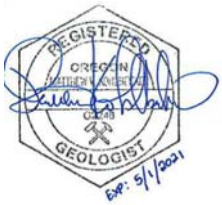
GSI Water Solutions, Inc.



TECHNICAL MEMORANDUM

Peer Review of the Boeing Company and Cascade Corporation Request for a Partial No Further Action Determination at the East Multnomah County Site

To: Doug Wise / City of Portland

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Date: July 3, 2020

This technical memorandum presents a peer review of a partial No Further Action (NFA) request for the East Multnomah County (EMC) Site, and was prepared by GSI Water Solutions, Inc. (GSI) under Task Order No. 2 of the Portland Water Bureau's Groundwater Technical Services Contract (Contract No. 31001632).

Executive Summary

In April 2020, the Boeing Company (Boeing) and Cascade Corporation (Cascade) submitted a request to the Oregon Department of Environmental Quality (DEQ) for a partial NFA at the EMC Site in Gresham, Oregon (Site). The partial NFA would apply to groundwater contamination in Zone A of the Troutdale Sandstone Aquifer (TSA) and to the entire Sand and Gravel Aquifer (SGA) (Landau and Geosyntec, 2020). This technical memorandum presents GSI's peer review of the NFA request, with a focus on evaluating whether the EMC Site has met the criteria required for a partial NFA to be issued by assessing whether Boeing and Cascade have met the Remedial Action Objectives (RAOs) in the Record of Decision (ROD) for the Site (DEQ, 1996).

GSI's peer review indicates that: (1) the RAOs for the SGA appear to have been met and therefore the SGA meets the criteria for a partial NFA, and (2) while Zone A of the TSA *currently* meets RAOs, there are data suggesting that Zone A of the TSA may not meet RAOs *in the future* because concentrations of trichloroethene (TCE) in groundwater have been steadily increasing in Zone A in recent years. It is reasonable to conclude that TCE concentrations may continue to increase in Zone A of the TSA to the point where RAOs are no longer met, especially since Boeing and Cascade plan to continue implementing a phased shut down of engineering controls (i.e., extraction wells) over time while the Site pursues regulatory closure. A conditional partial NFA, contingent on future groundwater quality monitoring results meeting RAOs, is more appropriate for Zone A of the TSA at this time.

1 Background

Volatile Organic Compounds (VOCs), primarily TCE, have contaminated groundwater at the Boeing facility (19000 NE Sandy Boulevard, Gresham, Oregon) and Cascade facility (2201 NE 201st Avenue, Gresham, Oregon), which are collectively referred to as the EMC Site. The contamination has impacted the Troutdale Gravel Aquifer (TGA), the TSA, and the SGA, which are aquifers used by the City of Portland (City) to supply potable groundwater to its citizens. The contamination is located within the 30-year time of travel of the

Wellhead Protection Area for the City's Columbia South Shore Well Field (PWB, 2013). While engineering controls (i.e., extraction wells) at the Site have prevented VOCs from reaching the City's wells to date, Boeing and Cascade plan a phased shut down of engineering controls over time as a part of site closure, thereby decreasing the level of protection afforded to the City's drinking water supply. The City needs to ensure that any partial NFAs issued for the Site (i.e., prior to a site-wide NFA) are appropriately conditioned so that appropriate response actions can be taken if engineering control shutdowns result in a significant threat to human health or the environment from migration of contaminants towards the City's public water supply wells. It is worth remembering that the presence of VOC contamination at the Site resulted in restrictions on the City's ability to use groundwater for public supply in the 1990s prior to the installation of engineering controls.

Boeing and Cascade are actively remediating the EMC Site under multiple RODs and consent orders. The TSA and SGA are being remediated in accordance with a 1996 ROD (DEQ, 1996) and Consent Order for remedial design and remedial action (DEQ, 1997). The EMC Site is divided into four zones—Zone A, Zone B, Zone C, and Zone D. In April 2020, Boeing and Cascade submitted a request for a partial NFA for Zone A of the TSA and for the SGA in all zones. Any NFAs for the Site must meet requirements in the Consent Order, which states that the EMC Site ". . . attain the degree of cleanup of hazardous substances and control of further release of hazardous substances as established in the Record of Decision" (DEQ, pg. B-1, 1997). Therefore, this peer review technical memorandum evaluates Boeing and Cascade's request for a partial NFA by assessing whether Boeing and Cascade have met the RAOs in the ROD for the SGA, and Zone A of the TSA.

This technical memorandum is organized into the following sections:

- **Section 1: Background.** Provides an overview of VOC contamination at the Site and the regulatory framework.
- **Section 2: Evaluation of Whether Remediation in the SGA and in Zone A of the TSA Meets Remedial Action Objectives.** Summarizes the six RAOs from the ROD (DEQ, 1996), and evaluates whether the SGA and Zone A of the TSA meet the RAOs now *and, with certainty, in the future*.
- **Section 3: Conclusions and Recommendations.** Summarizes the findings of the peer review, and presents a recommendation for the appropriate regulatory decision with respect to the EMC Site.

2 Evaluation of Whether Groundwater in Zone A of the TSA and in the SGA Meets Remedial Action Objectives

Six RAOs were established in the 1996 ROD for cleanup of the TSA and SGA at the EMC Site (DEQ, 1996). The following sections summarize each RAO, and GSI's evaluation of whether the SGA and Zone A of the TSA meet each RAO.

2.1 RAO(a): Meet Cleanup Levels.

RAO(a) requires that Boeing and Cascade (DEQ, pg. 6-1, 1996):

> *Restore the TSA to protective concentrations in a reasonable time, if feasible. If not feasible, minimize the extent of the TSA containing VOCs above MCLs, or 1x10^{-6} excess cancer risk levels, whichever is more stringent, and provide long-term containment of areas where concentrations are above MCLs.*

Note that, when citing RAO(a) in the request for a partial NFA, Landau and Geosyntec (2020) do not include the cancer risk levels as a regulatory standard, instead focusing only on MCLs [(see Section 4.2 and Section 4.3 of Landau and Geosyntec (2020)]. While the 1x10^{-6} excess cancer risk cleanup levels do not impact the partial NFA decision for the SGA and Zone A of the TSA, we mention the omission here because 1x10^{-6} cancer risk cleanup levels may impact future NFA decisions for other parts of the Site. The cleanup levels for the EMC site (i.e., MCLs and 1x10^{-6} excess cancer levels) are listed in Table 6-1 of the ROD, and are summarized in the table below.

Table 1. Cleanup Levels at the EMC Site.

COPC	Maximum Contaminant Level (ug/L)	Corresponding Excess Cancer Risk Level [1]	Corresponding 1 x 10^{-6} Cancer Risk Cleanup Level[2] (ug/L)
PCE	5	5 x 10^{-6}	1
TCE	5	1 x 10^{-6}	5
cis-1,2-DCE	70	NC	NC
1,1-DCE	7	1 x 10^{-4}	0.07
Vinyl chloride	2	7 x 10^{-4}	0.003

Notes

(1) From Table 6-1 of the ROD

(2) Calculated by GSI in this technical memorandum

COPC = chemical of potential concern

ug/L = micrograms per liter

NC = non-carcinogenic, the cancer risk is not applicable

PCE = tetrachloroethene

TCE = trichloroethene

cis-1,2-DCE = cis-1,2 dichloroethene

1,1-DCE = 1,1-dichloroethene

This discussion of RAO(a) is organized into the following sections: evaluation of whether TCE currently meets RAO(a) (Section 2.1.1), evaluation of whether TCE will meet RAO(a) in the future (Section 2.1.2), and implications of future TCE concentration increases (Section 2.1.3)

2.1.1: Evaluation of Whether TCE Currently Meets RAO(a)

Table 2 shows existing monitoring wells in the SGA and Zone A of the TSA, and the most-recent VOC concentrations at each well.

Table 2. VOC Concentrations in Existing Monitoring Wells in Zone A of the TSA and the SGA.

Well ID	Monitoring Party	PCE	TCE	Cis-1,2-DCE	1,1-DCE	VC
Zone A TSA Wells						
BOP-44(ds) [1]	Boeing/Cascade	<1.0	<1.0	<1.0	<1.0	<1.0
BOP-44(dg) [1]	Boeing/Cascade	<1.0	<1.0	<1.0	<1.0	<1.0
EMC-2(dg) [2]	Boeing/Cascade	--	<0.5	--	--	--
PWB-(uts) [3]	City of Portland	ND	0.73	ND	ND	ND
PWB-1(lts) [3]	City of Portland	ND	1.91	ND	ND	ND
PWB-2(lts) [3]	City of Portland	ND	ND	ND	ND	ND
SGA Wells						
BOP-44(usg) [4]	Boeing/Cascade	--	<1.0	--	--	--
PWB-1(usg)	City of Portland	ND	ND	ND	ND	ND

Notes

(1) Sample collected in August 2017. Data from Table C-1 of Geosyntec, Landau, and SSPA (2018).

(2) Sample collected in 2007. The TCE concentration is from Figure C-1 of Landau and Geosyntec (2020).

(3) Sample collected September 2019.

(4) Sample collected in 2013. The TCE concentration is from Figure C-2 of Landau and Geosyntec (2020).

"—" = concentration not available. Specifically, a sample was collected, but the report with the concentration is not available online through DEQ's ECSI database, and Landau and Geosyntec (2020) did not report the concentration.

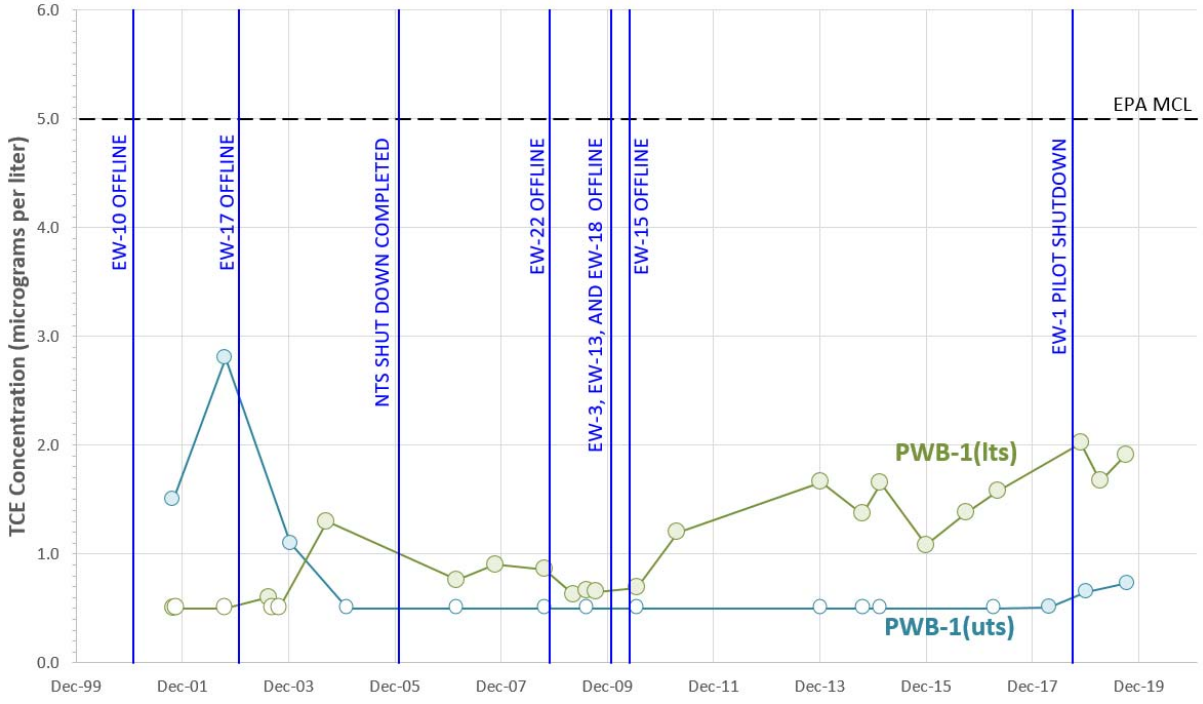
It is important to note that the partial NFA request prepared by Geosyntec and Landau (2020) does not include data from the PWB-1 well cluster because the wells were removed from the EMC Site sampling network in 2013. However, the City has continued monitoring the wells, and we have included data from the wells in this peer review.

The VOC concentrations in Table 2 do not exceed EPA MCLs or the cancer risk cleanup levels[1]. Therefore, the VOC concentrations in the SGA and Zone A of the TSA *currently* meet RAO(a).

2.1.2: Evaluation of Whether TCE Will Meet RAO(a) in the Future

It is important to note that there is uncertainty as to whether VOC concentrations in Zone A of the TSA will *continue* to meet RAO(a) due to increasing trends in TCE concentrations at monitoring well cluster PWB-1. Figure 1 shows TCE concentrations in groundwater at monitoring well cluster PWB-1. TCE detections are represented by the solid-filled data points, and non-detects are represented by the white-filled data points. TCE concentrations have exhibited a steadily increasing trend in monitoring wells PWB-1(lts) (since 2009) and PWB-1(uts) (since 2018).

Figure 1. TCE Concentrations in Zone A TSA Monitoring Wells



In order to further evaluate the significance of the TCE concentration increases, we followed protocols in the EPA guidance document *Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well* (EPA, 2014). This document provides protocols that are ". . . intended to help support a defensible determination that: (a) the groundwater in the well has met the

[1] Note that the detection limits for 1,1-dichloroethene and vinyl chloride exceed the $1x10^{-6}$ cancer risk level, so we cannot conclude that concentrations of these contaminants meet RAO(a); however, the detection limits shown in Table 2 are generally the lowest limits that can be achieved at a commercial lab, so it is not possible to demonstrate that 1,1-dichloroethene and vinyl chloride meet RAO(a).

cleanup level for each COC; and (b) provides assurance that the groundwater will continue to meet the COC cleanup level in the future" (EPA, pg. 3, 2014).

Our analysis of whether TCE concentrations in Zone A of the TSA will remain below cleanup levels was based on the following procedures outlined in EPA (2014):

- We evaluated TCE concentration increases since 2009, which is when EW-15 was shut-down. As such, the evaluation was based on 11 TCE concentrations from PWB-1(lts). EPA (2014) requires that at least 8 data points are used when evaluating attainment.
- A nonparametric Mann-Kendall trend test was performed at the 95% confidence interval to evaluate whether there was statistically significant evidence of an increasing trend in TCE concentrations at PWB-1(lts).

We used ProUCL version 5.1 to perform the Mann-Kendall trend test. The Mann-Kendall test found that, at the 95% confidence interval, there is statistically significant evidence of an increasing trend in TCE concentrations at monitoring well PWB-1(lts) (*p*-value = 0.0098). Documentation of the Mann-Kendall analysis is provided in Attachment A.

2.1.3: Implications of Future TCE Concentration Increases

Over 20 engineering controls (i.e., extraction wells) were installed in the TSA to hydraulically control contaminated groundwater and remove VOCs. Boeing and Cascade have been shutting down engineering controls at the Site (i.e., extraction wells) using a phased approach as a part of pursuing Site closure. Figure 1 shows dates that extraction wells in the TSA were shut down. Only TSA extraction wells located in Zone A and zones located upgradient of Zone A (i.e., Zone B and Zone C) are shown because the shut down of engineering controls in these zones is most likely to affect TCE concentrations in Zone A, either due to rebound of groundwater elevations or loss of hydraulic capture. Also note that Figure 1 only shows the shut-down of an extraction well if the exact date of the shut-down was identified in Geosyntec, Landau and SSPA (2013; 2019) or Landau and Geosyntec (2020).

Landau and Geosyntec (2020) imply that the rising concentrations in PWB-1(lts) may be related to well construction. Specifically, the report states that PWB-1(lts) was not constructed with a step-down seal during drilling, and the well screen at PWB-1(lts) is directly on top of the contact between the lower TSA and the underlying Confining Unit 1 (CU1). However, we do not consider this explanation for rising TCE concentrations to be likely because: (1) it is not clear why drilling technique (i.e., a step down seal) would cause TCE concentrations to begin rising in 2004, about 12 years after the well was drilled, and (2) placement of the well screen in PWB-1(lts) does not explain the recently rising concentrations in PWB-1(uts). It is more likely that the rising TCE concentrations in both wells are related to the shut down of institutional controls, either due to rebound as groundwater levels recover or the loss of hydraulic capture of the TCE plume.

With respect to the increasing TCE concentrations in Zone A of the TSA, EPA (pg. 10, 2014) concludes:

> *In general, if the trend line has a statistically significant positive slope (the concentration trend is increasing), a determination that the groundwater will continue to meet the contaminant cleanup level for each COC in the future may be premature. If the concentration trend is increasing, additional monitoring is recommended to evaluate the possibility of contaminant rebound for the COC in the aquifer. In this case, the attainment monitoring phase normally would not be complete.*

With respect to meeting RAO(a), we conclude that:

- RAO(a) appears to have been met in Zona A of the TSA *at the current time.* However, due to increasing TCE concentrations in PWB-1(lts) and PWB-1(uts), there is uncertainty as to whether RAO(a) *will continue*

to be met in Zone A of the TSA. According to a Mann-Kendall analysis, the increasing TCE concentrations in PWB-1(lts) are statistically significant.

- RAO(a) appears to have been met in the SGA because VOCs are not currently detected in SGA wells, nor have there been increasing trends in VOC concentrations.

2.2 RAO(b): Prevent Ingestion of Groundwater with VOCs above MCLs

RAO(b) requires that Boeing and Cascade (DEQ, pg. 6-1, 1996):

> *Prevent ingestion of TSA groundwater that contains TCE, PCE, cis-1,2-DCE, and 1,1-DCE at concentrations above their respective MCLs.*

As shown in Table 2 and Figure 1, concentrations of TCE, PCE, cis-1,2-DCE, and 1,1-DCE concentrations in Zone A of the TSA and in the SGA are currently below their respective MCLs. However, statistically significant increases in TCE concentrations are occurring in monitoring well PWB-1(lts), implying that TCE concentrations will exceed MCLs in the future.

With respect to meeting RAO(b), we conclude that:

- RAO(b) appears to have been met in Zone A of the TSA *at the current time.* However, due to statistically significant increases in TCE concentrations in PWB-1(lts), there is uncertainty as to whether RAO(b) will be met in the future in Zone A of the TSA.
- RAO(b) appears to have been met in the SGA because VOCs are not currently detected in SGA wells, and there are not increasing trends in VOC concentrations.

On Page 1 of the partial NFA request, Landau and Geosyntec (2020) state that ". . . groundwater use restrictions related to the EMC Site will not remain active for the SGA and Remedy Zone A (of the TSA) once the Partial NFA is determined." Note that TCE concentrations in Zone A of the TSA exceed the DEQ Risk Based Concentration (RBC) for ingestion of tap water under the residential scenario (0.49 micrograms per liter) and urban residential scenario (2.0 micrograms per liter) (DEQ, 2018). Therefore, removal of institutional controls prohibiting groundwater use in Zone A of the TSA may pose a significant threat to human health.

2.3 RAO(c): Protection of Aquatic Receptors

RAO(c) requires that Boeing and Cascade (DEQ, pg. 6-1, 1996):

> *Protect environmental receptors by preventing surface water discharge of TSA groundwater with VOC concentrations that exceed surface water ambient water-quality criteria.*

Because the focus of this technical memorandum is whether the EMC Site remedy is protective of groundwater used by humans as drinking water, we did not evaluate whether the EMC site has met RAO(c).

2.4 RAO(d): Prevent Further Spread of Contamination in the TSA

RAO(d) requires that Boeing and Cascade (DEQ, pg. 6-1, 1996):

> *Prevent the further spread of contamination in the TSA to the extent practicable.*

While it would be premature to conclude that the statistically significant increases in TCE concentrations indicate the plume is spreading, it is clear that the plume has not yet reached a steady-state condition. In other words, there is uncertainty as to whether Boeing and Cascade have met RAO(d) for the TSA in Zone A. Future groundwater sampling and evaluation of TCE concentration trends from the PWB-1 monitoring well cluster will resolve whether the plume is approaching a new steady-state condition (e.g., due to rebounding

water levels as engineering controls are shut off) or whether the plume is spreading (e.g., due to loss of hydraulic capture as engineering controls are shut off).

2.5 RAO(e): Protect Groundwater Quality

RAO(e) requires that Boeing and Cascade (DEQ, pg. 6-1, 1996):

> *Protect groundwater quality in the SGA and BLA.*

As shown in Table 2, VOCs have not been detected recently in SGA groundwater. In addition, regular groundwater quality monitoring by the City of Portland indicates that VOCs have not been detected in BLA wells. Therefore, Boeing and Cascade appear to have met RAO(e).

2.6 RAO(f): Existing Uses of Groundwater Resources

RAO(f) is a groundwater quality goal that is not directly tied to MCLs or a $1x10^{-6}$ excess cancer risk cleanup level. RAO(f) requires that Boeing and Cascade (DEQ, pg. 6-2, 1996):

> *Allow existing uses of groundwater resources in eastern Multnomah County, or if not feasible, minimize the type and length of groundwater use restrictions.*

The City of Portland, which operates several municipal supply wells downgradient of the EMC Site that are completed in the TSA and SGA, is an existing user of groundwater resources in eastern Multnomah County. With respect to meeting RAO(f), we conclude that:

- While Boeing and Cascade *currently* meet RAO(f), the statistically significant increases in TCE concentrations in Area A of the TSA may represent early-warning of plume migration and future impairment of groundwater at a City well. Therefore, there is uncertainty as to whether Boeing and Cascade meet RAO(f) in Zone A of the TSA.
- RAO(f) appears to have been met in the SGA, because there are no increasing trends in VOC concentrations in SGA wells (and no recent detections of VOCs for that matter).

3 Conclusions and Recommendations

This section summarizes conclusions from the peer review of Boeing and Cascade's request for a partial NFA in the SGA and in Zone A of the TSA at the EMC Site. Conclusions are presented in Section 3.1, and recommendations are presented in Section 3.2.

3.1 Conclusions

Table 3 summarizes the findings of GSI's peer review analysis of whether RAOs at the EMC Site have been met. The EMC Site appears to meet the RAOs for the SGA; therefore, the SGA has met the conditions for a partial NFA determination from DEQ. Zone A of the TSA does not appear to be a candidate for a partial NFA because while Zone A of the TSA *currently* meets most RAOs, there is considerable uncertainty about whether Zone A of the TSA will *continue to meet* RAOs because of rising TCE concentrations in monitoring well cluster PWB-1.

Table 3. Evaluation of Whether RAOs Have Been Met.

RAO	RAO Description	Has the RAO Been Met?	
		Area A of the TSA	SGA
RAO(a)	Meet Cleanup Levels	Currently – Yes Future – Uncertain	Yes
RAO(b)	Prevent Ingestion of Groundwater with VOCs above MCLs	Currently – Yes Future – Uncertain	Yes
RAO(c)	Protect Aquatic Receptors	Not Evaluated	Not Evaluated
RAO(d)	Prevent Further Spread of Contamination in the TSA	Uncertain	NA
RAO(e)	Protect Groundwater Quality in the SGA and BLA	NA	Yes
RAO(f)	Protect Existing Uses of Groundwater	Uncertain	Yes
Overall		**Uncertain**	**Yes**

Notes
RAO = Remedial Action Objective TSA = Troutdale Sandstone Aquifer SGA = Sand and Gravel Aquifer

NA = Not Applicable to the Aquifer

3.2 Recommendations

It is reasonable to conclude that TCE concentrations in Zone A of the TSA could continue to increase as Boeing and Cascade continue a phased shut down engineering controls at the EMC Site, potentially causing RAOs not to be met in the future. The concentrations may increase as groundwater recovers to its pre-pumping levels, or due to loss of hydraulic capture of TCE-contaminated groundwater. It would be more appropriate, in light of the statistically significant increases in TCE concentrations in Zone A of the TSA, to issue a type of partial NFA that is specifically designed to ensure that engineering controls are maintained at an adequate level to ensure RAOs are met in the future. DEQ offers a special type of NFA, called a conditional NFA (or cNFA), that is issued to sites with institutional or engineering controls designed to ensure that contaminants left-in-place do not pose an unacceptable risk to human health or the environment in the future (DEQ, 2017). A cNFA, conditioned on continued groundwater quality monitoring in Zone A of the TSA, would be appropriate for the EMC Site because it would mitigate the uncertainty of about whether RAOs will continue to be met in Zone A of the TSA in the future. We further point out that, based on our application of the EPA (2014) guidance for evaluating whether restoration goals have been met, additional monitoring is recommended.

References

ATSDR. 2019. Toxicological Profile for Trichloroethylene. June.

PWB, 2013. Columbia South Shore Well Field – Wellhead Protection Area. Available online at: https://www.portlandoregon.gov/water/article/461798. Accessed by GSI on 26 June 2020.

DEQ. 1996. DEQ Remedial Action Record of Decision for the East Multnomah County Groundwater Contamination Site, Troutdale Sandstone Aquifer. December.

DEQ. 1997. DEQ No. WMCSR-NWR-96-08 Order on Consent.

DEQ. 2017. Fact Sheet: Information about DEQ's No Further Action Decisions. Available online at: https://www.oregon.gov/deq/FilterDocs/NoFurtherActionDecisions.pdf. Accessed by GSI on 28 June 2020.

DEQ. 2018. Risk-Based Concentrations for Individual Chemicals. Available online at: https://www.oregon.gov/deq/FilterDocs/RBDMTable.pdf. Accessed by GSI on 29 June 2020.

EPA. 2014. Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at a Groundwater Monitoring Well. OSWER 9283.1-44, August. Available online at: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100NB98.PDF?Dockey=P100NB98.PDF.

Geosyntec, Landau, and SSPA. 2013. Semi-Annual Performance Report, 1 October 2012 – 31 March 2013, Five Year Remedy Evaluation, Troutdale Sandstone Aquifer Remedy. Prepared for: Cascade Corporation and Boeing Company. 151 pp.

Geosyntec, Landau, and SSPA. 2018. Annual Performance Report, 1 January 2017 – 31 December 2017, East Multnomah County, Troutdale Sandstone Aquifer Remedy, ECSI 1479. Prepared for: Cascade Corporation and Boeing Company. 174 pp.

GSI. 2019. Review of *Annual Performance Report, 1 January 2018 – 31 December 2018; Five Year Remedy Performance Evaluation; East Multnomah County Troutdale Sandstone Aquifer Remedy; ECSI 1479; dated May 31, 2019.*

Landau and Geosyntec. 2020. Partial No Further Action Request, East Multnomah County Troutdale Sandstone Aquifer Remedy, Zone A and SGA, ECSI 1479. Prepared for: Cascade Corporation and the Boeing Company. 58 pp.

Attachment A

Output from ProUCL Version 5.1 Mann-Kendall Analysis

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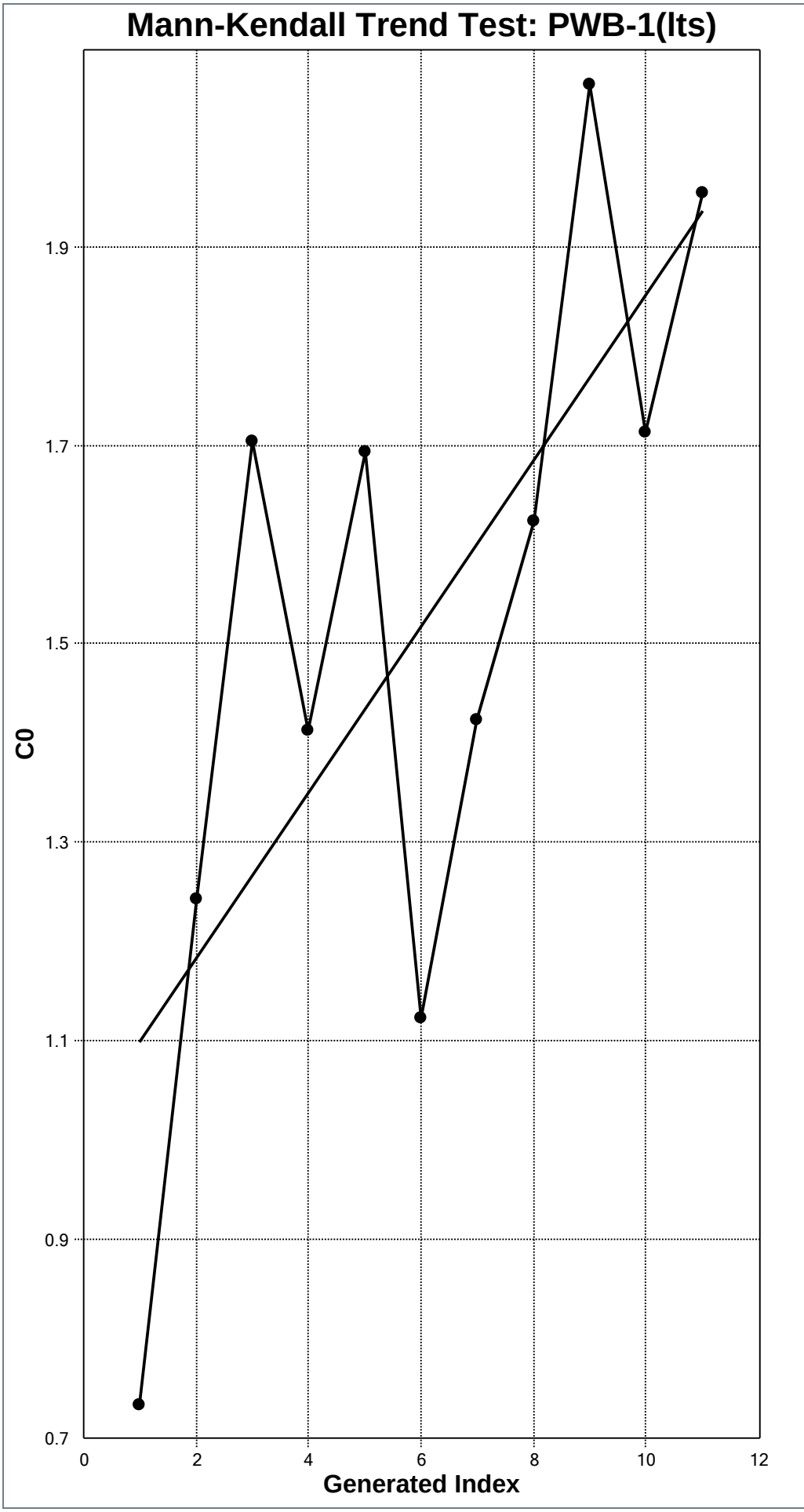
	Mann-Kendall Trend Test Analysis	
User Selected Options		
Date/Time of Computation	ProUCL 5.17/3/2020 2:55:13 PM	
From File	WorkSheet.xls	
Full Precision	OFF	
Confidence Coefficient	0.95	
Level of Significance	0.05	

C0

General Statistics	
Number or Reported Events Not Used	0
Number of Generated Events	11
Number Values Reported (n)	11
Minimum	0.69
Maximum	2.02
Mean	1.474
Geometric Mean	1.419
Median	1.58
Standard Deviation	0.383
Coefficient of Variation	0.26

Mann-Kendall Test	
M-K Test Value (S)	31
Tabulated p-value	0.008
Standard Deviation of S	12.85
Standardized Value of S	2.335
Approximate p-value	0.00976

Statistically significant evidence of an increasing trend at the specified level of significance.



Mann-Kendall Trend Analysis

n	11
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	12.8452
Standardized Value of S	2.3355
M-K Test Value (S)	31
Tabulated p-value	0.0080
Approximate p-value	0.0098

OLS Regression Line (Blue)

OLS Regression Slope	0.0837
OLS Regression Intercept	0.9713

Statistically significant evidence of an increasing trend at the specified level of significance.