San José-Santa Clara
Regional Wastewater Facility
Reporting Period June 1 – October 31, 2021

Pond A18

2021 Annual Self-Monitoring Report

Order No. R2-2005-0003

Prepared for:
California Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94560

Prepared by:
City of San Jose, Environmental Services Department
San José-Santa Clara Regional Wastewater Facility
700 Los Esteros Road
San Jose, CA 95134

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I. INTRODUCTION

This report summarizes 2021 water quality monitoring for Pond A18. Monitoring began June 1 and ended October 31 as required by the Waste Discharge Requirement (WDR) Order No. R2-2005-0003 (Order) and subsequent modifications to the Order as approved by the Executive Officer of the San Francisco Bay Regional Water Quality Control Board (Water Board).

This was the City of San José's (City) seventeenth year of continuous discharge monitoring for Pond A18. Figure 1 indicates the location of Pond A18 hydraulic control structures and sampling sites in the receiving water (Artesian Slough and Coyote Creek).

A. Waste Discharge Requirements

Pond A18 circulates San Francisco Bay (Bay) water by means of two water control structures located at the northern and southern ends of the levee bounding the western edge of the pond. Discharge of pond water back into the Bay via Artesian Slough is regulated by the WDR, and the water quality of the pond must meet the discharge limitations outlined in Table 1.

Table 1. Pond A18 discharge requirements for Salinity, Dissolved Oxygen, and pH

Constituent	Instantaneous Maximum	Instantaneous Minimum	Units
Salinity	44		ppt
Dissolved Oxygen[1]		5.0	mg/L
pH	8.5	6.5	standard units

Pond A18 must also meet the following water quality requirements:

1. Discharge temperature into Artesian Slough shall not exceed the receiving water temperature by 20°F.
2. If pond dissolved oxygen (DO) levels at station A18-D fall below 1.0 mg/L, the discharger shall monitor, report, and take corrective actions required by Provision D.2.

[1]Discharger may select station A18-D or the downstream receiving water monitoring station nearest to the A18 discharge to evaluate compliance with the dissolved oxygen limit. In cases where receiving waters do not meet the Basin Plan Objective, the Discharger must show, as described in its Operations Plan, that pond discharges are not causing low dissolved oxygen in the receiving water.

B. Monitoring Requirements

Monitoring in 2021 was conducted in compliance with the Pond A18 WDR monitoring requirements on page 9, Table 2 of the "Self-Monitoring Program" of the Order, and subsequent revisions to the WDR. The City continuously monitored (15-min intervals) pond discharge from June 1 to October 31, 2021 for DO, pH, temperature, and salinity. Discrete measurements of these same parameters and chlorophyll *a* were collected between 0800 and 1000 hours once per month in the pond. Additionally, City staff conducted monthly discrete monitoring at four stations in the receiving water. A multiparameter sonde was used to record DO, pH, temperature, and salinity at the surface and bottom, while a Van Dorn bottle was used to collect discrete grab samples from just below the surface and above the bottom for laboratory analysis of turbidity.

Following the 2012 annual report, a letter from the Water Board's Executive Officer, Bruce Wolfe, dated April 9, 2013, eliminated the requirement of continuous receiving water monitoring. In 2021, receiving water was monitored with weekly discrete water column measurements in response to the pond's weekly 10^{th} percentile DO concentration falling below the 3.3 mg/L trigger threshold. The dates and results of trigger monitoring are presented on Page 11, Table 6.

Per a modification to the WDR in 2018 (Provision D.7), the previous requirement for monitoring of receiving water sediments for mercury and methyl mercury every other year was eliminated. The City demonstrated that from 2011 through 2017, Artesian Slough sediment mercury levels were consistently near the average mercury concentration in Lower San Francisco Bay, and therefore no further sediment monitoring was necessary. This monitoring was conducted for the final time in September 2017.

C. Pond Operations in 2021

Pond A18 was successfully operated in the southern discharge orientation throughout 2021, with no repairs or unusual operations required. Since completion of the South Levee Repair Project in 2018, City staff have carefully monitored the structural integrity of the southern gate apparatus and levee. Throughout the 2021 monitoring season, City staff adjusted pond flow rate and water depth to balance minimizing levee stress with maximizing pond flushing.

At the onset of the monitoring season during the first weeks of June, pond salinity periodically measured near or just above the maximum discharge limit of 44 PSU. In response, staff opened the pond's twin 48-inch northern intake gates by over 50% to increase water flow into the pond, and the southern discharge gates were raised by 3" each to promote water circulation while limiting potential levee stress. These gate adjustments were maintained throughout the monitoring season, and salinity decreased below the discharge limit by 17 June 2021. Going forward, when the pond is being operated in the southern discharge orientation, water level will be managed primarily from the southern gate structure to maximize circulation and prevent such high salinity conditions.

In addition to monitoring by City staff, a geotechnical engineer from Cal Engineering and Geology, Inc. evaluated the structural integrity of the southern gate apparatus on 31 August 2021. The evaluation showed that the sheet pile walls and gate structure are continuing to perform well, although some soil and rock surfaces around the structure and levee crest show signs of settling and degradation. City staff and Cal Engineering contractors will continue monitoring the southern structure, and recommended baserock additions will be implemented as deemed necessary by ongoing geotechnical assessment.

Figure 1. Pond A18 monitoring stations and hydraulic control structures- Southern Discharge. Arrows indicate the flow of water through the control structures

As the pond was operated continuously in the southern discharge orientation throughout the 2021 dry season, water quality monitoring and weekly 10th percentile DO assessments were conducted at the southern structure. Monthly discrete monitoring, as well as low-DO trigger monitoring when required, were conducted in accordance with Artesian Slough stations outlined in the southern release scenario of the WDR and Operations Plan (Figure 1). Station 1 was located just upstream of the southern structure, nearest to Facility effluent discharge, and Station 2 was located just downstream of the southern structure. Station 3 was located at the halfway point between the southern structure and Artesian Slough's confluence with Coyote Creek, and Station 4 at the downstream end of Artesian Slough, just before the confluence with Coyote Creek.

II. MONITORING METHODS AND RESULTS

City staff at the San José-Santa Clara Regional Wastewater Facility (Facility) used water quality monitoring sondes manufactured by YSI, Inc. for general water quality monitoring (DO, pH, temperature, salinity). The EXO3 model sonde was deployed for continuous monitoring and recorded water quality measurements every 15 minutes in the pond at the southern gate structure. The EXO1 model sonde was used for discrete monitoring of surface and bottom measurements in the receiving water. All sondes were outfitted with an optical DO probe, a conductivity/temperature probe, and a pH probe. In addition, Secchi depth was measured weekly and chlorophyll *a* monthly in the pond at the southern gate structure. Temperature, salinity, pH, DO, and turbidity were also measured monthly at the surface and bottom in the receiving water (Figure 1) as part of the discrete monitoring program.

Monitoring throughout the 2021 dry season was performed following COVID-19 safety protocols. City staff responsible for Pond A18 monitoring primarily worked from home and were required to complete a health screening survey before entering the Facility to perform field work. During all on-site work and boating operations, staff wore face coverings, maintained social distancing to the extent possible, and minimized time spent together indoors. Careful planning and adherence to safety protocols allowed City staff to complete all work required for Pond A18 monitoring without issue.

A. Quality Assurance/Quality Control

City staff calibrated and maintained sondes to ensure accuracy before deploying. After each use, staff checked sondes for their accuracy against known standards for conductivity, pH and DO. An unattended EXO3 sonde was deployed in the pond for 1 week and then replaced with another cleaned and calibrated sonde. This rotation continued throughout the duration of dry season monitoring.

Data Validation

Staff followed established acceptance criteria for sonde data with post-deployment readings within 5% of the theoretical level accepted. Data within 5 - 10% were accepted or rejected based on best professional judgment. Staff rejected data with post deployment measurements exceeding 10% of theoretical and investigated the cause of such failures.

Calibration standards used for post-deployment accuracy checks to validate sonde data were:

- DO – percent saturation in water-saturated air (theoretical of 100% saturation).
- pH – a 2-point calibration (pH 7 and pH 10) to establish a pH slope.
- Conductivity – 50,000 microSiemens standard.

Sonde post-deployment measurements passed QA/QC throughout the monitoring season. Sonde battery voltage was checked before each deployment to ensure the battery would remain above the data recording threshold, determined at the end of the 2019 monitoring season, for the entire week of deployment. Sonde batteries were replaced before deployment if their voltage read below 2.8 V when connected to the KOR software. This protocol helped yield consistent, reliable continuous monitoring data throughout the 2021 dry season.

B. Continuous Monitoring

During the 2021 dry season monitoring period, sondes at the Pond A18 discharge point (Station A18-D, Figure 1) recorded temperature, salinity, pH, and DO every 15 minutes. Following deployment, staff uploaded these data to a computer where they were checked for accuracy and completeness, summarized, and evaluated with respect to discharge requirements and action triggers. Weekly 10^{th} percentile DO readings for pond discharge indicated the need for any adaptive management responses during the upcoming week. Such responses could include, but were not limited to, additional receiving water monitoring, aeration, reversing direction of flow, or strategic timing of pond discharges to limit low DO discharge.

Temperature

Water temperature for Pond A18, under both discharge and non-discharge conditions, is presented in Table 2.

Table 2. Temperature results – 2021 continuous monitoring (°C)

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	13.5	31.5	23.1	23.9	13,581
A18 Non-Discharge	14.3	30.5	24.0	24.6	1,103

During both discharge and non-discharge periods, pond minimum temperatures in 2021 were approximately 1-2°C lower than in 2020, and maximum temperatures were approximately 1°C higher than in 2020. Mean and median 2021 temperatures were also consistent with those in 2020. In typical fashion, temperatures showed mid-summer peaks and dropped considerably at the end of the monitoring season. Temperatures did not differ noticeably between discharge and non-discharge periods (Figure 2).

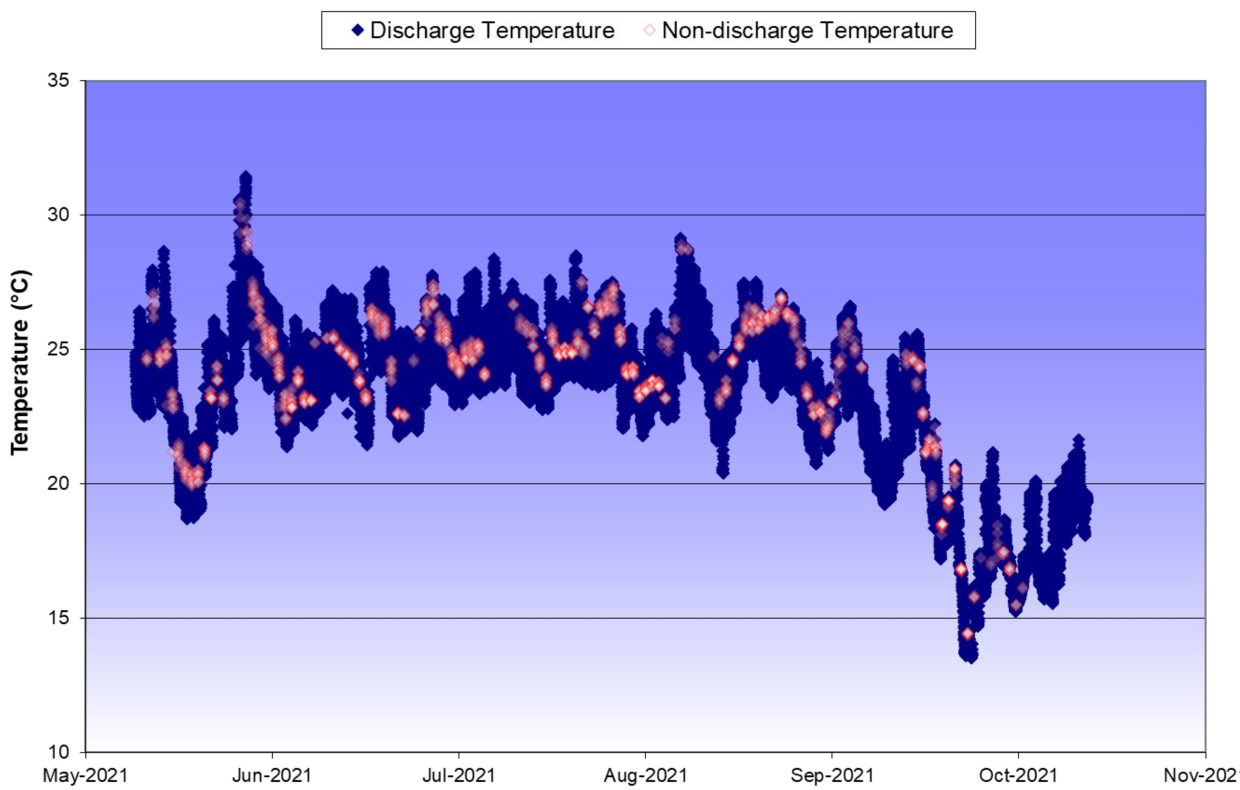

Figure 2. Temperature profile – Pond A18 2021 dry season

Salinity

Pond salinity, under both discharge and non-discharge conditions, is presented in Table 3.

Table 3. Salinity results - 2021 continuous monitoring (PSU[2])

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	20.4	44.8	39.8	39.8	13,581
A18 Non-Discharge	21.9	44.6	39.7	39.8	1,103

For discharge and non-discharge periods, maximum salinity in 2021 was approximately 4 PSU above that in 2020, while minimum 2021 salinity was 3-4 PSU below that in 2020. Mean and median pond salinity values in 2021 were approximately 8-10 PSU higher than in 2020 and approximately double 2019 values. Salinity continued to be significantly elevated compared to years before 2019. This trend reflects the change from the northern discharge orientation implemented from 2016 through late 2018, in which the southern structure was used to intake Facility effluent-rich slough water, to the southern discharge orientation implemented from late 2018 onward, in which the northern structure was used to intake more Bay-influenced water from farther downstream Artesian Slough. Additionally, the 2020-2021 water years combined rank as the two driest years in California's statewide precipitation record (CA Department of Water Resources), which likely exacerbated high-salinity conditions.

Salinity began around 43 PSU at the start of the monitoring season and periodically rose above 44 PSU, to a maximum of 44.8 (Table 3), between 7 and 17 June 2021. The gates at the northern and southern water control structures were raised in response, as described above in the "Pond Operations in 2021" section, to decrease salinity by allowing increased circulation of pond water. An imprecise adjustment to the southern gates resulted in brief periods when Artesian Slough water backflowed into Pond A18 during high tides, causing intermittent salinity drops between 1 and 7 July 2021. After this adjustment was corrected on 7 July, salinity hovered between approximately 38 and 41 PSU until late October, when salinity dropped to around 36 PSU (Figure 3).

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[2]Practical Salinity Units (PSU) are a measurement of salinity from the specific conductance measured in water. An algorithm based on the ion composition of natural sea water converts specific conductance into PSU. One PSU is approximately equivalent to one part-per-thousand salinity.

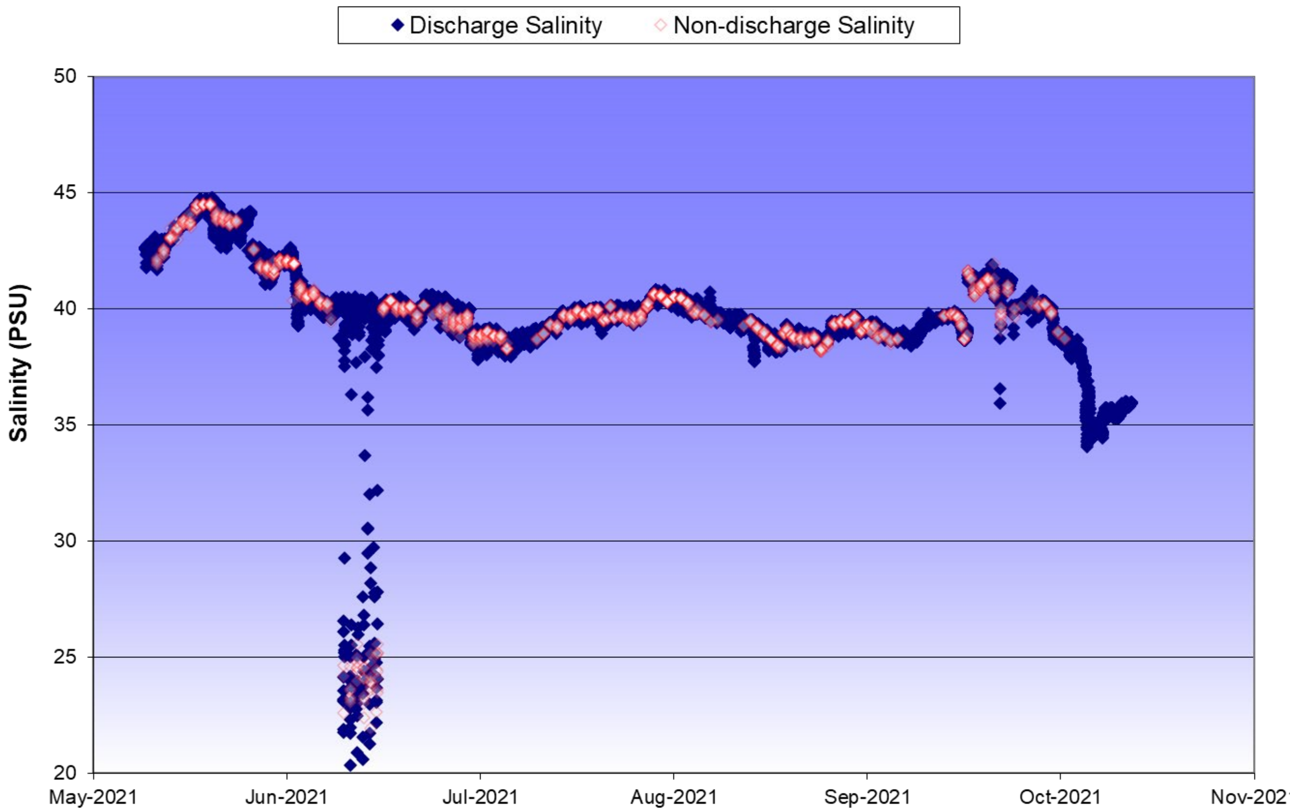

Figure 3. Salinity profile – Pond A18 2021 dry season

pH

Pond pH, under discharge and non-discharge conditions, is shown in Table 4.

Table 4. pH results – 2021 continuous monitoring

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	8.3	9.5	8.7	8.7	13,581
A18 Non-Discharge	8.3	9.3	8.7	8.7	1,103

The Basin Plan Objective for pH requires that receiving water pH remain between 6.5 and 8.5, and pond pH was above this range for much of 2021, as is typical of Pond A18 dry season conditions. While pond pH was often above the range in the Basin Plan, discrete pH monitoring, performed at least monthly in the receiving water (page 15, Table 9) demonstrated that the Basin Plan Objective for pH was consistently met at the surface. In addition, previous years of continuous receiving water monitoring for pH (2005 – 2012) have demonstrated no adverse affects to receiving water pH from elevated pH pond discharges.

Minimum discharge and non-discharge pH values in 2021 (Table 4) were consistent with those in 2020, while maximum values were 0.7-0.8 units lower. Mean and median pH decreased by approximately 0.5 units from 2020 to 2021. Similar to 2020 and unlike 2019, pH in 2021 generally decreased throughout the monitoring season, especially in the first half (Figure 4). Episodes of intense photosynthesis due to high algal biomass, elevated water temperature and increased solar irradiance tend to coincide with increased pH. This is usually followed by declines in pH when algae die off and decompose later in the season. Changes in these conditions generally coincide with shifts in phytoplankton species composition. As is typical, discharge and non-discharge pH did not differ from each other.

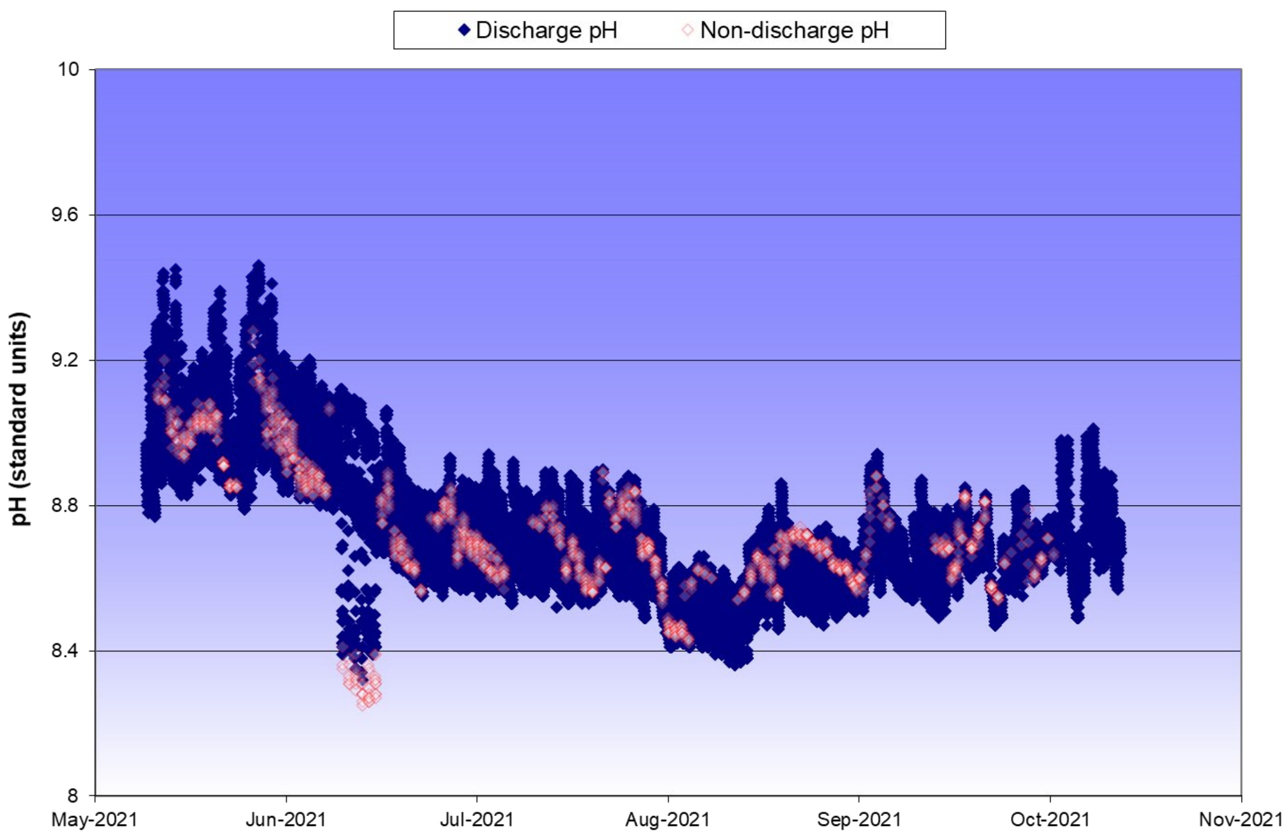

Figure 4. pH profile – Pond A18 2021 dry season

Dissolved Oxygen

Pond DO concentrations, under both discharge and non-discharge conditions, are summarized in Table 5.

Table 5. DO results – 2021 continuous monitoring (mg/L)

Site/Condition	Minimum	Maximum	Mean	Median	# of Measurements (n)
A18 Discharge	0.0	24.4	5.7	5.6	13,581
A18 Non-Discharge	0.0	17.6	5.4	4.9	1,103

Pond DO is primarily influenced by a photosynthesis-driven diurnal pattern (Figure 5) of high primary productivity by algae during the day and high net ecosystem respiration at night by algae and other organisms residing in the pond. Other factors influencing pond DO to a lesser extent include hydraulic residence time and flushing in the pond, intensity and duration of sunlight/cloud cover, temperature, and algal biomass and community composition.

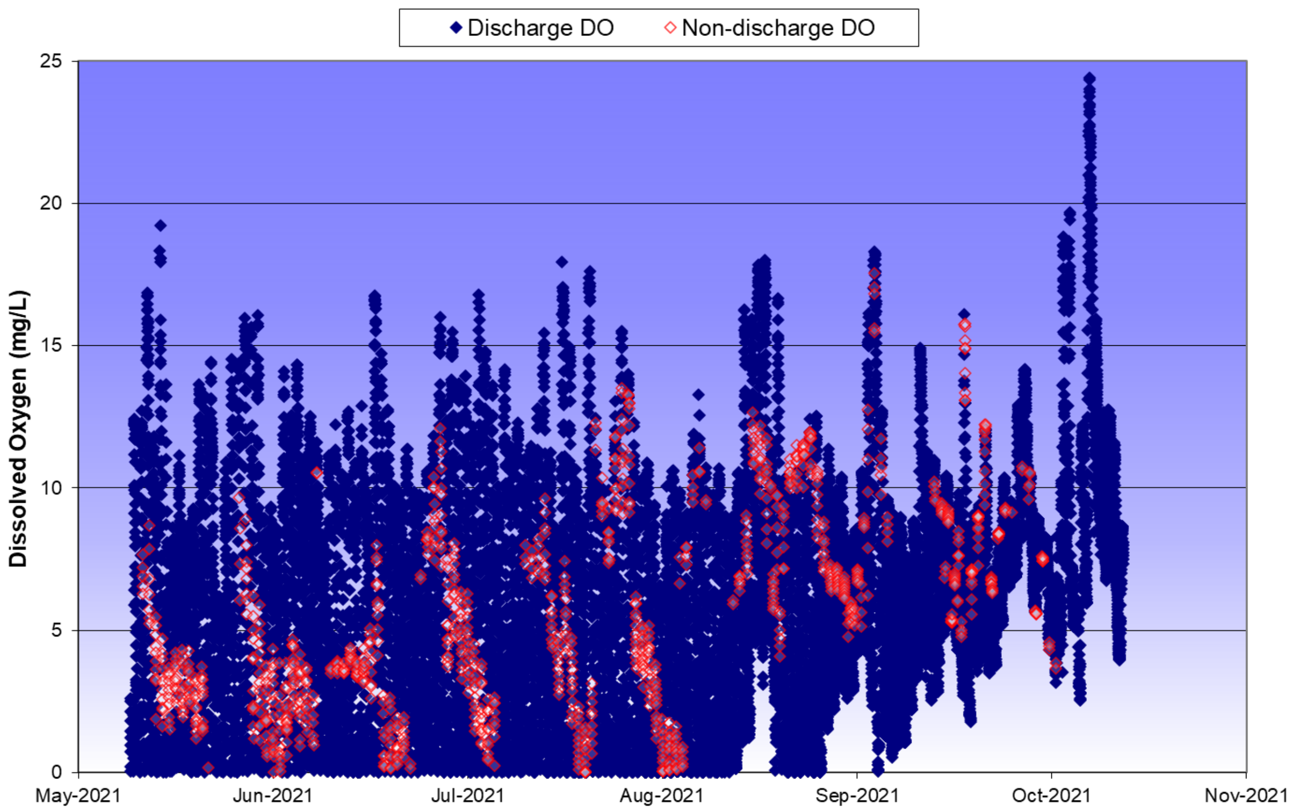

Figure 5. DO profile – Pond A18 2021 dry season

Pond DO concentrations were more variable in 2021 than in 2020, with maximum values (Table 5) approximately 2 and 5 mg/L higher during non-discharge and discharge periods, respectively. Mean and median 2021 discharge and non-discharge DO values were approximately 1-3 mg/L lower than in 2020. Throughout the monitoring season, DO showed strong diurnal cycles of nightly anoxia or hypoxia followed by daytime supersaturation. DO dipped to zero most nights from June to September, and it showed an increasing trend from mid-September through October concurrent with drops in salinity and temperature.

Whenever the pond's weekly 10th percentile DO concentration fell below the 3.3 mg/L threshold, the City's trigger response consisted of weekly discrete water column sonde measurements at the surface and bottom at three receiving water monitoring stations. Under Pond A18's southern release configuration, these stations were located in Artesian Slough at Stations 1, 2, and 3 (Figure 1). Trigger monitoring occurred seventeen times in 2021 (Table 6). Trigger data was evaluated by City staff and revealed no persistent negative effects from episodic low DO pond discharges, therefore, no additional adaptive management or monitoring actions were implemented. Trigger monitoring results are presented and discussed in Section III of this report.

Table 6. Weekly 10th percentile DO values for Pond A18 discharge and response in 2021

Week and Date Range	10th Percentile Value (mg/L)	Response
1: 6/1 – 6/2	0.0	None required- start of dry season monitoring
2: 6/2 – 6/9	0.0	Trigger monitoring initiated 6/16- low DO measured at bottom of Station 2
3: 6/9 – 6/16	0.0	Trigger monitoring continued 6/23- no impacts
4: 6/16 – 6/23	0.0	Trigger monitoring continued 6/30- no impacts
5: 6/23 – 6/30	0.1	Trigger monitoring continued 7/7- no impacts
6: 6/30 – 7/7	0.0	Trigger monitoring continued 7/14- no impacts
7: 7/7 – 7/14	0.0	Trigger monitoring continued 7/21- no impacts
8: 7/14 – 7/21	0.0	Trigger monitoring continued 7/22- no impacts
9: 7/21 – 7/28	0.0	Trigger monitoring continued 8/4- no impacts
10: 7/28 – 8/4	0.0	Trigger monitoring continued 8/11- no impacts
11: 8/4 – 8/11	0.0	Trigger monitoring continued 8/13- low DO measured at bottom of Station 2
12: 8/11 – 8/18	0.0	Trigger monitoring continued 8/25- no impacts
13: 8/18 – 8/25	0.0	Trigger monitoring continued 9/1- no impacts
14: 8/25 – 9/1	0.0	Trigger monitoring continued 9/8- low DO measured at bottom of Station 2
15: 9/1 – 9/8	1.8	Trigger monitoring continued 9/15- no impacts
16: 9/8 – 9/15	0.1	Trigger monitoring continued 9/22- no impacts
17: 9/15 – 9/22	2.9	Trigger monitoring continued 9/29- no impacts
18: 9/22 – 9/29	1.4	Trigger monitoring continued 9/30- no impacts
19: 9/29 – 10/6	4.2	None required
20: 10/6 – 10/13	3.8	None required
21: 10/13 – 10/20	6.8	None required
22: 10/20 – 10/27	4.7	None required
23: 10/27 – 10/31	5.6	None required- end of dry season monitoring

General Observations

Patterns of pond clarity and water color during the 2021 monitoring season differed considerably from preceding years. While pond water was a typical green shade in June (Figure 6), macroalgae was much less abundant than in previous years. Unlike typical dry season pond conditions, benthic and filamentous algae only grew in sparse patches near the pond's southern margins throughout the 2021 monitoring season, and the expansive floating algal mats observed in 2020 remained absent in 2021 (Figure 6 through Figure). Water clarity was also consistently lower than in previous years, with Secchi depths in the 12-20 cm range, as opposed to ~40-80 cm in 2020 (Table 7).

Figure 6. June 2 – green water at start of dry season

Throughout the 2021 monitoring season, the air was generally warm and clear with little wind until late October. As a result, pond water conditions changed relatively little, maintaining a consistent green-yellow color, although water clarity increased slightly toward the end of the monitoring season (Table 7). Air in mid-August was filled with smoke blown westward from fires in the Lake Tahoe area (Figure 8), but this condition did not persist for long and did not appear to affect Pond A18 water conditions.

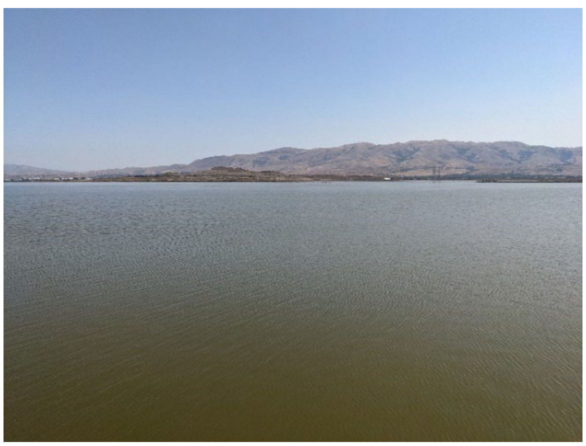

Figure 7. July 14 – light green water, no surface algae

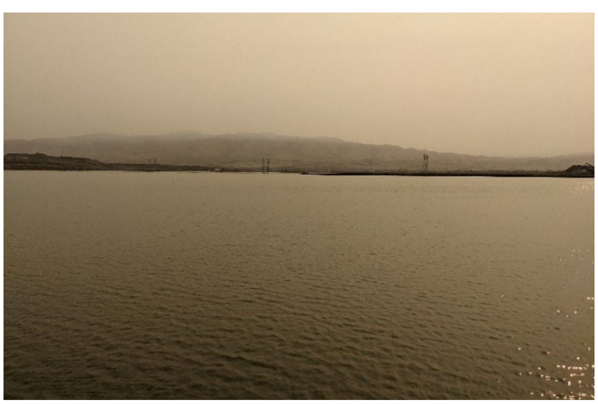

Figure 8. August 18 – smoky skies from Tahoe wildfires

Figure 9. September 22 – calm green water, no algae along pond margins

Figure 10. October 13 – conditions unchanged from previous months

Figure 11. November 11 – post-monitoring season. Slightly darker green waters accompany cloudier, wetter weather

Table 7. Secchi measurements in 2021. Water quality measurements included for context to illustrate general changes in pond characteristics.

Date and Time	Secchi Depth (cm)	Temp (°C)	Salinity (PSU)	DO (mg/L)	pH
6/2 10:15	15	22.6	43.0	0.0	8.9
6/9 10:00	12	19.3	44.5	3.6	9.0
6/16 09:30	15	22.1	43.9	0.0	8.8
6/23 09:00	14	24.0	42.2	1.5	8.9
6/30 12:30	17	24.4	40.4	7.5	9.0
7/7 12:30	16	23.1	39.6	8.4	8.9
7/14 11:30	16	22.3	40.6	1.2	8.6
7/21 10:00	15	23.8	39.1	2.4	8.7
7/28 09:45	16	24.0	38.6	0.8	8.6
8/4 09:30	17	23.2	39.5	0.0	8.6
8/11 10:15	16	24.2	39.6	1.0	8.6
8/18 09:15	14	22.1	40.2	0.4	8.5
8/25 10:00	16	22.5	40.0	0.2	8.4
9/1 12:30	16	23.0	39.2	4.5	8.4
9/8 13:15	17	25.4	39.3	3.3	8.6
9/15 09:30	17	23.5	38.3	0.3	8.5
9/22 14:15	18	24.4	39.0	6.2	8.7
9/29 11:15	17	19.3	39.3	5.8	8.6
10/6 12:15	16	21.3	38.9	5.8	8.7
10/13 08:30	19	13.6	41.2	5.4	8.5
10/20 11:00	18	15.4	38.7	6.8	8.7
10/27 12:00	20	16.4	35.2	10.1	8.8

C. Discrete Monitoring

The WDR requires discrete water quality monitoring in both the pond and receiving water at monthly intervals.

Pond Discrete Monitoring

The WDR requires the collection of discrete water quality measurements in Pond A18 once per month. Monthly discrete DO and chlorophyll *a* readings for the pond need to be taken between 0800 and 1000 hours per the A18 WDR Monitoring Provisions. Staff measured the discrete pond water quality using temperature, salinity, pH, and DO from the continuous discharge monitoring sonde to fulfill these discrete monitoring requirements (Table 8). These measurements were recorded on the same date and time as the required monthly chlorophyll *a* sampling, which is detailed below in the section "Chlorophyll *a* Monitoring."

Table 8. 2021 discrete monthly water quality measurements at Pond A18 discharge

Date and Time	Temperature (C)	Salinity (PSU)	pH	DO (mg/L)
6/15 09:45	22.4	43.6	8.9	2.2
7/21 09:00	23.5	39.1	8.6	0.5
8/13 08:00	23.8	40.1	8.6	0.1
9/8 09:00	24.9	38.9	8.5	2.6
10/13 09:00	13.6	41.3	8.5	5.3

Receiving Water Discrete Monitoring

Discrete monthly water quality sampling is required at four receiving water locations (Figure 1) during the monitoring season (Figure 12). These surface and bottom measurements of DO, pH, temperature, salinity, and turbidity (Table 9) characterize the mixing of fresh slough water with Bay salt water during tidal exchange, and illustrate the effects (if any) that Pond A18 discharge may have on water quality. The WDR requires these measurements to be recorded while the pond is discharging.

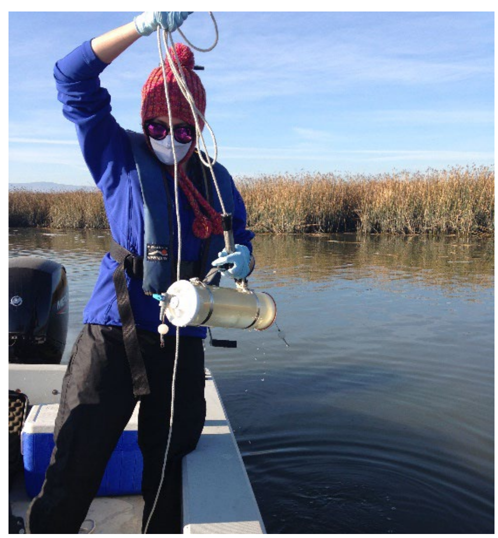

Figure 12. Biologist Jaylyn Babitch collects a discrete water sample from Artesian Slough

Table 9. Receiving water monthly surface and bottom water quality measurements in 2021

Date and Time	Site	Tide	Depth	Temp (°C)	Salinity (PSU)	pH	DO (mg/L)	Turbidity (NTU)	A18 Flow (cfs)
6/16 08:35	1	Ebb	Surface	24.7	0.8	7.2	7.0	1.0	11.1
6/16 08:36	1	Ebb	Bottom	24.7	0.9	7.7	5.9	1.6	11.1
7/21 09:59	1	Flood	Surface	26.3	0.8	7.3	7.1	1.9	33.7
7/21 10:00	1	Flood	Bottom	25.3	9.0	7.9	5.6	9.3	33.7
8/13 09:38	1	Ebb	Surface	26.8	0.9	7.5	7.5	2.5	37.5
8/13 09:39	1	Ebb	Bottom	26.8	0.9	7.5	7.6	4.3	37.5
9/8 11:59	1	Flood	Surface	27.6	0.8	7.5	7.8	1.7	33.7
9/8 12:02	1	Flood	Bottom	27.5	1.4	7.5	7.6	1.9	33.7
10/13 11:52	1	Ebb	Surface	24.3	1.4	7.4	7.3	1.9	25.6
10/13 11:56	1	Ebb	Bottom	17.1	17.7	7.9	4.1	14.4	26.9
6/16 08:42	2	Ebb	Surface	24.5	1.7	7.4	6.8	2.9	11.6
6/16 08:47	2	Ebb	Bottom	22.9	32.2	8.5	0.3	8.5	11.6
7/21 10:03	2	Flood	Surface	25.5	6.4	7.7	6.6	5.7	33.7
7/21 10:06	2	Flood	Bottom	24.1	30.4	8.4	1.9	79.2	33.7
8/13 09:45	2	Ebb	Surface	26.6	2.0	7.5	7.2	4.8	37.5
8/13 09:47	2	Ebb	Bottom	24.4	30.6	8.2	1.4	35.6	37.5
9/8 12:08	2	Flood	Surface	27.1	7.6	7.9	8.5	3.8	31.5
9/8 12:11	2	Flood	Bottom	25.6	29.6	7.5	2.3	28.0	31.5
10/13 12:00	2	Ebb	Surface	23.2	4.1	7.5	7.0	4.0	26.9
10/13 12:02	2	Ebb	Bottom	15.6	27.4	7.9	4.2	26.6	26.9
6/16 08:52	3	Ebb	Surface	24.0	3.6	7.5	5.5	8.6	11.6
6/16 08:55	3	Ebb	Bottom	23.6	27.5	8.3	0.2	26.6	12.5
7/21 10:09	3	Flood	Surface	23.5	16.1	7.7	2.3	29.2	31.9
7/21 10:12	3	Flood	Bottom	23.4	16.1	7.7	1.6	55.9	31.9
8/13 09:55	3	Ebb	Surface	25.8	3.7	7.6	6.4	16.6	38.4
8/13 09:58	3	Ebb	Bottom	25.1	8.9	7.9	4.1	265	38.4
9/8 12:16	3	Flood	Surface	24.9	16.5	7.8	3.1	36.7	31.5
9/8 12:18	3	Flood	Bottom	24.4	16.2	7.5	0.6	64.5	31.5
10/13 12:09	3	Ebb	Surface	21.6	6.5	7.7	7.1	9.2	28.3
10/13 12:12	3	Ebb	Bottom	16.0	16.5	7.8	3.8	27.8	28.3
6/16 09:04	4	Ebb	Surface	24.0	6.5	7.7	5.2	16.6	12.5
6/16 09:05	4	Ebb	Bottom	23.8	19.5	8.0	0.5	31.1	12.5
7/21 10:16	4	Flood	Surface	22.9	20.2	7.9	3.7	30.4	31.9
7/21 10:17	4	Flood	Bottom	22.9	20.4	7.9	3.1	31.5	31.9
8/13 10:20	4	Ebb	Surface	25.5	7.9	7.7	4.7	25.9	39.4
8/13 10:22	4	Ebb	Bottom	25.2	12.6	7.9	2.4	53.0	39.4
9/8 12:24	4	Flood	Surface	24.3	21.1	7.9	3.1	42.7	29.1
9/8 12:26	4	Flood	Bottom	24.4	20.8	7.9	3.0	45.4	29.1
10/13 12:17	4	Ebb	Surface	20.2	8.9	7.8	7.0	13.4	28.3
10/13 12:19	4	Ebb	Bottom	15.4	22.2	7.9	4.3	36.5	28.3

Temperature

Receiving water temperature in 2021 was relatively consistent across the stations throughout the monitoring period, with a slight decrease moving downstream. Temperatures were lower at the bottom than at the surface, with the most temperature stratification apparent at Station 2 (Figure 13). These trends were consistent with 2020 receiving water observations.

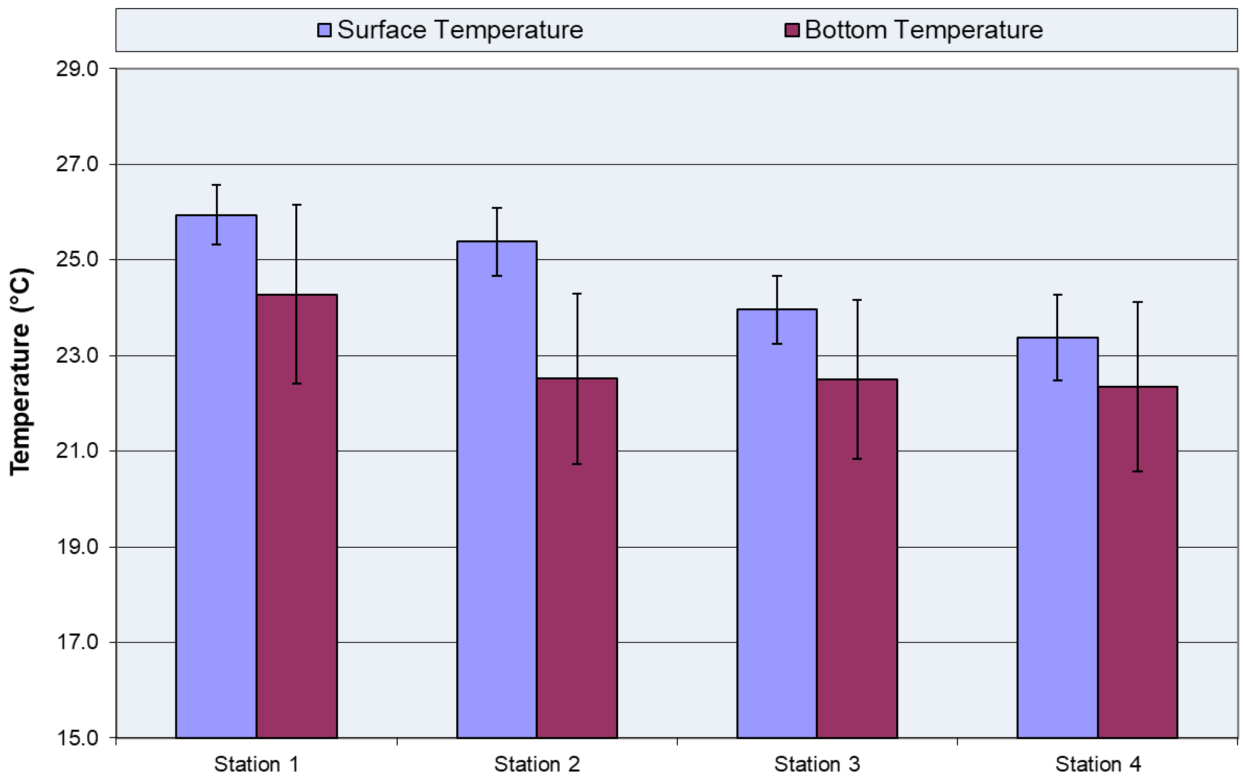

Figure 13. Mean (± SE) monthly temperature in receiving water in 2021

Salinity

Receiving water average salinities were higher in 2021 than in 2020, but they showed similar trends among stations and depths. As in 2020 and other years when the pond was operated in the southern discharge orientation, the receiving water salinity profile was dictated by upstream stratification (Stations 1 and 2) and downstream mixing (Stations 3 and 4) in Artesian Slough (Figure 14). In typical fashion, Station 2 showed the greatest stratification, although bottom salinity generally remained well below salinity in Pond A18, indicating minimal impact of pond discharge on slough water quality. The slough-wide pattern of greater stratification upstream is caused by fresher, less dense Facility effluent water floating on top of saltier, denser Bay water, an interaction that diminishes downstream as tidal mixing increases.

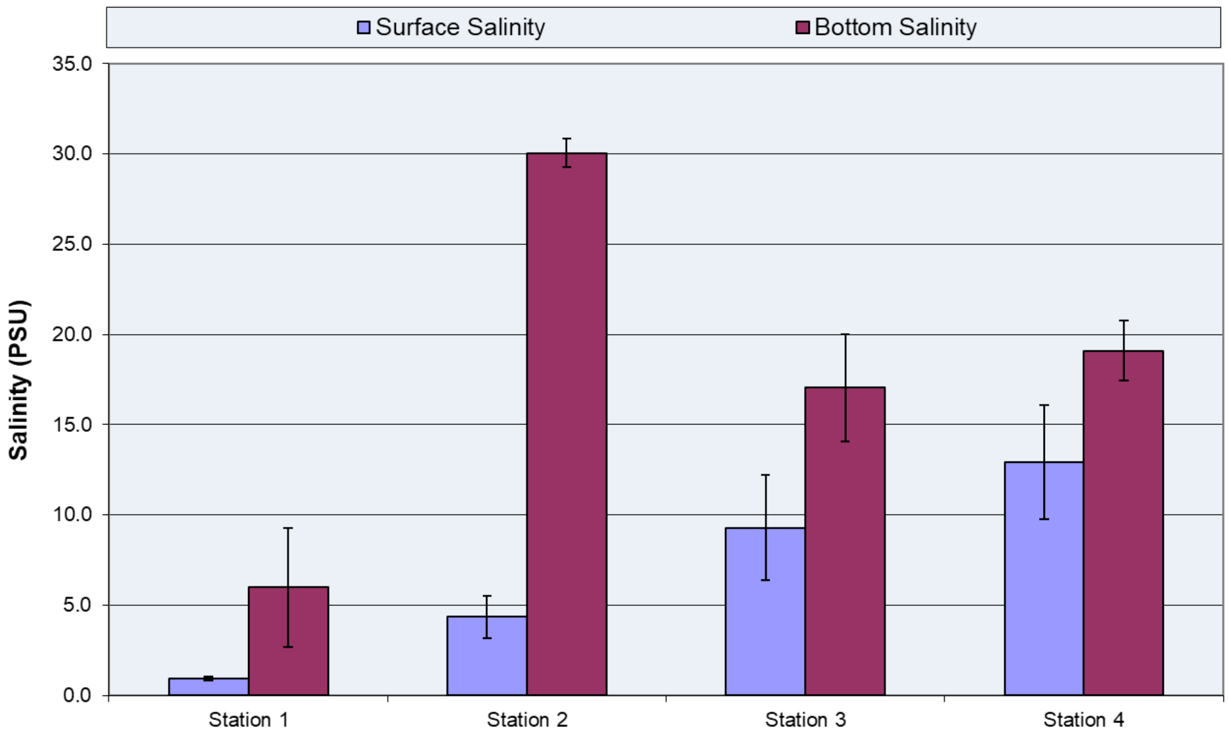

Figure 14. Mean (± SE) monthly salinity in receiving water for 2021

pH

Pond pH was generally higher (8.3 – 9.5; Table 4) than the surface and bottom measurements of the receiving water (7.2 – 8.5; Table 9). Despite this, pH in receiving waters remained within the Basin Plan Objective (6.5-8.5) throughout the 2021 monitoring season.

At all four monitoring stations, pH was higher at the bottom than at the surface (Figure 15). Surface pH increased steadily moving downstream, while bottom pH was highest at Station 2, as also observed in 2020. Stratification generally decreased moving downstream. These results demonstrate that receiving water conditions are driven primarily by localized conditions and broader, more significant hydraulic inputs from the Bay, tributaries and the RWF discharge rather than being strongly influenced by Pond A18 discharge.

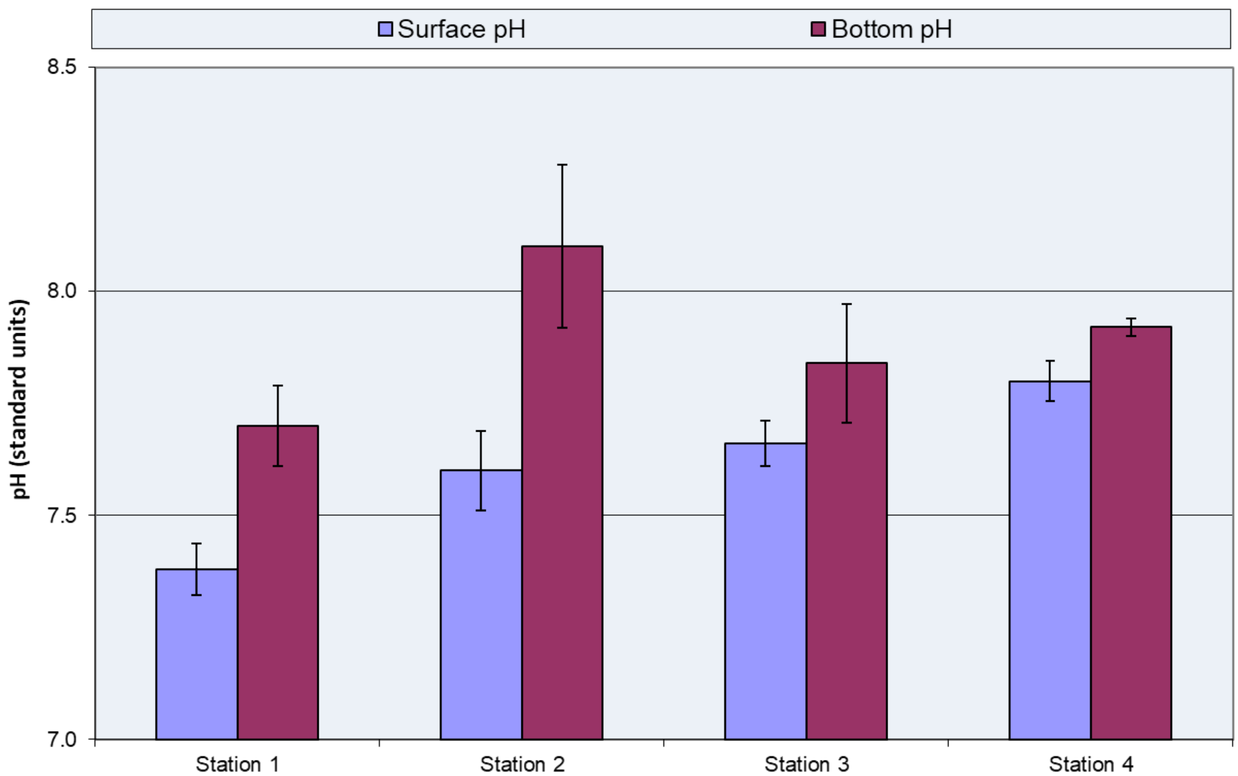

Figure 15. Mean (± SE) monthly pH in receiving water for 2021

Dissolved Oxygen

The WDR requires the Discharger to monitor, report, and take corrective action if monthly discrete DO levels in Pond A18 fall below 1.0 mg/L. This scenario occurred twice during the 2021 monitoring season, on 21 July at 09:00 and 13 August at 08:00 (Table 8). Trigger monitoring for temperature, salinity, pH and DO was conducted every week from June through September while pond DO levels consistently fell below the 10th percentile weekly trigger of 3.3 mg/l. The pond's northern and southern gates were also raised considerably in an attempt to improve water circulation.

Surface DO values were highest at Stations 1 and 2 and decreased downstream (Figure 16), reflective of the oxygen-rich effect of the RWF effluent on upstream DO. Bottom DO was approximately 2-3 times higher at Station 1 than at the other stations, similar to 2020 trends. Stratification was highest at Station 2 and decreased downstream as the effects of tidal mixing increased, also similar to previous years.

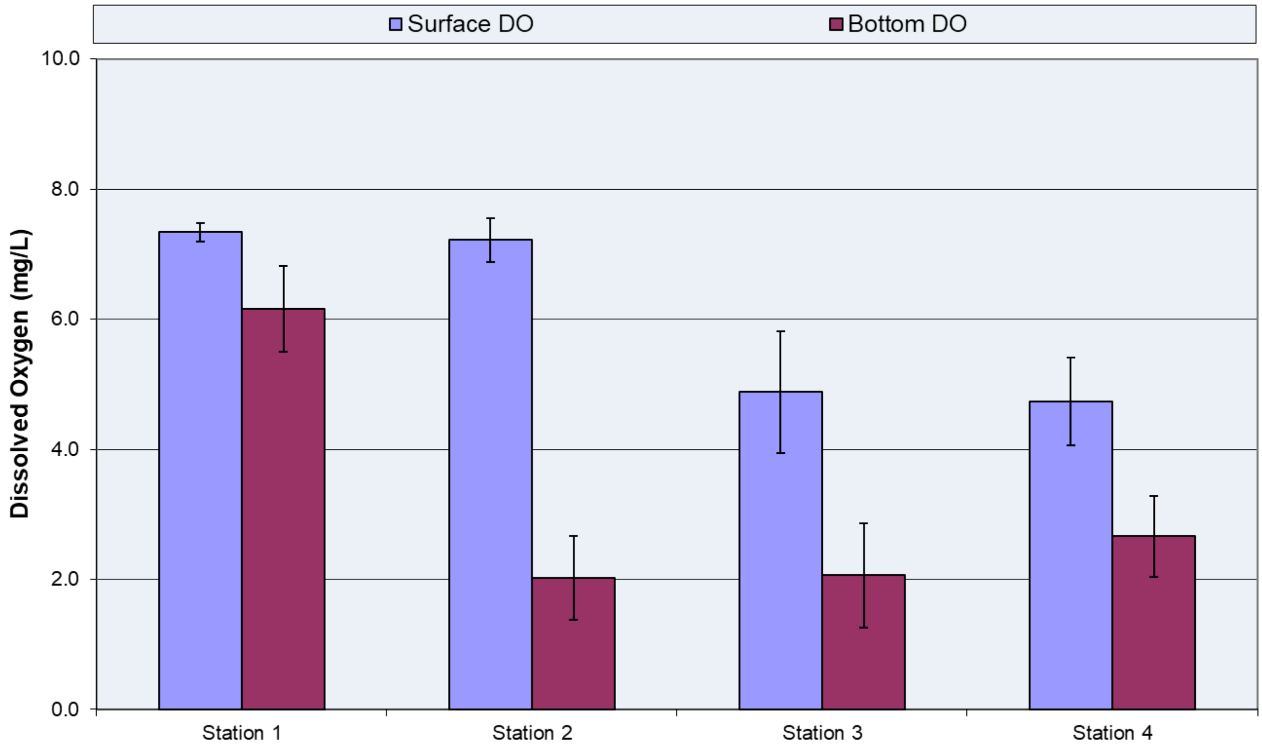

Figure 16. Mean (± SE) monthly Dissolved Oxygen in receiving water for 2021

Turbidity

Turbidity was measured monthly at the four monitoring stations (Figure 17). As expected, turbidity was higher at the bottom than surface at each station, with the most stratification evident at Stations 2 and 3. As observed in 2020, surface turbidity in 2021 steadily increased moving downstream, while bottom turbidity was highest at Station 3. Similar to 2020 and 2019, overall turbidity in Artesian Slough was lower than during the 2016-2018 northern discharge period, especially at the two stations nearest the Facility.

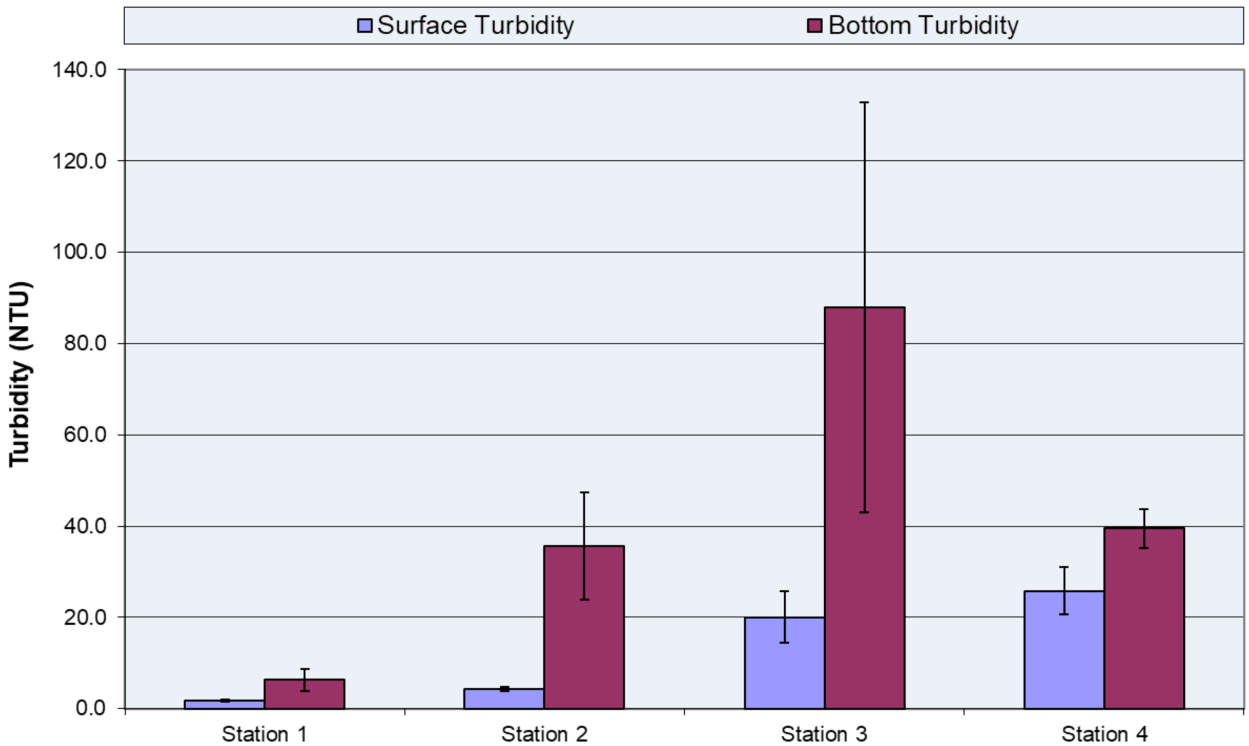

Figure 17. Mean (± SE) monthly turbidity in receiving water for 2021

Chlorophyll *a* Monitoring

The City measured chlorophyll *a* as an index of phytoplankton biomass in Pond A18 by collecting a monthly grab sample in a 2-liter brown plastic bottle. This sample, kept cool and out of direct light, was immediately brought to the Facility's Environmental Laboratory for fluorometric analysis (EPA Method 445.0) by City laboratory staff.

Aside from the month of June, phytoplankton biomass in the pond in 2021 (Table 10. Monthly chlorophyll a measurements at Pond A18 discharge in 2021. DO and salinity measurements are included for context to indicate general changes in pond characteristics.) was lower than in 2020. Unlike years 2019 and 2020 which showed mid-season chlorophyll peaks, chlorophyll in 2021 was highest in June, then decreased by approximately 30% in July. Chlorophyll gradually increased from August to October, a trend concurrent with increasing DO. The observed variability in phytoplankton biomass reflects both seasonal and interannual cycles of community succession among phytoplankton flowing through the pond. Persistent high salinity may have limited phytoplankton production in the pond, leading to generally lower biomass than previous years.

Table 10. Monthly chlorophyll a measurements at Pond A18 discharge in 2021. DO and salinity measurements are included for context to indicate general changes in pond characteristics.

Month	Date sampled	Chlorophyll *a* (μg/L)	DO (mg/L)	Salinity (PSU)
June	6/15/2021	149.0	2.2	43.6
July	7/21/2021	44.3	0.5	39.1
August	8/13/2021	70.0	0.1	40.1
September	9/8/2021	73.0	2.6	38.9
October	10/13/2021	94.5	5.3	41.3

III. EXCEEDANCES AND TRIGGERED ACTIONS

A. Trigger Monitoring Results

Table 6 lists the DO trigger events for pond discharges in 2021 and subsequent responses.

In 2021, the response to Pond A18's weekly 10th percentile DO concentration falling below the trigger threshold of 3.3 mg/L consisted of recording additional weekly discrete water column measurements at Stations 1, 2, and 3 in Artesian Slough (Figure 1) to determine if lower DO pond discharges were adversely affecting receiving water DO (Figure 18).

Figure 18. Environmental Specialist Bryan Frueh records water quality data in Artesian Slough using a multi-probe YSI

Monitoring was performed in response to seventeen low-DO trigger events in weeks 2 through 18 of the 2021 dry season. Results are detailed in Table 11. Due to a logging error, no surface measurements were recorded at Station 1 on 30 June 2021. Since the bottom DO measurement at Station 1 (7.2 mg/L) was above the surface DO trigger threshold of 5.0 mg/L, we inferred that surface DO at Station 1 would have also been above this threshold. Nonetheless, trigger monitoring continued through the following week.

Trigger monitoring is designed to detect impacts of pond discharge on receiving water quality. Any confirmed negative impacts trigger additional adaptive management actions (e.g., additional water quality monitoring or valve adjustments). Negative impacts from pond discharges are defined as follows:

- Receiving water DO at Artesian Station 2 is < 5.0 mg/L at surface or < 3.3 mg/L at bottom, and;
- 2-hour average pond DO bracketing the time that receiving water measurements were taken is less than measured receiving water DO.

Low DO conditions in the receiving water must be linked to Pond A18 discharge to necessitate additional adaptive management measures.

There were fourteen instances among weeks 2 through 18 when trigger monitoring measured receiving water DO less than 3.3 mg/L at the bottom at Station 2 (Table 11). Continuous sonde data in the pond was evaluated to determine if pond discharge contributed to these readings. The 2-hour average pond DO values bracketing the trigger measurement times were below Station 2 bottom DO readings during three instances. Pond DO 2-hour averages were 0.05 mg/L on 16 June, 1.3 mg/L on 13 August, and 2.2 mg/L on 8 September. Trigger monitoring was continued the following week after each of these dates, and the pond gates were adjusted to maintain relatively high water level and encourage circulation through the pond. Pond DO improved from mid-September through the end of the dry season, so additional corrective actions were not implemented. Surface DO at Station 2 never measured below 5.0 mg/L during any trigger monitoring event in 2021 (Table 11).

Table 11. Discrete trigger monitoring results in 2021. ND indicates no data due to sonde malfunction

Week	Date & Time	Site	Tide	Depth	Temp (°C)	Sal (PSU)	pH	DO (mg/L)
2	6/16 8:35	1	Ebb	Surface	24.7	0.8	7.2	7.0
	6/16 8:36	1	Ebb	Bottom	24.7	0.9	7.7	5.9
	6/16 8:42	2	Ebb	Surface	24.5	1.7	7.4	6.8
	6/16 8:47	2	Ebb	Bottom	22.9	32.2	8.5	0.3
	6/16 8:52	3	Ebb	Surface	24.0	3.6	7.5	5.5
	6/16 8:55	3	Ebb	Bottom	23.6	27.5	8.3	0.2
3	6/23 12:07	1	Flood	Surface	25.3	10.0	8.1	6.5
	6/23 12:09	1	Flood	Bottom	24.5	14.8	8.1	2.5
	6/23 12:12	2	Flood	Surface	26.3	4.5	7.9	8.4
	6/23 12:14	2	Flood	Bottom	24.3	33.8	7.9	0.9
	6/23 12:18	3	Flood	Surface	23.8	19.7	7.8	3.4
	6/23 12:18	3	Flood	Bottom	23.7	16.4	8.1	1.2
4	6/30 10:29	1	Ebb	Surface	ND	ND	ND	ND
	6/30 10:31	1	Ebb	Bottom	25.7	1.0	7.5	7.2
	6/30 10:35	2	Ebb	Surface	25.6	2.1	7.5	6.9
	6/30 10:38	2	Ebb	Bottom	23.6	30.7	8.5	3.8
	6/30 10:42	3	Ebb	Surface	24.6	4.8	7.8	6.2
	6/30 10:44	3	Ebb	Bottom	24.1	22.8	8.3	0.2
5	7/7 10:47	1	Flood	Surface	25.7	0.8	7.3	7.1

	7/7 10:48	1	Flood	Bottom	25.7	0.9	7.4	6.9
	7/7 10:50	2	Flood	Surface	25.3	2.0	7.6	7.9
	7/7 10:51	2	Flood	Bottom	23.1	32.1	8.5	1.2
	7/7 10:55	3	Flood	Surface	23.5	7.9	7.8	4.4
	7/7 10:56	3	Flood	Bottom	22.5	11.5	7.8	1.0
6	7/14 13:03	1	Flood	Surface	26.7	0.8	7.5	8.2
	7/14 13:05	1	Flood	Bottom	26.7	0.8	7.5	8.3
	7/14 13:07	2	Flood	Surface	26.8	3.7	7.6	8.3
	7/14 13:10	2	Flood	Bottom	23.4	31.3	7.5	3.7
	7/14 13:13	3	Flood	Surface	26.7	11.4	8.1	6.1
	7/14 13:15	3	Flood	Bottom	24.1	20.9	8.3	2.9
7	7/21 9:59	1	Flood	Surface	26.3	0.8	7.3	7.1
	7/21 10:00	1	Flood	Bottom	25.3	9.0	7.9	5.7
	7/21 10:03	2	Flood	Surface	25.5	6.4	7.7	6.6
	7/21 10:06	2	Flood	Bottom	24.1	30.4	8.4	1.9
	7/21 10:09	3	Flood	Surface	23.5	16.1	7.7	2.3
	7/21 10:12	3	Flood	Bottom	23.4	16.1	7.7	1.6
8	7/22 12:14	1	Flood	Surface	26.0	4.4	7.7	7.0
	7/22 12:15	1	Flood	Bottom	23.7	16.4	7.9	2.2
	7/22 12:16	2	Flood	Surface	26.8	3.5	7.8	9.0
	7/22 12:17	2	Flood	Bottom	23.8	17.8	7.9	2.2
	7/22 12:20	3	Flood	Surface	23.3	20.4	7.8	3.9
	7/22 12:21	3	Flood	Bottom	23.1	17.8	7.6	1.2
9	8/4 14:05	1	Ebb	Surface	26.9	2.6	7.3	6.8
	8/4 14:06	1	Ebb	Bottom	23.8	18.3	7.8	0.8
	8/4 14:08	2	Ebb	Surface	27.1	3.4	7.6	7.5
	8/4 14:10	2	Ebb	Bottom	23.9	32.3	8.4	0.2
	8/4 14:18	3	Ebb	Surface	26.7	5.7	7.8	9.1
	8/4 14:19	3	Ebb	Bottom	23.5	16.8	7.4	2.1
10	8/11 14:41	1	Flood	Surface	27.9	1.3	7.5	8.2
	8/11 14:42	1	Flood	Bottom	25.5	16.5	8.0	2.8
	8/11 14:45	2	Flood	Surface	28.4	3.6	7.9	9.4
	8/11 14:48	2	Flood	Bottom	25.2	21.9	8.2	2.1
	8/11 14:51	3	Flood	Surface	25.3	19.6	7.9	4.5
	8/11 14:52	3	Flood	Bottom	25.1	20.2	7.8	3.7
11	8/13 9:38	1	Ebb	Surface	26.8	0.9	7.5	7.5
	8/13 9:39	1	Ebb	Bottom	26.8	0.9	7.5	7.6
	8/13 9:45	2	Ebb	Surface	26.6	2.0	7.5	7.2
	8/13 9:47	2	Ebb	Bottom	24.4	30.6	8.2	1.4
	8/13 9:55	3	Ebb	Surface	25.8	3.7	7.6	6.4
	8/13 9:58	3	Ebb	Bottom	25.1	8.9	7.9	4.1
12	8/25 11:52	1	Flood	Surface	26.7	0.8	7.4	8.1
	8/25 11:53	1	Flood	Bottom	26.7	0.8	7.4	8.2
	8/25 11:55	2	Flood	Surface	26.4	4.9	7.5	8.3

	8/25 11:57	2	Flood	Bottom	23.5	28.4	7.5	1.8
	8/25 12:00	3	Flood	Surface	25.1	9.1	7.8	5.4
	8/25 12:02	3	Flood	Bottom	24.0	15.6	7.3	0.3
13	9/1 14:41	1	Ebb	Surface	27.4	1.5	7.4	7.6
	9/1 14:42	1	Ebb	Bottom	25.1	18.7	7.8	5.1
	9/1 14:53	2	Ebb	Surface	27.1	3.2	7.6	7.8
	9/1 14:54	2	Ebb	Bottom	23.8	21.2	8.0	1.9
	9/1 14:57	3	Ebb	Surface	27.0	5.7	7.6	7.7
	9/1 14:58	3	Ebb	Bottom	24.3	21.6	7.8	1.3
14	9/8 11:59	1	Flood	Surface	27.6	0.8	7.5	7.8
	9/8 12:02	1	Flood	Bottom	27.5	1.4	7.5	7.6
	9/8 12:08	2	Flood	Surface	27.1	7.6	7.9	8.5
	9/8 12:11	2	Flood	Bottom	25.6	29.6	7.5	2.3
	9/8 12:16	3	Flood	Surface	24.9	16.5	7.8	3.1
	9/8 12:18	3	Flood	Bottom	24.4	16.2	7.5	0.6
15	9/15 13:19	1	Ebb	Surface	27.2	1.1	7.4	7.3
	9/15 13:20	1	Ebb	Bottom	25.3	9.7	7.7	4.9
	9/15 13:24	2	Ebb	Surface	27.2	2.2	7.5	7.0
	9/15 13:26	2	Ebb	Bottom	24.2	30.2	7.3	0.3
	9/15 13:31	3	Ebb	Surface	26.5	5.0	7.6	7.0
	9/15 13:33	3	Ebb	Bottom	23.2	22.0	7.9	0.8
16	9/22 11:34	1	Flood	Surface	27.0	0.8	7.4	7.4
	9/22 11:36	1	Flood	Bottom	27.0	0.8	7.4	7.4
	9/22 11:41	2	Flood	Surface	26.6	4.7	7.7	7.7
	9/22 11:44	2	Flood	Bottom	24.4	30.6	8.5	4.4
	9/22 11:47	3	Flood	Surface	24.7	13.2	7.7	3.7
	9/22 11:49	3	Flood	Bottom	22.8	17.5	7.7	1.8
17	9/29 13:33	1	Ebb	Surface	26.4	0.7	7.6	7.9
	9/29 13:35	1	Ebb	Bottom	26.3	1.0	7.5	7.9
	9/29 13:28	2	Ebb	Surface	26.2	1.8	7.4	7.7
	9/29 13:29	2	Ebb	Bottom	20.7	31.5	7.9	1.2
	9/29 13:39	3	Ebb	Surface	25.5	3.8	7.6	7.8
	9/29 13:40	3	Ebb	Bottom	22.2	15.7	7.9	4.2
18	9/30 12:59	1	Ebb	Surface	26.3	1.8	7.3	7.1
	9/30 13:01	1	Ebb	Bottom	21.9	21.0	7.9	1.1
	9/30 13:04	2	Ebb	Surface	26.0	2.9	7.5	6.9
	9/30 13:06	2	Ebb	Bottom	20.8	32.7	8.5	2.4
	9/30 13:10	3	Ebb	Surface	25.7	4.3	7.6	7.1
	9/30 13:11	3	Ebb	Bottom	21.4	25.3	7.6	0.4

B. Summary of Corrective Action

There were seventeen weeks in which the weekly 10th percentile DO level in the pond's discharge dipped below the trigger threshold. The City responded by adjusting pond gates to increase water flow and conducting additional weekly discrete water column measurements at three stations in Artesian Slough (Figure 1; **Error! Reference source not found.**). An evaluation of trigger data revealed no persistent negative effects in the receiving water that could be attributed to Pond A18 discharge, so no additional corrective actions were necessary. During the brief period in mid-August when wildfire smoke obscured sunlight, weekly monitoring observations identified no fish kills or any other indicators of declining ecological condition in the pond or receiving water. UC Davis researchers studying fish abundance and community composition, as well as San Francisco Bay Bird Observatory (SFBBO) staff monitoring for avian disease, also did not report impacts to wildlife or water quality in the vicinity of Pond A18 or Artesian Slough.

Regardlesss of periodic low-DO pond conditions, native Bay fish species such as the Longfin Smelt and Northern Anchovy were observed spawning in Artesian Slough from June through September, according to monthly trawl data collected by UC Davis fish ecology researchers (summarized further in the 2021 Facility Annual Report). The relatively high numbers of native Bay fish species recorded in Artesian Slough during the 2021 dry season indicate that episodic low-DO pond discharges did not negatively affect native biota in the Alviso Marsh Complex.

IV. DISCUSSION AND INTERPRETATION OF 2021 RESULTS

Temperature

Pond water temperature in 2021 was relatively consistent with 2020 temperatures, and temperatures during both dry seasons were higher than during the preceding period of northern discharge (2016-2018). Temperatures in 2021 remained consistent between discharge and non-discharge periods throughout the monitoring season. The pond is large and shallow with a limited flow, so pond water temperature is highly influenced by ambient air temperature. Pond temperatures generally peak in midsummer and exhibit large fluctuations depending on heat waves or cloud cover. Mean monthly receiving water temperatures were slightly lower in 2021 than in 2020.

Salinity

Pond discharge salinity in 2021 was considerably higher than in 2020 and 2019. Increased salinities in recent years, as compared to the 2016-2018 northern discharge period, were likely due to the higher salinity of more Bay-influenced water flowing into the pond through the northern structure, as opposed to the fresher Facility effluent-rich water flowing in through the southern structure. Salinity readings above normal marine levels throughout 2021 indicated that evaporation and limited circulation were driving up salinity of the incoming Bay water as it flowed through the pond. Low rainfall in the South Bay during the 2020-2021 water years may have precipitated these conditions before dry season monitoring began.

Average receiving water salinities in 2021 were higher than in 2020 but showed similar trends between stations. Consistent with prior years, salinity gradients in the receiving water were driven by tidal cycles and freshwater effluent from the Facility. Less dense freshwater tends to float on top of saltier bay water that is pushed into Coyote Creek and Artesian Slough by the flooding tide.

pH

Increases in pond pH are driven by high rates of photosynthesis, accompanied by high irradiance and temperatures. Conversely, high salinity can act as a buffer, limiting pH increases. Pond pH in 2021 was generally lower than in 2020 and decreased during the first half of the monitoring season before stabilizing. This temporal trend reflects the typical effects of summer algal decomposition, which was likely driven more by phytoplankton than macroalgae in 2021.

Receiving water pH in 2021 was relatively consistent with previous years, showing the most stratification at Station 2, and it remained within the Basin Plan Objective throughout the monitoring season.

Dissolved Oxygen

Pond DO was more variable in 2021 than in 2020 and 2019. Extreme diurnal swings between anoxia and supersaturation were persistent from June until September, when the severity of nighttime hypoxia began to steadily decrease. As DO improved toward the end of the dry season, phytoplankton biomass also showed modest increases.

Receiving water surface DO concentrations in 2021 were relatively consistent with those in 2020, while bottom DO values were approximately 1 mg/L lower than in 2020. Decreases in bottom DO at Station 2 coincided with low pond DO in three instance during the 2021 monitoring season, but continued trigger monitoring showed that these conditions were not persistent. Relatively low average bottom DO at Stations 3 and 4 indicated that incoming Bay water may have contributed to periodic low-DO conditions at Station 2 and within Pond A18. This is consistent with observations and measurements of DO in the Lower South Bay as measured by other researchers such as those from UC Davis, USGS, and San Francisco Estuary Institute.

Water clarity and productivity

Secchi depths in the pond were unusually low in 2021 compared to preceding years. However, turbidity values and spatial trends in the receiving water were fairly similar to 2020 observations, aside from higher average bottom turbidity at Station 3 that was likely driven by a particularly high measurement of 265 NTU on 13 August 2021 (Table 9). Receiving water turbidity in 2021 continued to be considerably lower than during the 2016-2018 period of northern discharge orientation.

Chlorophyll *a* concentrations in 2021 were lower than those measured in 2020 and much lower than during the dry seasons of 2016 through 2018 (northern discharge pond flow). This result indicates that the southern discharge regime, which brings more Bay-influenced, lower-nutrient water into the pond, leads to relatively lower phytoplankton productivity as compared to the northern discharge regime, which brings more Facility effluent-rich, higher-nutrient water into the pond. Variation in chlorophyll *a* can be due not only to changes in overall phytoplankton cell growth and abundance, but also to shifts in the relative abundances of various taxa with different traits, such as cell size, growth rate, or carbon:chlorophyll ratio. The persistently turbid, dull green waters in the pond despite somewhat low chlorophyll concentrations suggest that phytoplankton taxa with low chlorophyll content and high salinity tolerance, such as certain cyanobacteria, may have dominated the Pond A18 algal community during the 2021 dry season.

Nuisance Filamentous Macro-algae

The presence of filamentous macro-algae in Pond A18 varies from year to year. Filamentous algae consist of macroscopic filaments which are of little value to pond productivity since benthic filter feeders and filter-feeding zooplankton (copepods, cladocerans, rotifers, shrimp, aquatic insects) are not able to utilize them effectively. Further, filamentous algal mats impede light penetration through the water column, thereby decreasing phytoplankton production and overall pond productivity.

Filamentous algae were much less prevalent during the 2021 dry season than in 2020. Unlike previous years, filamentous and benthic algae only grew in small sparse patches along Pond A18's margins, and the large floating algal mats typical of past summer conditions were absent in 2021. This lack of macroalgal growth may have been due to the persistent high-salinity conditions observed throughout the 2021 dry season, which appear to have supported mostly microalgal growth as evidenced by relatively high chlorophyll *a* concentrations in the pond, as compared to typically lower phytoplankton biomass in Artesian Slough and Lower South Bay.

Pond Infrastructure

In 2018, the City contracted HydroScience Engineers, Inc., Environmental Science Associates (ESA), and Sweetwater Construction to complete the South Levee Repair Project. From August 23 to September 24, 2018, the deteriorating levee embankments in the vicinity of Pond A18's southern structure were repaired and reinforced to allow for flow in either direction. On October 9, 2018, the pond's continuous circulation was configured for inflow through the northern hydraulic structure and discharge from the southern structure, and this configuration has since been continued.

Due to high pond salinity in 2021, the pond's southern hydraulic gates were adjusted higher than normal to allow more circulation and decrease water residence time in the pond. To confirm these adjustments were not compromising the structural integrity of the southern gate apparatus or levee, on 31 August 2021, a geotechnical engineer from Cal Engineering and Geology evaluated the southern hydraulic structure using LiDAR scanning and visual observations. No significant distress was noted regarding the sheet pile walls or gate structure, but the rock surface of the levee crest and timber platforms showed mild degradation. The soil surface adjacent to the bulkhead of the west platform also showed continued signs of settling, but it did not appear to be subject to any imminent sudden failure. The City continues to monitor the mechanical and geotechnical vulnerabilities of the pond's southern structure, and to adjust operations to improve pond circulation while keeping sediment transport, scour and levee erosion in check.

Future Uses of Pond A18

The timing for determination of future uses of A18 will depend on the outcomes of the Shoreline Levee Project, currently underway, which will construct a flood control levee along the southern boundary of A18. The future flood control levee will replace the current flood protection provided by A18 levees, allowing for increased flexibility to restore or alter Pond A18. The Shoreline Levee Project is a partnership with the California State Coastal Conservancy, the U.S. Army Corps of Engineers (USACE), and regional stakeholders to provide tidal flood protection, restore and enhance tidal marsh and related habitats, and provide recreational and public access opportunities along ponds A12, A13, A16, and A18 (see Valley Water District map here).

During the summer of 2019, pre-construction work activities on the flood control levee commenced on the eastern portions of the Alviso reaches. The USACE closed bidding for the construction of 1.6 miles of flood risk management levees in Reaches 1-3 for Phase I of the Project in January 2021 and awarded the construction contract in August 2021. Construction of Reach 1 (from the Alviso Marina to the Union Pacific railroad) and Reaches 2 & 3 (from Union Pacific railroad to the Artesian Slough) began in late 2021. A revised cost estimate for the project was prepared, which will require increased federal appropriations for USACE and cost share funds from the non-federal sponsors, California State Coastal Conservancy and Valley Water. The timeline for the design of the remaining project elements outside of Reaches 1-3 is uncertain. City staff continues to coordinate with USACE, California Coastal Commission, and Valley Water on Reaches 4 and 5 that will extend the levee across the RWF outfall and along the southern edge of Pond A18. Conceptual plans for the future of Pond A18 have included pond restoration and conceptual designs for an ecotone levee.

Avian Habitat Value

The City partners with the Santa Clara Valley Audubon Society to evaluate local Christmas Bird Count (CBC) data to assess avian population trends. The Alviso Complex CBC dataset, encompassing the Facility and surrounding wetlands, most notably Pond A18, extends back to 1975 and provides 40+ years of data which has been instrumental in evaluating bird recovery in the context of Facility treatment advancements and large-scale wetlands restoration efforts (Figure 19).

Figure 19. Great Egret photographed by James Ervin in the Alviso Marsh Complex

2021 waterfowl abundance data underscores the habitat value of the Alviso Complex system. The number of birds observed at Pond A18 was consistent with the previous year, and total CBC counts increased by approximately 6% from 2020 to 2021. Bird abundance continued to be higher than counts recorded before Pond A18, along with nearby Ponds A16, A17, A19, and A20, were breached and managed for long-term restoration in 2005-2006. Such positive trending illustrates Pond A18 continues to provide foraging and congregating habitat for many resident and migrating waterbirds.

V. LESSONS LEARNED AND RECOMMENDATIONS

1. Pond A18's primary productivity can decrease with cloud cover and rain events, which can decrease photosynthesis and temporarily lower DO. No adverse effects on receiving water DO have been measured during these short-term decreases in the seventeen years of monitoring. In 2021, a combination of low rainfall during the 2020-2021 water years, high summertime evaporation, and possible limited pond water circulation may have led to the high-salinity, low-DO conditions observed throughout much of the dry season. By further opening the pond's water control gates to increase flow, salinity was maintained below the 44 PSU Basin Plan Objective after mid-June, and DO conditions improved by October.

   Recommendation: Continuous pond discharge provides the most stable conditions in the pond. Shutting the discharge valve as a result of temporary low DO due to uncontrollable conditions may exacerbate low DO due to stagnation of pond water. The pond gates will be adjusted with respect to water quality conditions to maximize flow and reduce water residence time in the pond.

2. Continuation of the southern discharge regime in 2021 resulted in lower phytoplankton biomass in Pond A18 than during the 2016-2018 northern discharge period, likely due to lower-nutrient waters flowing into the pond. As with all previous years, the low DO conditions in 2021 did not adversely affect water quality in Artesian Slough, indicating that the pond discharges have minimal spatial influence on receiving water DO.

   Recommendation: Operating the pond in either the northern discharge or southern discharge configurations has had negligible effect on receiving water DO as demonstrated by multiple years of receiving water monitoring. However, the southern discharge scenario has resulted in lower phytoplankton biomass in the pond and more stable in-pond conditions compared to those documented during years of northern discharge. The City shall continue to manage the pond's operations to minimize sediment transport, scour, and levee erosion by adjusting flow and discharge configuration with levee integrity in mind. If levee condition is stable, the default operational setting will continue to be the southern discharge configuration to provide for more stable in-pond conditions.

3. Monitoring during the COVID-19 pandemic requires careful planning and adherence to safety protocols. In 2021, City staff were able to conduct all required monitoring and operations for Pond A18 while following COVID-19 safety procedures.

Recommendation: During the COVID-19 pandemic and any future public health crises, City staff will continue to prioritize health and safety in their work. Per current City policy, staff will continue to self-assess for disease symptoms and complete a health screening survey before entering any part of the Facility or other City property. Staff should continue to wear face coverings and maintain social distancing as much as possible while conducting on-site work.