



## Memorandum

*To: Kaiser Aluminum*

*From: CDM Smith*

*Date: December 9, 2024*

*Subject: Task 4 of Part IV.A of Agreed Order No. 16958 – Pilot-Scale Ultraviolet Advanced Oxidation Process (UVAOP) Study Results for Treatment of PCBs at Outfall 001*

### 1.0 Introduction

Under Agreed Order 16958 (Agreed Order) and NPDES Permit No. WA0000892, Kaiser Aluminum LLC (Kaiser) is required by the Washington State Department of Ecology (Ecology) to conduct pilot-scale testing of candidate technologies and/or methods for prevention and control of polychlorinated biphenyls (PCBs) in the discharge at Outfall 001 to the Spokane River from the Trentwood facility located in Spokane, Washington (referred herein as the Site). On behalf of Kaiser, CDM Smith has prepared this memorandum to describe the testing conducted for submittal to Ecology.

This memorandum provides a summary of the pilot tests performed on the Outfall 001 stream, and presents an evaluation of the effectiveness of treating PCBs using ultraviolet advanced oxidation processes (UVAOP) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), along with the existing Walnut Shell Filtration System (WSFS) System. In this kind of UVAOP reactor, ultraviolet (UV) light converts the dosed H<sub>2</sub>O<sub>2</sub> into hydroxyl radicals that oxidize the PCBs and other organic matter present. Previous bench scale testing was performed at CDM Smith's Research and Testing Laboratory (RTL) in Bellevue, Washington, using water collected downstream of the WSFS system on July 29, 2020. Results from the bench scale testing indicated a range of UVAOP conditions required to lower total PCBs and the H<sub>2</sub>O<sub>2</sub> dosage needed for treatment (CDM Smith 2021). Those bench scale testing results were used to update pilot testing objectives and execution details for the pilot work described herein.

For this pilot test, Kaiser constructed a pilot UVAOP system that uses two Neotech UV lamps and operated in a continuous operating mode during testing. Pilot testing was performed with the WSFS system upstream of the Neotech skid, utilizing the WSFS system as a pre-filtration step. Pilot testing was also performed with water prior to the WSFS (i.e., with it removed from the treatment train). Two target UV doses and four different target H<sub>2</sub>O<sub>2</sub> doses were utilized in separate test runs. Study objectives, testing summaries, results and observations, and conclusions and next steps are provided in the subsequent sections.

## 2.0 Study Objectives

The primary objective of the pilot study is to evaluate UVAOP treatment for PCB removal from Site process water. Specific objectives included:

- Establish baseline incoming water quality in regard to PCB loading and other potential water quality parameters that would affect UVAOP performance.
- Perform continuous UVAOP tests with different UV and H<sub>2</sub>O<sub>2</sub> doses with the pilot-scale flow through reactor system and determine the resulting changes to PCB destruction in water treated by the WSFS.
- Conduct additional testing without the WSFS upstream of the UVAOP, to understand if pretreatment by the WSFS is appropriate to optimize PCB removal.
- Identify variability and dependency of PCB destruction on influent water quality and key operational parameters.

## 3.0 Methods

This section provides a brief description of the procedures and equipment that were used throughout the pilot test.

Prior to testing, sampling was conducted to provide key baseline water quality data. The samples were sent to Trojan Technologies, a UVAOP manufacturer, for analysis. Given the pilot system influent PCB concentrations were variable depending on whether the water had been treated by the WSFS or not, and depending on WSFS operational dynamics, rather than relying on baseline data, influent samples were collected and analyzed for PCBs throughout the test for direct comparability to effluent samples.

Pilot testing was performed in two configurations, one with the WSFS used as a pre-filtration step, and one with the WSFS system removed from the treatment train, where the water used for testing was taken from upstream of the WSFS. Process water was conveyed from the influent or effluent of the WSFS through two centrifugal transfer pumps before entering the UVAOP treatment system, which consists of two UV reactors in parallel operation. Water ran via booster pumps from the effluent of the WSFS system to the pilot skid, where H<sub>2</sub>O<sub>2</sub> was fed into the system upstream of the UV lamp through an injection quill and controlled by a chemical metering pump. The H<sub>2</sub>O<sub>2</sub> was mixed with process water via a static mixer before being pumped through the UVAOP chambers.

Pilot testing activities began on March 12, 2024, when the UVAOP and WSFS systems operated continuously, and field parameters were first collected. During each run, the system operated continuously during the week to minimize UV bulb power cycling. The system was turned off over the weekends and during maintenance activities such as bulb sleeve cleaning. Test run durations, target UV doses, and target H<sub>2</sub>O<sub>2</sub> doses are summarized in **Table 1**.

During each test run, field parameters including pH, oxidation reduction potential (ORP), temperature, H2O2 dose, UV range, and flow rate, were measured at a frequency of at least three times throughout the day. Field parameter data from all test runs are shown in **Attachment A**. UVAOP system influent and effluent sampling occurred a minimum of three times throughout each test run. The influent samples were taken upstream of H2O2 injection, and the effluent samples were collected downstream of the UVAOP treatment.

The UV dose was estimated in the field by using the field parameter data described above and the calculation below. Given the flow rate was variable, both minimum and maximum estimated doses are presented in **Attachment A**.

$$UV\ Dose = \frac{k * Lamp\ Intensity}{Flow\ Rate}$$

Where:

$$k = 1,666\ for\ the\ Neotech\ D438\ UV\ Lamp$$

$$UV\ Dose = \text{Value in } \frac{millijoule(mJ)}{square\ centimeters(cm^2)}$$

$$Lamp\ Intensity = \text{Value in } \frac{mW}{cm^2}$$

$$Flow\ Rate = \text{Value in gallons per minutes (gpm)}$$

Sample taps were installed on the influent and effluent lines, where samples were collected and labelled as each specific test run (e.g. Outfall1-P1, Outfall2-P2). Samples were sent to Eurofins Environment Testing in Spokane, Washington and analyzed by EPA Method 1668C Chlorinated Biphenyl Congeners. A summary of the analytical PCB results is shown on **Table 2**.

## 4.0 Testing Results/Observations

This section provides a summary of testing results and observations made throughout the UVAOP test runs. All field parameter results are shown in **Attachment A**.

### 4.1 Baseline Sampling

Baseline samples of WSFS influent and effluent were sent to Trojan Technologies for analysis for a variety of parameters that impact UVAOP performance. The analytical results for both samples are presented below in **Exhibit 1**.

**Exhibit 1. Baseline Data Water Quality**

Sample ID <sup>1</sup>	Total Chlorine	Free Chlorine	pH	Alkalinity	UV Transmittance at 254 nanometers	Total Organic Carbon	Total Iron	Nitrate ppm as NO <sub>3</sub> <sup>-</sup>		Scavenging Term
	ppm	ppm		ppm as CaCO <sub>3</sub>	%	ppm	ppm	UV spec	IC	(1/second)
Outfall 1-PO-Inf-01	0.02	0.02	7.9	164.99	95.3	3.061	0.01	2.32	0.24	134,000
Outfall 1-PO-Eff-01	0.01	0.01	7.9	169.02	94.7	2.859	0.02	0.55	0.17	107,000

Notes

CaCO<sub>3</sub> = calcium carbonate, NO<sub>3</sub><sup>-</sup> = nitrate

1. Both samples were filtered at 8 micrometers by Trojan Technologies laboratory.

## 4.2 Field Parameters and Operational Issues

Throughout the pilot testing, water quality parameters were recorded to characterize the influent water and its potential variability. pH, oxidation reduction potential (ORP), temperature, and turbidity were recorded multiple times per day by the field staff. The water quality remained stable with insignificant changes for pH and ORP. The temperature increased throughout the duration of the testing as seasonal ambient air temperature increased. The turbidity fluctuated, which can be attributed to the cycling and performance of the WSFS system. However, there were no notable changes in turbidity as readings remained below 20 Nephelometric Turbidity Units (NTUs). The relatively low turbidity is advantageous for UVAOP, as ultraviolet transmittance (UVT) (fraction of UV light that passes through water) is critical to the UVAOP treatment efficacy. Given the storage capacity of the site lagoon, consistent water quality was expected and observed during the test.

Flow measurement was conducted to confirm loading through the reactor and estimate the UV dose using the formula above. However, it was determined that flow rates shown on the installed paddlewheel type flowmeters did not reflect actual flow rates at the low end of the instrument range (less than 1.0 gallons per minute [gpm]). To confirm this accuracy, field bucket testing was performed during the end of run Outfall1-P5, and these tests confirmed that rates shown on the flowmeter were above actual rates. A new flowmeter (rotameter type) was installed between runs Outfall1-P5 and Outfall1-P6 and tested again using a bucket test. Bucket testing confirmed that the new flowmeter provided more accurate flow rates. For this reason, flow rates measured by the paddlewheel and presented in **Attachment A** for run Outfall1-P1 through a portion of run Outfall1-P5 (through May 17, 2024) were adjusted retroactively based on the bucket tests results. Estimates of UV dose during this period were made using this adjusted data, and then an additional plus or minus 20% for the maximum and minimum UV dose, respectively. Once the bucket tests were completed (starting on May 20, 2024), and then after the rotameters were installed and used (starting on June 4, at the beginning of run Outfall1-P6), flow data no longer required adjustment. However, for testing runs Outfall1-P1 through Outfall1-P5, it is uncertain if the 6,000 millijoules per square centimeter (mJ/cm<sup>2</sup>) target UV dose was achieved due to flowrate accuracy issues.

UV intensities were also recorded approximately every two hours while the field technician was onsite during the test runs. The respective intensities and flowrates were used to calculate a UV dose. During all test runs, the target UV dose was 6,000 mJ/cm<sup>2</sup> except for run Outfall1-P6, where the target dose was 7,500 mJ/cm<sup>2</sup>. Estimated actual minimum and maximum UV doses are shown on **Table 3**. The minimum UV dose was calculated by multiplying the minimum UV intensity by the k value, then dividing that by the maximum flow rate, and the maximum UV dose was calculated by multiplying the maximum UV intensity by the k value, then dividing by the minimum flow rate. This process was used to compare estimated UV dosages to the target UV dose throughout each test run.

During the first run (Outfall1-P1), significant lamp sleeve fouling was observed as indicated by the rapid decrease in UV intensities. Visual inspection of the reactors confirmed that high castor oil loading associated with the WSFS system (upstream of the UVAOP system) was contributing to the lamp sleeve fouling. To address this, the castor oil feed to the WSFS was adjusted from 5 parts per million (ppm) to 1 ppm after samples were collected on March 22, 2024 and kept at 1 ppm for the rest of the test runs. Despite this change, throughout pilot testing, influent water quality continued to result in hazy lamp sleeves and oil deposits within the reactor, and declining UV intensities as the system operated longer without lamp sleeve cleaning. To address this and maintain consistent UV dosages, operators slowed system flow. However, when too much fouling was observed to maintain target UV doses, the reactors were shut down and individual lamp sleeves were removed and cleaned in accordance with NeoTech procedures, with the substitution of dish soap in place of the NeoTech cleaning chemical solution. The reactor and lamp sleeves were cleaned using a dish soap and water solution that circulated for 15 minutes using a sump pump. After the mechanical cleaning was performed, UV intensities increased; however, the intensity steadily still decreased throughout the duration of the pilot study, as shown in **Figure 1**. Preoperational intensities were never achieved after initial UVAOP treatment began, even though mechanical cleaning was performed after each test run throughout the duration of the pilot testing. The location of the castor oil feed was also adjusted during the study to determine if that would reduce fouling. Prior to the initiation of Outfall1-P5, the castor oil feed was moved from the wastewater pump suction to downstream of the wastewater pump. This was done to evaluate whether the castor oil feed in the wastewater pump suction was creating mechanically induced emulsions, thus potentially making fouling worse within the UVAOP reactor. The castor oil feed was moved back to the pump suction prior to beginning Outfall1-P7. **Table 3** shows a comparison of target UV dose to the minimum and maximum UV doses estimated for each run.

The low flow rates required during test runs also made parallel operation of the UV reactors hydraulically difficult during sampling. As a result, the valves to one UV reactor were closed divert flow to the other reactor prior to sample collection. Once the samples were collected, the valves were re-opened and parallel operation continued.

H2O2 dosing, and influent, and residual/effluent H2O2 concentrations were measured throughout the test. A new H2O2 dosing pump (a Master Flex unit) was also installed on the first day of test run Outfall1-P6. The Master Flex pump had higher sensitivity speed control, which yielded better

operational flow control at the low system flowrates needed to achieve the target H<sub>2</sub>O<sub>2</sub> doses.

**Table 3** also shows a comparison of target H<sub>2</sub>O<sub>2</sub> dose to the measured H<sub>2</sub>O<sub>2</sub> influent concentration to the reactor, and the residual H<sub>2</sub>O<sub>2</sub> in the UVAOP effluent.

### 4.3 PCB Destruction

Despite the operational challenges described above, the pilot testing showed that UVAOP treatment was successful in PCB treatment and achieved an overall PCB percent removal of 55 to 98%, or a log reduction of up to 1.79. A summary of treatment performance for each run is shown in **Table 2**. The data sets indicate the following:

- PCB destruction during the early part of run Outfall1-P1, when castor oil dosage was higher (5 ppm), was decreased compared to later in the same run, when castor oil dosage was lower (1 ppm), and estimated UV doses were lower.
- Comparison of data from runs Outfall1-P1 through Outfall1-P4 showed similar PCB destruction, with only slight improvements in log reduction with increasing H<sub>2</sub>O<sub>2</sub> dosing.
- PCB treatment observed during run Outfall1-P5 was significantly reduced. This is likely the result of decreased general water quality upstream of the WSFS, higher radical scavenging (as observed in baseline data), slightly higher turbidity (as shown in **Attachment A**), and slightly higher organic carbon concentrations.
- With a higher UV dose (7,500 mJ/cm<sup>2</sup>), run Outfall1-P6 demonstrated that high log reduction of PCBs in water not treated by the WSFS was possible. The influent and effluent sample pair with the highest degree of PCB reduction was actually observed during this run: total PCB influent concentrations ranged from 33,241 to 225,368 pg/L, and effluent concentrations ranged from 2,589 to 7,818 pg/L. The log reduction ranged from 0.629 to 1.790. As shown on **Figure 2**, which shows PCB concentrations with a logarithmic x-axis, treatment efficiencies also did not decline with increasing influent PCB concentrations, meaning UVAOP treatment was successful even with higher influent concentrations.
- Run Outfall1-P7 showed the highest log reductions for all tests, consistently achieving between 0.9 log reduction or greater, despite it occurring last, after the most fouling and sleeve cleaning had occurred. Influent concentrations ranged from 4,713 to 8,680 pg/L, and effluent concentrations ranged from 209 to 545 pg/L. The results from this run and Outfall1-P6 are also based on reliable flow data and UV dose estimates.
- PCB concentration results also showed that fouling was a significant concern. During Outfall1-P5, the system operated for three weeks with no cleaning performed on the UV lamp sleeves to establish a fouling curve for the system with respect to PCB destruction. This test run showed the UVAOP unit became ineffective at treating PCBs after approximately three weeks due to UV sleeve fouling. In efforts to achieve the target UV doses as the run continued (and UV intensity declined with increasing sleeve fouling), the flow also had to continuously be adjusted, which as

described above, caused flow uncertainties. **Figure 3** highlights the PCB log reduction for the weeks during test run Outfall1-P5. No improvements to the rate of fouling, as measured by changes in UV intensities, were observed with modifications to the castor oil feed location.

## 5.0 Pilot Test Conclusions

This pilot test addressed the objectives listed in Section 2. Results indicated the following:

- Overall, the UVAOP system was successful in PCB destruction. The later runs Outfall1-P6 and Outfall1-P7 showed effluent concentrations ranging from 209 pg/L to 545 pg/L, or a 76-98% removal efficiency, with an average of 93%.
- The highest H2O2 dose, which was 18 ppm in this pilot study, yielded better PCB treatment than lower H2O2 doses, at either the 6,000 or 7,500 mJ/cm<sup>2</sup> target UV doses.
- WSFS pretreatment was beneficial. Comparing results from test runs Outfall1-P5, Outfall1-P6, and Outfall1-P7 showed that high PCB destruction can be achieved using the UVAOP system, but a higher UV dose was needed when the WSFS system was not utilized for upfront mass removal.
- PCB destruction in Outfall 001 water appeared to be most successful with high UV and H2O2 doses, as highlighted in Outfall1-P6 and Outfall1-P7, where target UV and H2O2 doses were also met consistently. As the UV intensity decreased, target goals were more difficult to sustain due to lamp fouling therefore substantially decreasing total PCB destruction.

Further investigations may be completed by Kaiser, such as lamp sleeve fouling and cleaning studies, PCB congener analysis, and castor oil impacts. Some initial considerations for future pilot tests, if warranted, include:

- Testing of wipers on the UV lamps sleeves and/or other cleaning options to help collect fouling material and minimize mechanical cleaning efforts;
- The use of more accurate flowmeters and dosing pumps; and
- Testing of a UVAOP system with variable power lamps, so that intensity can be adjusted as fouling increases.

## 6.0 References

CDM Smith, 2021. Task 3 of Part IV.A of Agreed Order No. 16958 – Kaiser’s Effluent (Outfall 001) Bench-Scale Testing Results of Advanced Oxidation Processes (AOP) for Removal of Polychlorinated Biphenyls (PCBs) via Ultraviolet (UV)/Hydrogen Peroxide (H2O2) and Proposed Pilot Scale Testing Scope and Schedule. August 9.

## 7.0 Tables, Figures, and Attachments

The following tables, figures, and attachments are included:

### **Tables**

1. Pilot Test Run Summary
2. Summary of PCB Results
3. Dosing Summary

### **Figures**

1. Average UV Intensities vs. Test Run Duration
2. Removal Efficiencies and Total PCB Concentration
3. Outfall1-P5 PCB Removal

### **Attachments**

- A. Water Quality Parameters



**TABLE 1 - PILOT TEST RUN SUMMARY**

KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY  
SPOKANE VALLEY, WASHINGTON

Test Run ID	Source Water	Duration (days)	Target UV dose (mJ/cm <sup>2</sup> )	Target H2O2 dose (mg/L)	Average Flow Rate <sup>1</sup> (gpm)
Outfall1-P1	BSWF Effluent	13	6,000	3	4.4
Outfall1-P2	BSWF Effluent	4	6,000	6	3.0
Outfall1-P3	BSWF Effluent	4	6,000	9	2.9
Outfall1-P4	BSWF Effluent	4	6,000	18	1.9
Outfall1-P5	BSWF Influent	12	6,000	18	1.4
Outfall1-P6	BSWF Influent	4	7,500	18	0.9
Outfall1-P7	BSWF Effluent	15	6,000	18	1.7

**Notes:**

gpm = gallons per minute

UV = ultraviolet

mJ/cm<sup>2</sup> = millijoules per square centimeter

mg/L = milliliters per liter

1. Flow rates measured in runs P1 through P5 may not be as accurate as P6 and P7. See Section 4.2.

2. Castor oil dosage to the Walnut Shell Filtration System (WSFS) was reduced from 5 to 1 parts per million on 3/22, midway through Test Run Outfall1-P1.

**TABLE 2 - SUMMARY OF PCB RESULTS**

KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY

SPOKANE VALLEY, WASHINGTON

Test Run ID	Date	Sample Location	Total PCB Concentration (pg/L)	Log Reduction	% Removal
Outfall1-P1	3/20/2024	Influent	9,903	0.577	74%
		Effluent	2,621		
	3/21/2024	Influent	6,408	0.545	72%
		Effluent	1,825		
	3/22/2024	Influent	5,955	0.559	72%
		Effluent	1,646		
	4/2/2024	Influent	NA	NA	NA
		Effluent	NA		
	4/3/2024	Influent	6,562	0.957	89%
		Effluent	725		
	4/4/2024	Influent	7,778	1.056	91%
		Effluent	684		
Outfall1-P2	4/10/2024	Influent	9,760	0.961	89%
		Effluent	1,067		
	4/11/2024	Influent	11,005	0.795	84%
		Effluent	1,763		
	4/12/2024	Influent	6,733	1.013	90%
		Effluent	654		
Outfall1-P3	4/17/2024	Influent	7,621	0.993	90%
		Effluent	774		
	4/18/2024	Influent	7,600	1.052	91%
		Effluent	675		
	4/19/2024	Influent	NA	NA	NA
		Effluent	NA		
Outfall1-P4	4/24/2024	Influent	7,179	1.234	94%
		Effluent	419		
	4/25/2024	Influent	10,408	0.917	88%
		Effluent	1,261		
	4/26/2024	Influent	7,879	1.219	94%
		Effluent	476		

**TABLE 2 - SUMMARY OF PCB RESULTS**

KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY

SPOKANE VALLEY, WASHINGTON

Test Run ID	Date	Sample Location	Total PCB Concentration (pg/L)	Log Reduction	% Removal
Outfall1-P5	5/7/2024	Influent	23,599	0.517	70%
		Effluent	7,182		
	5/8/2024	Influent	81,818	0.561	73%
		Effluent	22,464		
	5/10/2024	Influent	41,640	0.573	73%
		Effluent	11,126		
	5/14/2024	Influent	22,677	0.593	74%
		Effluent	5,789		
	5/16/2024	Influent	51,239	0.346	55%
		Effluent	23,078		
	5/17/2024	Influent	58,090	0.382	59%
		Effluent	24,103		
Outfall1-P6	5/24/2024	Influent	29,358	-0.026	-6%
		Effluent	31,185		
	6/4/2024	Influent	33,241	0.629	76%
		Effluent	7,818		
	6/5/2024	Influent	53,858	1.318	95%
		Effluent	2,589		
Outfall1-P7	6/6/2024	Influent	225,368	1.790	98%
		Effluent	3,653		
	6/11/2024	Influent	5,789	1.297	95%
		Effluent	292		
	6/13/2024	Influent	4,517	1.335	95%
		Effluent	209		
	6/14/2024	Influent	8,680	1.433	96%
		Effluent	321		
	6/21/2024	Influent	4,793	0.944	89%
		Effluent	545		
	6/28/2024	Influent	4,713	1.290	95%
		Effluent	242		

**Notes:**

NA = not available. Samples collected on 4/2/24 and 4/19/24 were broken in transit.

pg/L = picograms per liter

1. Castor oil dosage to the Walnut Shell Filtration System (WSFS) was reduced from 5 to 1 parts per million after samples were collected on 3/22.

**TABLE 3 - DOSING SUMMARY**

KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY

SPOKANE VALLEY, WASHINGTON

Test Run ID	UV Target Dose (mJ/cm <sup>2</sup> )	Min UV Dose (mJ/cm <sup>2</sup> )	Max UV Dose (mJ/cm <sup>2</sup> )	H2O2 Target Concentration (ppm)	Actual Influent H2O2 Concentration (ppm)	Residual H2O2 Concentration (ppm)
Outfall1-P1	6,000	463	10,797	3	4	4
Outfall1-P2	6,000	1,055	7,663	6	6	6
Outfall1-P3	6,000	926	7,882	9	9	8
Outfall1-P4	6,000	1,246	6,652	18	17	14
Outfall1-P5	6,000	877	6,997	18	21	17
Outfall1-P6	7,500	4,165	11,454	18	17	9
Outfall1-P7	6,000	1,515	7,590	18	19	14

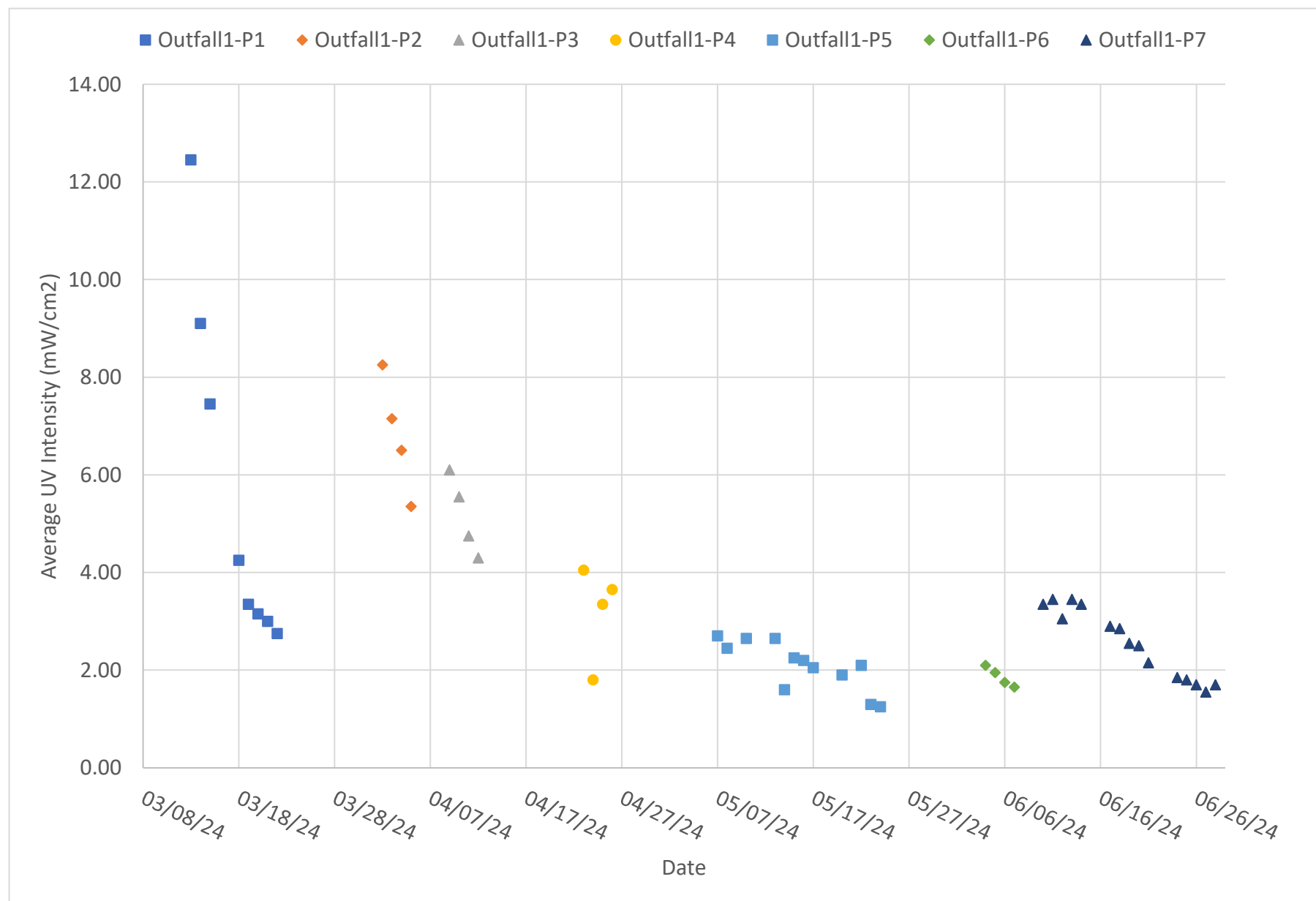
**Notes:**

UV = ultraviolet

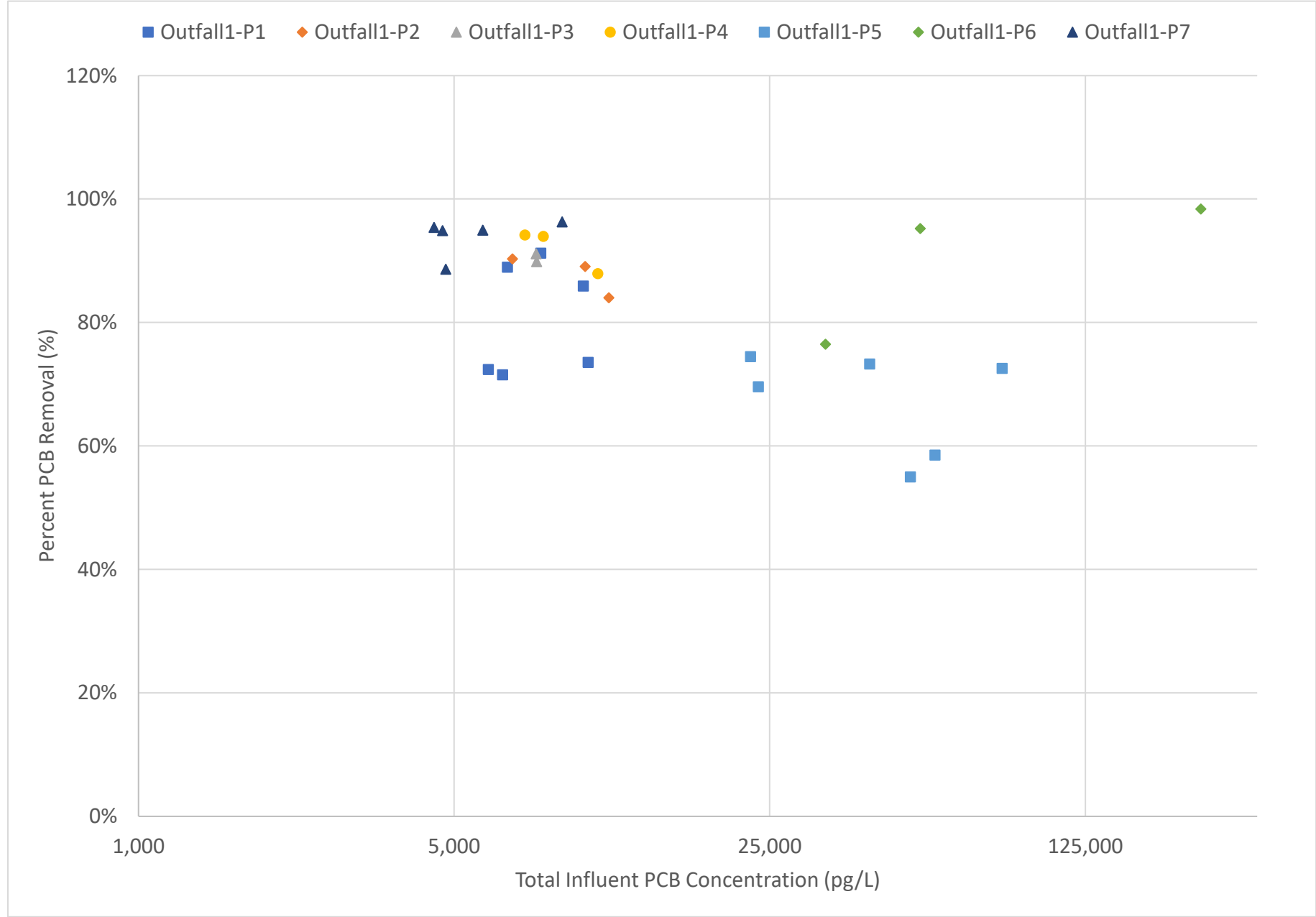
mJ/cm<sup>2</sup> = millijoules per square centimeter

ppm = parts per million

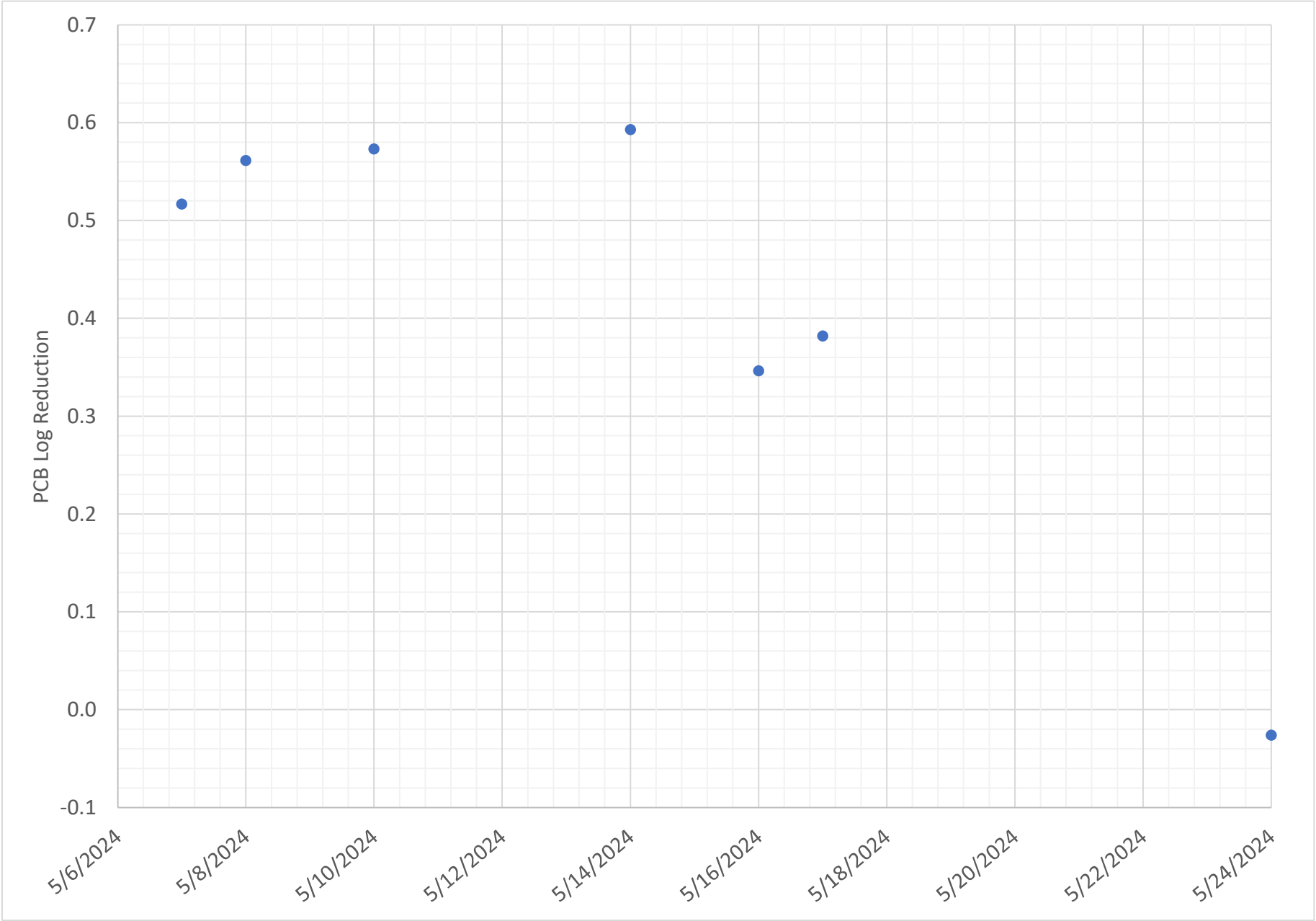
**FIGURE 1 - AVERAGE UV INTENSITIES VERSUS TEST RUN DURATION**  
 KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY  
 SPOKANE VALLEY, WASHINGTON



**FIGURE 2 - REMOVAL EFFICIENCIES AND TOTAL PCB CONCENTRATIONS**  
KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY  
SPOKANE VALLEY, WASHINGTON



**FIGURE 3 - OUTFALL1-P5 PCB REMOVAL**  
KAISER ALUMINUM-TRENTWOOD FACILITY UVAOP PILOT STUDY  
SPOKANE VALLEY, WASHINGTON



Date	Time	UVAOP-1 (2024 UNIT)						UVAOP-2 (2020 UNIT)						Influent					Effluent					Comments
		Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	
Run Outfall1-P1 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 3 ppm (Castor Oil: 5 ppm)																								
03/12/24	10:30	21	21	4.1	0.00	7163	10744	--	--	--	--	--	--	8.20	212	24.2	4.94	6	8.20	217	24.5	3.97	5	Flow readings based on paddlewheel, adjusted after the fact by bucket test results. UV Dose range based on adjusted flow rate, plus or minus 20% of estimated flow.
	12:30	21.4	21.4	4.1	0.00	7198	10797	--	--	--	--	--	--	8.11	225	24.0	3.98	5	8.06	232	24.3	3.03	5	
	14:30	18.2	18.2	4.1	0.00	6122	9183	--	--	--	--	--	--	8.09	218	24.3	4.51	6	8.09	231	24.4	4.12	5	
	16:00	--	--	4.1	0.00	--	--	--	--	--	--	--	--	8.04	196	23.7	4.79	5	8.10	203	23.9	4.02	5	
03/13/24	11:45	10.2	14.7	4.2	0.00	3339	7217	4.6	5.3	4.2	0	1047	1809	8.13	197	23.8	3.53	--	8.12	198	23.7	3.10	--	
	14:30	7.4	11.2	2.6	0.00	3886	8822	3.7	4.8	2.6	0	1557	3029	8.15	173	24.6	5.12	--	8.17	182	24.3	4.14	--	
03/14/24	12:00	7.4	10.8	2.5	0.00	4061	8890	4.5	5.0	2.5	0	2015	3359	8.17	70	23.6	3.62	--	8.28	74	23.3	3.24	--	
	14:15	6.7	9.9	2.5	0.00	3677	8149	4.0	4.9	2.5	0	1791	3292	8.21	70	24.3	3.89	--	8.24	71	24.0	3.35	--	
03/15/24	8:00	6.0	8.9	2.2	0.00	3808	8473	3.8	4.5	2.2	0	2110	3749	8.21	52	24.3	3.46	--	8.29	56	23.4	2.77	--	
	12:00	5.5	8.2	2.2	0.00	3491	7806	3.5	4.3	2.2	0	1944	3582	8.19	55	24.4	3.61	--	8.24	56	23.4	2.83	--	
	15:00	5.4	8.1	2.2	0.00	3427	7711	3.4	4.3	2.2	0	1888	3582	8.14	83	25.1	3.10	--	8.25	85	24.2	2.28	--	
03/18/24	12:00	3.3	5.2	1.6	0.10	2834	6697	2.5	3.2	1.6	0.1	2314	4443	8.24	81	25.0	3.22	4	8.23	88	25.7	3.21	5	
	15:00	3.1	4.7	1.6	0.10	2662	6053	2.0	3.1	1.6	0.1	1851	4304	8.23	58	26.5	3.34	4	8.24	67	26.8	3.29	4	
03/19/24	8:00	2.7	4.0	1.4	0.07	2593	5762	2.0	2.3	1.4	0.07	2314	3991	8.12	39	25.8	6.00	4	8.12	40	26.0	5.65	4	
	12:00	2.4	3.6	1.4	0.07	2305	5186	1.8	2.0	1.4	0.07	2083	3471	8.06	59	25.7	16.22	4	8.01	77	26.4	8.08	4	
	14:30	2.2	3.3	1.4	0.07	2199	4949	1.6	1.9	1.4	0.07	2019	3597	8.16	62	26.3	8.66	3	8.09	60	27.0	8.50	3	
03/20/24	7:45	2.5	3.8	1.5	0.07	2310	5266	1.9	2.1	1.5	0.07	2029	3364	8.19	42	25.8	10.05	4	8.14	45	26.5	8.20	5	
	14:30	2.3	3.4	1.3	0.03	2505	5555	--	--	1.3	0.03	--	--	8.18	65	24.9	8.43	4	8.09	70	25.8	7.28	4	
03/21/24	8:15	2.4	3.6	1.3	0.07	2614	5882	1.8	2.1	1.3	0.07	2777	4859	7.51	131	25.2	6.50	4	7.40	153	25.9	6.15	4	
	12:00	2.4	3.6	1.3	0.03	2502	5630	1.7	2.2	1.3	0.03	2360	4582	7.57	169	23.5	5.74	4	7.53	176	24.3	4.98	4	
	14:45	2.3	3.5	1.3	0.07	2398	5474	1.7	2.0	1.3	0.07	2360	4165	7.59	155	23.4	6.46	4	7.52	172	24.0	6.46	3	
03/22/24	8:00	2.2	3.3	1.3	0.03	2396	5392	1.8	2.1	1.3	0.03	2777	4859	7.55	148	23.7	7.12	4	7.56	163	24.5	5.88	4	System stopped and cleaned using flowthrough system and mechanical scrubbing. Walnut Shell Filtration System (WSFS) castor oil dose changed from 5 ppm to 1 ppm.
Run Outfall1-P1 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 3 ppm (Castor Oil: 1 ppm)																								
04/02/24	12:00	6.7	9.8	4.5	0.20	2055	4508	2.2	2.8	4.5	0.2	463	883	7.63	125	26.8	1.94	4	7.59	121	26.9	2.03	4	
	15:00	6.2	9.3	2.2	0.07	3835	8629	2.2	2.5	--	--	--	--	7.58	257	27.2	1.94	4	7.56	212	27.3	2.23	4	
04/03/24	7:30	5.8	8.5	2.1	0.07	3780	8309	1.9	2.4	2.1	0.07	1099	2083	7.59	275	25.1	2.55	3	7.56	213	25.2	2.77	3	
	10:30	5.7	8.5	2.2	0.08	3618	8092	1.9	2.4	2.2	0.08	1055	1999	7.61	308	24.3	2.47	4	7.59	282	24.4	2.37	3	
	14:30	5.5	8.3	2.1	0.07	3683	8337	2.4	2.5	2.1	0.07	1449	2264	7.57	318	24.3	2.28	4	7.55	287	24.7	2.45	4	
04/04/24	8:15	5.2	7.8	2.0	0.07	3580	8056	1.8	2.3	2.0	0.07	1136	2177	7.75	308	23.6	1.71	3	7.75	270	24.0	1.90	4	
	12:06	4.9	7.5	2.0	0.06	3472	7972	2.0	2.7	2.0	0.06	1322	2678	7.81	302	24.3	1.26	6	7.77	245	25.1	1.84	6	
	14:30	5.1	7.6	2.0	0.06	3614	8078	1.8	2.3	--	--	--	--	7.81	263	25.0	1.94	4	7.79	245	25.2	2.13	3	
04/05/24	7:42	4.3	6.4	1.8	0.05	3339	7454	1.6	2.0	1.8	0.05	1234	2314	7.95	268	24.0	3.07	5	7.93	298	24.2	2.82	4	
	12:05	4.4	6.5	1.8	0.05	3416	7570	1.7	2.0	1.8	0.05	1311	2314	7.89	287	22.0	2.82	5	7.86	298	22.6	2.99	6	
	14:39	4.4	6.4	1.8	0.05	3416	7454	1.5	2.1	1.8	0.05	1157	2430	8.38	335	22.7	2.55	4	7.90	294	22.3	2.75	4	
Run Outfall1-P2 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 6 ppm																								
04/09/24	11:00	4.9	7.3	2.2	0.15	3110	6950	1.9	2.2	2.2	0.15	1055	1833	7.87	221	25.7	1.97	7	7.83	221	25.9	1.92	6	
	15:00	5.7	7.0	1.9	0.12	4160	7663	1.7	2.1	1.9	0.12	1180	2187	7.86	272	25.6	2.20	7	7.84	252	25.8	2.21	6	
04/10/24	8:00	4.5	6.6	1.8	0.12	3386	7449	1.6	2.3	1.8	0.12	1169	2521	7.75	309	25.0	2.64	7	7.75	245	25.4	2.39	5	
	12:00	4.3	6.4	1.8	0.11	3339	7454	1.6	2.1	1.8	0.11	1234	2430	7.76	259	25.3	2.32	6	7.77	241	25.7	2.21	6	
	14:30	4.3	6.3	1.7	0.10	3449	7579	2.0	2.2	--	--	--	--	7.72	298	25.5	2.34	6	7.71	265	26.1	2.27	6	
04/11/24	8:00	3.8	5.7	1.8	0.10	2950	6639	1.5	1.9	1.8	0.1	1157	2198	7.75	233	25.7	2.66	6	7.74	217	26.1	2.64	6	
	12:30	3.7	5.5	1.6	0.09	3177	7084	1.5	1.9	--	--	--	--	7.70	284	25.5	2.86	6	7.70	237	25.9	3.10	6	
04/12/24	10:00	3.5	5.1	1.6	0.08	3115	6809	1.7	1.9	--	--	--	--	7.73	224	25.9	2.37	7	7.74	218	26.6	2.02	6	
	14:00	2.1	4.1	1.4	0.07	2100	6149	1.4	1.7	1.4	0.07	1767	3218	7.77	195	26.1	2.10	5	7.76	184	26.5	1.92	4	
Run Outfall1-P3 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 9 ppm																								
04/16/24	12:45	4.9	7.2																					



Date	Time	UVAOP-1 (2024 UNIT)						UVAOP-2 (2020 UNIT)						Influent					Effluent					Comments
		Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	
Run Outfall1-P4 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 18 ppm																								
04/23/24	12:00	3.3	4.8	1.8	0.36	2483	5417	--	--	--	--	--	--	7.90	286	24.1	1.77	16	7.82	283	25.5	1.68	11	
	16:00	3.2	4.9	1.6	0.25	2848	6542	--	--	--	--	--	--	7.87	301	25.3	1.51	15	7.81	300	25.6	1.99	13	
04/24/24	12:00	1.4	2.2	1.6	0.25	1246	2937	1.4	2.1	1.4	0.25	1620	3644	7.90	308	24.7	1.39	15	7.86	311	25.2	1.21	13	
	14:30	3.3	4.8	1.5	0.23	3049	6652	2.2	2.7	0.8	--	--	--	7.86	313	24.5	1.61	18	7.81	317	25.1	1.39	15	
04/25/24	7:00	3.0	3.7	1.6	0.25	2670	4940	1.7	2.1	1.5	0.25	1816	3364	7.89	320	24.4	1.55	18	7.86	318	24.8	1.61	14	
	11:20	2.9	4.4	1.5	0.23	2679	6097	1.8	2.0	1.4	0.23	2083	3471	7.89	324	24.2	1.48	14	7.82	328	24.6	1.48	12	
	15:30	2.7	4.3	1.4	0.22	2593	6194	2.2	2.4	0.8	--	--	--	7.84	319	24.6	1.98	17	7.80	318	25.0	1.98	15	
04/26/24	8:30	2.9	4.4	1.4	0.22	2785	6338	2.1	2.4	0.8	--	--	--	7.89	324	24.1	1.34	17	7.85	318	24.8	1.61	20	
	12:30	2.7	4.3	1.4	0.22	2593	6194	1.7	1.9	1.5	0.22	1816	3044	7.85	325	24.4	1.71	21	7.84	324	24.8	1.62	17	
Run Outfall1-P5 - Target Parameters: UV Intensity Range 6000 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 18 ppm																								
05/07/24	10:00	2.2	3.2	1.3	0.16	2396	5229	1.4	1.6	0.8	--	--	--	7.87	240	24.8	7.89	19	7.67	264	25.4	7.74	19	
	14:00	2	2.9	1.8	0.67	1505	3273	1.2	1.6	1.8	0.67	877	1754	7.70	194	25.0	11.99	16	7.65	214	25.2	11.88	14	
	15:30	1.9	2.9	1.6	0.54	1631	3735	1.2	1.6	1.6	0.54	1111	2221	7.69	250	25.4	8.50	20	7.70	253	25.6	9.66	18	
05/08/24	8:10	2.0	2.9	1.3	0.36	2085	4535	1.3	1.6	1.3	0.36	1805	3332	7.83	248	25.8	8.77	19	7.82	262	26.2	8.55	18	
	13:05	1.7	2.7	1.2	0.14	1939	4618	1.6	1.9	0.8	--	--	--	7.78	244	25.7	10.83	17	7.72	250	26.3	10.57	15	
05/10/24	10:00	2.2	3.1	1.3	0.32	2396	5065	1.3	1.7	1.3	0.32	2005	3934	7.72	190	25.0	7.08	15	7.65	195	25.4	6.88	13	
	14:00	2.2	3.3	1.3	0.16	2396	5392	1.3	1.7	0.8	--	--	--	7.63	263	25.7	5.94	19	7.57	271	26.4	6.58	18	
05/13/24	13:45	2.2	3.1	1.3	0.16	2396	5065	1.4	1.6	1.3	0.16	2160	3702	7.77	298	27.3	9.17	23	7.71	300	27.8	7.80	20	
05/14/24	8:45	1.3	1.9	1.1	0.11	1636	3586	1.3	1.6	1.1	0.11	3008	5553	7.71	309	25.7	15.69	23	7.76	304	26.1	11.75	22	
	14:00	2.1	3.0	1.2	0.14	2395	5132	1.3	2.0	1.2	0.14	2256	5206	7.74	309	27.1	5.00	22	7.67	309	27.7	5.02	17	
05/15/24	13:00	1.8	2.7	1.2	0.14	2053	4618	1.2	1.6	1.2	0.14	2083	4165	7.76	317	25.9	6.83	23	7.67	321	26.3	6.94	19	
	14:48	1.7	2.7	1.3	0.16	1852	4412	1.2	1.6	1.3	0.16	1851	3702	7.73	317	27.1	9.03	20	7.67	319	27.5	8.76	16	
	9:00	1.8	2.6	1.2	0.13	2154	4666	1.1	1.4	1.2	0.13	2182	4165	7.71	329	25.7	6.81	24	7.68	328	26.5	6.95	17	
05/16/24	10:00	1.8	2.6	1.2	0.13	2154	4666	1.1	1.4	1.2	0.13	2182	4165	7.73	314	25.7	7.82	20	7.63	311	26.6	9.88	17	
	13:30	1.8	2.7	1.2	0.13	2154	4845	1.3	1.5	1.2	0.13	2578	4463	7.70	319	26.5	10.88	22	7.65	318	27.1	9.51	20	
05/17/24	7:25	1.7	2.4	1.2	0.13	2034	4307	1.0	1.3	1.2	0.13	1983	3868	7.69	337	23.4	10.58	18	7.67	341	24.2	10.05	15	
	13:45	1.0	2.4	1.2	0.14	1140	4105	1.1	1.3	1.2	0.14	1909	3384	7.69	338	24.9	7.17	17	7.68	344	25.3	7.50	15	
05/20/24	13:25	1.5	2.3	0.6	--	4165	6386	1.0	1.2	0.6	--	2314	4165	7.81	329	25.2	3.50	20	7.74	331	26.3	3.88	20	Flow readings based on bucket test
	14:20	1.5	2.3	0.6	--	4165	6386	1.0	1.2	0.6	--	2314	4165	7.77	307	24.7	3.84	17	7.69	312	26.3	4.50	13	
05/22/24	12:20	2.1	2.1	0.5	--	6997	6997	0.9	1.0	0.5	--	2499	4165	7.74	311	21.6	4.33	32	7.65	309	24.5	4.47	18	Noticed increased difficulty with setting peroxide dosage.
	15:38	1.0	1.0	0.5	--	3332	3332	0.9	1.1	0.5	--	2499	4582	7.15	335	23.9	3.76	27	7.15	330	25.6	3.90	18	Adjusted peroxide and tested multiple time could not achieve desired
05/23/24	10:34	1.0	1.6	0.45	--	3702	5924	0.9	1.0	0.45	--	2777	4628	7.21	342	22.9	5.35	18	7.03	348	24.6	5.72	10	peroxide dosage at flows below 0.6 per reactor.
	15:43	0.9	1.4	0.45	--	3332	5183	0.7	1.0	0.45	--	2160	4628	7.19	339	24.7	7.73	17	7.07	335	26.8	6.79	10	
05/24/24	7:45	1.0	1.5	0.4	--	4165	6248	0.9	1.0	0.4	--	3124	5206	7.13	303	24.2	3.75	33	6.87	301	32.4	8.82	29	
	13:45	1.0	1.5	0.4	--	4165	6248	1.0	1.1	0.4	--	3471	5727	7.04	315	26.4	3.65	17	7.08	325	28.8	4.20	9	
Run Outfall1-P6 - Target Parameters: UV Intensity Range 7500 mJ/cm <sup>2</sup> and H <sub>2</sub> O <sub>2</sub> Concentration 18 ppm																								
06/04/24	12:30	1.7	2.5	0.5	--	5664	8330	1.6	2.0	0.5	--	4443	8330	7.35	280	23.5	4.34	17	7.01	257	25.8	6.16	7	Flow readings based on rotameter
	14:30	1.8	2.5	0.5	--	5998	8330	1.5	2.1	0.5	--	4165	8747	7.21	301	23.7	6.05	18	7.02	297	25.4	5.37	10	
06/05/24	12:00	1.7	2.2	0.5	--	5664	7330	1.7	2.2	0.5	--	4720	9163	7.21	320	26.5	4.45	17	7.05	315	27.8	5.47	11	
	15:15	1.6	2.2	0.5	--	5331	7330	1.7	2.3	0.5	--	4720	9580	7.20	326	26.9	2.85	15	7.03	321	28.6	3.48	11	
06/06/24	9:00	1.6	1.9	0.45	--	5924	7034	1.6	2.0	0.45	--	4936	9256	7.19	332	24.8	4.79	18	7.03	327	26.5	4.61	11	
	12:50	1.4	1.9	0.4	--	5831	7914	1.5	2.1	0.4	--	5206	10933	7.21	326	25.9	5.09	17	7.06	333	28.0	4.94	8	
06/07/24	9:30	1.4	1.9	0.4	--	5831	7914	1.7	2.2	0.4	--	5900	11454	7.24	324	26.6	3.73	18	7.10	330	28.3	4.31	7	
	12:25	1.5	2.0	0.45	--	5553	7404	1.7	2.2	0.45	--	5245	10181	7.22	333	26.5	5.57							

Date	Time	UVAOP-1 (2024 UNIT)						UVAOP-2 (2020 UNIT)						Influent					Effluent					Comments
		Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	Minimum UV Intensity Range (mW/cm2)	Maximum UV Intensity Range (mW/cm2)	Flow Rate (gpm)	H2O2 Addition (mL/min)	Min Calculated UV Dose (mJ/cm <sup>2</sup> )	Max Calculated UV Dose (mJ/cm <sup>2</sup> )	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	pH	ORP	Temperature	Turbidity	H <sub>2</sub> O <sub>2</sub> Concentration (ppm)	
06/18/24	8:00	2.3	3.4	1	0.31	3832	5664	1.3	1.7	1	0.31	1805	3540	7.46	303	25.4	1.60	20	7.33	310	26.3	1.47	13	
	12:00	0	0	0.9	0.3	0	0	1.3	1.6	0.95	0.3	1900	3507	7.33	306	25.1	1.22	20	7.29	307	25.4	1.59	16	
	14:00	2.2	3.3	0.9	0.285	4072	6109	1.3	1.6	0.95	0.285	1900	3507	7.29	311	25.6	1.24	19	7.25	310	26.9	1.76	15	
06/19/24	9:00	2.0	3.1	0.85	0.28	3920	6076	1.2	1.5	0.9	0.28	1851	3471	7.39	273	24.7	1.44	21	7.22	276	25.8	1.49	17	
	11:30	2.0	3.1	0.85	0.275	3920	6076	1.2	1.5	0.9	0.275	1851	3471	7.27	281	24.7	1.67	20	7.15	281	26.1	1.66	11	
	13:00	2.0	3.0	0.85	0.275	3920	5880	1.2	1.5	0.9	0.275	1851	3471	7.29	295	25.8	1.84	19	7.20	292	27.1	1.95	15	
06/20/24	9:45	2.0	3.0	0.85	0.273	3920	5880	1.2	1.5	0.9	0.273	1851	3471	7.41	279	27.0	1.75	20	7.25	282	28.1	2.08	14	
	13:00	2.0	2.9	0.8	0.266	4165	6039	1.1	1.4	0.85	0.266	1797	3430	7.28	288	26.5	1.82	20	7.16	285	27.5	1.63	15	
	14:30	1.9	2.9	0.8	0.245	3957	6039	1.2	1.4	0.85	0.245	1960	3430	7.26	292	26.8	1.22	20	7.16	292	27.6	1.37	11	
06/21/24	8:15	1.7	2.6	0.7	0.187	4046	6188	1.1	1.2	0.75	0.187	2036	3332	7.29	295	27.2	1.81	18	7.11	293	28.8	1.91	9	
	13:50	1.7	2.6	0.7	0.187	4046	6188	1.1	1.3	0.7	0.187	2182	3868	7.28	306	27.4	2.56	19	7.15	311	28.4	2.36	14	
06/24/24	8:00	1.5	2.2	0.6	0.19	4165	6109	0.8	1.2	0.7	0.19	1587	3570	7.31	264	26.9	3.00	21	7.29	259	28.2	2.76	15	
	12:00	1.5	2.2	0.6	0.19	4165	6109	0.9	1.1	0.7	0.19	1785	3273	7.30	290	27.0	2.84	20	7.29	286	28.3	2.68	16	
	14:00	1.5	2.2	0.6	0.19	4165	6109	0.9	1.2	0.7	0.19	1785	3570	7.30	301	26.9	3.21	20	7.29	296	28.3	2.88	16	
06/25/24	8:00	1.4	2.2	0.65	0.19	3588	5639	0.8	1.2	0.7	0.19	1587	3570	7.30	302	26.7	1.74	19	7.18	306	28.7	2.13	14	
	12:00	1.4	2.1	0.65	0.19	3588	5382	0.8	1.1	0.7	0.19	1587	3273	7.30	304	26.8	2.03	19	7.21	307	28.7	2.27	15	
	14:00	1.4	2.1	0.65	0.19	3588	5382	0.8	1.1	0.7	0.19	1587	3273	7.31	305	26.8	3.01	20	7.22	307	28.8	2.53	15	
06/26/24	8:00	1.4	2.0	0.65	0.19	3588	5126	0.9	1.0	0.7	0.19	1785	2975	7.38	300	26.7	1.65	19	7.23	307	29.1	1.73	12	
	11:30	1.3	2.0	0.6	0.19	3610	5553	0.8	1.1	0.7	0.19	1587	3273	7.35	300	26.7	2.32	19	7.22	306	29.0	2.43	13	
	14:00	1.3	2.0	0.6	0.19	3610	5553	0.8	1.1	0.7	0.19	1587	3273	7.31	302	26.8	2.16	20	7.21	307	29.1	1.78	13	
06/27/24	7:30	1.3	1.8	0.55	0.19	3938	5452	0.8	1.0	0.7	0.19	1587	2975	7.29	305	27.2	1.73	20	7.19	307	29.1	2.02	12	
	12:00	1.3	1.9	0.55	0.18	3938	5755	0.8	1.1	0.7	0.18	1587	3273	7.28	304	27.1	1.99	18	7.20	308	29.1	2.33	10	
	14:30	1.3	1.9	0.55	0.18	3938	5755	0.8	1.0	0.7	0.18	1587	2975	7.29	305	27.2	2.07	18	7.21	308	29.1	2.37	11	
06/28/24	9:00	1.4	2.0	0.55	0.10	4241	6058	0.8	1.1	--	--	--	--	7.29	305	27.2	2.47	17	7.20	309	29.0	2.10	9	

Notes:

-- = Not Measured or Not Estimated

gpm = gallons per minute

UV = ultraviolet

UV1 = northernmost UV unit (2024 UNIT)

UV2 = southernmost UV unit (2020 UNIT)

mW/cm<sup>2</sup> = milliwatts per square centimeter

mL/min = milliliters per minute

ORP = oxidation-reduction potential

ppm = parts per million