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PARTIAL NO FURTHER ACTION REQUEST
EAST MULTNOMAH COUNTY TROUTDALE SANDSTONE AQUIFER REMEDY, ZONE A AND SGA
ECSI 1479

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April 23, 2020

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
BLA	Blue Lake Aquifer
Boeing	The Boeing Company
Cascade	Cascade Corporation
cis-1,2-DCE	cis-1,2-dichloroethene
COPC	Compounds of Potential Concern
CSSWF	Columbia South Shore Wellfield
CTS	Central Treatment System
CU1	Confining Unit 1
CU2	Confining Unit 2
DEQ	Oregon Department of Environmental Quality
ECSI	Environmental Cleanup Site Information
EMC	East Multnomah County Area Groundwater
ft bgs	feet below ground surface
ICP	Institutional Controls Plan
IRAMs	interim remedial action measures
MCLs	maximum contaminant levels
MW	monitoring well
NFA	No Further Action
NPDES	National Pollutant Discharge Elimination System
PCE	tetrachloroethene
PMX	Portland Monitoring Reference
PWB	Portland Water Bureau
RAOs	Remedial Action Objectives
RI	remedial investigation
ROD	Record of Decision
RPW	Remedial pumping well
SGA	Sand and Gravel Aquifer
SSPA	S.S. Papadopulos & Associates, Inc.

LIST OF ACRONYMS AND ABBREVIATIONS (Cont'd)

SVE	soil vapor extraction
TCE	trichloroethene
TGA	Troutdale Gravel Aquifer
TSA	Troutdale Sandstone Aquifer
VC	vinyl chloride
VOCs	volatile organic compounds
WWTP	wastewater treatment plant

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AQUIFER REMEDY, ZONE A AND SGA
ECSI1479

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1.0 PURPOSE

This document presents the basis for the Oregon Department of Environmental Quality's (DEQ's) recommendation for a Partial No Further Action (NFA) determination for portions of the East Multnomah County Area Groundwater (EMC) Site located in Gresham, Oregon (EMC Site). The Partial NFA is for the Zone A of the Troutdale Sandstone Aquifer (TSA) and for the underlying Sand and Gravel Aquifer (SGA).

The EMC Site includes groundwater in portions of the TSA and the underlying SGA that were historically impacted by past use of trichloroethene (TCE) and to a smaller extent other volatile organic compounds (VOCs) including (tetrachloroethene [PCE], cis-1,2-dichloroethene [cis-1,2,DCE], 1,1-Dichloroethene [1,1-DCE], and vinyl chloride [VC] at the Cascade Corporation (Cascade) facility, located at 2201 NE 201st Ave in Gresham, Oregon, and The Boeing Company (Boeing) facility, located at 19000 NE Sandy Boulevard in Portland, Oregon (Figure 1). Cascade and Boeing are jointly responsible for the remedy being implemented under DEQ's Consent Order No. WMCSR-NWR-96-08 (DEQ 1997).

Four groundwater restoration areas (Zone A, B, C, and D) were identified in the DEQ Record of Decision (ROD) for the TSA (DEQ 1996), as shown on Figure 1. Further clarification on the concept of restoration zones was provided in the Troutdale Sandstone Aquifer Remedial Action Annual Performance Evaluation for April 1, 1998 – March 31, 1999 (Landau Associates 1999). Contaminant concentrations of the dissolved VOC plume in groundwater in TSA Zone A, located north of Sandy Boulevard, and the SGA, located throughout the EMC Site, have met remedy performance criteria and are below cleanup levels specified in the ROD. At the present time, only three wells remain in TSA Zone A and one in the SGA, as wells were systematically decommissioned as the remedy progressed over time and analytical results indicated that groundwater quality met the Consent Order requirements. Analytical results from the last remaining three TSA wells and one SGA well have also met the Consent Order requirements and have been approved by DEQ for decommissioning (DEQ, 2018b). Based on these criteria, a Partial NFA determination is recommended for TSA Zone A and the SGA throughout the EMC Site.

The remedial actions undertaken at the EMC Site were completed under Oregon Administrative Rules, Chapter 340 Division 122, and the proposed Partial NFA determination described in this memorandum meets the requirements of Oregon Revised Statutes 465.230. Restoration actions taken at the EMC Site have attained a degree of cleanup in specific areas (or zones) and control of further release(s) that provides protection of present and future public health, safety, welfare, and the environment. Institutional controls, such as groundwater use restrictions related to the EMC Site, will not remain active for Remedy Zone A and the SGA once the Partial NFA is determined as the criteria for the institutional controls have been achieved. However, this determination will not remove the EMC Site from the Confirmed Release List, rather, the Partial

NFA will recognize that the selected portions of the EMC Site (TSA Zone A and the SGA) meet restoration goals and are below cleanup levels set forth in the ROD. It is worth noting that this area of the remedy is located within the Columbia South Shore wellhead protection area, which has established institutional controls also in place restricting groundwater use.

The Partial NFA recommendation is based on information documented in the Administrative Record for the EMC Site. A copy of the Administrative Record index is presented in Appendix A.

2.0 BACKGROUND

The background described in this document covers the entire EMC Site, although the Partial NFA recommended in this document is for a portion of the TSA (Zone A) and the SGA throughout the EMC Site.

The original study area for the EMC Site was an area approximately 3.6 square miles that is bound by the Columbia River to the north, Fairview Avenue and Campbell Road to the east, NE Halsey Street to the south, and NE 181st Avenue to the West (Figure 1). The EMC Site is located in Sections 19, 20, 28, and 29 in Township 1 North, Range 3 East. Topography at the EMC Site is highest to the south and descends in elevation in a series of river/flood cut terraces northward to the Columbia River. Topography in the northern portion of the EMC Site is generally flat.

Four TSA restoration areas were described in the ROD and subsequently assigned letters as follows and are shown in Figure 1:

TSA Restoration Zone	Zone Location
Zone A	Area north of Sandy Boulevard
Zone B	Area south of Sandy Boulevard in the western portion of the Boeing facility
Zone C	Area south of Sandy Boulevard directly east of Zone B and west of N.E. 205th Avenue
Zone D	Area south of Sandy Boulevard, directly east of Zone C and area east of N.E. 205th Avenue

2.1 EMC Site Setting

The EMC Site is located approximately 7 miles east of the Portland International Airport and is located within the Columbia South Shore Wellfield (CSSWF) – Wellhead Protection Area, which is operated by the Portland Water Bureau (PWB) as a backup/alternative drinking water source for the City of Portland. Both the Boeing and Cascade facilities are located within the EMC Site boundary, along with a mix of residential, manufacturing, agricultural, and vacant properties, as shown in Figure 2.

The original EMC Site dissolved groundwater plume was approximately 400 acres; however, the dissolved VOC plume based on 2018 data, as defined by groundwater concentrations with Compounds of Potential Concern (COPC) above the Consent Order cleanup levels, is approximately 28 acres. An estimated 93% of the remedy footprint has met the Consent Order

cleanup levels. The remaining 7% of the remedy area is active and will continue with remediation and monitoring.

The 2018 and historic monitoring well network, extraction well and treatment system locations, and zone designations are shown in Figures 3, 4, and 5.

2.2 Physical Setting

The following section describes the geologic and hydrogeologic setting of the EMC Site, along with groundwater and surface water use.

2.2.1 Geology

The principal geologic units beneath the EMC Site, from shallowest to deepest, include alluvial floodplain deposits (referred to as the Troutdale Gravel, Blue Lake Gravel, and Floodplain sand and silt), siltstone unit 1, a sandstone unit, a conglomerate unit, siltstone unit 2, and a deeper conglomerate unit. These hydrogeologic units include three primary aquifers which include, from shallowest to deepest, The Troutdale Gravel Aquifer (TGA), the TSA (also referred as the Upper TSA) and the Troutdale Conglomerate Aquifer (also referred as the Lower TSA), and the SGA. The TGA is separated from the TSA by Confining Unit 1 (CU1), while the TSA is separated from the SGA by a second confining layer identified as Confining Unit 2 (CU2) (Swanson, et al., 1993). Both confining layers have distinct subunits of siltstone interbedded with sandstone (Landau Associates 1995). A comprehensive discussion of the geology and hydrogeology, including cross sections and a stratigraphic column, are included in the ROD (DEQ 1997). A cross section depicting the northern portion of the EMC Site, including Zone A and the SGA, is provided as Figure 6.

Near the northeast portion of the EMC Site, between Blue Lake and the south shore of the Columbia River, erosion and suspected faulting of the Troutdale Formation has occurred and resulted in a deep channel of the Columbia River that has incised the Troutdale Formation. The channel was subsequently filled with gravel and comprises the Blue Lake Aquifer (BLA).

2.2.2 Hydrogeology

Shallow TGA groundwater flow is to the north and discharges in a series of springs in the southern/central portion of the EMC Site (in Zones C and D) and along the truncation where CU1 and the TGA have been eroded. The approximate extent of the erosional truncation is shown in Figure 3. This truncation does not extend to the southwest into Zone B where the TGA is encountered at 7 to 20 feet below ground surface (ft bgs) and dips to the northwest with TGA thickness ranging from 10 to 100 ft bgs. CU1 and CU2 are generally unsaturated silt/clay stone units, although sandstone interbeds are occasionally water-bearing. Groundwater in Zone A is

often encountered within a few feet of ground surface, and artesian conditions have been described historically in portions of the remedy area.

Regional groundwater flow in the TSA and the SGA is generally northward towards the Columbia River. However, the Upper TSA in the central to northeastern portion of the EMC Site is unsaturated, likely due to a geologic structural high and possibly due to a higher degree of cementation in the TSA. The approximate extent of this TSA unsaturated area is shown in Figure 3. Groundwater flow directions near this feature appear to mound due to increased recharge from the TGA and other areas of the Upper TSA to the TSA north of the TGA/CU1 erosional truncation, resulting in radial flow to the southeast/south/southwest, as described in the ROD. The pre-pumping flow gradient in the Upper TSA and Lower TSA is shown in Figures 7 and 8, respectively. The portion of the EMC Site with the radial groundwater flows is referred to as the mound area. Groundwater flow in the mound area and resultant contaminant distribution in the Upper and Lower TSA is complex and is the area of focused extraction pumping for capture of the dissolved VOC plume (Figures 9 and 10).

Depths to groundwater in the Upper TSA vary significantly across the EMC Site and in each Zone, range from:

- Zone A: 5 to 36 ft bgs (12 to 8 feet above mean sea level); no current active remedy (TSA or SGA) groundwater pumping;
- Zone B: 70 to 125 ft bgs (9 to -6 feet above mean sea level); no current active remedy groundwater pumping;
- Zone C: 50 to 155 ft bgs (60 to -30 feet above mean sea level); in areas of active remedy groundwater pumping; and
- Zone D: 55 to 95 ft bgs (60 to 15 feet above mean sea level); no current active remedy groundwater pumping.

2.2.3 Groundwater Use

Groundwater use in the EMC Site historically was a mix of domestic, irrigation, and industrial water supply. Many of these wells were repurposed in the 1990s for the EMC Site for use as groundwater monitoring wells and extraction wells. Many wells were decommissioned in the early phase of the project, as summarized in the *Remedial Investigation/Feasibility Study* (Emcon and Landau Associates 1995). During the early phase of the investigations, groundwater quality samples and groundwater elevation data were collected from multiple sources, such as local private water wells, municipal production wells, industrial water supply wells, and remedy extraction and monitoring wells. Due to the complex network of wells, each early phase well was also identified with unique Portland Monitoring Reference (PMX) well nomenclature. If analytical

results indicated no impacts from the EMC Site, then the use of the wells for data collection was discontinued and access agreements were terminated. Groundwater use for domestic water supply in the area of the EMC Site, including Zone A, is restricted, and applications for new wells must be approved by DEQ, per the Institutional Controls Plan (ICP; Landau Associates, Prowell Environmental 1999).

2.2.4 Surface Water Use

Surface water bodies nearest the EMC Site provide scenic and recreational uses, are water sources for irrigation, and include the following:

- The Columbia River slough located north of NE Sandy Blvd (Zone A): Analytical testing of the slough was not included as a requirement of the Consent Order, since initial testing indicated that VOCs were less than cleanup goals, and testing of treated groundwater is conducted at the EMC groundwater treatment system discharge locations.
- Storm Drain Creek discharges into the Columbia River slough north of NE Sandy Blvd (Zone A): Historically, this creek received treated water from the West Treatment System (TSA groundwater treatment stopped in 2009) and transferred water to the Columbia River slough. Analytical testing of the West Treatment System discharge was conducted as part of the EMC National Pollutant Discharge Elimination (NPDES) permit.
- Fairview Lake and Blue Lake located to the north-northeast (Zone A): During the early phase of the EMC remedial investigation (RI), groundwater elevation data from the two lakes were included in the groundwater modeling program.
- Two springs (Shepard and Taggart Springs) located on the Cascade and Dermody (former Boyd's) properties, respectively, north of Interstate 84 (Zone C): These springs discharge TGA groundwater along the erosional truncation. Shepard Springs was contained and piped to the City of Gresham wastewater treatment plant (WWTP) as part of the Cascade TGA Remedy. TCE concentrations at Taggart Springs were below the cleanup level and did not require remediation, and sampling at Taggart Springs was discontinued once TCE concentration was no longer detected. Taggart Springs currently is free flowing (natural conditions).
- Osborn Creek located to the eastern side of Zone D): Samples collected upstream of Osborn Creek at East Ditch. VOC concentrations were below the laboratory reporting limits, which resulted in Osborn Creek and East Ditch being removed from the Consent Order for additional sampling and remedial action.

- East and West Salish Ponds located southeast of the EMC Site and beyond the EMC Site boundaries: These ponds are upgradient with respect to both surface and groundwater flow.

Stormwater that does not infiltrate unpaved areas is diverted to catch basins that go to the City of Gresham WWTP located on NE Sandy Boulevard.

3.0 BENEFICIAL LAND AND WATER USE DETERMINATION

3.1 Land Use

The EMC Site includes a mixture of industrial, commercial, residential, agricultural, and recreational land uses. Historically, zoning in the area was primarily agricultural; however, conversion of these properties to mixed use has increased over the past few years and is ongoing. Below are examples of some of the land use in the EMC Site and within Remedy Zone A. The current property zoning within the EMC Site is summarized in Figure 2.

EMC Site:

The EMC Site contains land uses summarized below:

- Various industrial land use, including Boeing and Cascade, grocery distribution facilities, and Dermody Properties (formerly Boyd Coffee) warehouse, located south of NE Sandy Boulevard. Other industrial land use properties are located south of Interstate 84.
- Residential areas are located north and south of Interstate 84 and north and east of NE 201st Avenue.
- Current and former agricultural land north of NE Sandy Boulevard. Much of the former agricultural land is being developed with light industrial and commercial warehousing and distribution facilities.

Zone A:

- A Union Pacific Railroad corridor bisects Remedy Zone A running east to west, while NE Sandy Boulevard is directly south of the zone.
- Recreational use of water bodies (Blue Lake, Fairview Lake, and the Columbia Slough), along with Blue Lake Park and the Columbia River marina (directly north of Zone A).
- Residential areas located near the above-mentioned water bodies and a mobile home development.
- Agricultural areas located throughout that are undergoing development with light industrial and commercial warehouses.
- Light industrial and commercial areas located along the northern side of NE Sandy Boulevard.

3.2 Groundwater Use

The EMC Site is located within the CSSWF – Wellhead Protection Area, and City of Portland water is provided to users within the Locality of Facility. The primary source of the City of Portland drinking water is the Bull Run Reservoir; however, a groundwater wellfield is activated periodically to supplement the City of Portland water supply, as needed. The PWB-operated wells are located north of the EMC Site (north of Zone A), and the wells in the direct vicinity of the EMC Site are shown in Figure 1. Contingency plan monitoring requirements are in place for the EMC project (Landau Associates 2019).

A review of Oregon Water Resources Department well logs was for the vicinity of the EMC Site (Township 1N Range 3E, Sections 19-22 and 27-34). No domestic or supply wells have been installed in the EMC Site since the RI phase (1995). Domestic and supply wells installed prior to 1995 are discussed in Section 4.1.

3.3 Surface Water Use

The Upper Columbia Slough is located north of the EMC Site and is an approximately 31-mile waterway that extends from Fairview Lake (northeast of the EMC Site) to the confluence of the Willamette and Columbia Rivers. The Columbia Slough is identified by DEQ as an Area of Concern. DEQ issued a generalized ROD for remedial action approach for Columbia Slough sediment in 2005 for cleaning up contaminated sediment within the waterway (DEQ 2005). DEQ has been authorized to enter into Prospective Purchasers Agreements to encourage beneficial use and redevelopment of commercial and industrial properties within the Columbia Slough vicinity.

Treated groundwater from the EMC Site's Central Treatment System (CTS) is discharged under the NPDES attached to the ROD to the Gresham WWTP that discharges to the Columbia Slough. EMC treated water is tested quarterly at the CTS, and TCE concentrations currently and historically are below detection limits. The clean treated water is piped west and north from the CTS to the City of Gresham's Sandy Boulevard WWTP.

In the EMC Site ROD, discharge of groundwater to surface water in the Columbia Slough was evaluated as a surface water point of compliance, and the ROD concluded that future groundwater discharges to surface water would not cause an exceedance of these criteria, which was confirmed through sampling (ROD Section 5.2).

4.0 INVESTIGATION AND CLEANUP ACTIVITIES

4.1 EMC Site Discovery and Investigations

A summary of the EMC Site discovery and investigations is presented in Appendix B and discussed below.

The EMC Site discovery and groundwater investigations of the TSA and the SGA began in 1986. Results of the early investigations indicated groundwater VOC concentrations above the maximum contaminant levels (MCLs) for TCE, PCE, cis-1,2-DCE, 1,1-DCE, and VC. TCE was determined to be the predominant contaminant and continues to be utilized to evaluate the progress of the remedy. Under natural aquifer conditions, limited breakdown products of TCE have been observed.

In 1990, DEQ implemented a groundwater use management plan (ROD, Section 4.2.2) that included decommissioning of some domestic and supply wells for the EMC Site, as well as coordination with the PWB regarding pumping at the CSSWF. Currently, groundwater use at the EMC Site is restricted, as documented in a DEQ-approved ICP (Landau Associates, Prowell Environmental 1999). A well inventory was conducted as part of the EMC Site RI (Emcon and Landau Associates 1995). The ROD identified 53 private water supply (irrigation and domestic) wells within the EMC Project Area (ROD Section 3.1.2); of these, 27 were utilized to augment RI findings (discussed below), and 6 SGA and 2 TSA wells were decommissioned and the properties provided with public water supply. The remaining 18 private water supply wells were no longer needed for EMC monitoring, and the wells were transferred back to private property owners. These 18 wells and other private water supply/irrigation wells that were utilized during the early phase of the EMC Site investigation prior to and after the ROD that were determined to be not impacted by the dissolved VOC plume were no longer needed for sampling and were "returned" to the well owner[1].

A total of 27 of the private wells (typically denoted with the "PMX" prefix) were incorporated into the EMC Site network and converted to use for monitoring (23 wells) or remedy extraction pumping (4 wells). A total of 80 wells have been decommissioned, as remedy cleanup goals have been achieved and an additional 8 wells have been approved by DEQ for pending

[1] Well counts vary within the ROD. For example, Table 3-1 identifies 56 wells although only 53 were discussed in Section 3.1.2. It appears that many private wells were sampled and no longer monitored if VOCs were not detected, with variation as to whether or not the wells were part of the official EMC Site network.

decommissioning. The monitoring and extraction well network, utilized for the EMC Site remedy after the 1997 Consent Order, are summarized in Table 1, and the current and historic groundwater monitoring well network is shown in Figures 3, 4, and 5. Zones for these wells are designated in these tables and figures.

All but two SGA wells [BOP-44(usg) and PWB-1(usg)] have been decommissioned with DEQ approval based on TCE concentrations below the MCL. Groundwater monitoring at these two remaining wells was discontinued in 2013, as approved by DEQ. Well PWB-1(usg) was installed by the City of Portland for monitoring groundwater quality in the CSSWF and was also utilized by the EMC for remedy monitoring. Once the well was determined to be unneeded to monitor the SGA remedy, DEQ approved the removal of the well from the EMC monitoring program. The City of Portland elected to maintain the well for continued monitoring related to the CSSWF.

Currently, groundwater quality and water level monitoring continue throughout the EMC Site at 67 TSA wells (Table 1 and Figures 3 through 5). Eleven wells were installed in 2011-2019 for combined groundwater monitoring and vapor extraction in Zone C; two of these wells have been decommissioned. Groundwater monitoring is conducted at select sentinel wells during PWB CSSWF pumping (Landau Associates, 2015 and 2019). The current EMC Site groundwater monitoring wells are shown in Figures 9 and 10.

4.2 Remedial Action Objectives

Remedial Action Objectives (RAOs) established in the ROD and Consent Order were for the restoration of the TSA to MCL levels within specific timeframes. These RAOs were based on analyses performed for the Feasibility Study (Landau Associates and Emcon 1996) and subsequent analyses performed for DEQ (SSPA 1996a and b). The RAOs defined in the ROD include:

a) Restore TSA groundwater to protective concentrations (MCLs) within a reasonable time (i.e., 20 years), if feasible. If not feasible, minimize the extent of TSA groundwater with concentrations above the MCL and provide long-term containment;

b) Prevent ingestion of TSA groundwater that contains COPCs above MCLs;

c) Prevent surface water discharge of TSA groundwater with VOC concentrations in excess of surface water cleanup levels;

d) Prevent further spread of contamination in the TSA to the extent practicable;

e) Protect groundwater quality in the SGA and the BLA; and

f) Allow existing uses of groundwater in eastern Multnomah County or minimize type and length of groundwater use restrictions.

4.3 Cleanup Levels

Groundwater cleanup goals, or cleanup levels, were set forth in the ROD as the federal MCLs (Section 6.2), as follows:

- TCE - 5 micrograms per liter (μg/L);
- PCE – 5 μg/L;
- Cis-1,2-DCE - 70 μg/L;
- 1,1-DCE – 7 μg/L; and
- VC – 2 μg/L.

Cleanup levels for surface water were set at the ambient water quality criteria, which were greater than concentrations detected in groundwater. Therefore, the ROD concluded that future groundwater discharges to surface water would not cause an exceedance of these criteria, which was confirmed through sampling (ROD Section 5.2). TCE was determined to be the predominant contaminant and continues to be utilized as the key COPC to evaluate the progress of the remedy. Under natural aquifer conditions, limited breakdown products of TCE has been observed.

4.4 Remedial Actions

The remedial action timeline for TSA Zone A and the SGA is presented in Table B-1 in Appendix B and discussed below.

Installation of groundwater monitoring wells and interim remedial action measures (IRAMs) were completed in the TGA and the TSA at both the Boeing and Cascade properties following initial discovery of TCE in groundwater. Groundwater cleanup began in the TGA in 1989 at both Boeing and Cascade properties under separate Consent Orders. Cleanup of TGA groundwater is ongoing at the Boeing facility (Environmental Cleanup Site Information [ECSI] #13) and was completed at the Cascade facility (ECSI #635) where a Certificate of Closure was issued in January 2015 (DEQ, 2015). IRAMs included source control measures in the TGA and closure of industrial water supply wells in the TSA. In 1993, TSA groundwater extraction using pump and treat methods was commenced as an IRAM in the northern most portion of the EMC Site plume (remedial pumping "RPW" wells). In 1997, installation of extraction wells and the CTS were completed in the TSA mound area (Emcon 1997). The EMC Site RI and Feasibility Study reports were published in 1995 and 1996 (Emcon and Landau 1995; Landau and Emcon, 1996), followed by selection of the remedial action (groundwater containment, pump and treat) described in the ROD (DEQ 1996) and Consent Order (DEQ 1997).

Six groundwater extraction pump and treatments systems were installed between 1993 to 2000 and are shown in Figures 3, 4, and 5. A summary of the systems is provided below. Generally, the

extraction wells were shut down in accordance with the Remedy Performance Criteria discussed in Section 4.5.1.

- North Treatment System (Figures 3, 4, and 5): Located in Zone A and began pilot testing in 1993 with full-scale operation starting in 1997 with one Upper TSA extraction well (EW-9), 5 Lower TSA extraction wells (EW-6, -7, -9, -19, and RPW-2), and one SGA extraction well (EW-20). Extraction wells were shut down and decommissioned in phases, and the treatment system was shut down in 2006 with DEQ approval (DEQ 2006) based on TCE concentrations below the cleanup level. In Zone A, the historical maximum TCE concentrations were 64 µg/L (EW-10) in the TSA (Upper and Lower TSA) and 29 µg/L in the SGA (EW-20). All other COPC results were below the respective MCLs for the North Treatment System extraction wells.
- Far North Treatment System (Figures 3 and 4): Located in Zone A and installed as a stand-alone system with one Lower TSA extraction well EW-17. The system operated from 1998 to 2003 and was decommissioned with DEQ approval in 2007 because TCE concentrations were consistently below the cleanup level for the prior 2 years. All other COPC results were below the respective MCLs for the Far North Treatment System extraction well.
- West Treatment System (Figures 3 and 4): Located in Zone B and began operation in 1989. The system remains in operation for the Boeing TGA project (ECSI #13); however, operation of the system for TSA groundwater was discontinued in 2009. Historically, the system operated with up to 17 TGA extraction wells, along with 2 Upper TSA extraction wells (EW-3 and EW-22) and one Lower TSA extraction well (EW-13). Extraction well EW-22 was decommissioned in 2010, and operation of EW-3 and EW-13 was discontinued in 2009, with DEQ's approval, based on TCE concentrations meeting cleanup levels. Wells EW-3 and EW-13 are currently utilized as groundwater monitoring wells. In this area of the EMC Site remedy (Zone B), the historical maximum TCE concentration 340 µg/L was reported in 1994 at BOP-60(ds). However, TCE concentrations decreased, and by 2018, concentrations in all Zone B wells decreased to below the MCL with the exception of two wells (BOP-61(ds, dg)) where TCE concentration were just above the MCL. All other COPC results were below the respective MCLs for the West Treatment System extraction wells with the exception of EW-3, which had one historical 1,1-DCE detection (23 µg/L in October 1996) above the MCL.
- Central Treatment System (CTS; Figure 4): The system is installed in the TSA mound area in Zone C and started operation in 1997. The CTS continues to operate to provide hydraulic capture of the dissolved VOC plume. A total of 11 Lower TSA extraction wells are routed groundwater to the system (EW-1, -2, -4, -5, -8, -11, -12, -14, -15, -16, -18, and -23). Currently, EW-1 (pilot shutdown mode), EW-2, EW-14, and EW-23 are in active

operation. Wells EW-4, EW-16, and EW-18 have been decommissioned with DEQ approval based on TCE concentrations meeting cleanup levels, while the remaining wells were converted into groundwater monitoring wells. Groundwater monitoring well MW-18(dg) has been utilized to evaluate TCE concentration in this area of the remedy and has yielded the historical and current maximum TCE concentrations (250 µg/L and 98.6 µg/L, respectively).

- East Treatment Systems (Figure 3): Installed as a stand-alone system with one Upper TSA extraction well (EW-10). The system started operation in 1998 and was discontinued in 2001 due to groundwater VOC concentrations being below the MCLs; however, the well was subsequently operated for the property owner's beneficial use until 2005. Historical maximum TCE concentration in this area was 64 µg/L. DEQ approved the shutdown and decommissioning of the East System in March 2005 (DEQ 2005), based on TCE concentrations that had remained below the remedy cleanup level since November 2001. In addition, the EW-21 Treatment System was implemented in 1998, utilizing private supply well PMX-417 with carbon treatment. EW-21/PMX-417 was an irrigation well screened in the Upper TSA. The maximum TCE concentration of 140 µg/L was detected in 2000 and declined to below detection limits in 2003. Based on the low concentrations, the well was shut down in 2004 and extraction was discontinued. TCE concentrations were detected in subsequent monitoring events but were stable below the MCL through 2007. DEQ approved monitoring cessation in 2007, when the well was removed from the remedy program. The owner of the well elected to maintain the well for irrigation purposes.
- SGA Treatment (Figure 5): Cleanup of the SGA was implemented at one groundwater extraction well (EW-20), located in Zone A as part of the North Treatment System (Figure 5). Historically, TCE concentrations in the SGA were between 9.9 and 59 µg/L and highest at three wells EW-20, DEQ-3(usg), and BOP-69(usg). However, TCE concentrations were consistently below the respective reporting limits for other SGA wells. The environmental impact to the SGA was limited in size and concentration. Cleanup of the SGA also was initially envisioned through cleanup of the lower TSA, including control of vertical gradients from the TSA and decommissioning of private water supply wells with suspected leaking well seals. Groundwater extraction in the Lower TSA and the SGA successfully restored SGA groundwater by the year 2000 as cleanup goals were met, and the system was shut down in 2007.

Currently, only the CTS remains in operation with four operating extraction wells, including EW-1 (in temporary shutdown mode), EW-2, EW-14, and EW-23. The four operating extraction wells are screened within and pump groundwater from the Lower TSA, and in 2018, approximately 1.3 pounds of VOCs were removed. By the end of 2018, approximately 494 pounds of VOCs had

been removed in total. The extraction wells also provide hydraulic containment of the dissolved VOC plume, which is a requirement of the ROD.

Performance data indicate that the existing pump and treat system continues to be effective in containing the groundwater VOC plume and for reducing VOC concentrations to below the cleanup level; however, progress toward restoration in the mound area (Zone C) is slow. It is anticipated that operation of the pump and treat system within Zone C will continue until VOC concentrations meet the Consent Order requirements.

In 2014, a soil vapor extraction (SVE) pilot study was commenced in the TSA mound area (Zone C) to evaluate enhanced removal of VOC s in the vadose zone that may contribute mass to the groundwater plume as the water table rises. The system was successful in removing VOC mass, and full-scale operation of the system was implemented in 2015. The system was expanded in 2016 and again in 2019, and additional expansion is being considered where TCE concentrations in groundwater remain above the cleanup level. By the end of 2018, approximately 60 pounds of VOCs had been removed. The current SVE wells are shown in Figure 3.

4.5 Restoration Progress

Cleanup goals have been met in large portions of the TSA, Zone A in particular, and in the SGA throughout the EMC Site. A comparison of the average TCE concentrations through time in the TSA remedy zones indicates that groundwater meets the RAO goals in both Zone A and the SGA (100% compliant) and therefore, a Partial or Conditional NFA determination is being evaluated for these areas of the EMC Site. Other remedy zones (Zones B and D) have also met the RAO goals, with the exception of one well in Zone D. These Zones are currently being evaluated for a Partial or Conditional NFA determination. TCE concentrations in 11 of 33 remaining Remedy Zone C wells remain above cleanup goals where remediation is ongoing. Spatially, the EMC Site plume reduced from over 400 acres in 1994 to 28 acres in 2018, or a 93% decrease in the plume footprint (Figures 3, 4, and 5). It is worth noting that the ROD reports the area of the dissolved plume was 300 acres; however, the Annual Performance Report for 1 January 2018 – 31 December 2018 (Geosyntec, Landau Associates, and SSPA 2019) indicate that the maximum areal extent of the dissolved plume was 400 acres. A discussion of the EMC Site TSA Remedy (including Zone A and the SGA) restoration progress is provided in the following sections.

4.5.1 Monitoring Network Criteria

The ROD establishes criteria for the remedy well network, including extraction and monitoring wells. In broad terms, the remedy well network will provide hydraulic control of the plume and provide information for the evaluation of restoration progress and hydraulic control. The specific criteria established in the 2005 Annual Report (Landau Associates, Prowell Environmental, Pegasus Geoscience 2006) and used thereafter for evaluating changes to the remedy well

network is provided in Table 2 and includes shutting down extraction wells, modifying the monitoring well network, and well decommissioning. Extraction and monitoring wells removed from the remedy well network represent treatment areas where: 1) detectable concentrations have been shown to be below the cleanup levels (MCLs); and 2) well locations no longer provide information useful in evaluating restoration progress or hydraulic control (i.e., well locations are redundant).

4.5.2 Remedial Zone Status

The 2018 Annual Performance Report (Geosyntec, Landau Associates, and SSPA 2019) describes remedy progress and summarizes the status of each restoration zone. Restoration goals for Zone A and the SGA have been attained, and restoration goals for Zones B and D are also nearing attainment. Elevated TCE concentrations persist in Zone C, and remedy actions have extended beyond the estimated 2018-year timeframe described in the ROD. Additional remedy alternative evaluations, including implementation of an SVE system, are being conducted for Zone C.

In 2018, TCE was detected at 29 wells and concentrations remained above cleanup goals at 12 of 44 wells monitored as of August 2018 (Geosyntec, Landau Associates, SSPA, 2019). Nine of these 12 wells with TCE above the MCL are located in Zone C, two are located in Zone B, and one is located in Zone D. TCE concentrations in the TSA above the MCL are generally in three regions: 1) north of the Cascade property in the TSA mound area (located in the central portion of the original plume in Remedy Zone C); 2) on the Boeing property in the vicinity of wells BOP-61(ds) and BOP-61(dg) (Remedy Zone B/C boundary); and 3) in the vicinity of 207th Avenue near MW-26(dg) (Remedy Zone D). TCE concentrations in wells in Zones B and D are typically near the MCL and have limited areal extents.

The following summarizes the status of each restoration zone.

SGA

- Cleanup goals were met, and restoration of the SGA was achieved by 2007. As SGA groundwater quality met the MCL and the established well network criteria (Table 2), DEQ approved the decommissioning of all wells in the SGA. Out of the 24 SGA wells incorporated into the EMC Site, only one SGA well, BOP-44(usg), remains. This well has been used as part of the PWB Contingency Monitoring Plan, and DEQ approved decommissioning of BOP-44(usg) in 2018 (DEQ 2018a), since concentrations of TCE were below the cleanup level from 1997 through 2013.

Zone A

- Four wells remain in the EMC Site well network in Zone A for use during PWB contingency monitoring, but these wells are no longer monitored as part of the EMC Remedy performance evaluation, since TCE concentrations were consistently below the MCL in Remedy Zone A and met the remedy performance and monitoring criteria. PWB Contingency monitoring wells in Zone A were monitored during the 2018 and 2019 PWB CSSWF pumping events, and TCE was not detected and groundwater flow directions did not change significantly in the TSA wells monitored.
- PWB monitors several groundwater monitoring wells in Zone A as part of the CSSWF monitoring program. Four PWB wells were also utilized for EMC Site monitoring purposes during the early phases of the investigation; however only two wells, PWB-1 (well cluster with wells screened in the Upper TSA, Lower TSA, and SGA) and PWB-2 (two wells screened in the Lower TSA and SGA) were monitored for the EMC Site during full-scale remediation operation. At Upper TSA well PWB-1(uts), TCE concentrations decreased from the maximum concentration of 49 µg/L (1994) to below the MCL in 2000, and then consistently to non-detect at the laboratory reporting limit from 2004 to 2015 when the well was removed from the EMC monitoring program with DEQ's approval. PWB well PWB-1(lts), screened in the Lower TSA, had a maximum TCE concentration of 42 µg/L in 1997; however, concentrations decreased to below the MCL in 1998. In the past few years, low-level TCE concentrations, ranging from 1 to 2.05 µg/L, have been detected by both PWB and the EMC Site. The low-level concentrations are less than half of the MCL (5 µg/L) and appear to be isolated to PWB-1(lts), as TCE concentrations in EMC Site wells located closer to the dissolved plume are non-detect at the laboratory reporting limit (0.2 to 1.0 µg/L). To evaluate potential reasons for the low-level concentrations, PWB-1(lts) well construction was compared to other, similar Lower TSA EMC Site wells [i.e., BOP-44(dg)]. Both wells are constructed similarly with schedule 80 polyvinyl chloride well casing and 0.020-ft slot sized screens installed toward the base of the Lower TSA and the top of CU2. However, the bottom of PWB-1(lts) screen interval is directly on top of the contact between the Lower TSA and the underlying CU2, while BOP-44(dg) is approximately 2 feet above the contact. In addition, a step-down in drilling casing was utilized during drilling of BOP-44(dg) to minimize the potential of downward migration of impacted material during drilling from the upper CU1 to the underlying Upper TSA, but does not appear to have been conducted at PWB-1(lts). The PWB continues to monitor PWB-1(lts) and other vicinity wells as part of their groundwater monitoring network.
- Restoration has been achieved in Zone A for the Upper TSA, Lower TSA, and the underlying SGA. EMC Site wells that remain in Zone A include one Upper TSA well, BOP-44(ds), two Lower TSA wells BOP-44(dg) and EMC-2(dg), and one SGA well,

BOP-44(usg). PWB continues to monitor several of their wells located in Zone A, including PWB-1lts, PWB-1uts, PWB-1usg, and PWB-2lts.

Zone B

- In Zone B, TCE was detected in 9 of 15 wells monitored, with only 2 above the MCL as of August 2018. As of August 2018, TCE was below the MCL in all Zone B wells monitored. TCE concentrations in the two wells have fluctuated near the cleanup level for the past 5+ years.
- Restoration in Zone B is complete as of August 2018 monitoring, and TCE concentrations were below the cleanup level for all Zone B monitoring wells. Monitoring wells will continue to be monitored to verify that the Zone meets the Consent Order cleanup levels.

Zone C

- In Remedy Zone C, TCE was detected in 17 out of 26 wells monitored as of August 2018. The 9 wells with TCE concentrations that exceed the MCL span an area of approximately 28 acres. This area extends for about 1,200 feet in an east-west direction (from west of well D-17(ds) to east of well MW-18(ds)) and to the south of the TGA/CU1 erosional truncation.
- Restoration in Zone C continues, as this portion of the remediation area has been slower to respond to remedial actions and TCE concentrations in the mound area fluctuate. The SVE system was installed in 2015 in the central portion of Zone C and expanded in 2019 to expedite mass removal from the unsaturated zone. Additional remedy evaluations are ongoing.

Zone D

- Of the three wells monitored in Zone D, TCE concentrations have been above the MCL at one well, MW-26dg, during the last three (2018-2019) monitoring events. TCE was not detected in the other two wells monitored in Zone D in 2018-2019.
- Restoration in Zone D is almost complete, as current TCE concentrations are above the cleanup level in 1 of the 3 wells monitoring for this zone. In 2018, TCE concentrations in CMW-26dg were detected at 3.7 and 6.46 µg/L, and the majority of sample results concentrations are near the MCL of 5 µg/l. Continued groundwater monitoring in Zone D is ongoing.

VOC results in groundwater for Zone A and SGA are summarized in Table 3. TCE profiles for select Zone A TSA wells and SGA wells are presented in Figures C-1 and C-2 in Appendix C. VOC results for wells in the remaining remedy zones are available in the 2018 Annual Report.

5.0 RISK EVALUATION

This section describes the risk conceptual site model, sources of contamination, and pertinent receptors and pathways that were determined for the EMC Site.

5.1 Risk Conceptual Site Model

Potential human and ecological exposures were evaluated as part of the Endangerment Assessment completed in the RI (Emcon and Landau 1995) and summarized in the ROD. Potentially complete exposure pathways evaluated included occupational exposures to TSA groundwater, residential exposures to TSA and SGA groundwater, and residential and recreational exposures to groundwater discharges into the Columbia Slough. Risk estimates for cancer and non-cancer endpoints, with TCE as the primary COPC, ranged from $4.0x10^{-5}$ to $4.8x10^{-6}$ for the TSA and $3.4x10^{-6}$ to $4.6x10^{-7}$ for the SGA, as summarized in the ROD. For ecological receptors, discharge of groundwater to surface water in the Columbia Slough was evaluated, with the marsh wren and muskrat as key indicator species. Results of the ecological risk evaluation indicated that these receptors were not expected to be impacted by COPCs in the Columbia Slough.

Volatilization of contaminants from groundwater to residential receptors, including inhalation (along with ingestion and dermal), was evaluated as part of the Endangerment Assessment in the ROD. The cleanup levels established in the ROD were selected to be protective of the groundwater exposures above. For human health, these were selected as the federal drinking water MCLs and for ecological receptors as the ambient water quality criteria (as described in Section 4.3). These two potentially complete pathways are applicable for EMC TSA Remedy Zone A.

5.2 Sources of Contamination

As defined in the ROD, the primary source of contamination of the TSA is the discharge of contaminated groundwater from the overlying TGA, which was released into the environment at both the Cascade and Boeing facilities. Potential migration pathways from the TGA to the TSA include spring infiltration, seeps, and vertical leakage along well casings of former water supply wells, leakage through the confining layer (CU1), and lateral flow across the TGA and underlying CU1 erosional truncation.

The primary source of contamination of the underlying SGA is likely leakage along well casings completed through the confining layer (CU2) between the TSA and the SGA, as defined in the ROD.

In EMC TSA Remedy Zone A, the primary source of contamination was from groundwater migration via lateral flow in the TSA and the SGA along regional flowpaths and gradients.

5.3 Pertinent Pathways and Receptors Zone A and SGA

Of the COPCs identified during early initial investigations in the EMC Site, TCE was the compound most detected by mass in the dissolved VOC plume. During the early phase of the remedy, the maximum TCE concentration reported in the SGA was 59 µg/L (DEQ-3(i)) and 68 µg/L (EW-10) in the TSA Zone A wells. Nine wells installed in the BLA were monitored during the early phase of the investigation; however, all analytical results were below the laboratory reporting limit at the time of sampling (0.5 µg/L). Groundwater sampling of the BLA as part of the EMC ceased in 1997. The table below provides a summary of TCE concentrations in the SGA, the BLA, and the TSA in Zone A. Time versus concentration plots for select SGA and Zone A TSA wells are included in Appendix C.

Aquifer/ Zone	No of Wells	No. Samples	Maximum TCE Concentration (µg/L)	Minimum TCE Concentration (µg/L)	MCL	No. of Detects Above MCL (1986-2012)	No. of Detects Above MCL (2013-2018)
SGA	24	631	59	<0.2	5	59	0
TSA Zone A	38	1429	68	<0.2	5	661	4
BLA	9		0.3	<0.2	5	0	Not applicable

5.3.1 Columbia South Shore Wellfield

The SGA, the BLA, and the TSA that provide groundwater for the PWB CSSWF and portions of the EMC Site are located within the CSSWF Wellhead Protection Area and upgradient of the CSSWF. Based on the proximity of the EMC Site to the CSSWF, DEQ and PWB have an interagency agreement in which PWB can provide comments and recommendations on the EMC Site remedy progress to DEQ, while also keeping DEQ informed of pending timeframes of wellfield operations.

Typically, the CSSWF is only operated for maintenance purposes or to augment the water provided by the Bull Run Reservoir. The CSSWF is capable of producing millions of gallons a day from the aquifers to provide drinking water to the City of Portland. During active operation of the CSSWF, groundwater elevations in some EMC wells can decrease anywhere from 10 to 40 feet, based on the duration of the PWB pumping event, the CSSWF wells that are selected to operate during the event, and the extraction rate and depth of the CSSWF individual production wells. During active operation of the CSSWF, hydraulic capture of the dissolved VOC plume is

maintained in the mound area, although water levels can decrease temporarily in the northern extent of the EMC Site.

A PWB Contingency Monitoring Plan has been implemented during prolonged operation of the CSSWF, and the ICP was last updated in 2019 (Landau Associates, 2019). The objective of the contingency plan is to monitor the hydraulic control of the dissolved VOC plume, groundwater containment, and remedy restoration progress during periods of both non-pumping and active pumping of the CSSWF. The plan identifies selected sentinel wells located downgradient of the dissolved VOC plume and upgradient of the CSSWF and increased monitoring efforts for EMC Site wells during CSSWF pumping. The sentinel wells are equipped with dataloggers to allow for continuous water-level measurements, and increased groundwater quality monitoring is conducted during and after operation of the CSSWF wellfield. Data from the contingency monitoring are shared with both DEQ and PWB.

6.0 CONCLUSIONS

Monitoring wells located in EMC Remedy Zone A and the SGA met monitoring well network and ROD requirements, and in 2018, DEQ authorized the preparation of partial closure (partial NFA) for the SGA and TSA Remedy Zone A (DEQ 2018b). Based on successful restoration of groundwater quality in the EMC Site TSA Remedy Zone A and the underlying SGA (throughout the EMC Site), a Partial NFA/partial closure is recommended for these areas of the EMC Site. Remedy shall continue in other areas of the EMC Site until Consent Order criteria are met.

Following the Partial NFA for Zone A and SGA, the remaining four (3 TSA and 1 SGA) wells will be decommissioned. Monitoring of other EMC Site sentinel wells will continue during times of PWB CSSWF pumping in accordance with the DEQ-approved 2019 PWB Contingency Monitoring Plan.

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TABLES

Table 1
EMC TSA Remedy
Well Inventory and Construction Details

Well Name	Remedy Zone	PMX No.	Aquifer	Installed/ Completed Date	Decommission Date	Well Included in 2018 EMC Well Network (Yes/No)
A-1d (Supply Well)	Zone B	--	TSA	03/16/1976	08/01/2000	No
A-2d (Supply Well)	Zone B	--	TSA	08/26/1964	07/01/1988	No
A-3 (Supply Well)	Zone B	--	TSA	03/12/1957	06/01/1989	No
A-4 (Supply Well)	Zone B	--	TSA	10/11/1961	06/29/2004	No
A-5d (Supply Well)	Zone B	555	TSA	01/25/1971	--	No
A-6 (Supply Well)	Zone B	--	TSA	06/01/1989	07/15/2004	No
A-7 (Supply Well)	Zone B	--	TSA	05/14/1986	03/01/1990	No
BOP-13(dg)	Zone C	--	TSA	1/4/1987	--	Yes
BOP-13(ds)	Zone C	465	TSA	10/26/1993	--	Yes
BOP-14d	Zone C	--	TSA Cong	12/08/1986	03/12/1990	No
BOP-14s	Zone C	--	TSA SS	02/12/1987	03/12/1990	No
BOP-20(dg)	Zone B	515	TSA	3/11/1989	--	Yes
BOP-20(ds)	Zone B	516	TSA	16-Mar-89	--	Yes
BOP-21(dg)	Zone B	--	TSA	06-Mar-89	06/2000	No
BOP-21(ds)	Zone B	519	TSA	12-Mar-89	--	Yes
BOP-22(dg)	Zone B	--	TSA	05-Mar-89	10/21/2016	No
BOP-22(ds)	Zone B	--	TSA	13-Mar-89	01/05/2009	No
BOP-22R(ds)	Zone B	--	TSA	14-Oct-08	11/17/2019	Yes
BOP-23(dg)	Zone C	522	TSA	02-Feb-90	--	Yes
BOP-23(ds)	Zone C	--	TSA	10-Mar-10	03/10/2010	No
BOP-31(dg)	Zone C	528	TSA	16-Jan-91	--	Yes
BOP-31(ds)	Zone C	526	TSA	09-Jan-91	--	Yes
BOP-41(dg)	Zone B	542	TSA	04-Feb-92	11/01/2015	No
BOP-41(ds)	Zone B	543	TSA	27-Jan-92	11/01/2015	No
BOP-42(dg)	Zone B	544	TSA	05-Feb-92	--	Yes
BOP-42(ds)	Zone B	545	TSA	07-Feb-93	--	Yes
BOP-43(dg)	Zone A	546	TSA	17-Apr-92	09/06/2012	No
BOP-43(ds)	Zone A	547	TSA	22-Apr-92	09/05/2012	No
BOP-44(dg)	Zone A	592	TSA	01-Aug-07	pending	Yes
BOP-44(ds)	Zone A	591	TSA	01-Aug-07	pending	Yes
BOP-44(usg)	Zone A	--	SGA	01-Aug-07	pending	Yes
BOP-60(dg)	Zone B	455	TSA	18-Apr-94	--	Yes
BOP-60(ds)	Zone B	--	TSA	09-May-94	03/30/2010	No
BOP-60R(ds)	Zone B	--	TSA	03-Mar-10	11/17/2019	Yes
BOP-61(dg)	Zone B	457	TSA	24-Jun-94	--	Yes
BOP-61(ds)	Zone B	456	TSA	31-May-94	--	Yes
BOP-62(ds)	Zone B	458	TSA	15-Mar-94	--	Yes
BOP-63(ds)	Zone B	--	TSA	13-Jul-94	06/2000	No
BOP-64(ds)	Zone B	--	TSA	03/22/1994	06/2000	No
BOP-65(ds)	Zone B	461	TSA	07/05/1994	--	Yes
BOP-66(ds)	Zone B	462	TSA	05/17/1994	--	Yes
BOP-67(ds)	Zone B	--	TSA	02/02/1995	06/2000	No
BOP-68(usg)	--	--	SGA	05/08/1995	09/06/2012	No
BOP-69(usg)	--	--	CU2/SGA	07/01/1997	05/24/2012	No
BOP-70(ds-215)	Zone A	--	TSA	03/29/2007	10/30/2018	No
BOP-70(ds-245)	Zone A	--	TSA	03/29/2007	10/30/2018	No
BOP-70(ds-275)	Zone A	--	TSA	03/29/2007	10/30/2018	No
BOP-71(ds)	Zone A	--	TSA	03/01/2007	pending	No
C-3/PW7	--	136	SGA	11/24/1981	PW	No
Cascade Industrial Well (Supply Well)	Zone C	--	TSA	10/26/1964	01/01/1991	No
D-15(dg)	Zone A	590	TSA	02/04/1993	03/01/2010	No
D-15(ds)	Zone A	589	TSA	02/09/1993	03/01/2010	No
D-16(dg)	Zone A	594	TSA	08/10/1993	10/02/2018	No

Table 1
EMC TSA Remedy
Well Inventory and Construction Details

Well Name	Remedy Zone	PMX No.	Aquifer	Installed/ Completed Date	Decommission Date	Well Included in 2018 EMC Well Network (Yes/No)
D-16(ds)	Zone A	593	TSA	09/02/1993	10/01/2018	No
D-17(dg)	Zone C	467	TSA	11/17/1993	--	Yes
D-17(ds)	Zone C	466	TSA	11/12/1993	--	Yes
D-18(dg)	Zone A	--	TSA	04/13/1995	03/02/2010	No
D-18(ds)	Zone A	--	TSA SS	04/19/1995	10/10/2018	No
DEQ-1(dg)	Zone C	902	TSA	10/25/1990	07/11/2019	Yes
DEQ-1(ds)	Zone C	901	TSA	09/17/1990	03/02/2010	No
DEQ-3(d)	--	905	SGA	10/25/1990	10/18/2006	No
DEQ-3(i)	Zone A	904	TSA	10/31/1990	10/18/2006	No
DEQ-3(s)	Zone A	--	TSA	09/06/1990	05/1998	No
DEQ-3(usg)	--	--	SGA	11/27/1996	10/18/2006	No
DEQ-4(d)	--	907	SGA	09/24/1990	08/03/1999	No
DEQ-4(s)	Zone A	906	TSA	09/14/1990	08/03/1999	No
DEQ-5(dg)	Zone B	910	TSA	03/16/1993	07/10/2019	Yes
DEQ-5(ds)	Zone B	909	TSA	03/29/1993	07/10/2019	Yes
EMC-1(dg)	Zone A	912	TSA	02/12/1993	03/15/2000	No
EMC-1(ds)	Zone A	911	TSA	02/24/1993	03/15/2000	No
EMC-2(dg)	Zone A	914	TSA	05/28/1993	pending	Yes
EMC-2(ds)	Zone A	913	TSA	06/03/1993	03/02/2010	No
EMC-2(usg)	--	--	SGA	09/11/1997	04/27/2017	No
EW-1	Zone C	--	TSA	12/07/1996	--	Yes
EW-10 [PMX-189]	Zone A	189	TSA	08/25/1950	05/2005	No
EW-11	Zone C/D	--	TSA	01/23/1998	--	Yes
EW-12	Zone C	--	TSA	06/26/1997	--	Yes
EW-13	Zone B	--	TSA	11/25/1997	--	Yes
EW-14	Zone C	--	TSA	11/13/1997	--	Yes
EW-15	Zone D	--	TSA	07/16/1998	--	Yes
EW-16	Zone D	--	TSA Cong & CU2	10/21/1997	--	Yes
EW-17	Zone A	--	TSA	02/11/1998	10/23/2008	No
EW-18	Zone C/D	--	TSA	05/08/1998	11/20/2015	No
EW-19	Zone A	--	TSA	11/24/1997	10/23/2008	No
EW-2	Zone C	--	TSA	09/23/1996	--	Yes
EW-20(usg)	--	--	CU2 Equiv & Upper	05/27/1998	10/18/2006	No
EW-21 [PMX-417]	Zone D	417	TSA	02/02/1983	PW	No
EW-22	Zone B	--	TSA	06/12/2003	03/26/2010	No
EW-23	Zone B/C	--	Lower TSA	01/23/2007	--	Yes
EW-3	Zone B	--	TSA	10/28/1996	--	Yes
EW-6	Zone A	--	TSA	05/12/1997	10/18/2006	No
EW-7	Zone A	--	TSA	05/07/1997	10/23/2008	No
EW-8	Zone C	--	TSA	06/10/1997	--	Yes
EW-9	Zone A	--	TSA	05/20/1997	10/23/2008	No
MW-10(dg)	Zone C	816	TSA	05/14/1990	pending	Yes
MW-10(ds)	Zone C	821	TSA	12/26/1990	--	Yes
MW-14(dg)	Zone C	825	TSA	12/14/1990	03/2007	No
MW-14(ds)	Zone C	826	TSA	12/11/1990	03/2007	No
MW-14(usg)	--	--	SGA	10/27/1995	03/13/2007	No
MW-14R(dg)	Zone C	--	TSA	02/06/2007	03/01/2010	No
MW-14R(ds)	Zone C	--	TSA	02/07/2007	--	Yes
MW-16(dg) [EW-4]	Zone D	831	TSA	06/02/1992	11/12/2015	No
MW-17(ds)	Zone C	833	TSA	05/06/1992	--	Yes
MW-18(ds)	Zone C	834	TSA	06/19/1992	--	Yes
MW-19(ds)	Zone C	835	TSA	06/08/1992	--	Yes
MW-2	Zone C	802	TSA SS & Cong	09/11/1988	12/11/2000	No
MW-20(dg)	Zone C	851	TSA	01/19/1993	03/02/2010	No

Table 1
EMC TSA Remedy
Well Inventory and Construction Details

Well Name	Remedy Zone	PMX No.	Aquifer	Installed/ Completed Date	Decommission Date	Well Included in 2018 EMC Well Network (Yes/No)
MW-20(ds)	Zone C	850	TSA	01/22/1993	--	Yes
MW-22(dg)	Zone C	855	TSA	05/10/1993	--	Yes
MW-22(ds)	Zone C	854	TSA	05/14/1993	03/01/2010	No
MW-23(ds)	Zone C	836	TSA	06/26/1992	03/13/2007	No
MW-24(dg) [EW-5]	Zone C	847	TSA	10/07/1992	--	Yes
MW-25(dg)	Zone C	848	TSA	09/24/1992	--	Yes
MW-26(dg)	Zone D	--	TSA	03/04/1994	--	Yes
MW-26(ds)	Zone D	837	TSA	03/07/1994	11/22/2005	No
MW-29(dg)	Zone D	866	TSA	03/22/1995	03/15/2000	No
MW-29(ds)	Zone D	865	TSA	03/01/1995	03/01/2010	No
MW-3	Zone C	803	TSA SS & Cong	10/06/1988	pending	Yes
MW-36(dg)	Zone A/C	--	TSA	11/08/1996	--	Yes
MW-37(usg)	--	--	SGA	12/13/1996	03/2007	No
MW-38(usg)	--	--	SGA	09/30/1997	03/13/2007	No
MW-41(ds)	Zone A	--	TSA	08/28/1998	03/02/2010	No
MW-8(dg)	Zone C	811	TSA	04/02/1990	pending	Yes
PMX128	Zone A	128	TSA	09/10/1980	09/02/1987	No
PMX-133	--	133	BLA	NA	PW	No
PMX-135	--	135	SGA	08/01/1981	06/27/1990	No
PMX138	Zone A	138	TSA	01/01/1976	PW	No
PMX-140	--	140	SGA	07/22/1977	12/2000	No
PMX-141	Zone A	141	TSA	08/29/1977	PW	No
PMX-147	--	147	BLA	10/11/1982	PW	No
PMX-165 [E. Interlachen]	Zone A	165	TSA	08/01/1981	PW	No
PMX-166 [W. Interlachen]	--	166	SGA	07/27/1967	PW	No
PMX-167 [W. Interlachen]	Zone A	167	TSA	08/01/1981	PW	Yes
PMX168	--	168	TSA	NA	05/06/1992	No
PMX-170	--	170	BLA	10/07/1982	PW	No
PMX-174 [E. Interlachen]	--	174	SGA	10/17/1967	PW	No
PMX175	--	175	TSA	NA	PW	No
PMX176	--	176	SGA	05/30/1956	PW	No
PMX-192 [Pelfrey]	--	192	SGA	12/12/1959	PW	No
PMX-194 [Schmidt]	--	194	SGA	05/14/1962	06/01/1998	No
PMX-195 [Handy]	--	195	SGA	12/01/1968	07/1998	No
PMX-196 [Andrews]	Zone A	196	TSA	06/25/1982	PW	No
PMX-198 [Udd]	Zone A	198	TSA	03/19/1964	PW	No
PMX-202 [Rolling Hills]	--	202	SGA	09/27/1971	PW	No
PMX-207 [Shepard]	--	207	SGA	10/01/1951	10/10/1996	No
PMX-208(dg) [Sandy Mobile]	Zone C	208	TSA	07/09/1965	PW	No
PMX-208R [Sandy Mobile]	--	208R	SGA	07/30/1999	PW	No
PMX-225 [Cherry Blossom]	--	225	SGA	08/30/1967	05/29/1997	No
PMX-227 [Rockwood]	--	227	SGA	12/17/1980	01/01/2005	No
PMX235	--	235	SGA	NA	PW	No
PMX239	--	239	SGA	01/01/1976	PW	No
PMX-345 [Edwards]	Zone A	345	TSA Cong	12/15/1976	PW	No
PMX-409 [Sandy Mobile]	--	409	SGA	NA	07/31/1997	No
PMX-410R [Terrand]	--	410R	SGA	06/16/1997	PW	No
PMX-419 [Big Eddy]	Zone A	419	TSA	NA	PW	No
PMX-434 [Schmautz]	Zone A	434	TSA	03/23/1977	PW	No
PMX60	--	60	SGA	09/02/1987	PW	No
PMX66	--	66	SGA	NA	PW	No
PMX72	--	72	TSA	NA	PW	No
PMX78	--	78	SGA	NA	PW	No
PMX8	--	8	SGA	NA	PW	No

Table 1
EMC TSA Remedy
Well Inventory and Construction Details

Well Name	Remedy Zone	PMX No.	Aquifer	Installed/ Completed Date	Decommission Date	Well Included in 2018 EMC Well Network (Yes/No)
PW-11	--	12	SGA	NA	09/02/1987	No
PW-12	--	150	BLA	10/26/1982	PW	No
PW-13	--	162	BLA	09/13/1983	PW	No
PW-14	--	132	SGA	06/13/1983	PW	No
PW-17	--	148	BLA	11/18/1983	PW	No
PW-18	--	155	BLA	10/31/1983	PW	No
PW-19	--	158	BLA	05/09/1984	PW	No
PW-4	--	122	SGA	07/15/1980	PW	No
PW-8	--	142	SGA	09/28/1981	PW	No
PW-9	--	126	SGA	03/22/1982	PW	No
PWB-1(lts)	Zone A	392	TSA	08/08/1992	PW	Yes
PWB-1(usg)	--	393	SGA	08/07/1992	PW	No
PWB-1(uts)	Zone A	391	TSA	08/09/1992	PW	Yes
PWB-2(lts)	Zone A	--	TSA	09/21/1994	PW	Yes
PWB-2(usg)	--	--	SGA	09/30/1994	PW	No
PWB-4(d)	--	--	SGA	05/30/1997	PW	No
PWB-4(i)	--	--	TSA	06/16/1997	PW	No
PWB-4(s)	Zone A	--	TSA	06/06/1997	PW	No
RPW-1(dg)	Zone A	859	TSA	08/18/1993	09/14/2010	No
RPW-1(ds)	--	858	TSA	08/08/1993	07/01/2018	No
RPW-2	Zone A	860	TSA	04/04/1994	10/23/2008	No
TW-14	--	131	SGA	01/18/1978	PW	No
TW-19	--	157	BLA	04/29/1983	PW	No
VMW-A	Zone C	--	TSA	11/21/2016	--	Yes
VMW-B	Zone C	--	TSA	11/23/2016	--	Yes
VMW-C	Zone C	--	TSA	11/30/2016	--	Yes
VMW-D	Zone C	--	TSA	12/05/2016	--	Yes
VMW-E	Zone C	--	TSA	02/23/2019	--	Yes
VMW-F	Zone C	--	TSA	02/20/2019	--	Yes
VMW-G	Zone C	--	TSA	02/26/2019	--	Yes
VMW-H	Zone C	--	TSA	02/28/2019	--	Yes
VW-17d-75.0	Zone C	--	TSA SS	03/08/2012	10/01/2018	No
VW-17d-95.5	Zone C	--	TSA	03/23/2012	--	Yes

Notes:
-- Not applicable
NA = Data not available
BLA = Blue Lake Aquifer
CGL = conglomerate
CU 1 = Confining Unit 1
CU 2 = Confining Unit 2
PMX = Portland Monitoring Reference identification system developed by the East County Site project.
PW = Well owned by either private property owner and used as a domestic well or a well utilized by Portland Water Bureau (PWB) as part of the Columbia South Shore Wellfield.
SGA = Sand and Gravel Aquifer
SS = Sandstone
TSA = Troutdale Sandstone Aquifer

Table 2
Remedy Well Network Criteria
East Multnomah County TSA Remedy

This table summarizes TSA remedy criteria for extraction well pilot shutdown, well and system decommissioning, monitoring well network modifications, and changes in sampling frequency. These criteria were presented in Section 5 of the eighth TSA annual performance report[1] and are summarized below for ongoing reference.

1. PILOT SHUTDOWN CRITERIA

The following criteria are for TSA extraction well(s) currently in pilot shutdown mode:

- *If TCE concentrations in these pilot shutdown wells increase to levels equal to or above the MCL for two consecutive quarters, extraction at individual wells shall resume.*
- *If TCE remains below the MCL cleanup level for 2 years, DEQ will evaluate potential decommissioning of these wells.*

2. MONITORING WELL NETWORK MODIFICATION

Wells may be removed from the monitoring program if a well meets one or more of the following criteria:

- *TCE concentrations have been consistently below detection limits for 2 or more years.*
- *The well is located outside the limits of the plume and is no longer needed to monitor hydraulic plume control or restoration progress.*
- *The location of a well duplicates another well better suited to evaluate hydraulic control and restoration progress.*

3. SAMPLING FREQUENCY MODIFICATIONS

The following criteria serve to standardize current and future monitoring adjustments as restoration progresses over the coming years:

Criteria for Increasing Sampling Frequency:

- *The sampling frequency will be increased at a well if TCE concentrations increase to detected levels for two consecutive sampling events where they have been below detection limits for 2 or more years.*
- *The sampling frequency will be increased at a well if TCE concentrations increase above the MCL for two consecutive sampling events where they have been below the MCL for 2 or more years.*

Criteria for Reducing Sampling Frequency:

- *If TCE has been consistently below detection limits for the prior 2 years, the sampling frequency may be reduced.*
- *If TCE has been stable to declining for the prior 2 years, the sampling frequency may be reduced.*

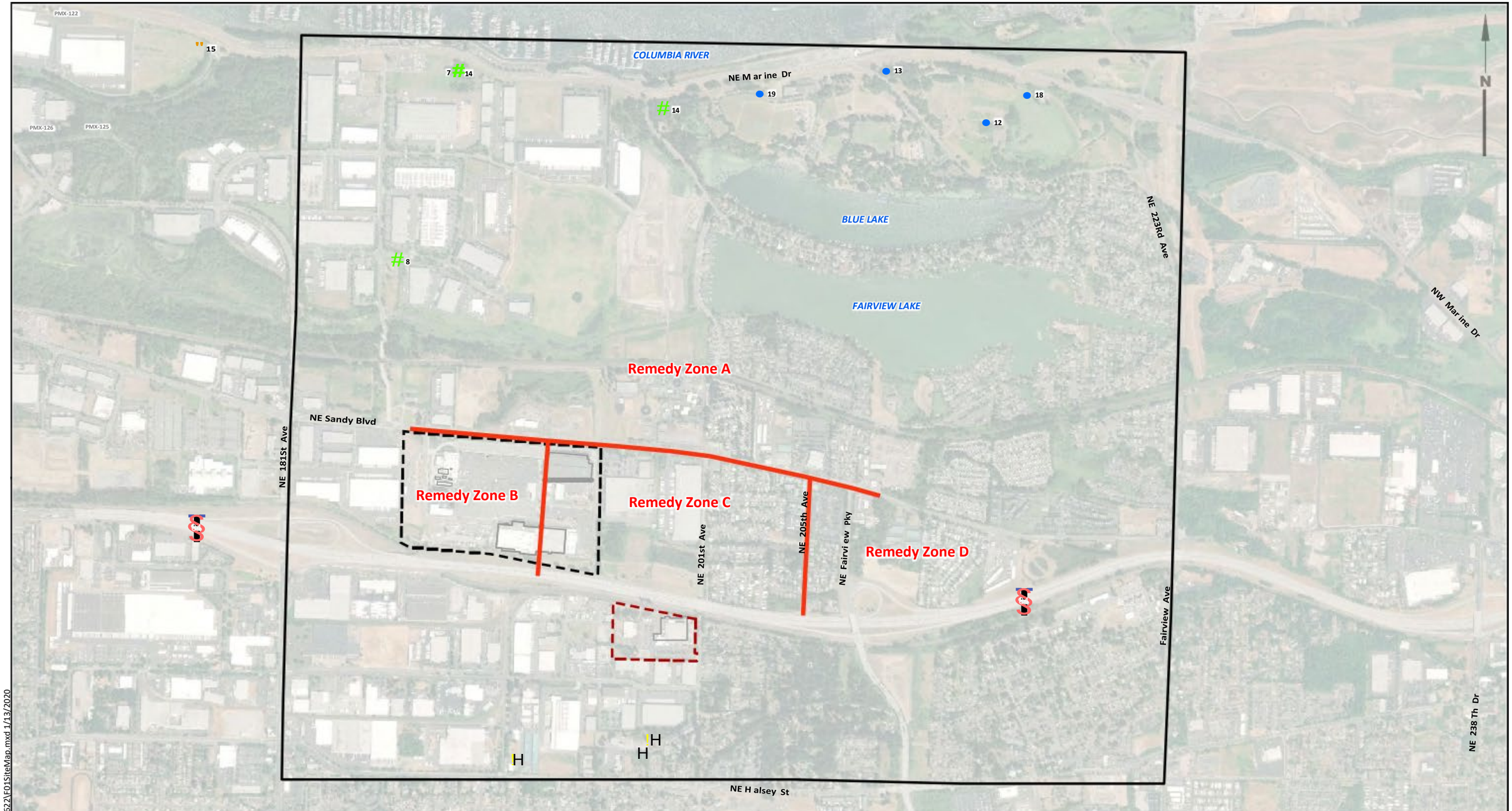
4. CRITERIA FOR WELL DECOMMISSIONINGS

Extraction and monitoring well decommissionings will be proposed to DEQ if the following criteria are met:

- *Extraction well decommissioning may be proposed to DEQ if TCE concentrations remain consistently below the MCL in that well for 2 years following pilot shutdown; two consecutive TCE detections at or above the MCL may prompt resumed operation.*
- *Monitoring well decommissioning will be proposed to DEQ if TCE concentrations remain below the MCL for 2 consecutive years.*

[1] Landau Associates, Prowell Environmental, Pegasus Geoscience, 2006. Troutdale Sandstone Aquifer Remedial Action Annual Performance Evaluation, 04/01/05 through 03/31/06. 30 June 2006.

FIGURES



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Legend

- PWB BLA Production Well
- PWB SGA Production Well
- PWB TSA Production Well
- Gresham/Rockwood Municipal Well
- Boeing Portland Property
- Cascade Corporation Property
- Original EMC Site Study Area

0 1,200 2,400

Scale in Feet

Data Source: Esri World Imagery.

Note

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

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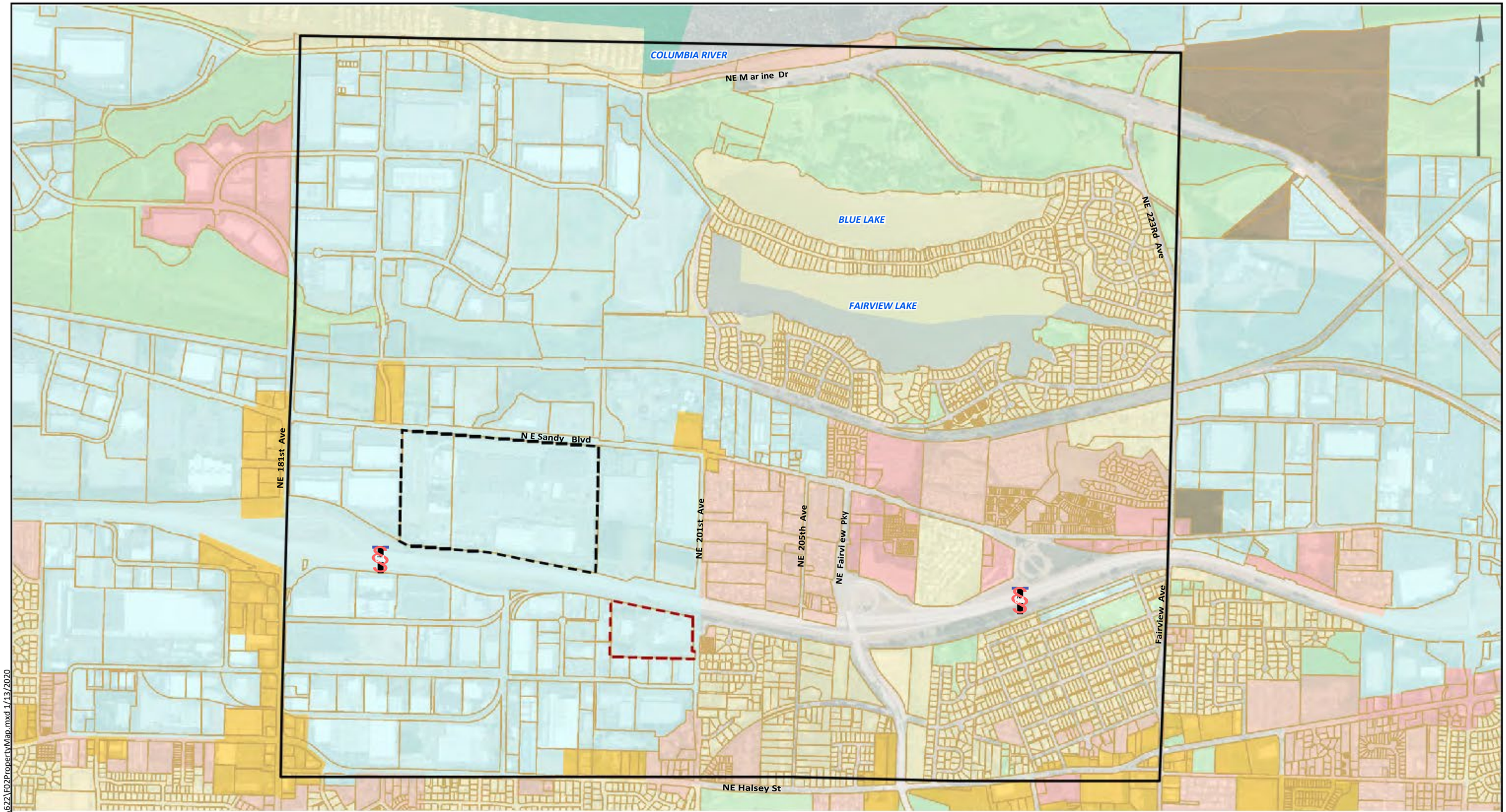
East Multnomah Site Gresham, Oregon	**Site Map**	Figure 1



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Legend

- Boeing Portland Property
- Cascade Corporation Property
- Original EMC Site Study Area
- Taxlots

Generalized Zoning Classifications

- Commercial
- Future Urban Development
- Industrial
- Multi Family
- Mixed Use Residential
- Public Facilities
- Parks and Open Spaces
- Rural
- Single Family

0 1,200 2,400

Scale in Feet

Data Sources: Oregon Metro RLIS; Esri World Imagery.

Note

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

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East Multnomah Site Gresham, Oregon	**Property Zoning Map**	Figure 2

COLUMBIA RIVER
NE Marine Dr
N
PMX-168
NE 223 Rd Ave
D-15(ds)
BLUE LAKE
PMX-138.18
PMX-167
EMC-1(ds)
PMX-141
RPW-1(ds)
D-16(ds)
D-18(ds)
FAIRVIEW LAKE
PWB-1(uts)
Remedy Zone A
North Groundwater Treatment System (Decommissioned 2008)
BOP-44(ds)
EMC-2(ds)
BOP-70(ds)
BOP-43(ds)
EW-9
DEQ-3(s)
PWB-4(s)
BOP-71(ds)
MW-41(ds)
A-7(i)
BOP-22(ds)
BOP-21(ds)
BOP-20(ds)
A-5(d)
BOP-22R(ds)
BOP-67(ds)
East Groundwater Treatment System (Decommissioned 2005)
A-3(s)
EW-22
Remedy Zone B
BOP-23(ds)
EW-10 (PMX-189)
A-6(ia)
A-4(i)
BOP-60R(ds)
BOP-14(s)
A-2(d)
BOP-60(ds)
BOP-63(ds)
Remedy Zone C
EW-3
BOP-61(ds)
NE 201st Ave
NE 205th Ave
NE Sandy Blvd
West Groundwater Treatment System
BOP-65(ds)
BOP-31(ds)
MW-29(ds)
BOP-41(ds)
A-1(d)
BOP-62(ds)
BOP-66(ds)
MW-17(ds)
Remedy Zone D
BOP-64(ds)
VMW-A
VW-17d-95.5
VMW-H
D-17(ds)
VW-17d-75.0
BOP-42(ds)
BOP-13(ds)
VMW-C
VMW-G
MW-18(ds)
MW-26(ds)
VMW-B
VMW-F
VMW-D
MW-20(ds)
VMW-E
EW-21 (PMX-417)
MW-10(ds)
DEQ-5(ds)
MW-19(ds)
EW-21 Groundwater Treatment System (Decommissioned 2007)
MW-3
DEQ-1(ds)
Fairview Ave

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Legend

- Supply Wells
- TSA Extraction Wells
- TSA Monitoring Wells
- TSA Monitoring Wells - Private
- Upper/Lower TSA Monitoring Wells - Private
- Decommissioned Wells
- Aquifer Restoration Zones
- Treatment Systems
- Original EMC Site Study Area
- Boeing Portland Property
- Cascade Corporation Property
- TSA TCE Plume 1998
- TSA TCE Plume 2019
- Unsaturated Areas
- Approximate Location of Truncation
- Cross Section Location

0 1,000 2,000
Scale in Feet

ta Source: Esri World Imagery.

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

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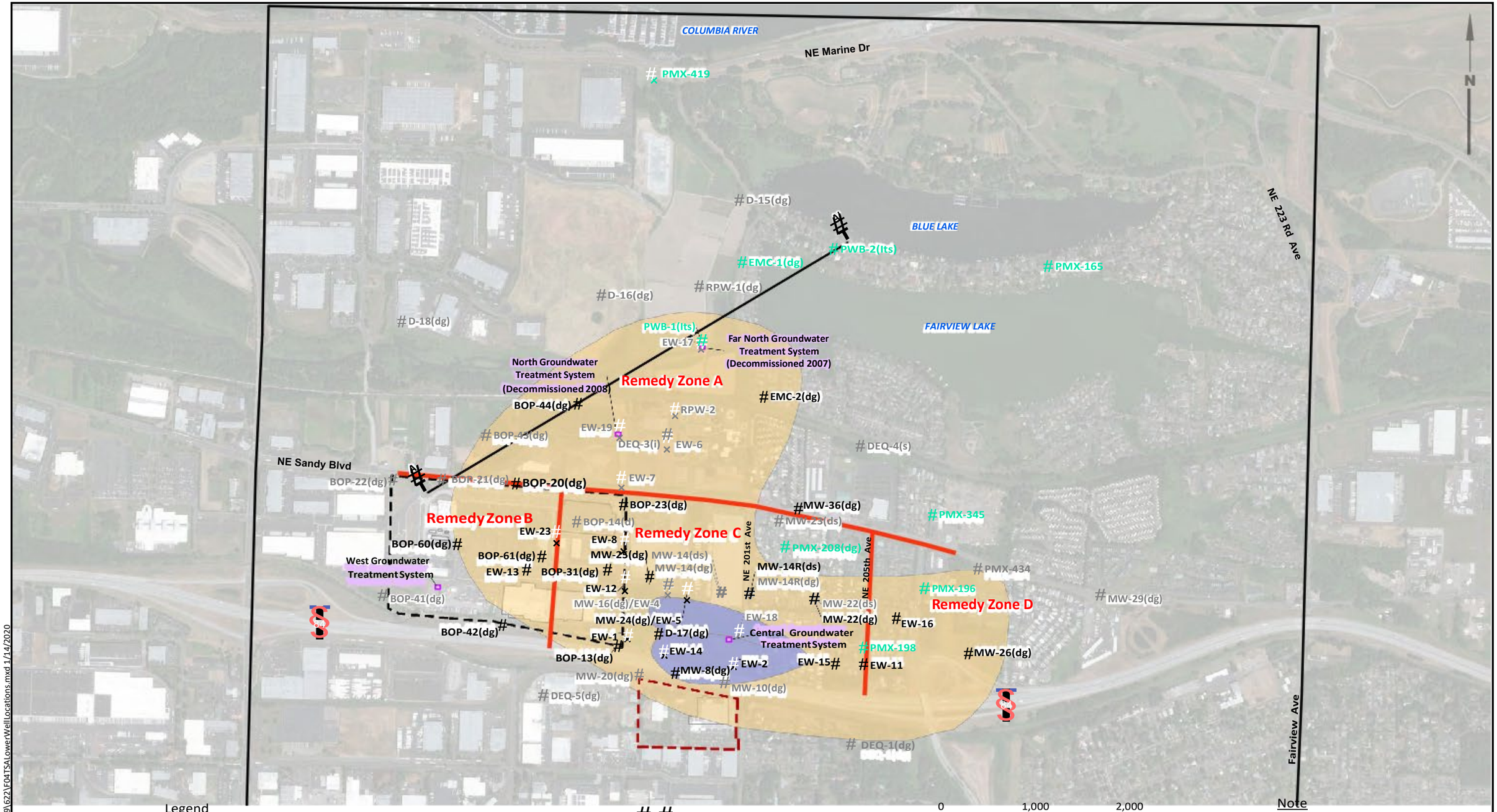
East Multnomah Site
Gresham, Oregon

Upper TSA Well Locations

Figure 3



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East Multnomah Site Gresham, Oregon	**Lower TSA Well Locations**	Figure 4

COLUMBIA RIVER

NE Marine Dr

PMX-135 PMX-136

PW-13 PW-17 PMX-147(a,b,c) PW-18

PW-19 TW-19

PMX-131 PMX-132

PW-11 PW-12

PMX-133

PMX-170(a,b,c,d)

NE 223 Rd Ave

BLUE LAKE

PWB-2(usg)

PMX-166

PMX-140 PW-8

PMX-174 PMX-175 PMX-340

FAIRVIEW LAKE

PWB-1(usg)

PMX-176

North Groundwater Treatment System (Decommissioned 2008)

BOP-44(usg)

EMC-2(usg)

BOP-68(usg)

EW-20 DEQ-3(usg)

DEQ-4(d)

PWB-4(d)

NE Sandy Blvd

BOP-69(usg)

PMX-202

PMX-192

MW-38(usg)

NE 201st Ave

PMX-409

PMX-208

PMX-208R

NE 205th Ave

PMX-194

MW-14(usg)

PMX-410(r)

MW-37(usg)

PMX-195

PMX-225

PMX-185

N

G:\Projects\025\116\619\622\F05SGAWellLocations.mxd 1/14/2020

Legend

- Blue Lake Aquifer Wells
- SGA Extraction Wells
- SGA Monitoring Wells
- SGA Monitoring Wells - Private
- Decommissioned Wells
- Treatment Systems
- Original EMC Site Study Area
- Boeing Portland Property
- Cascade Corporation Property
- SGA Historical Plume (1997)

0 1,000 2,000

Scale in Feet

Data Source: Esri World Imagery.

Note

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

LANDAU ASSOCIATES

East Multnomah Site
Gresham, Oregon

SGA and BLA Well Locations

Figure 5

TCE Concentration Notes

BOP-44(dg): TCE all ND at -RL ranging from 0.5 to 1.0 µg/L from 2006-2017

PWB-1(lts): TCE ranged from 1.1 to 1.8 µg/L between 2015 and 2018

Legend

BOP-21(ds) — Project Exploration Designation
(Offset 12' W) Offset Distance in Feet and Direction

Soil Type Contact

Well Screen Interval

Bottom of Exploration

FP: Flood Plain Deposits: Silty, sandy GRAVEL

TGA: Troutdale Gravel: Sandy, silty GRAVEL

SUA / SUB / SUC / SUD: SU_1: Siltstone Unit 1 consisting of four distinct low permeable layers (SUA, SUB/CU_1, SUC, & SUD) with the second layer being a blueish/gray Clayey Siltstone

TSA (Upper): Upper portion of the Troutdale Sandstone Unit: Sandstone

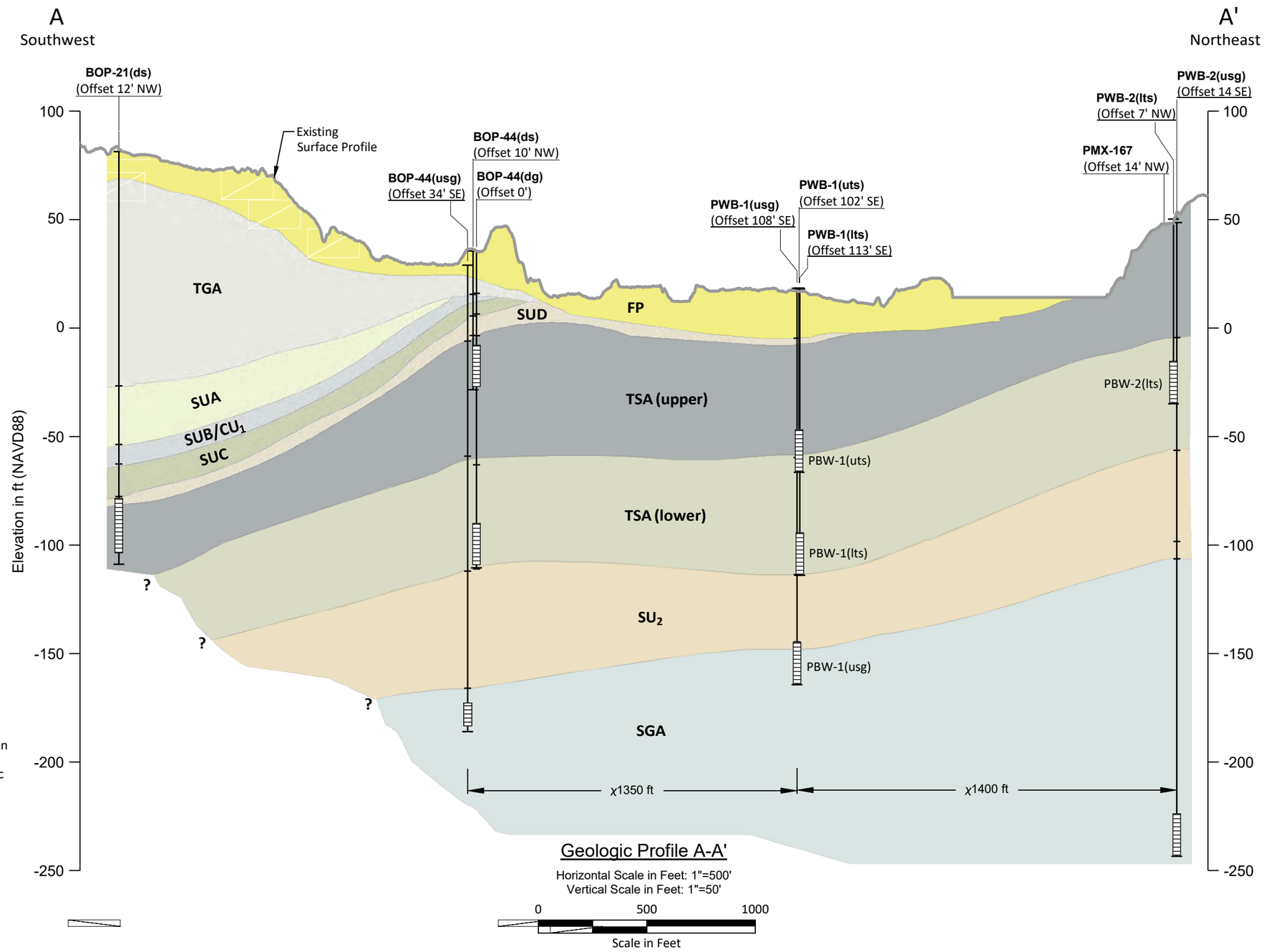
TSA (Lower): Lower portion of the Troutdale Sandstone Unit: Conglomerate

SU_2: Siltsone Unit 2

SGA: Sand and Gravel Aquifer

Notes

1. Soil descriptions are generalized, based on interpretation of field and laboratory data. Stratigraphic contacts are interpolated between borings and based on topographic features; actual conditions may vary.
2. See report text for descriptions of geologic units.
3. For Cross Section location, see the Site and Exploration Plan, Figure _.
4. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Geologic Profile A-A'

Horizontal Scale in Feet: 1"=500'
Vertical Scale in Feet: 1"=50'

0 500 1000
Scale in Feet

Source: DOGAMI Lidar, 2014

East Multnomah Site Gresham, Oregon	**Geologic Cross Section A-A'**	Figure 6

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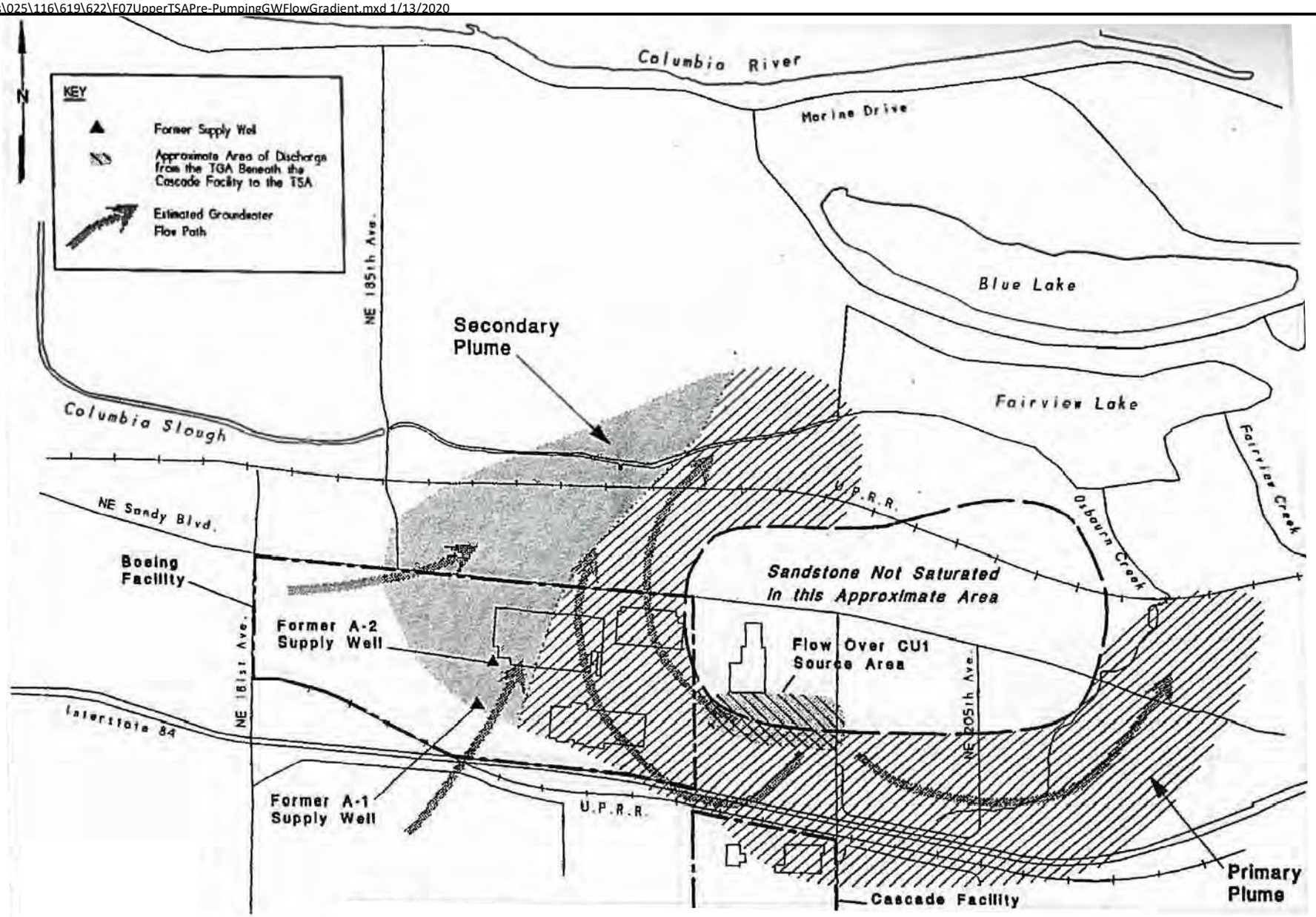

Data Source: Landau Associates, 1995.

0 1,250 2,500

Scale in Feet

LANDAU ASSOCIATES

East Multnomah Site
Gresham, Oregon

Upper TSA Pre-Pumping Groundwater Flow Gradient

Figure 7

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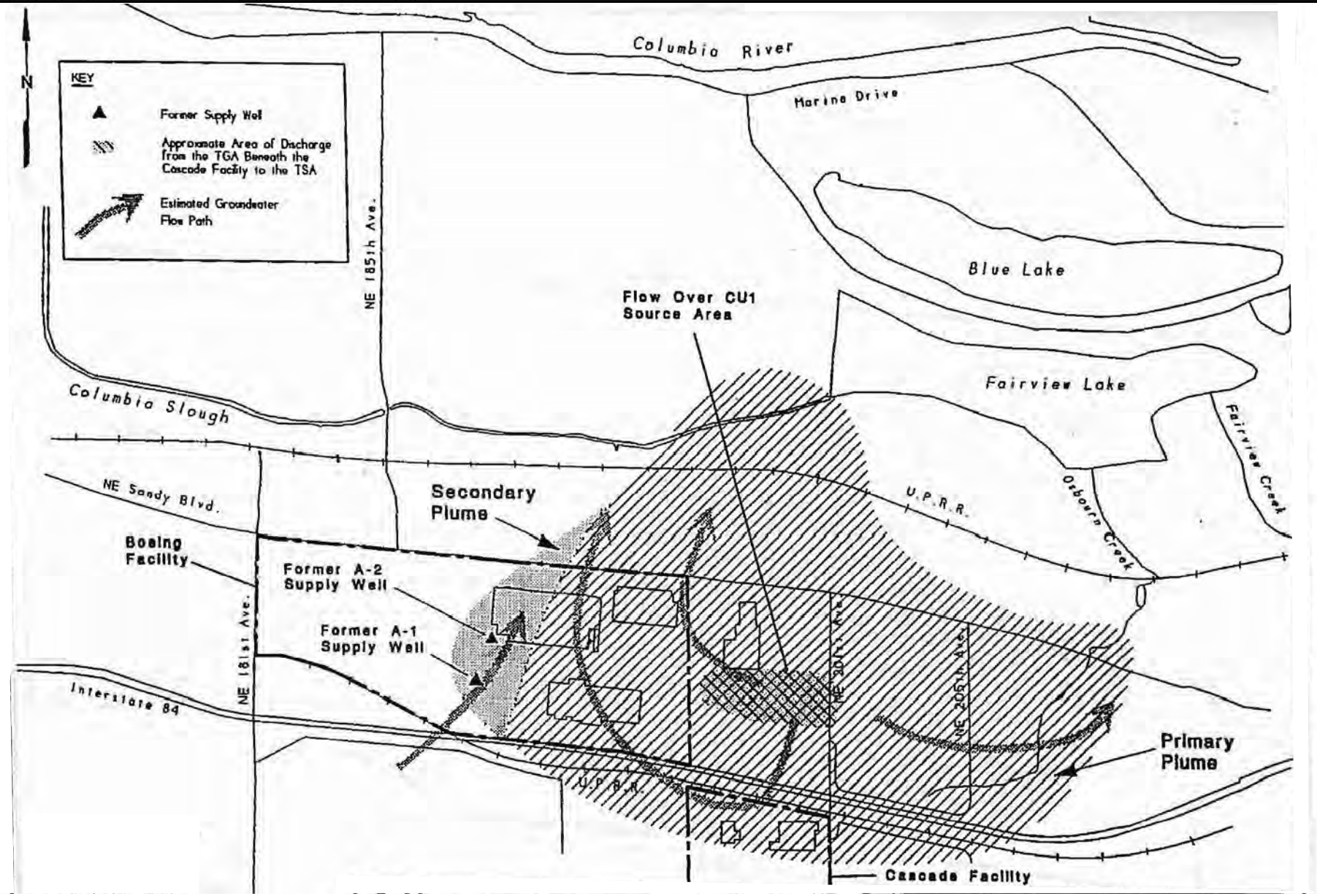


Data Source: Landau Associates, 1995.

0 1,250 2,500

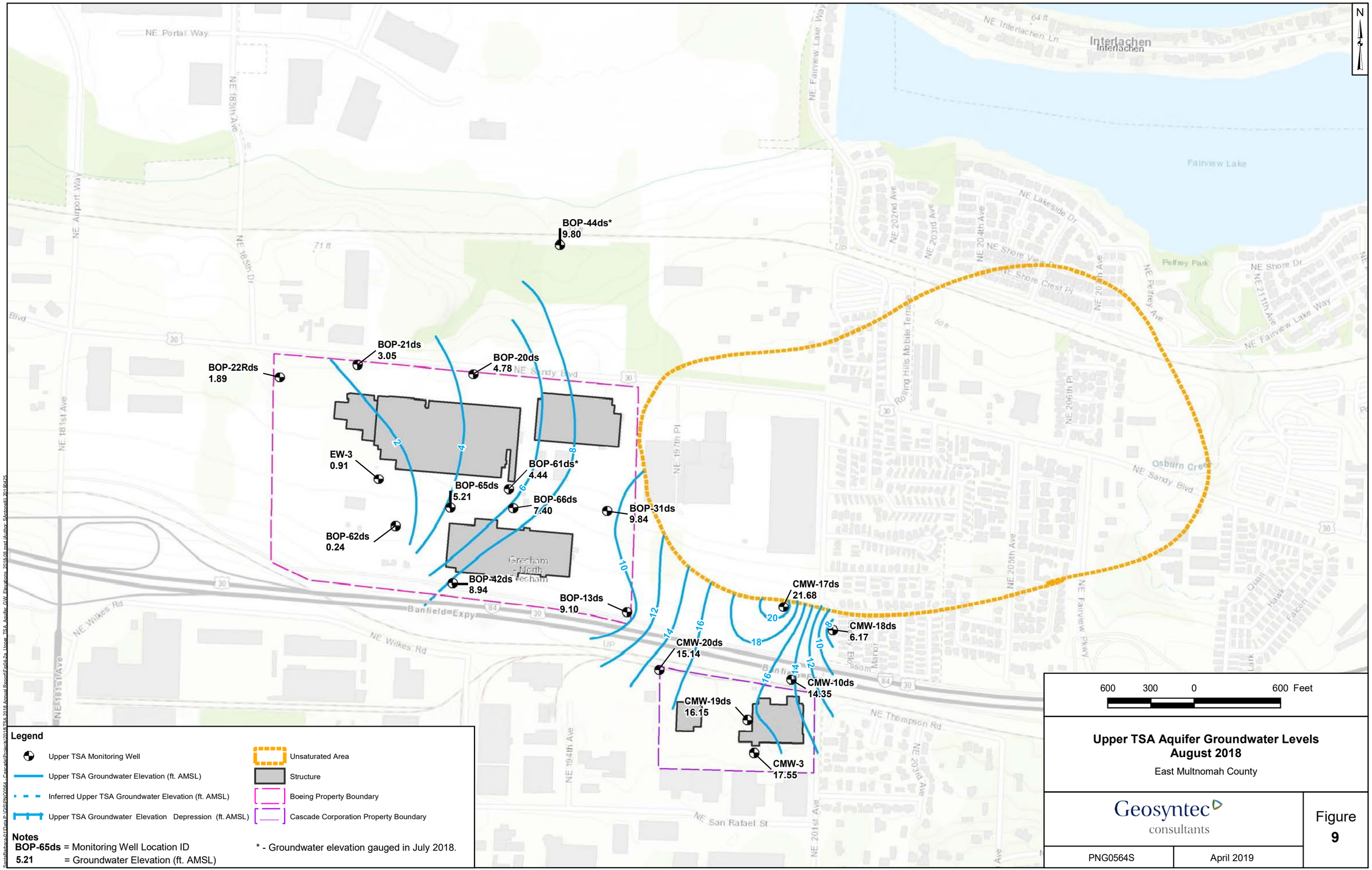
Scale in Feet

LANDAU ASSOCIATES

East Multnomah Site
Gresham, Oregon

Lower TSA Pre-Pumping Groundwater Flow Gradient

Figure 8



Legend

- Upper TSA Monitoring Well
- Upper TSA Groundwater Elevation (ft. AMSL)
- Inferred Upper TSA Groundwater Elevation (ft. AMSL)
- Upper TSA Groundwater Elevation Depression (ft. AMSL)
- Unsaturated Area
- Structure
- Boeing Property Boundary
- Cascade Corporation Property Boundary

Notes

BOP-65ds = Monitoring Well Location ID
5.21 = Groundwater Elevation (ft. AMSL)

* - Groundwater elevation gauged in July 2018.

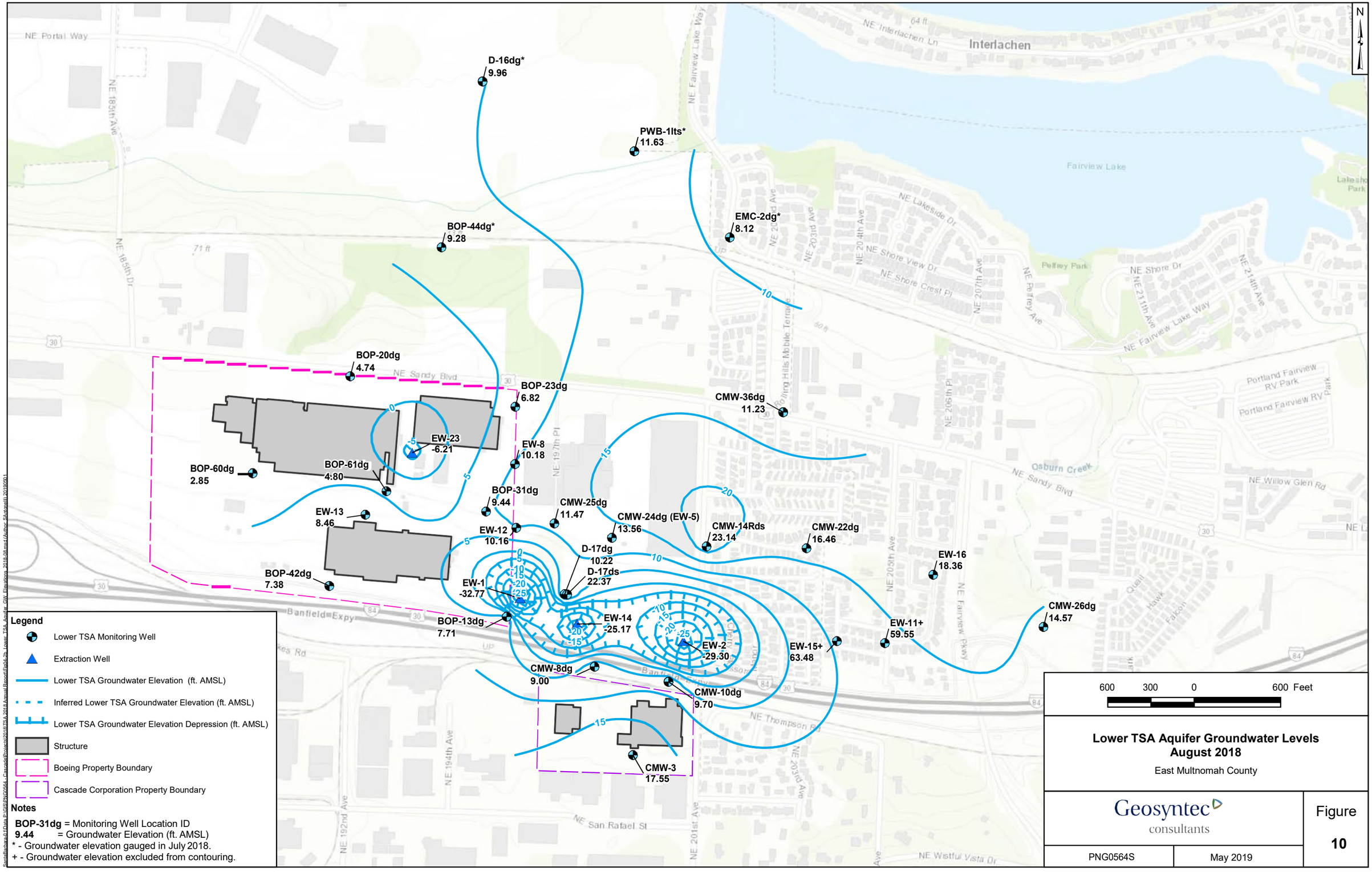
Upper TSA Aquifer Groundwater Levels August 2018

East Multnomah County

Geosyntec consultants

PNG0564S | April 2019

Figure **9**



Lower TSA Aquifer Groundwater Levels August 2018

East Multnomah County

Geosyntec consultants

PNG0564S | May 2019

Figure 10

APPENDIX A

Administrative Record Index

Appendix A

Administrative Record Index

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APPENDIX B

EMC TSA Remedy Timeline

Table B-1
East Multnomah County-TSA and SGA Remedy Timeframe

Action	Date
Corrective Measures Element	
Entered into Order on Consent with DEQ for TSA Removal Action to control northerly plume migration (DEQ No. ECSR-NWR-93-07)	1993
Installed RPW-1 and RPW-2 and began extracting RPW-2 and treating effluent	1994
Completed TSA RI/FS	
Entered into Addendum to Order on Consent to complete TSA RI/FS	1994
Entered into Second Addendum to Order on Consent for NPDES discharge permit	1996
Performed and completed TSA RI/FS, including well installations, aquifer testing, model construction, evaluations, design planning, and reporting	1994 - 1996
DEQ issued TSA Remedy Record of Decision	1996
Enter into Order on Consent with DEQ for design and implementation of remedial measures (DEQ No. WMCSR-NWR-96-08)	1997
Implemented TSA Remedy	
Installed SGA monitoring wells to characterize water quality; decommissioned selected private SGA wells for migration pathway protection; provided replacement water supply to residences	1996-1997
Performed phased remedy implementation including: construction of monitoring and extraction wells (EW-1, EW-2, EW-3), convert monitoring wells MW-16 and MW-24 to extraction wells EW-4 and EW-5, install conveyance and treatment systems, and performance/protection evaluations	1996-1998
Began phased startup of remedy extraction/treatment systems, installation of extraction wells EW-6, EW-7, EW-8, EW-9, EW-10, EW-11, EW-12, EW-13, EW-14, EW-15, EW-16, EW-17, EW-18, EW-19, and EW-20	1996-1998
Entered into Order on Consent with DEQ for remedy implementation and effluent discharge	1997

Table B-1
East Multnomah County-TSA and SGA Remedy Timeframe

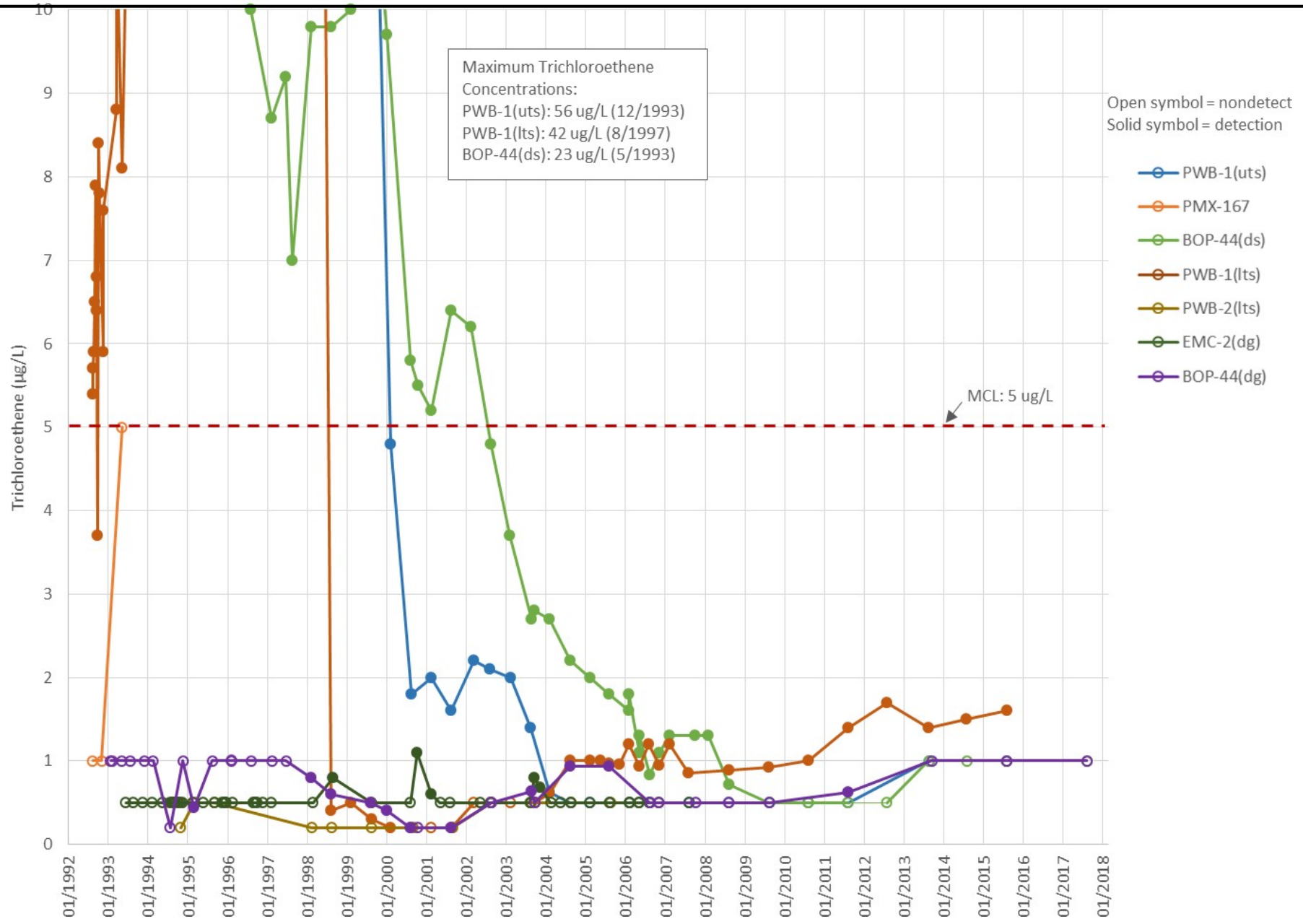
Action	Date
Began full scale remedy implementation of GWTS (West), Central, East, North, and Far North Systems	1998
Began operating EW-21 Treatment System for TSA Sandstone plume capture near MW-26(ds)	2000
Amended TSA RD/RA work plan and documented transfer of TSA remedy responsibilities from Boeing to Cascade	2001
Began operating EW-22 for TSA Sandstone plume capture near BOP-22(ds)	2003
Began operating EW-23 from Lower TSA	2007
Began Remedy Modifications, Due to Restoration Progress	
Decommision East Treatment System	2005
Decommission Far North System	2007
Decommission North Treatment System	2008
Adopt diffusion bag samplers methods for groundwater sampling, pilot shutdown of EW-7, EW-9, EW-19, and EW-20; and installation of TSA Sandstone well EW-23	2006
Decommission BOP-22(ds) and install replacement well BOP-22R(ds), install BOP-70(ds) and BOP-71(ds)	2008-2009
Shutdown EW-22	2008
Pilot Shutdown EW-3 and EW-13	2009
Cessation of TSA treatment at Groundwater Treatment System (GWTS - West)	2009
Install replacement well BOP-60R(ds) and decommission BOP-60(ds)	2010
Decommission EW-22	2010
Cascade Corporation recieves NFA for TGA	2015
Begin SVE operation in TSA Mound Area	2015

APPENDIX C

TCE profiles - Select Zone A and SGA wells

Trichloroethene Profile

1/14/20 P:\025\116\WIP\T\EQuIS\Exports\TSA\C-10 Zone A TCE Profiles.docx



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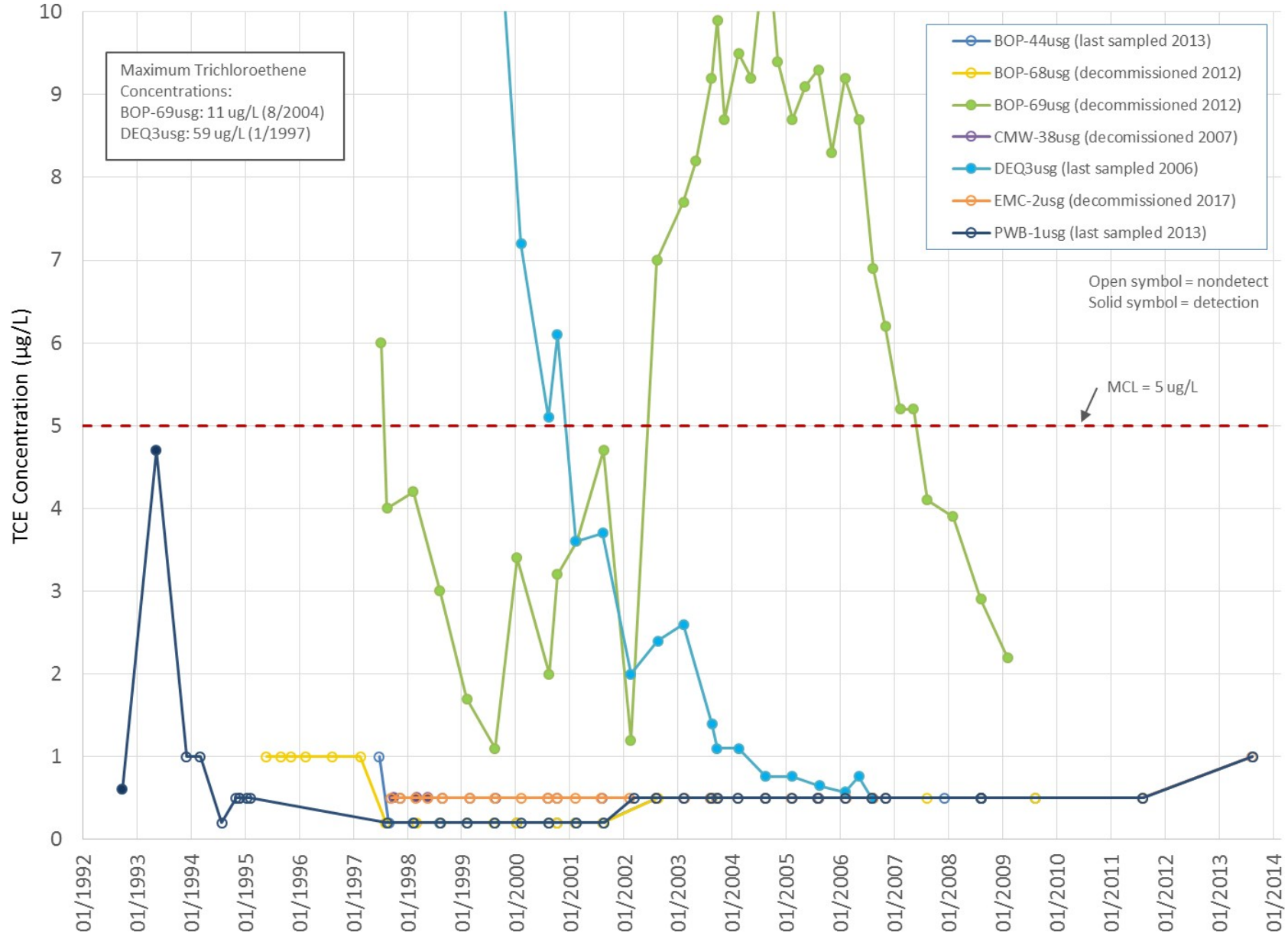
East Multnomah County Remedy

Zone A Select TSA Well- TCE Profiles

Figure
C-1



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East Multnomah County Remedy

TCE Profiles for Select SGA Wells

Figure
C-2