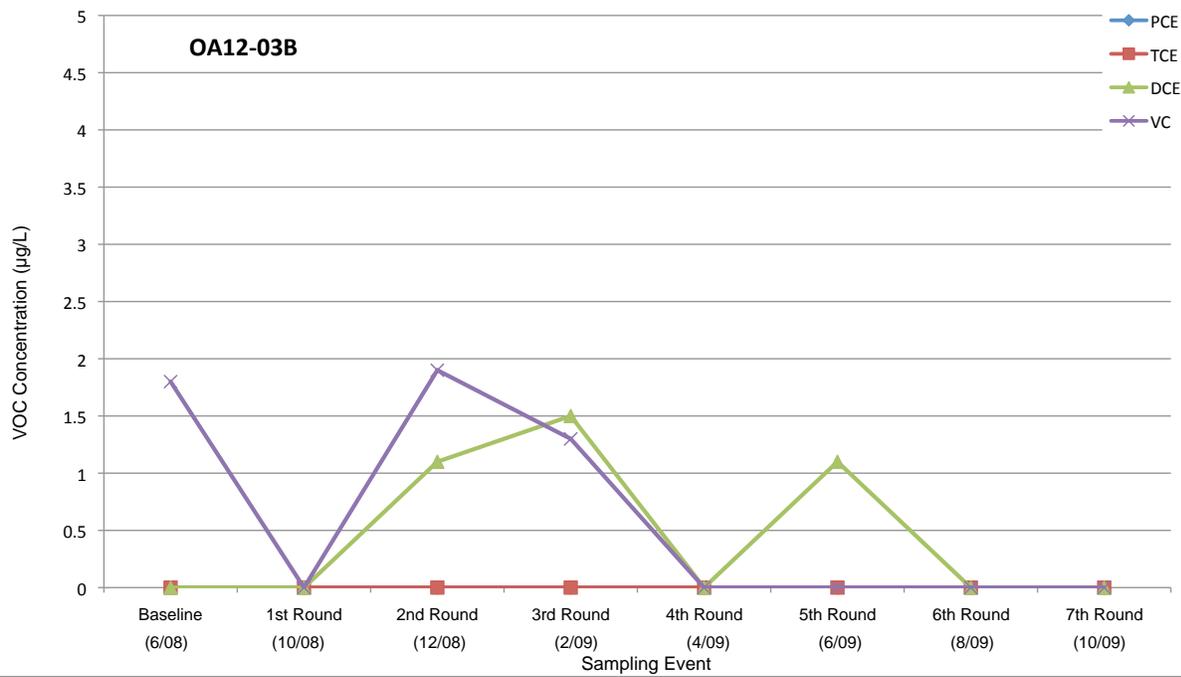
- Tetrachloroethene
- Trichloroethene
- Dichloroethene
- Vinyl chloride

µg/L = micrograms per liter



**FIGURE E3**  
VOC TREND PLOTS FOR  
OA12-01B AND OA12-02B

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10



**KEY:**

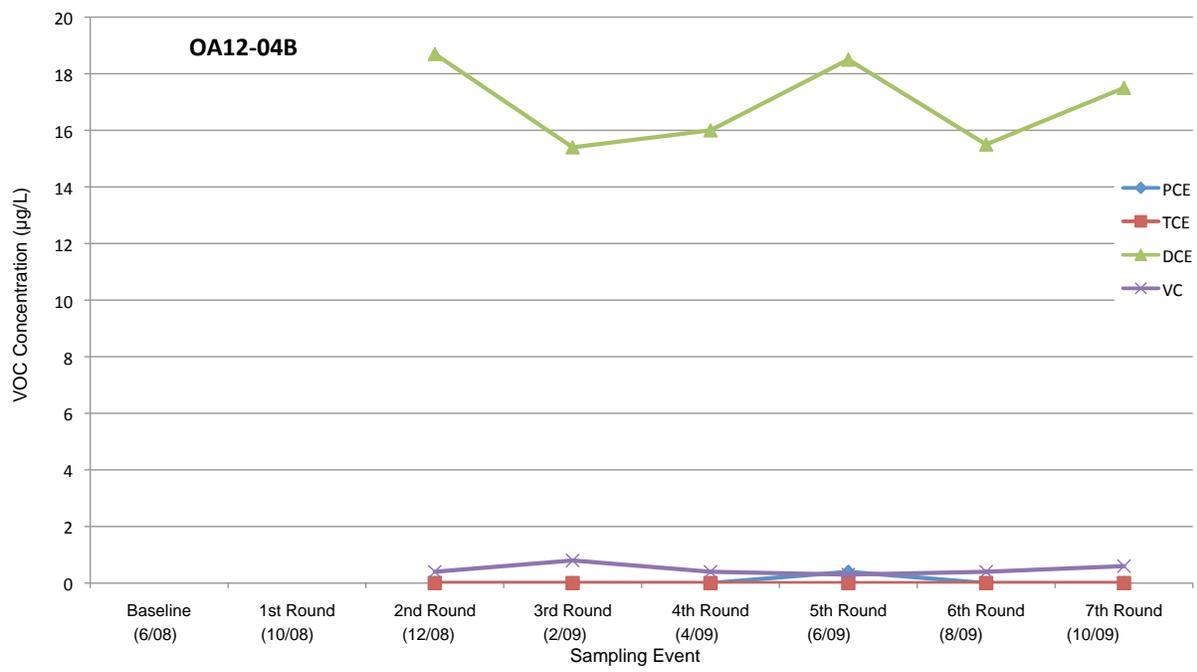
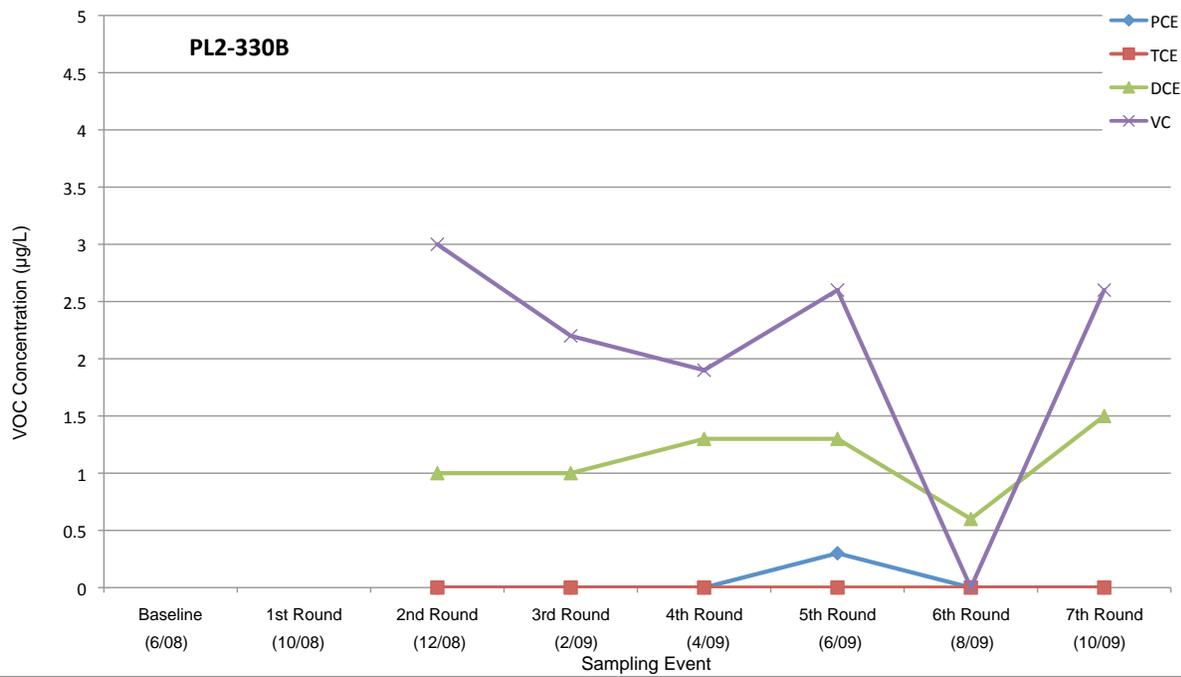
- Tetrachloroethene
  - Trichloroethene
  - Dichloroethene
  - Vinyl chloride
- µg/L = micrograms per liter



**FIGURE E4**

VOC TREND PLOTS FOR  
OA12-03B AND PL2-315B

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10



**KEY:**

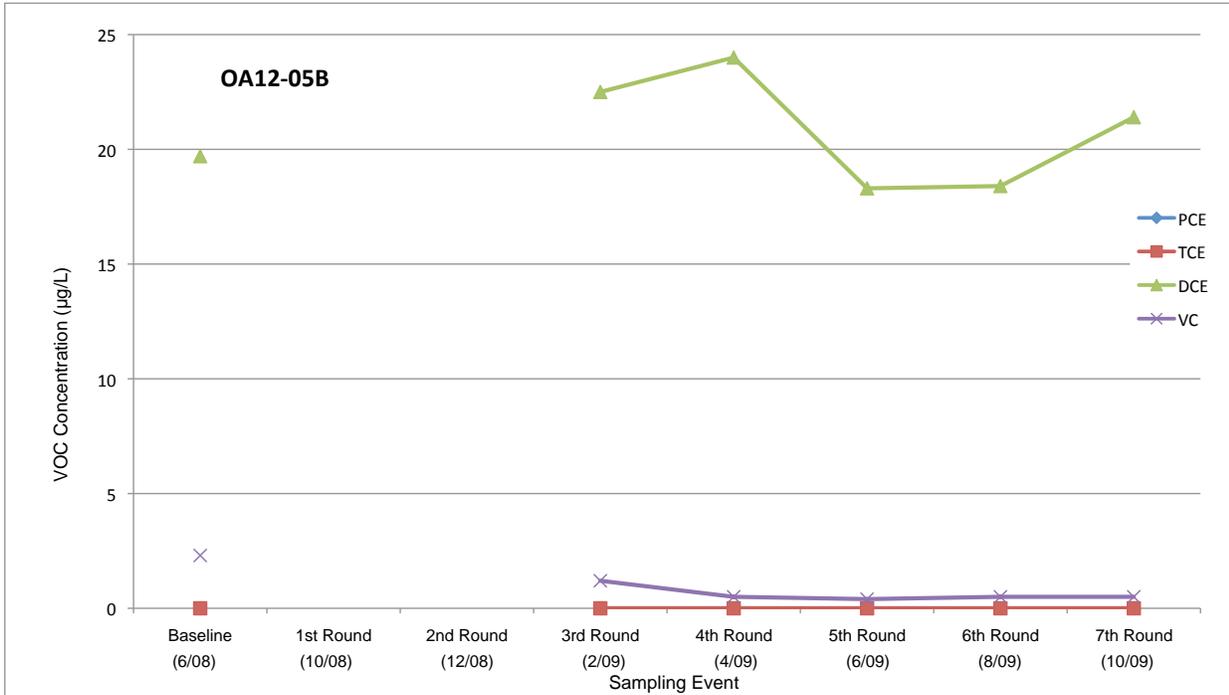
- Tetrachloroethene
- Trichloroethene
- Dichloroethene
- Vinyl chloride

µg/L = micrograms per liter



**FIGURE E5**  
 VOC TREND PLOTS FOR  
 PL2-330B AND OA12-04B

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10



**KEY:**

- Tetrachloroethene
  - Trichloroethene
  - Dichloroethene
  - Vinyl chloride
- µg/L = micrograms per liter



**FIGURE E6**

VOC TREND PLOT  
FOR OA12-05B

<b>PROJECT</b>	OA-12 IM SEMIANNUAL REPORT		
<b>PREPARED FOR</b>	THE BOEING COMPANY		
<b>LOCATION</b>	BOEING PLANT 2 SEATTLE/TUKWILA, WASHINGTON		
<b>SHEET</b> 1 of 1	<b>DRAWN BY</b> JLD	<b>REVIEWED BY</b> DCK	<b>DATE</b> 2/17/10