



The Boeing Company
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Seattle, WA 98127-2207

June 28, 2021
DAT-2021-026

Mr. Kenneth Thiessen
Oregon Department of Environmental Quality
Northwest Region Portland Office
700 NE Multnomah Street, Suite 600
Portland, OR 97232

Subject: Boeing Portland Facility
Troutdale Groundwater Aquifer Remedy
1,4-Dioxane Reconnaissance-Level Investigation Work Plan

Dear Mr. Thiessen:

Enclosed please find the following document that presents a work plan to conduct a reconnaissance-level investigation for 1,4-dioxane concentrations in groundwater at The Boeing Company's Portland facility:

- 1,4-Dioxane Reconnaissance-Level Investigation Work Plan, Boeing Portland, Troutdale Gravel Aquifer, Gresham, Oregon, dated June 23, 2021.

Two hard copies will be produced and mailed to your attention.

Please contact me if you have any questions.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Debbie Taege'.

Debbie Taege
Project Manager
Boeing EHS Remediation
deborah.a.taege@boeing.com
Mobile (818) 720-5575

Technical Memorandum

TO: Debbie Taege, The Boeing Company
FROM: Evelyn Ives, PE, and Christine Kimmel, LHG
DATE: June 23, 2021
RE: **1,4-Dioxane Reconnaissance-Level Investigation Work Plan
Boeing Portland, Troutdale Gravel Aquifer
Gresham, Oregon
ECSI #13
Project No. 025116.120.410**

Purpose

Landau Associates, Inc. (LAI) has prepared this work plan on behalf of The Boeing Company (Boeing) in support of the ongoing remediation of the Troutdale Gravel Aquifer (TGA) at the Portland facility (Site) located in Gresham, Oregon. Remediation activities for the TGA are conducted under the Order on Consent No. LQSR-NWR-04-12(h) issued to Boeing by the Oregon Department of Environmental Quality (ODEQ; 2008). Groundwater remediation has primarily consisted of corrective actions to address the dissolved volatile organic compounds (VOCs), primarily trichloroethene (TCE) concentrations.

On March 16, 2021, ODEQ requested a reconnaissance-level groundwater sampling event for 1,4-dioxane to evaluate whether it is present at concentrations above the ODEQ risk-based cleanup standards in groundwater (ODEQ 2021). The purpose of this work plan is to propose an investigation to determine the presence or absence of 1,4-dioxane in groundwater at the Site.

Investigation Approach and Schedule

As requested by ODEQ, a subset of existing groundwater monitoring wells was selected for 1,4-dioxane testing. Wells were selected to represent groundwater quality in identified VOC source areas, along with wells located upgradient and downgradient of the current dissolved VOC plume. Current and historical concentrations of TCE and 1,1,1-TCA were considered when selecting representative locations for potential 1,4-dioxane impacts.

A total of four TGA wells were selected for 1,4-dioxane testing, as shown on Figures 1a and 1b: BOP-57(ia), BOP-73(i), D-8(i), and BOP-59(i). For each of the selected wells, Figures 1a and 1b indicate historical maximum concentrations of 1,1,1-TCA and TCE concentrations along with current (August 2020) TCE concentrations. Time versus concentration plots for 1,1,1-TCA and TCE for each proposed sampling location are shown on Figures 2 through 5. The rationale for well selection is presented below:

- **BOP-57(ia):** Well BOP-57(ia) was selected because of its location as a historical source area well and historical 1,1,1-TCA maximum detections. BOP-57(ia) is located in the direct vicinity

of the primary source of TGA contamination, former irrigation well A-2, which was screened through the majority of the TGA and the underlying Troutdale Sandstone Aquifer (TSA). Historical results from samples collected at BOP-57(ia) indicate a maximum 1,1,1-TCA concentration of 5,500 micrograms per liter ($\mu\text{g/L}$) detected in 1994. With the development and implementation of remedial actions, 1,1,1-TCA concentrations declined to below the laboratory reporting limit by 2008. Similarly, TCE concentrations at BOP-57(ia) have decreased from a maximum concentration of 1,400 $\mu\text{g/L}$ in 1994 to nondetect at the laboratory reporting limit in February 2021.

- **BOP-73(i):** Well BOP-73(i) was selected as a representative location in the Former Vapor Degreaser Source Area (FVDSA), an area of the Site where TCE concentrations remain highest. Between 2010 and 2020, eight bioremediation injection events for enhanced reductive dechlorination that have been conducted in the FVDSA. Well BOP-73(i) has consistently been utilized for monitoring only (no donor material injected into the well) and has been used to evaluate the remedy progress in this area of the Site. 1,1,1-TCA has never been detected at the well; while, TCE concentrations have ranged from 17,000 $\mu\text{g/L}$ (maximum; detected in 2013) to nondetect at the laboratory reporting limit.
- **D-8(i):** Well D-8(i) was selected as a representative downgradient location. D-8(i) is located downgradient of the current dissolved VOC plume footprint and historically contained the highest 1,1,1-TCA concentrations compared to other monitoring wells near the downgradient edge of the plume contained by E-13. Elevated concentrations of 1,1,1-TCA were detected in the early remedy phase (1988 through 1995) at a maximum concentration of 950 $\mu\text{g/L}$; however, results have been consistently less than or near the laboratory reporting limit since 2008. TCE concentrations were historically as high as 570 $\mu\text{g/L}$ but have decreased to less than 10 $\mu\text{g/L}$ since 2017.¹
- **BOP-59(i):** Well BOP-59(i) was selected as a representative upgradient location. 1,1,1-TCA was only detected twice at 3.0 $\mu\text{g/L}$ since 1994 at BOP-59(i). TCE was historically detected at concentrations up to 1,800 $\mu\text{g/L}$ but has generally been less than the maximum contaminant level (MCL) of since 2015.

The 1,4-dioxane reconnaissance-level sampling event will be conducted during the next routine groundwater sampling event in August 2021. The timing will allow for 1,4-dioxane results to be compared to VOC (e.g., TCE and 1,1,1-TCA) results during data evaluation.

Sampling and Analytical Procedures

Sampling for 1,4-dioxane will be conducted in accordance with the ODEQ-approved Sampling and Analysis Plan (SAP; LAI 2012) developed for the TGA Site, with a few exceptions, which are discussed herein. Currently, passive diffusion bag (PDB) samplers are utilized for collection of groundwater samples for VOC analysis, while low-flow sampling techniques have been approved for non-VOC compounds. PDBs have several advantages compared to low-flow sampling including cost efficiency,

¹ In February and August 2019, TCE results exceeded 10 $\mu\text{g/L}$. These concentrations appeared abnormal, and, therefore, TCE concentration verification samples were collected within 1 month of the original sampling dates, respectively, to confirm observed concentrations. TCE verification concentrations were less than 10 $\mu\text{g/L}$.

the high level of precision, potential for vertical profiling, and low risk of cross-contamination and have been utilized at TGA since 2012.

Standard PBD samplers are not appropriate for 1,4-dioxane molecules, which are too large to pass through the polyethylene bag membrane. There are several commercially available passive diffusion membranes available for collection of larger molecules. The utilization of a snap sampler or hydrosleeve were considered during this evaluation; however, both techniques would require the installation of multiple samplers to analyze for both VOCs and 1,4-dioxane. For simultaneous collection of VOCs and 1,4-dioxane at the same depth, the use of Dual Membrane Passive Diffusion Bag (DMPDB™) samplers is recommended for this investigation. DMPBD samplers consist of a 1.75-inch diameter by 22-inch-long hollow tube comprised from two types of permeable membranes. The top 6 inches of membrane is 125-micrometer mesh nylon and the bottom 16 inches is low-density polyethylene. The top portion of nylon screen allows diffusion of larger molecules including 1,4-dioxane into the sampler. The lower part of the sampler allows diffusion of VOCs and acts as a reservoir. Chemical constituents that enter through either membrane diffuse vertically and mix within the sampler. As equilibration occurs, the concentration of constituents inside the sampler becomes equal to concentrations outside the sampler in the well.

The DMPDB is made by EON Products, Inc. and has been used since about 2015. The US Environmental Protection Agency (EPA) and the US Geological Survey (USGS) have conducted case studies on the sampler's effectiveness including comparisons between the DMPDB and low-flow sampling techniques. In particular, the USGS conducted a case study at the Kirtland Air Force Base in Albuquerque, New Mexico for two VOCs (1,2-dibromoethane and benzene). Results from the study indicate good agreement between the two sampling methods with more than 90 percent of the comparison sampling results within 20 percent relative difference of one another (USGS 2020). Bench scale DMPDB testing has been conducted by EON Products for a wider suite of chemicals, including 1,4-dioxane, and results are included as Attachment 1. Bench scale testing was conducted by hanging a DMPDB sampler in an 8-ft-tall column that was spiked with 1,4-dioxane. After 16 days, control and test samples were collected from the column and DMPDB, respectively. A total of two control samples and six test samples were collected for 1,4-dioxane analysis, and results indicate the test results (concentrations ranged between 3.6 and 4.2 µg/L) are within 14 percent relative difference of the control concentrations (4.2 and 3.7 µg/L).

The DMPDB will be field-filled with laboratory-supplied deionized water and deployed at least 3 weeks prior to sample collection to allow for equilibration in groundwater. The depth of DMPDB deployment will be the same depth of the routinely utilized standard PDBs to allow for results to be evaluated against historical VOC concentrations. The planned deployment depths of the DMPDB are listed below:

Selected Well	DMPDB Top Deployment Depth (feet below top of well casing)
BOP-57(ia)	98.5
BOP-73(i)	78
D-8(i)	87
BOP-59(i)	57

To meet quality objectives, described in the Sampling and Analysis Plan (SAP; LAI 2012) and the Quality Assurance Project Plan (QAPP; LAI 2013), a field duplicate sample will be collected from D-8(i). Because of the volume constraints of the DMPDB, the duplicate sample will be collected by deploying a secondary DMPDB directly below the primary sample depth interval. One DMPDB field blank sample will also be collected using laboratory-provided distilled water. The quality assurance samples will be analyzed for 1,4-dioxane by the same analytical methods as the primary DMPDB sample.

Samples will be submitted to the project-approved accredited laboratory Eurofins Lancaster Laboratories Environmental in Lancaster, Pennsylvania. 1,4-Dioxane samples will be analyzed by EPA Method 8270E with selected ion monitoring (SIM) with a reporting limit of 0.300 µg/L. Analytical results for 1,4-dioxane will be compared to ODEQ risk-based concentrations (RBCs) for groundwater ingestion and inhalation from tap water for the urban residential scenario (2.0 µg/L).

Reporting

Analytical results will undergo a Stage 2A data verification and validation in accordance with the project SAP and QAPP. Field and analytical laboratory control samples will be used to evaluate data precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity of the analytical results for this investigation. Data Quality Indicators (DQI) and Measurement Quality Objectives (MQO) are presented in Table 1.

The results of the 1,4-dioxane testing will be summarized and submitted to ODEQ in a technical memorandum. If 1,4-dioxane is detected at concentrations greater than the applicable RBC or outside the objective of the QAPP, then next steps will be discussed with ODEQ. Alternately, if 1,4-dioxane results are less than the applicable RBC, no additional sampling for 1,4-dioxane will be recommended.

Limitations

This work plan has been prepared for the exclusive use of Boeing for specific application to the Boeing Portland facility. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole

risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

LANDAU ASSOCIATES, INC.



Evelyn Ives, PE
Associate Engineer



Christine Kimmel, LHG
Senior Associate Geologist

EMW/CBK/EHI/ljl

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Attachments

Figure 1a: August 2020 TCE Groundwater Results and Historical 111 TCA and TCE Maximum Concentrations in TGA

Figure 1b: August 2020 TCE Groundwater Results and Historical 111 TCA and TCE Maximum Concentrations in TGA Former Vapor Degreaser Source Area

Figure 2: Selected Volatile Organic Compounds BOP-57(ia)

Figure 3: Selected Volatile Organic Compounds BOP-73(i)

Figure 4: Selected Volatile Organic Compounds D-8(i)

Figure 5: Selected Volatile Organic Compounds BOP-59(i)

Table 1: Sample Collection and Measurement Quality Objectives

Attachment 1: EON Products, Inc. DMPDB Bench Scale Test Results

References

LAI. 2012. Sampling and Analysis Plan, Troutdale Gravel Aquifer, Boeing Portland Facility, Gresham, Oregon. Landau Associates, Inc. July 6.

LAI. 2013. Quality Assurance Project Plan, Troutdale Gravel Aquifer, Boeing Portland Facility, Gresham, Oregon. Landau Associates, Inc. February 22.

ODEQ. 2008. Order on Consent LQSR-NWR-04-12(h). Oregon Department of Environmental Quality. September 8.

ODEQ. 2021. Letter: Request for Reconnaissance-Level Groundwater Sampling for 1, 4-Dioxane at Boeing Portland Facility, ECSI #13. From Kenneth Thiessen, Oregon Department of Environmental Quality, to Debbie Taege, The Boeing Company. March 16.

USGS. 2020. Passive Sampling of Groundwater Wells for Determination of Water Chemistry: Chapter 8 of Section D. Water Quality, Book 1. Collection of Water Data by Direct Measurement. US Geological Survey.

Legend

- E-13** TGA Extraction Well
- D-12** TGA Monitoring Well
- BOP-78(i)** TGA Multiple-Purpose Well
- BOP-7(i)** Wells Screened in Lower TGA and Upper Siltstone Layer of Confining Unit. Results are not Characteristic of TGA Conditions
- BOP-62(ds)** Upper TSA Monitoring Well
- 5** Approximate August 2020 TCE Concentration Contour (µg/L) and MCL

Approximate Limit of the TGA

D-8(i)	TCE	111 TCA
Aug-20	1.40	ND
Maximum	570	950

Columbia Slough

D-7(i)
0.951

D-12(i)
3.10

E-13
8.96

E-12
7.4

BOP-7(i)
208
BOP-7(d)
ND

E-2
ND

BOP-16(i)
0.365

E-4
18

E-3
2.0

BOP-81(i)
ND

BOP-80(i)
257

E-15
0.52

E-11
ND

E-16
1.1

BOP-9(i)
0.499

BOP-62(ds)
0.996

E-6
0.227

BOP-10(i)
30.3

E-7
26

DP-1
ND

LAI-7
5.57

LAI-4
0.497

E-5
NS

BOP-56(i)
12

E-8
9.3

BOP-65(ds)
0.232

BOP-61(ds)
3.17

BOP-66(ds)
0.714

See Figure 1b for Former Vapor Degreaser Source Area TCE Groundwater Concentrations

BOP-73(i)	TCE	111 TCA
Aug-20	1.17	ND
Maximum	17,000	ND

BOP-57(ia)	TCE	111 TCA
Aug-20	7.53	ND
Maximum	1,400	5,500

BOP-59(i)	TCE	111 TCA
Aug-20	1.02	ND
Maximum	1,800	3.0

Notes

ND = Not detected above the reporting limit
NS = Not sampled

1. TSA analytical results are shown as part of the CMI-specified evaluation of possible TGA activity affect on TSA water quality.
2. TCE concentration contours based on August 2020 sampling event.
3. All results shown in µg/L.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Highway I-84

0 400 800



Scale in Feet



G:\Projects\025\116\120\5\10\F01a\Aug2020TCE_TCATCEMaxConcentrations.mxd 6/23/2021



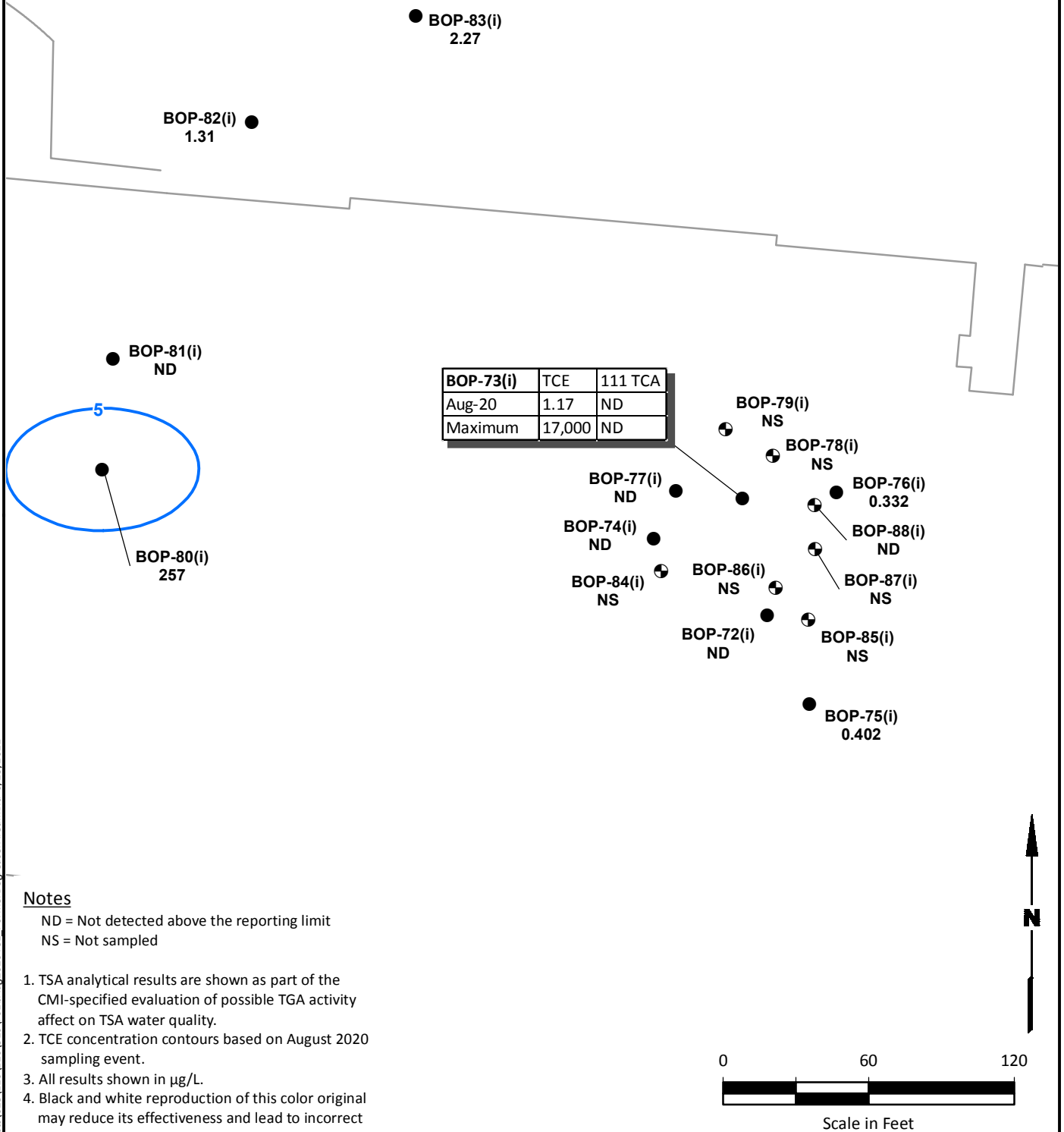
Boeing Portland
Gresham, Oregon

**August 2020 TCE Groundwater Results
and Historical 111 TCA and TCE
Maximum Concentrations in TGA**

Figure
1a

Legend

- **D-12** TGA Monitoring Well
- ⊕ **BOP-78(i)** TGA Multiple-Purpose Well
- 5— Approximate August 2020 TCE Concentration Contour (µg/L) and MCL



Notes

ND = Not detected above the reporting limit
 NS = Not sampled

1. TSA analytical results are shown as part of the CMI-specified evaluation of possible TGA activity affect on TSA water quality.
2. TCE concentration contours based on August 2020 sampling event.
3. All results shown in µg/L.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

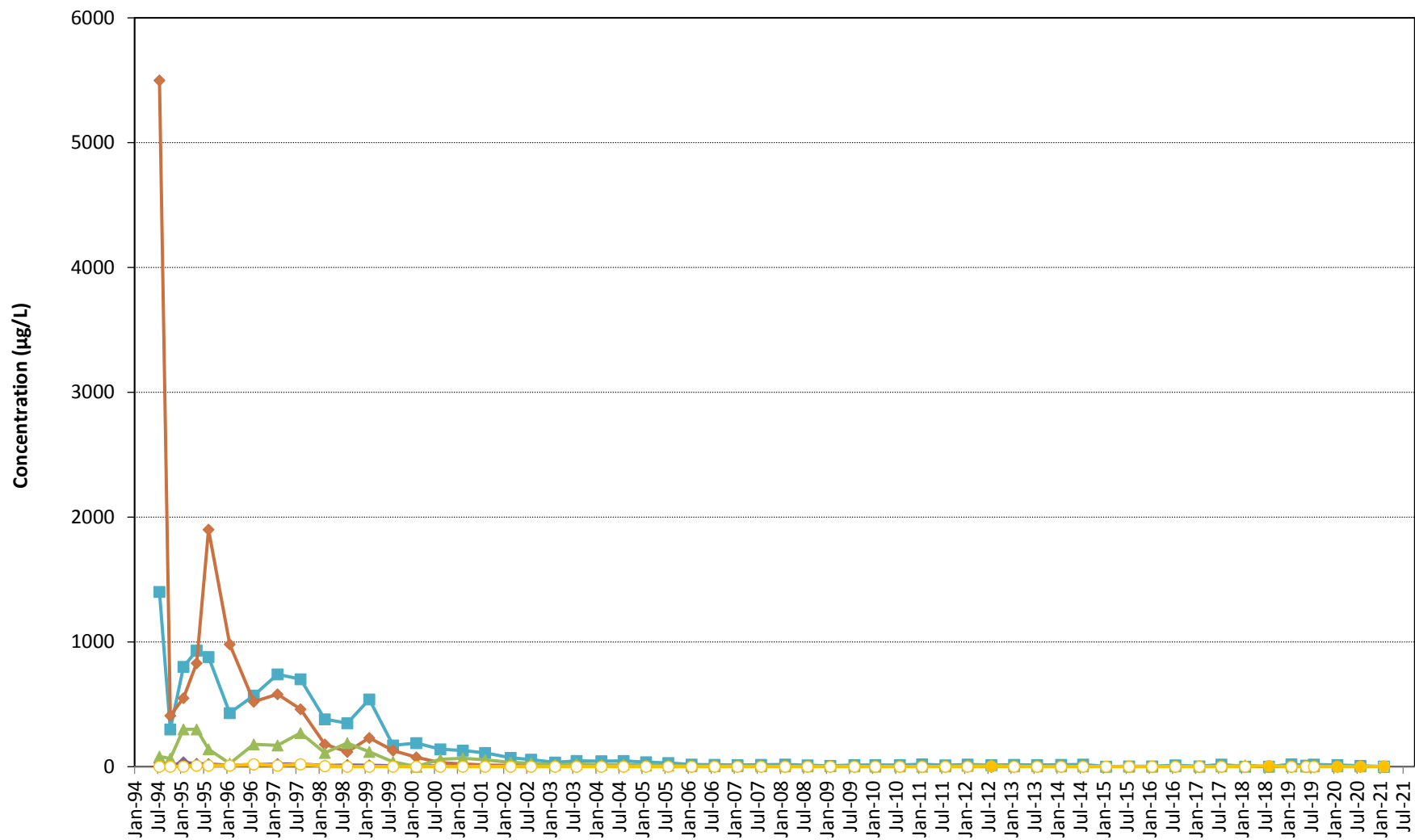
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Boeing Portland
Gresham, Oregon

**August 2020 TCE Groundwater Results
and Historical 111 TCA and TCE
Maximum Concentrations in TGA
Former Vapor Degreaser Source Area**

Figure
1b



Open symbol = nondetect
 Closed symbol = detect

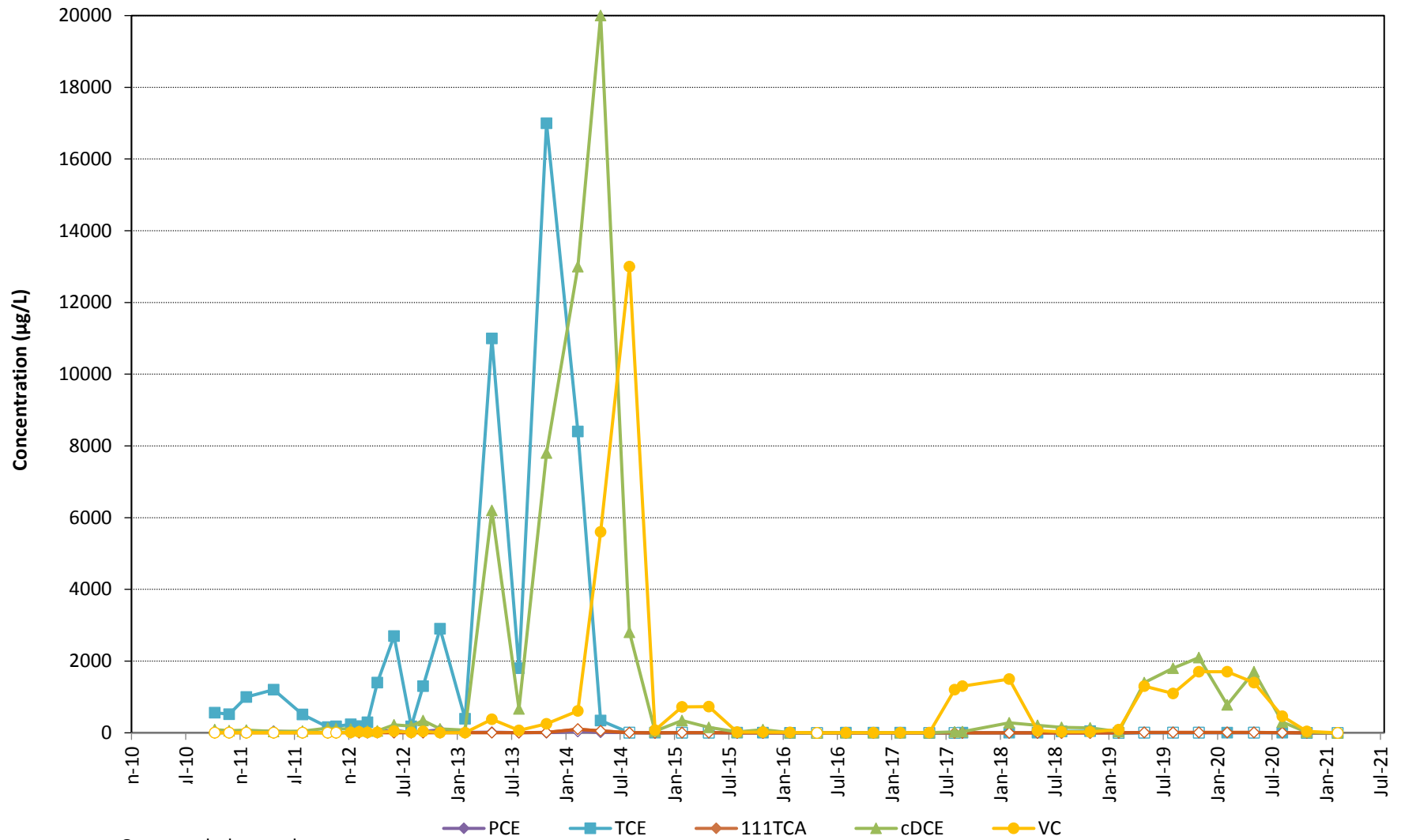
◆ PCE
 ■ TCE
 ◆ 111TCA
 ▲ cDCE
 ◆ VC



Boeing Portland
 Gresham, Oregon

**Selected Volatile Organic Compounds
 BOP-57(ia)**

Figure
2



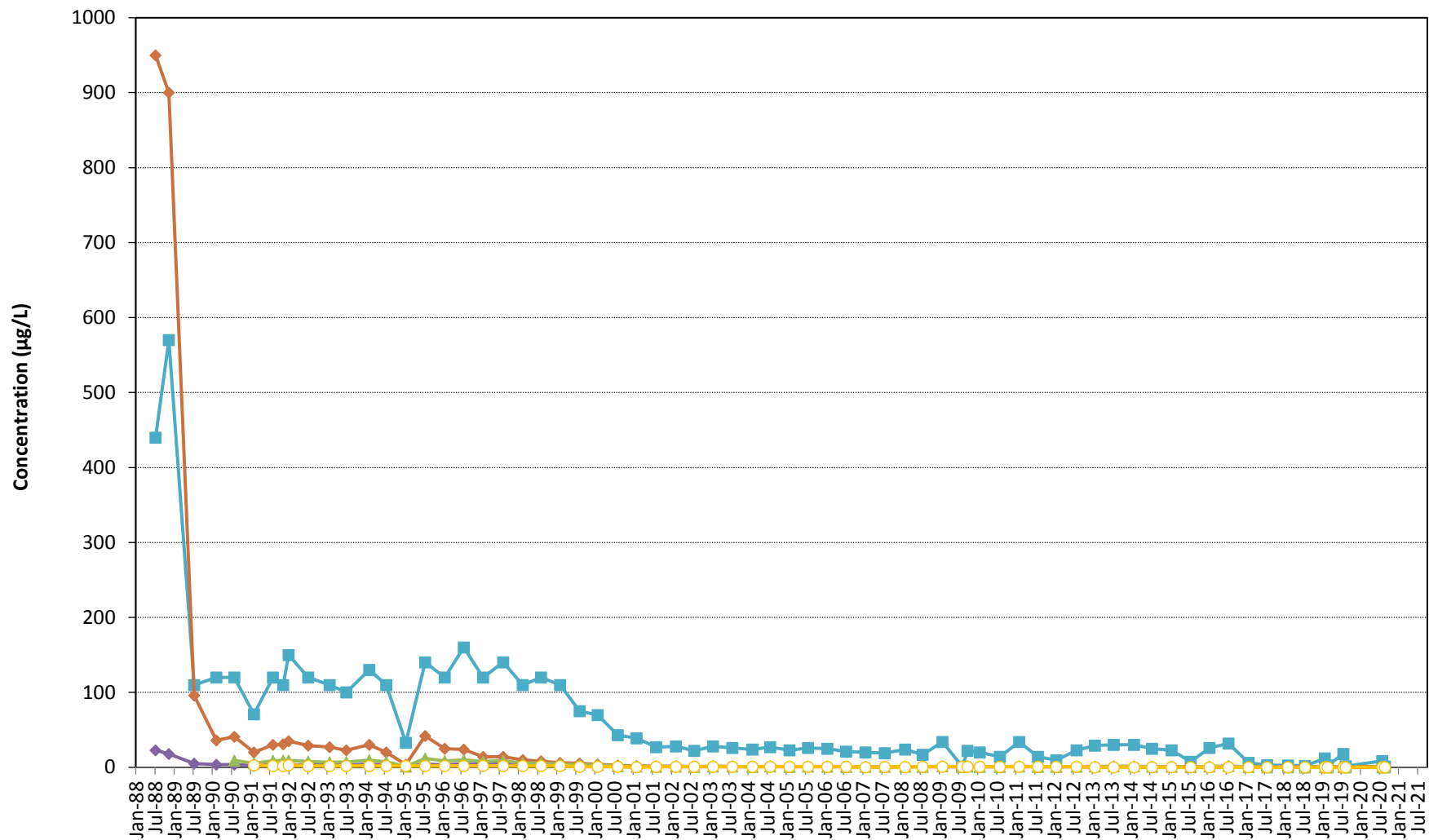
Open symbol = nondetect
 Closed symbol = detect



Boeing Portland
 Gresham, Oregon

**Selected Volatile Organic Compounds
 BOP-73(i)**

Figure
3



Open symbol = nondetect
 Closed symbol = detect

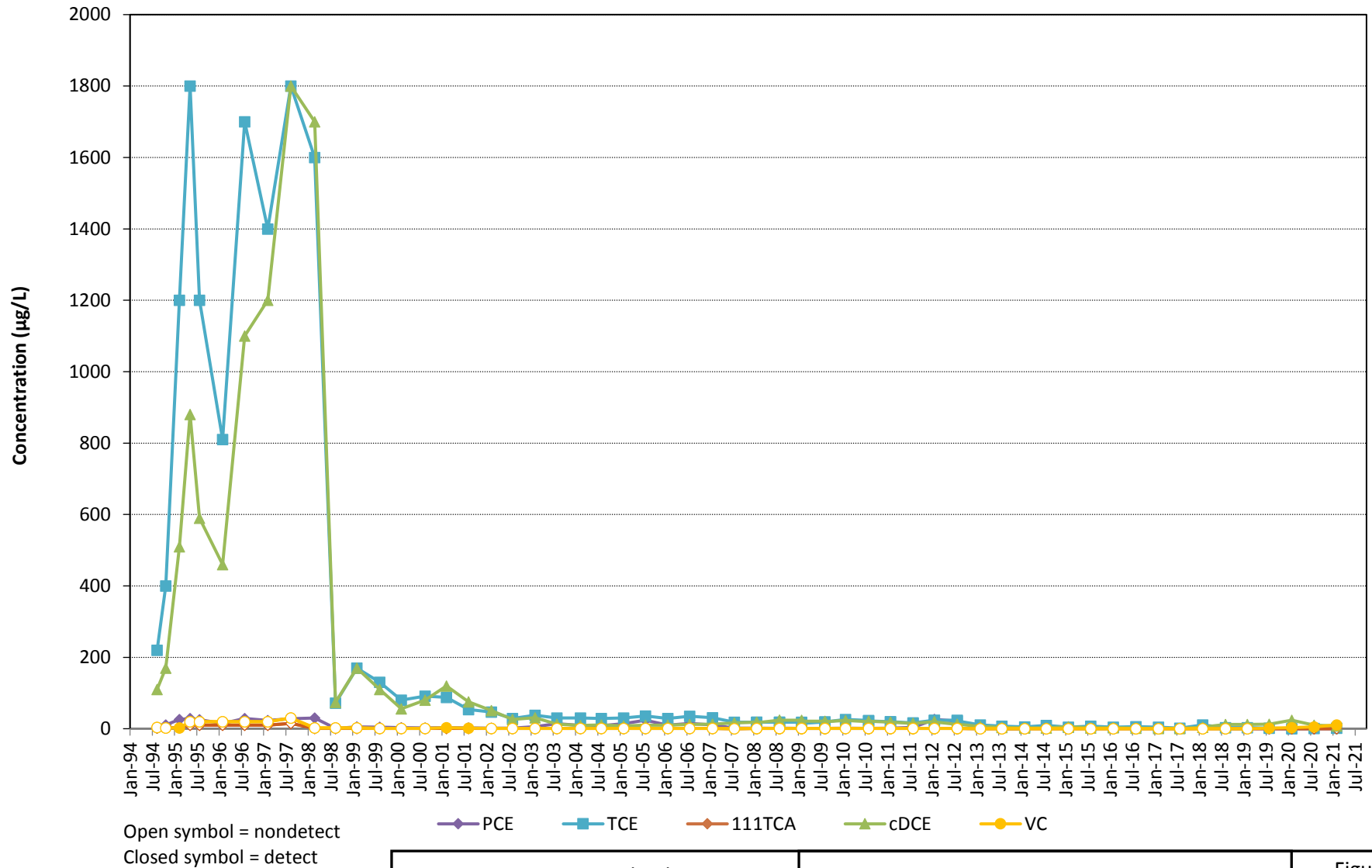
◆ PCE
 ■ TCE
 ◆ 111TCA
 ▲ cDCE
 ● VC



Boeing Portland
 Gresham, Oregon

**Selected Volatile Organic Compounds
 D-8(i)**

Figure
4



Boeing Portland
Gresham, Oregon

**Selected Volatile Organic Compounds
BOP-59(i)**

Figure
5

Table 1
Sample Collection and Measurement Quality Objectives
1,4-Dioxane Reconnaissance-Level Investigation Work Plan
Boeing Portland, Troutdale Gravel Aquifer
Portland, Oregon

Water Samples Analyzed for 1,4-dioxane by EPA 8270E SIM				
Container	Preservative	Holding Time (a)	Minimum Volume	Laboratory
2 x 250-mL amber glass	<6°C	7 days/40 days	250 mL	Eurofins Lancaster
DQI	QC Sample or Activity Used to Assess MQO	MQO	Frequency	Sampling or Analytical DQI
Representativeness	Cooler Temperature	< 6°C	All project samples	S
Bias	Surrogates	Recoveries within laboratory-specified control limits	All project and QA samples	A
Accuracy	LCS/LCSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Precision	LCS/LCSD and MS/MSD	RPDs within laboratory-specified control limits	1 per 20 samples or one per analytical batch	A
Method performance for matrix, bias	MS/MSD	Recoveries within laboratory-specified control limits	1 per 20 samples or one per analytical batch	S&A
Precision	Field Duplicates	RPD <20%	Duplicate sample collected (1 per 20 samples)	S&A
Bias/Contamination	Field Blank	Target analytes not detected at concentrations > 1/2 the RL	1 per sampling event	S&A
Bias/Contamination	Method Blank	Target analytes not detected at concentrations > 1/2 the RL	1 method blank per 20 samples, 1 every 12 hours, or 1 per analytical batch	S&A
Analytical Completeness	Number of usable (not rejected) results out of total number of results	90%	NA	S&A
Field Completeness	Number of samples collected out of planned samples	95%	NA	S

Abbreviations and Acronyms:

°C = degrees Celsius

% = percent

A = analytical

DQI = data quality indicator

EPA = US Environmental Protection Agency

LCS = laboratory control spike

LCSD = laboratory control spike duplicate

MQO = measurement quality objective

MS = matrix spike

MSD = matrix spike duplicate

NA = not applicable

QA = quality assurance

QC = quality control

RL = reporting limit

RPD = relative percent difference

S = sampling

SIM = selected ion monitoring

EON Products, Inc. DMPDB Bench Scale Test Results



Dual Membrane PDB Bench Test Results

In addition to successful side by side field testing, the Dual Membrane Passive Diffusion Samplers (DMPDBs) have been subject to a series of controlled Bench-Test studies to determine the correlation between the concentration of representative compounds in a sample acquired by the DMPDB and the concentration of those compounds in the fluid surrounding the sampler. For each Bench-Test, an 8-inch diameter by 8-foot tall test chamber was filled with water and spiked with the referenced compounds. DMPDBs were installed in the chamber and left in place for the indicated residence time to allow for diffusion of analyte molecules into the sampler. At the designated time, control samples were then taken of the fluid in the chamber through a discharge port. The DMPDBs were then removed and the contents discharged into lab bottles. A second control sample was taken from the chamber after the DMPDBs were sampled as a quality and repeatability check, and the controls and samples were sent to a certified lab for analysis. The control and DMPDB sample results are shown in the tables below.

Method: 524.2 - Volatile Organic Compounds (GC/MS) or Method: 8260B - Volatile Organic Compounds (GC/MS)	Control (ug/L)		Dual Membrane PDB (ug/L) Residence Time: 18 Days								
Sample ID>	3MC-11	3MC-21	3U4-21	3U4-31	3U4-11	3M4-21	3M4-31	3M4-11	3L4-21	3L4-31	3L4-11
1,1,1-Trichloroethane	6.7	6.0	6.7	6.5	6.6	6.5	6.4	6.7	6.3	6.6	6.7
1,1,2-Trichloroethane	15.0	14.0	16.0	15.0	15.0	15.0	15.0	16.0	15.0	16.0	16.0
1,1-Dichloroethane	21.0	19.0	21.0	21.0	21.0	21.0	20.0	21.0	20.0	21.0	21.0
1,1-Dichloroethene	2.6	2.3	2.5	2.5	2.6	2.7	2.4	2.6	2.5	2.5	2.6
1,2,4-Trimethylbenzene	3.1	2.8	3.0	3.0	3.0	3.1	3.0	3.0	2.9	3.1	3.1
1,2-Dichloroethane	16.0	15.0	17.0	16.0	16.0	16.0	16.0	17.0	16.0	17.0	17.0
1,2-Dichloropropane	5.0	4.6	5.0	4.9	5.0	5.0	4.9	5.1	4.8	5.1	5.0
1,3,5-Trimethylbenzene	2.8	2.6	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.9	2.8
2-Butanone (MEK)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
qualifier	U	U	U	U	U	U	U	U	U	U	U
4-Methyl-2-pentanone (MIBK)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
qualifier	U	U	U	U	U	U	U	U	U	U	U
Acetone	15.0	11.0	6.1	7.0	5.0	8.7	8.2	8.9	6.6	7.3	8.4
qualifier			J	J	U	J	J	J	J	J	J
Benzene	7.0	6.4	6.8	6.7	7.1	7.0	6.6	6.9	6.6	6.9	6.9
Chloroethane	32.0	29.0	32.0	31.0	32.0	32.0	31.0	32.0	30.0	32.0	32.0
cis-1,2-Dichloroethene	8.2	7.7	8.4	8.0	8.5	8.5	8.1	8.3	7.9	8.3	8.4
Ethylbenzene	13.0	12.0	13.0	13.0	13.0	13.0	12.0	13.0	12.0	13.0	13.0
Isopropyl alcohol	61.0	310.0	25.0	25.0	31.0	25.0	25.0	25.0	25.0	25.0	25.0
qualifier			U	U	J	U	U	U	U	U	U



Dual Membrane PDB Bench Test Results

Method: 524.2 - Volatile Organic Compounds (GC/MS) or Method: 8260B - Volatile Organic Compounds (GC/MS)	Control (ug/L)		Dual Membrane PDB (ug/L) Residence Time: 18 Days								
	Sample ID>	3MC-11	3MC-21	3U4-21	3U4-31	3U4-11	3M4-21	3M4-31	3M4-11	3L4-21	3L4-31
Methylene Chloride	7.0	6.5	7.0	6.8	6.9	6.9	6.9	7.0	6.7	7.1	7.1
m-Xylene & p-Xylene	4.5	4.0	4.4	4.5	4.6	4.5	4.3	4.6	4.3	4.6	4.6
Naphthalene	2.5	2.3	2.4	2.5	2.6	2.4	2.5	2.4	2.4	2.5	2.5
o-Xylene	5.7	5.3	5.8	5.7	5.8	5.9	5.7	5.9	5.5	5.9	5.8
Tetrachloroethene	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
qualifier	J	J	J	J	J	J	J	J	J	J	J
Toluene	3.9	3.6	3.8	3.8	4.0	3.9	3.7	3.8	3.7	3.9	3.8
trans-1,2-Dichloroethene	6.4	5.8	6.2	6.2	6.4	6.4	6.0	6.3	6.0	6.2	6.3
Trichloroethene	2.3	2.0	2.1	2.2	2.2	2.2	2.1	2.2	2.1	2.2	2.2
Xylenes, Total	10.0	9.3	10.0	10.0	10.0	10.0	10.0	11.0	9.8	10.0	10.0

Method: 522 - 1,4 Dioxane (GC/MS SIM)	Control Result (ug/L)		Dual Membrane Passive Diffusion Sampler Result (ug/L) Residence Time: 16 Days					
	Sample ID>	2MC-12	2MC-22	2M4-12	2U4-12	2M4-22	2M4-32	2M4-42
1,4-Dioxane	4.2	3.7	3.6	3.8	4.0	4.2	3.8	3.8

P.O. Box 443, Snellville, Georgia 30078-0443
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Dual Membrane PDB Bench Test Results

Method: 200.8-1994 R5.4 - Metals (ICP/MS)	Control (ug/L)		Dual Membrane Passive Diffusion Sampler (ug/L) Residence Time: 23 Days								
	3MC-24	3MC-14	3U4-14	3U4-24	3U4-34	3M4-14	3M4-24	3M4-34	3L4-14	3L4-24	3L4-34
Aluminum	97.0	96.0	94.0	93.0	96.0	99.0	97.0	94.0	96.0	94.0	93.0
Arsenic	25.0	24.0	22.0	22.0	22.0	22.0	23.0	22.0	23.0	22.0	22.0
Cadmium	30.0	30.0	29.0	28.0	29.0	29.0	30.0	29.0	29.0	28.0	28.0
Chromium	67.0	65.0	62.0	61.0	63.0	63.0	65.0	61.0	64.0	61.0	62.0
Lead	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	100.0	110.0

Method: 537 (modified) - Fluorinated Alkyl Substances			Residence Time 21 Days				
PFAS	Laboratory (ng/L)		Control Samples (ng/L)		DMPDB Samples (ng/L)		
Sample ID>	RL	MDI	4MC-16	4MC-26	4M4-16	4M5-16	4U5-16
6:2-Fts	1.75	0.87	29	30	28	30	28
Perfluoro-Octanesulfonate	1.75	0.35	18	20	20	21	19
Perfluorobutanesulfonic Acid	0.87	0.26	36	36	34	33	34
Perfluoroheptanoic acid	0.87	0.35	27	28	29	30	26
Perfluorohexanesulfonic Acid	1.75	0.35	29	27	24	27	26
Perfluorohexanoic acid	1.75	0.35	30	31	31	31	30
Perfluorooctanoic acid	0.87	0.26	37	35	33	35	36
Perfluoropentanoic acid	5.3	1.8	30	30	30	29	29

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Dual Membrane PDB Bench Test Results

Method: 537 (modified) - Fluorinated Alkyl Substances			Residence Time 41 Days							
PFAS	Laboratory (ng/L)		Control Samples (ng/L)		DMPDB Samples (ng/L)					
Sample ID>	RL	MDI	4MC-36	4MC-46	4M5-16	4L5-26	4U4-16	4MR-16	4L4-16	4M5-26
6:2-Fts	1.75	0.87	25	23	23	21	20	22	21	21
Perfluoro-Octanesulfonate	1.75	0.35	18	17	18	20	17	18	17	16
Perfluorobutanesulfonic Acid	0.87	0.26	30	28	29	29	28	28	29	26
Perfluoroheptanoic acid	0.87	0.35	24	23	23	21	22	22	22	23
Perfluorohexanesulfonic Acid	1.75	0.35	23	23	25	23	23	22	25	23
Perfluorohexanoic acid	1.75	0.35	29	29	27	27	29	26	26	28
Perfluorooctanoic acid	0.87	0.26	32	33	32	32	29	33	29	31
Perfluoropentanoic acid	5.3	1.8	25	25	24	24	23	24	24	25

Method: 537 (modified) - Fluorinated Alkyl Substances			Residence Time: 21 Days										
PFAS	Laboratory (ng/L)		Control Samples (ng/L)		DMPDB Samples (ng/L)								
Sample ID>	RL	MDL	5MC-16	5MC-26	5U4-16	5U5-16	5U5-26	5L4-16	5L5-16	5L5-26	5M4-16	5M5-16	5M5-26
Perfluorobutanoic acid (PFBA)	1.9	0.33	1.3	1.0	1.4	1.2	1.3	1.3	1.4	1.2	1.1	1.4	1.3
qualifier			JB	JB	JB	JB	JB	JB	JB	JB	JB	JB	JB
Perfluorooctanoic acid (PFOA)	1.9	0.81	10	10	9.8	9.8	11	9.8	10	11	9.7	10	9.9
Perfluorooctanesulfonic acid (PFOS)	1.9	0.51	6.5	5.9	5.9	14	6.3	5.8	8.3	6.1	7.3	6.1	6.0
Perfluoropentanoic acid (PFPeA)	1.9	0.47	7.5	7.4	7.6	6.7	7.3	6.9	7.7	7.9	6.7	8.1	7.3
Perfluorohexanoic acid (PFHxA)	1.9	0.55	8.6	8.2	9.1	9.2	8.9	8.5	8.8	8.6	9.0	8.8	8.4
Perfluoroheptanoic acid (PFHpA)	1.9	0.24	7.4	7.0	7.0	7.0	7.0	7.0	7.2	7.0	7.4	6.6	7.1
Perfluorobutanesulfonic acid (PFBS)	1.9	0.19	8.8	8.9	8.2	10	8.9	8.5	9.1	9.3	8.9	8.8	9.5
Perfluorohexanesulfonic acid (PFHxS)	1.9	0.16	7.3	7.5	7.2	7.3	7.0	7.3	7.5	7.3	7.5	7.3	7.2
qualifier			B	B	B	B	B	B	B	B	B	B	B
6:2 FTS	19	1.9	7.2	6.6	7.3	7.1	6.4	6.7	7.1	7.1	6.7	6.1	6.3
qualifier			J	J	J	J	J	J	J	J	J	J	J

*See Qualifier Information, Next Page

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Dual Membrane PDB Bench Test Results

Qualifier		Qualifier Description			
B		Compound was found in the blank and sample.			
J		Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.			
QC Method Blank	Result	Qualifier	RL	MDL	Unit
Perfluorobutanoic acid (PFBA)	0.476	J	2.0	0.35	ng/L
Perfluorohexanesulfonic acid (PFHxS)	0.357	J	2.0	0.17	ng/L