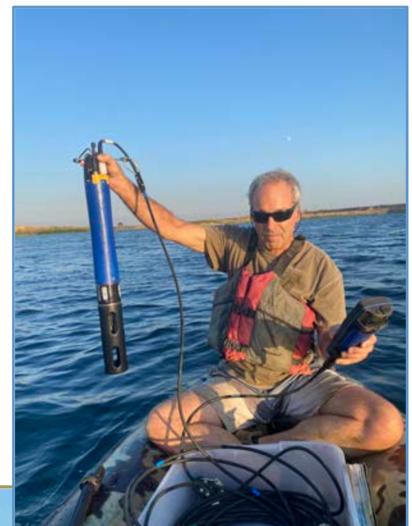
CACHE CREEK OFF-CHANNEL AGGREGATE MINING PONDS –

2021

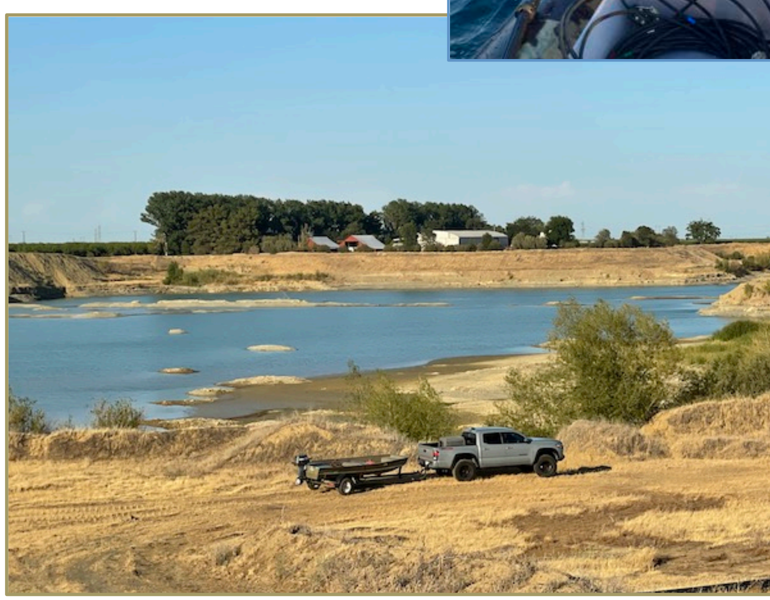
WATER COLUMN PROFILING



FINAL Report

Monitoring and Report by

Darell G. Slotton, Ph.D.*
and
Shaun M. Ayers



* *(530) 574-3491*
dgslotton@gmail.com

TABLE OF CONTENTS

SUMMARY BULLET POINTS

- Water testing was conducted in 2021 at seven Yolo County off-channel, aggregate-mining ponds. These were all ponds currently being monitored for fish mercury, per County Ordinance. Five ponds have been identified as significantly elevated in fish mercury in three or more years of five, relative to Cache Creek comparison samples. These were Syar-B1, Teichert-Esparto, Cemex-Phase 3-4 (now separate Phase 3 and Phase 4 ponds, both tested), and Syar-West. A sixth pond, Cemex-Phase 1, was also chosen for water testing, as a relatively low-mercury Control site. Water testing began at these ponds in 2018 (2019 at Syar-West), to provide supplemental information to better understand why fish mercury is high at some sites and low at others, and to help devise possible mercury management strategies. The final pond, Teichert-Woodland–Storz, is another lower mercury site that is not flagged for lake management; its water column was profiled one time, mid-summer, in line with recent revisions of the County Ordinance calling for routine annual, one-date water profiling in all fish-testing years.

Water Profiling Summary – All Sites, 2015-2021

<table>
<tr><th>Pit Sites</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th></tr>
<tr><td>Cemex – Phase 1 (control)</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Cemex – Phase 3</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td>✓</td></tr>
<tr><td>Cemex – Phase 4</td><td>✓</td></tr>
<tr><td>Teichert-Esparto – Reiff</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td></tr>
<tr><td>Teichert-Esparto – Mast</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Teichert-Woodland – Storz</td><td></td><td></td><td></td><td></td><td></td><td></td><td>(1x)</td></tr>
<tr><td>Syar – B1</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Syar – West (control to 2020)</td><td></td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>

- Several of the monitoring parameters fell within similar ranges at most of the tested ponds. These included pH (basic/non-acidic to very basic), salinity, conductivity, dissolved solids, and redox levels.

- A wide range of chemical and physical parameters were measured at each pond, from surface to near bottom, on 5 different dates spanning the warm season between early May and early November. These included bottom depth, water clarity, temperature, dissolved oxygen, conductivity, pH, turbidity, dissolved organic matter, algal chlorophyll (green algae) and phycocyanin (blue-green algae), salinity, dissolved solids (TDS), and oxidation-reduction potential (ORP).

- Most of the monitored ponds were too shallow to stratify completely (isolate water layers from each other) in the warm season. Occasional summer winds could stir the water down to or nearly down to the bottom.

- Despite occasional mixing of warm, oxygenated water from above, two of the tested shallower ponds, Teichert–Esparto and Syar–B1, maintained enough bottom water separation to lead to the depletion of dissolved oxygen in the bottom waters. This condition is known to accelerate the production of toxic methylmercury and its movement into fish. These two ponds have also been found to contain the highest fish mercury levels of the 7 ponds monitored in the overall mercury program. The deeper water profiling site of Syar–West was found to have strong seasonal water separation and bottom anoxia, together with elevated fish mercury. In contrast, the lowest fish-mercury ponds, the control site Cemex–Phase 1 and Teichert-Woodland–Storz, had no oxygen depletion. Seasonal bottom water anoxia (oxygen depletion) was identified as a likely key factor contributing to elevated fish mercury in some of the ponds – and a target for management.

- However, another elevated fish-mercury pond, Cemex-Phase 3-4, had no oxygen depletion, indicating that additional factors must be at play. Methylmercury production and movement into fish can be affected by many processes. Differences in water clarity were identified as likely important. Each of the ponds can have its own character; potential mercury management may need to use different approaches at different sites.

- The **Cemex–Phase 1** Pond, the relative 'control / low fish mercury' pond, continued to be shallow and turbid (cloudy water) from processing plant slurry discharges. In 2021, there was more of a temperature stratification between the surface water layer and bottom waters than in previous years, though still small. There continued to be no sign of bottom anoxia here. This factor may be a key link to lower methylmercury production and movement into fish here. Algae and dissolved organic matter levels were low, consistent with the cloudy water conditions blocking photosynthesis.

- The **Cemex–Phase 3** Pond: the former Phase 3-4 Pond has been separated, with a constructed levee, into two ponds, with active mining continuing in the Phase 4 portion, and the Phase 3 basin now isolated from mining and more sheltered from wind mixing. In this new configuration, the Phase 3 Pond behaved differently through the water column in 2021. Depth remained in about the 9-10 m range (28-33 ft) but water clarity was consistently clear (5-9 m / 17-29 ft). For the first time, a significant temperature stratification developed through the summer, separating bottom water from upper waters. This can lead to depletion of oxygen in ponds with murkier water but, with the very clear conditions in the Phase 3 Pond, there was light penetration, algal photosynthesis, and oxygen production to the bottom; rather than anoxia, there were buildups of algae and oxygen. There were also relative increases in the bottom water of turbidity, dissolved organic matter, and conductivity, and significant decreases in pH. The combined Phase 3-4 Pond was identified as elevated over baseline fish mercury; the 2021 fish results for Phase 3 remained elevated. This pond may be challenging for mercury management, as the elevated fish mercury here is not linked to oxygen depletion in the bottom water.

- The **Cemex–Phase 4** Pond: the Cemex–Phase 3-4 Pond, an identified elevated fish-mercury pond, was separated, with a constructed levee, into two ponds; active mining continued in the

Phase 4 portion. The water column of the Phase 4 Pond in 2021 behaved much like the larger pond in previous years. It was moderately deep (8.2-9.4 m / 27-31 ft) and with moderate visibility (1.5-5.9 m / 5-19 ft). Despite being fairly deep, the Phase 4 pond remained well-mixed, likely due to its long east-west dimension allowing wind energy to reach the bottom. The active mining also contributes to water column mixing. This is similar to prior years when it was part of the larger Phase 3-4 Pond, and contrasts with the Phase 3 Pond in 2021. Because of the mixing, there was no summer stratification; most of the parameters were similar top to bottom. There was no bottom anoxia. Like the Phase 3 Pond, this pond may be challenging for mercury management. However, the fish mercury status of the stand-alone Phase 4 pond is unclear at this time, with results from the last two years shifting the site out of 'elevated over baseline' status.

- The **Teichert–Esparto** Pond was greatly impacted by the 2021 drought, with water levels dropping 6 m (20 feet) from 2020 levels and separating the pond into three disconnected, shallow ponds. Water profiling continued in the central basin, formerly Mast Northwest. The overall site has been identified as significantly 'elevated over baseline' in fish mercury. The pond was moderately deep at the start of the season in May (9.4 m / 31 ft), but quickly dropped with the drought, eventually to 4.3 m (14 ft) by November. Water clarity continued to be very low/turbid, at 1.0-1.6 m (3-5 ft), blocking sunlight, algal photosynthesis, and oxygen production at depths below the near-surface. A temperature stratification developed through the summer, despite the shrinking water levels. With no deep oxygen production to replace oxygen naturally lost to biotic metabolism, bottom water oxygen dropped to low levels through the summer, almost certainly increasing methylmercury production and bioavailability to fish. Oxygen later recovered, with surface cooling and wind mixing, by early November. This seasonal cycle presents a clear mercury management option, through disruption of summer anoxia.

- The **Teichert–Woodland – Storz** Pond, a low fish-mercury pond, was surveyed one time, mid-summer, as part of the revised monitoring ordinance guidelines that call for annual water profiling at all ponds monitored for fish mercury. Like the Teichert-Esparto site, Storz was greatly impacted by the 2021 drought. Depths dropped down to around 3 m (9-10 ft) at deepest, splitting the pond into two disconnected basins. Both sides were surveyed for these mid-summer profiles. Results were similar in each. The shallow water was very warm, but with a small temperature stratification between upper and lower water layers. At these shallow depths, there was enough light penetration for algal photosynthesis and oxygen production below the thermocline, so there was ample oxygen from top to bottom. Both basins had accumulations of algal cells and dissolved organic carbon toward the bottom. Both had high conductivity and high pH (basic), particularly the east basin.

- The **Syar–B1** Pond, one of the ponds identified as significantly 'elevated over baseline' in fish mercury, was one of the sites that was heavily impacted by the drought conditions in 2021. As compared to depths in other years in the 8-11 m range (26-36 ft), levels dried down to 3 m (10 ft) by the fall of 2021. High surrounding berms give some protection from wind mixing, and a light stratification of the water column was seen as in other years, even with the shallow depths. Oxygen levels dropped toward the bottom, but not to the extent seen in most other years. This pond, like the Teichert-Esparto Pond, has been identified as one that may get mercury management benefits from disruption of summer oxygen depletion. The 2021 profiles also found accumulations of turbidity, algal cells, and dissolved organic matter toward the bottom.

- The **Syar–West** Pond was initially in the 'inconclusive' category for fish mercury but shifted into 'elevated' status in 2020. It has been monitored over the last several years to see if this significantly deeper pond would develop a stronger, more permanent thermal stratification in the warm season than the shallower ponds, with the possible depletion of oxygen in the bottom waters. Even with the drought-lowering of depths across 2021, the pond remained deep enough for this to again happen. The bottom water stayed much cooler than the surface layers, creating a 'density barrier', isolating it and leading to buildups of some water quality constituents in the bottom water and the consumption of oxygen through normal microbial metabolism – with no replenishment from above, because of the thermal barrier. Oxygen later recovered, with surface cooling and wind mixing, by early November. This 'classic warm season thermal stratification' pattern at Syar–West makes it a straightforward candidate pond for a mercury management trial, through warm season aeration of the bottom water by mixing.

INTRODUCTION

The Water Column Profiling work and this data report are in support of the ongoing Mercury Monitoring program for the Yolo County off-channel aggregate-mining ponds. The primary (fish-based) monitoring is reported separately. This supplemental data report presents information on water quality parameters from a subset of the ponds being monitored for fish mercury. The full set of aggregate ponds being monitored for mercury is shown in Table A and Figure A.

The County Surface Mining Reclamation Ordinance (Yolo County Code, 2019 **–** ***Sec. 10-5.517***) specifies the investigation of a suite of water quality parameters that may provide evidence of factors influencing the methylmercury cycle in certain ponds, as follows:

(f) Expanded Analysis.

(1) General.

If, during the mining or post-reclamation phase, any pit lake's average fish tissue mercury concentration exceeds the ambient mercury level for any three years, the operator shall undertake expanded analyses. The analysis shall include expanded lake water column profiling (a minimum of five profiles per affected wet pit lake plus one or more nonaffected lakes for control purposes) conducted during the warm season (generally May through October) in an appropriate deep profiling location for each pit lake. The following water quality parameters shall be collected at regular depth intervals, from surface to bottom of each lake, following protocols identified in subsection (a): temperature, dissolved oxygen, conductivity, pH and oxidation-reduction potential (ORP), turbidity or total suspended solids, dissolved organic matter, and algal density by Chlorophyll and/or Phycocyanin.

'Profiling' refers to taking a set of measurements throughout the water column, from surface to bottom. The May-October timing focuses this monitoring on the warm season of primary biological activity.

Starting in 2018, water column profiling has been done at 3 ponds identified as having fish mercury significantly elevated over Cache Creek baseline comparisons. These ponds are Syar-B1, Teichert-Reiff (now part of Teichert-Esparto Pond), and Cemex-Phase 3-4 (now separated into Phase 3 and Phase 4 Ponds). In addition, water testing has been done at a fourth pond, Cemex-Phase 1, which was identified as a relatively low-mercury control. The objective of the water column profiling work is to provide supplemental information to better understand why fish mercury may be elevated in some ponds and not in others, and to help in the development of potential mercury management strategies. Toward that end, a fifth pond – Syar–West – was added to the water monitoring in 2019. Fish mercury in that pond has been in the borderline elevated range, or 'inconclusive', but it is of particular interest because it is the only much deeper pond (depths of 50-60 feet) and only example of that type of likely end-habitat in the overall aggregate zone eventual restorations. We believe deep ponds may present unique mercury issues, as well as realistic management possibilities.

The recent revision of the County Ordinance added a provision that any pond being monitored for fish mercury, regardless of mercury status, will have water column profiling conducted at least once per year. This year, to satisfy that requirement, the Teichert-Woodland – Storz Pond was profiled on one mid-summer date.

The chemical and physical constituents measured in the water columns of the ponds are detailed below in Methods.

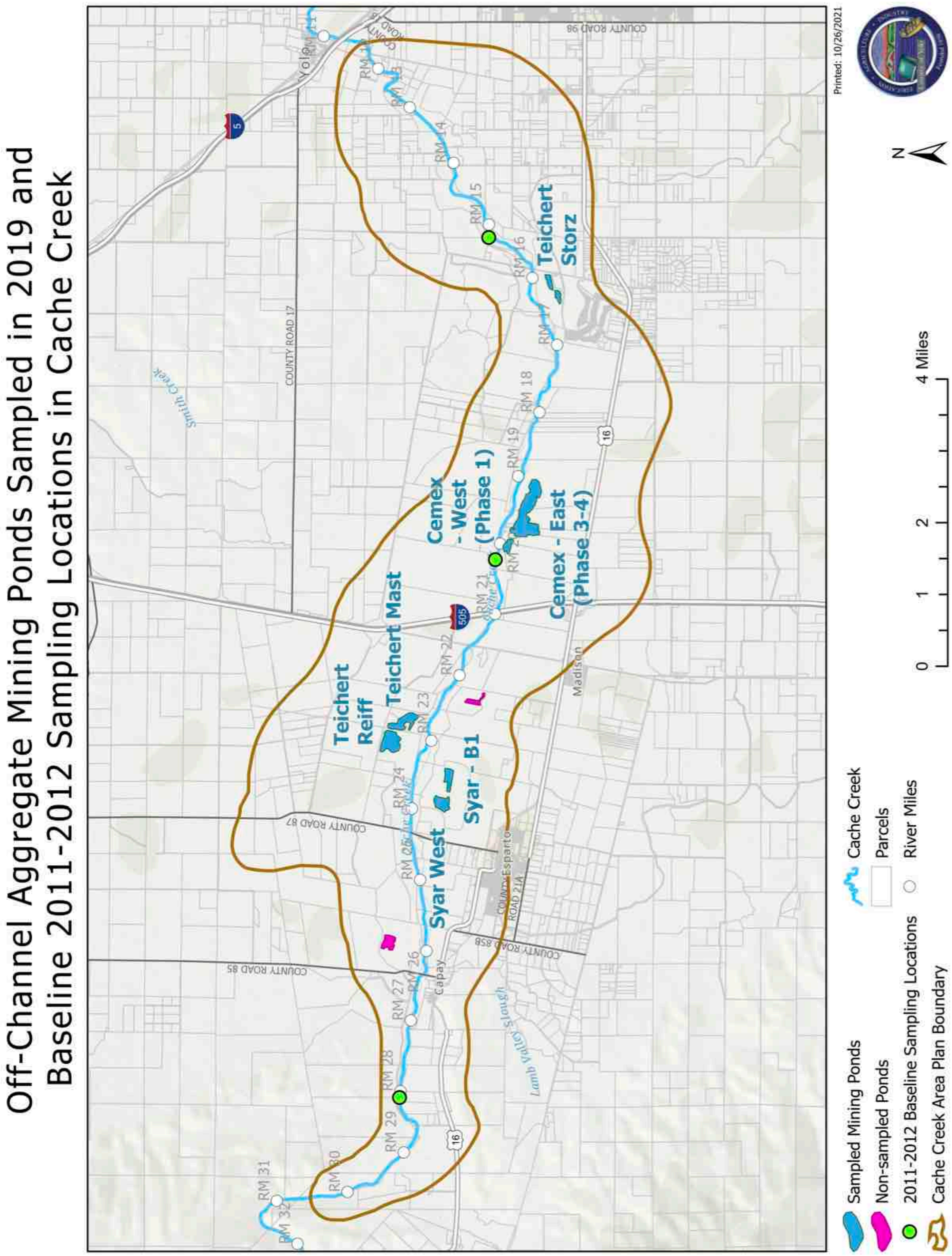
For each of the profiled ponds and each survey date (5 total between May and early November), a table of the survey data is presented, together with a figure depicting the water column with several key, foundational parameters including temperature, dissolved oxygen, maximum depth, and Secchi water clarity. Then, for each pond, water column profiles are shown of individual parameters across all 5 surveys in May-November plots.

Table A. Wet Pits Subject to Annual Fish Mercury Monitoring
(modified from Yolo County Exhibit C and annual mercury monitoring reports)

Blue text: water profiling conducted – low-mercury control pond
Red text: water profiling conducted – identified elevated-mercury ponds
* Syar–West: deep, fully stratifying control site through 2020; recently identified as elevated

Operator	Site	Pit	Year Mining Crossed Water Table (app)	End Reclamation Plan	Year Fish Mercury Monitoring Began	Year Water Profiling Began
Cemex	Madison	**Phase 1**	< 1996	Lake and habitat	2015	2018
Cemex	Madison	**Phase 3-4**	≤ 2002	Lake and habitat	(2015-2020)	(2018-2020)
(divided in 2020)						
Cemex	Madison	**Phase 3**	≤ 2002	Lake and habitat	2021	2021
Cemex	Madison	**Phase 4**	≤ 2002	Lake and habitat	2021	2021
Teichert	Esparto	**Reiff**	≤ 2002	Lake and habitat	(2015-2019)	(2018-2019)
Teichert	Esparto	**Mast**	2007-2008	Lake and habitat	(2017-2019)	–
(combined in 2020)						
Teichert	Esparto	**Esparto**	≤ 2002	Lake and habitat	2020	2020
Teichert	Woodland	**Storz**	2010-2011	Lake and habitat	2017	2021
Syar	Madison	**B1**	≤ 2002	Lake and habitat	2015	2018
Syar	Madison	**West ***	≤ 2002	Lake and habitat	2017	2019

Figure A. Site Map *(from 2019)*



Status of Other Components of the Mercury Monitoring Program

Fish Mercury Monitoring Summary – All Sites, 2015-2021

<table>
<tr><th>Pit Sites</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th></tr>
<tr><td>Cemex – Phase 1</td><td>≤</td><td>≤</td><td>≤</td><td>≤</td><td>≤</td><td>≤</td><td>≤</td></tr>
<tr><td>Cemex – Phase 3</td><td rowspan="2">></td><td rowspan="2">></td><td rowspan="2">></td><td rowspan="2">></td><td rowspan="2">></td><td rowspan="2">≤</td><td>></td></tr>
<tr><td>Cemex – Phase 4</td><td>INC</td></tr>
<tr><td>Teichert-Esparto – Reiff</td><td>INC</td><td>></td><td>></td><td>></td><td>></td><td rowspan="2">></td><td rowspan="2">></td></tr>
<tr><td>Teichert-Esparto – Mast</td><td></td><td></td><td>></td><td>INC</td><td>></td></tr>
<tr><td>Teichert-Woodland – Storz</td><td></td><td></td><td>INC</td><td>≤</td><td>≤</td><td>≤</td><td>≤</td></tr>
<tr><td>Syar – B1</td><td>></td><td>></td><td>></td><td>></td><td>></td><td>></td><td>></td></tr>
<tr><td>Syar – West</td><td></td><td></td><td>></td><td>≤</td><td>></td><td>></td><td>></td></tr>
</table>

≤ = at or below ambient INC = inconclusive > = elevated over ambient

Bottom Sediment Collections *(single event, elevated sites and controls)*

<table>
<tr><th>Pit Sites</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th></tr>
<tr><td>Cemex – Phase 1 *(control)*</td><td></td><td></td><td></td><td colspan="2">✓</td><td></td><td></td></tr>
<tr><td>Cemex – Phase 3-4</td><td></td><td></td><td></td><td colspan="2">✓</td><td></td><td></td></tr>
<tr><td>Teichert-Esparto – Reiff</td><td></td><td></td><td></td><td colspan="2">✓</td><td></td><td></td></tr>
<tr><td>Teichert-Esparto – Mast</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Teichert-Woodland – Storz</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Syar – B1</td><td></td><td></td><td></td><td colspan="2">✓</td><td></td><td></td></tr>
<tr><td>Syar – West *(deep control)*</td><td></td><td></td><td></td><td colspan="2">✓</td><td></td><td></td></tr>
</table>

Reports Completed

<table>
<tr><th>Report</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th></tr>
<tr><td>Fish Mercury Monitoring</td><td>Final</td><td>Final</td><td>Final</td><td>Final</td><td>Final</td><td>Draft</td><td>Draft</td></tr>
<tr><td>**Water Column Profiling**</td><td></td><td></td><td></td><td>Final</td><td>Final</td><td>Draft</td><td>Draft</td></tr>
<tr><td>Bottom Sediments (1x)</td><td></td><td></td><td></td><td colspan="2">Final</td><td></td><td></td></tr>
</table>

METHODS

Water column profiling was conducted from our sampling boat, where possible, at the deepest part of each pond. Pond bottom contours and the location of the deepest region were determined by slowly criss-crossing the pond area with a high-resolution depth meter mounted to the boat just below the water surface. For the sites that became inaccessible for boat launching in 2021 because of drought dry-down of the shorelines, an inflatable kayak was carried in and used as a profiling platform. General water clarity was measured with a limnological Secchi disk: a 25 cm (10") weighted disk lowered into the water, noting the depth of visual disappearance. Specific water quality constituents were measured by lowering a suite of sensors from the surface to near bottom, pausing at each meter of depth for equilibration and collection of the various readings. A custom-designed, multi-parameter unit was used for this work (YSI EXO-2). The meter includes sensors for measuring:

Temperature
Dissolved Oxygen: mg/L / % Saturation
Conductivity / Salinity / Total Dissolved Solids (TDS)
pH / Oxidation-Reduction Potential (ORP)
Turbidity
Algal Density (Chlorophyll for green algae, and Phycocyanin for blue-green algae)
Dissolved Organic Matter (DOC)

The sensors were carefully calibrated in the laboratory before each survey.

Logged data were transfered to our computers, where they were put into data tables and plotted in water column graphs.

PRESENTATION OF THE 2021 DATA

1. CEMEX–PHASE 1 POND

(Google Earth 10/21/20)

1. Cemex–Phase 1 Pond

In summary, the Cemex–Phase 1 Pond, the relative 'control / low fish mercury' pond, continued to be shallow and turbid (cloudy water) from processing plant slurry discharges. In 2021, there was more of a temperature stratification between the surface water layer and bottom waters than in previous years, though still small. There continued to be no sign of bottom anoxia here. This factor may be a key link to lower methylmercury production and movement into fish here. Algae and dissolved organic matter levels were low, consistent with the cloudy water conditions blocking photosynthesis.

The Phase 1 Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 1(a) (May) through 1(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 1(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 1(f) (Temperature) through 1(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters and in summary.

Water Depth (Tables and Figs. 1(a-e)): ranged narrowly between 5.3 and 5.8 m (17-19 ft) across the 2021 May-Oct profiling. This pond routinely received plant discharge slurry/water, replacing evaporation losses.

Secchi Water Clarity (Tables and Figs. 1(a-e)): was consistently low/turbid, at 0.7-2.3 m (2-8 ft). A function of plant slurry inflows clouding the water.

Temperature (Tables and Figs. 1(a-e), Fig. 1(f)): Overall range 16-28 °C (60-82 °F) between May and October. A slight thermal stratification was present on all dates, with surface waters warming 1.8-3.8 °C (3-7 °F) warmer than bottom water. However, the increases in bottom water temperatures during most of this time (to temperatures near surface levels) indicate ongoing, periodic mixing of the water column, presumably due to wind mixing of this shallow pond, together with the mixing influence of slurry inflows. Without such periodic mixing from above, bottom temperatures would remain essentially unchanged and cool through the summer.

Dissolved Oxygen (Tables and Figs. 1(a-e), Fig. 1(g)): remained at or above saturation levels throughout the season, between 9.0 and 10.1 mg/L (ppm). This corresponded to between 98% and 124% of saturation levels. Oxygen above saturation (or super-saturated) is a typical phenomenon in waters containing moderate or greater densities of algae; oxygen is produced during photosynthesis. 'Saturation' levels refer to the equilibrium amount of oxygen that will stay dissolved in water with no ongoing sources or sinks. It is temperature-dependent; cooler water can hold more dissolved oxygen than warm water. Under typical warm season conditions and particularly in deeper systems, a strong thermal stratification often develops in lakes and ponds, with sun-warmed surface waters floating above the winter-cooled bottom water. Because water masses of different temperature are very resistant to mixing (similar to oil and water), this seasonal stratification has the effect of isolating the bottom water from the upper water layers and the air above. If there is a moderate or greater amount of biological activity in the isolated bottom waters during this time, normal metabolism of microbes and other organisms will gradually deplete the dissolved oxygen, which cannot be replaced in the bottom waters until the pond mixes, bringing in new oxygen from above. We are particularly interested in potential seasonal oxygen depletion in this monitoring program, as that is a condition that can greatly accelerate the production and bioavailability of methylmercury. The temperature and oxygen data indicate that this pattern has not developed in the shallow Phase 1 Pond to date, presumably due to wind mixing in the shallow depths and ongoing slurry inflows from the aggregate processing plant. It is notable that this pond has consistently had among the lowest fish mercury levels of the ponds being monitored in the mercury program.

Conductivity (Tables 1(a-e), Fig. 1(h)): ranged between 561 and 670 µS/cm overall. Levels were quite uniform through the water column, but changing together with time.

Salinity (Tables 1(a-e)): was fairly uniform, at 0.27-0.32 ppt (parts per thousand, g/L) across the sampling season. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 1(a-e)): ranged fairly narrowly between 365-436 mg/L (ppm) across the sampling season.

pH (Tables 1(a-e), Fig. 1(i)): has been notably very basic (non-acidic; pH > 7.00) in all of the monitored ponds and over time. This is a function of their mining history and the basic nature of local sediments. Water pH in the Phase 1 Pond remained at a similar 8.23-8.50 across all depths and dates in 2020.

Oxidation/Reduction Potential (ORP) (Tables 1(a-e)): was in the range of 45-199 mV (millivolts) across all depths and dates, similar to previous years. Lowest values were seen in May-June (62-89 mV) and highest in August (175-199 mV).

Turbidity (Tables 1(a-e), Fig. 1(j)): This is one of two monitored ponds that regularly receives slurry discharge from aggregate processing plants (the other being Teichert-Esparto). As a result, it is normally high in suspended solids and turbidity. Similar to previous years, turbidities in 2020 ranged from moderately turbid (1-5 FNU) to very turbid, particularly toward the bottom, with readings to over 42 FNU.

Dissolved Organic Matter (FDOM) (Tables 1(a-e), Fig. 1(k)): In this shallow pond, the water column remained fairly well mixed top to bottom, as discussed above. The FDOM levels were similar top to bottom on each date, with small buildups at some depths. Overall levels ranged between 0.7 and 1.8 RFU, a similar range as in the last two years.

Green Algae (Chlorophyll) (Tables 1(a-e), Fig. 1(l)): Similar to the last two years, levels were very low throughout the sampling season and at all depths. This was not surprising, at this typically turbid pond, with corresponding low light penetration and poor conditions for algal growth. Across all depths and dates, chlorophyll levels were below 0.40 RFU (0.05-0.038).

Blue-Green Algae (Phycocyanin) (Tables 1(a-e), Fig. 1(m)): as in the last two years, were present at levels similar to green algae. The overall range was 0.04-0.47 RFU. Slight accumulations were seen in the deeper water depths in May, June, and November.

Table 1(a). Cemex – Phase 1 Pond: 2021 Water Column Profiling Data
MAY 7: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.7 m (5.6 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	23.0	9.41	110%	631	0.31	410	8.50	62
1	23.0	9.41	110%	631	0.31	410	8.49	73
2	21.2	9.41	106%	632	0.31	411	8.47	77
3	21.1	9.33	105%	631	0.31	410	8.45	79
4	21.1	9.31	105%	631	0.31	410	8.45	80
5	21.1	9.30	105%	631	0.31	410	8.45	82
5.5	21.0	9.28	104%	631	0.31	410	8.45	85

(additional parameters next page)

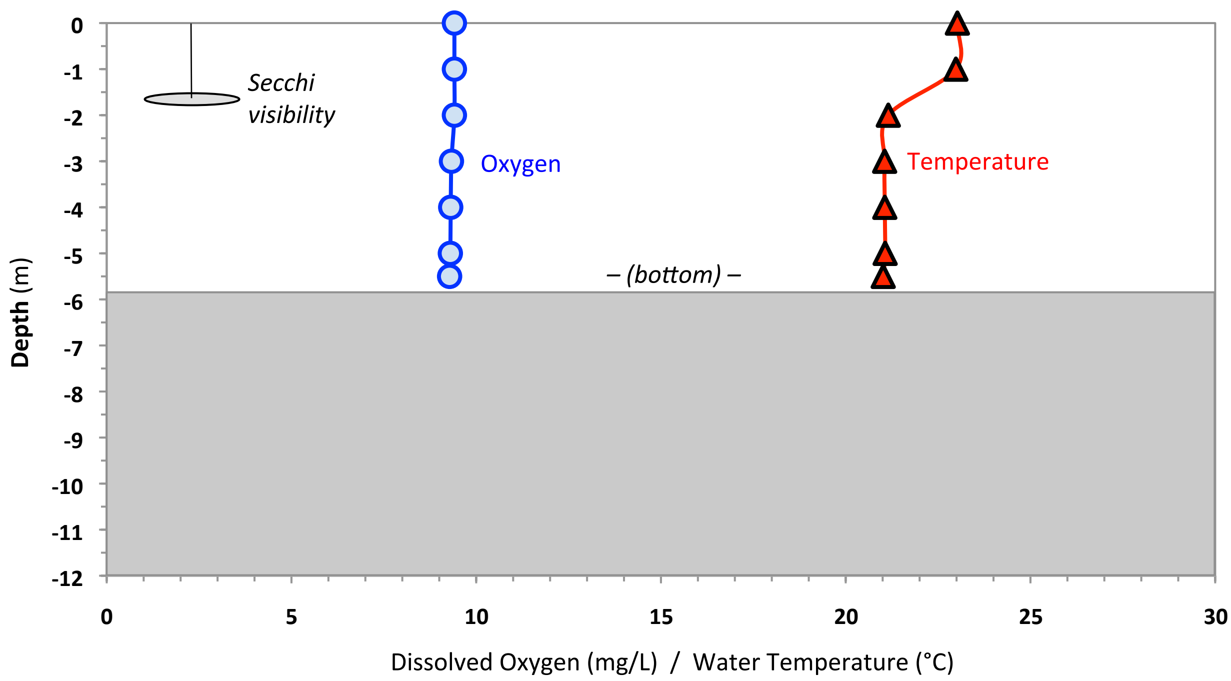


Figure 1(a). MAY 7, 2021 – Phase 1 Pond framework parameters

Table 1(a). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
MAY 7: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.7 m (5.6 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	23.0	9.41	110%	4.94	0.74	0.31	0.04
1	23.0	9.41	110%	5.03	0.71	0.33	0.09
2	21.2	9.41	106%	25.17	1.07	0.27	0.16
3	21.1	9.33	105%	30.98	1.16	0.29	0.19
4	21.1	9.31	105%	40.07	1.03	0.31	0.26
5	21.1	9.30	105%	42.38	0.78	0.37	0.30
5.5	21.0	9.28	104%	38.07	1.01	0.33	0.33

Table 1(b). Cemex – Phase 1 Pond: 2021 Water Column Profiling Data
JUN 17: max. depth 5.3 m (17.5 ft); Secchi disk water clarity: 2.3 m (7.5 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	28.0	9.70	124%	662	0.32	430	8.42	71
1	26.1	9.84	122%	662	0.32	430	8.41	76
2	25.1	9.80	119%	660	0.32	429	8.37	81
3	24.6	9.84	118%	660	0.32	429	8.36	85
4	24.3	9.63	115%	660	0.32	429	8.36	88
5.0	24.2	9.57	114%	659	0.32	429	8.36	89

(additional parameters next page)

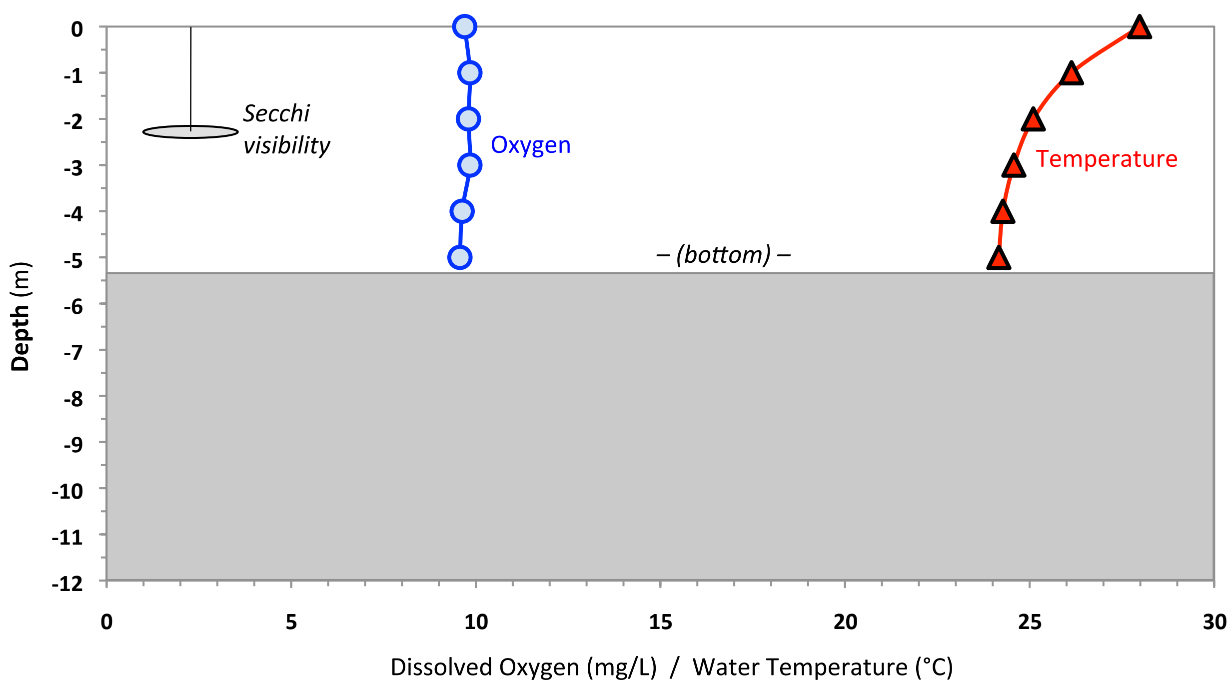


Figure 1(b). JUN 17, 2021 – Phase 1 Pond framework parameters

Table 1(b). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
JUN 17: max. depth 5.3 m (17.5 ft); Secchi disk water clarity: 2.3 m (7.5 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	28.0	9.70	124%	2.05	1.12	0.09	0.12
1	26.1	9.84	122%	1.63	1.22	0.11	0.14
2	25.1	9.80	119%	3.47	1.53	0.15	0.25
3	24.6	9.84	118%	8.63	1.30	0.21	0.39
4	24.3	9.63	115%	9.04	1.41	0.25	0.46
5.0	24.2	9.57	114%	10.05	1.33	0.33	0.47

Table 1(c). Cemex – Phase 1 Pond: 2021 Water Column Profiling Data
AUG 5: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.2 m (3.9 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	27.1	9.81	124%	666	0.32	433	8.35	175
1	26.8	9.72	122%	667	0.32	434	8.33	175
2	26.2	9.49	118%	666	0.32	433	8.32	179
3	25.9	9.27	114%	667	0.32	434	8.32	185
4	25.5	9.15	112%	670	0.32	435	8.29	189
5	25.4	9.12	111%	670	0.32	436	8.23	196
5.5	25.3	9.01	110%	670	0.32	436	8.23	199

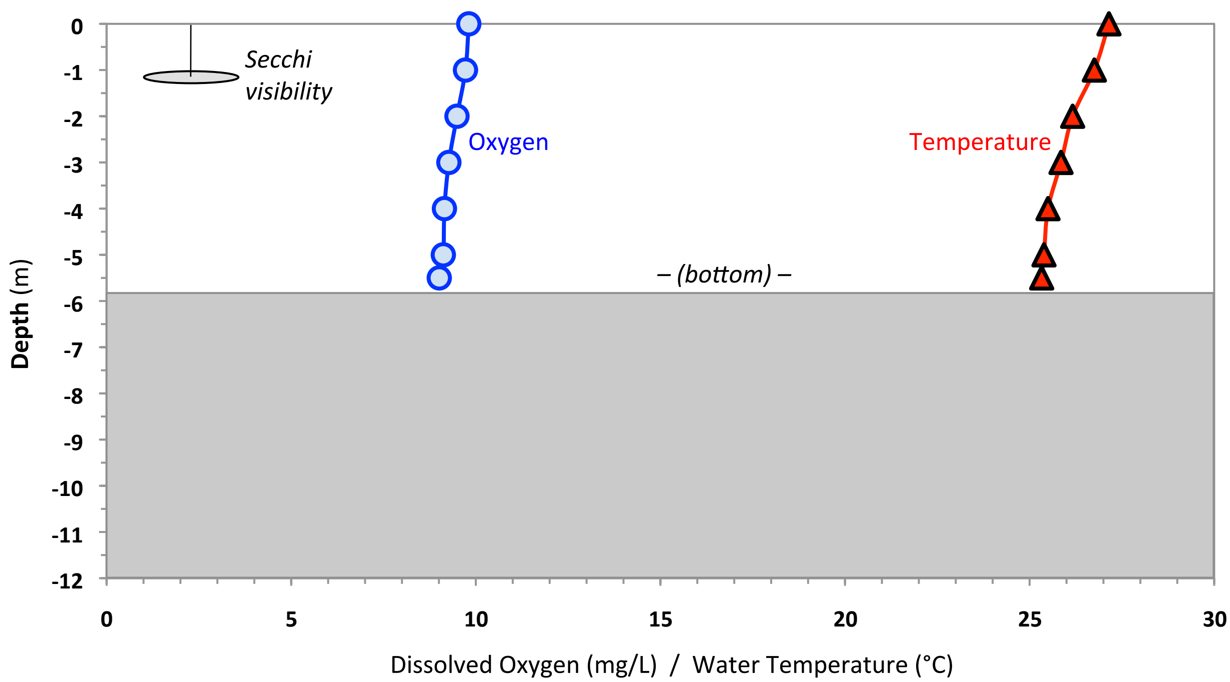


Figure 1(c). AUG 5, 2021 – Phase 1 Pond framework parameters

Table 1(c). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
AUG 5: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.2 m (3.9 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	27.1	9.81	124%	5.72	0.74	0.28	0.40
1	26.8	9.72	122%	4.58	0.77	0.30	0.37
2	26.2	9.49	118%	2.01	0.95	0.26	0.32
3	25.9	9.27	114%	6.87	1.03	0.27	0.41
4	25.5	9.15	112%	13.14	0.88	0.20	0.32
5	25.4	9.12	111%	18.55	1.04	0.07	0.32
5.5	25.3	9.01	110%	19.03	0.97	0.05	0.33

Table 1(d). Cemex – Phase 1 Pond: 2021 Water Column Profiling Data
SEP 16: max. depth 5.5 m (18 ft); Secchi disk water clarity: 0.7 m (2.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	25.2	9.54	116%	660	0.32	429	8.39	45
0.5	25.2	9.55	116%	660	0.32	429	8.38	46
1.0	24.8	9.57	116%	659	0.32	428	8.37	48
1.5	24.7	9.44	114%	659	0.32	428	8.38	49
2.0	24.7	9.44	114%	658	0.32	428	8.38	50
2.5	24.5	9.56	115%	659	0.32	428	8.38	51
3.0	24.5	9.59	115%	659	0.32	429	8.38	52
3.5	24.4	9.70	116%	661	0.32	430	8.37	53
4.0	24.4	9.82	118%	661	0.32	430	8.37	54
4.5	24.3	10.12	121%	659	0.32	428	8.39	54
5.0	24.2	10.13	121%	658	0.32	428	8.40	54

(additional parameters next page)

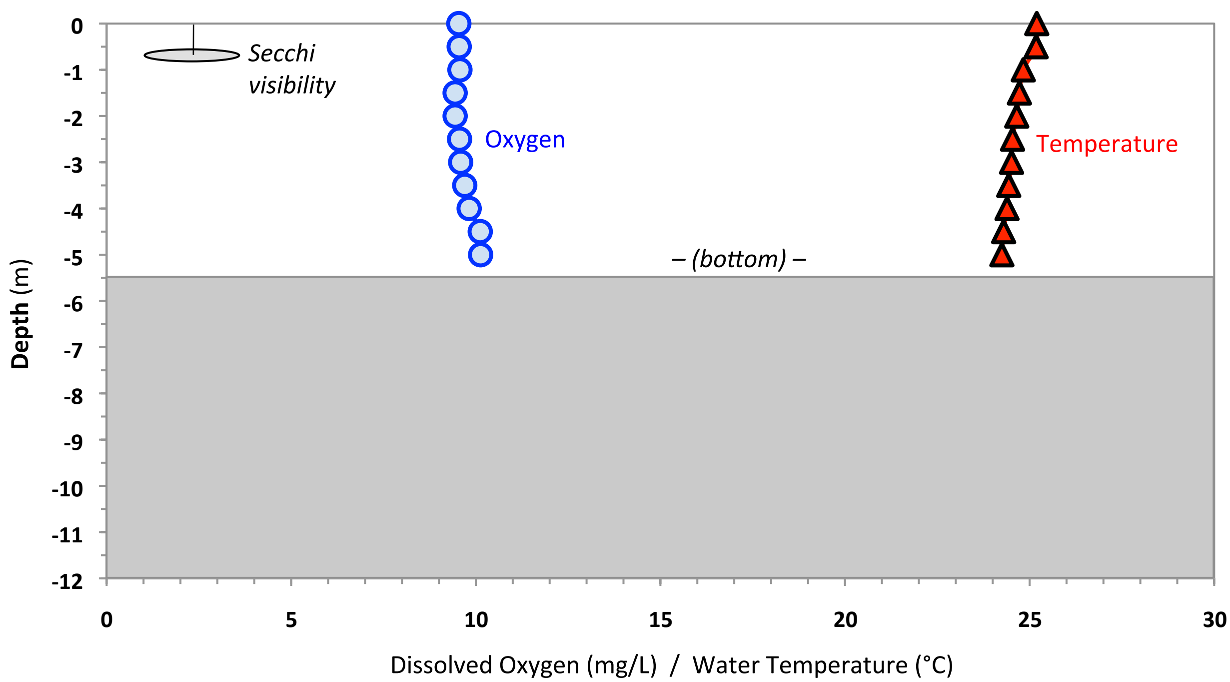


Figure 1(d). SEP 16, 2021 – Phase 1 Pond framework parameters

Table 1(d). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
SEP 16: max. depth 5.5 m (18 ft); Secchi disk water clarity: 0.7 m (2.3 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	25.2	9.54	116%	7.66	0.99	0.37	0.29
0.5	25.2	9.55	116%	7.24	0.98	0.38	0.33
1.0	24.8	9.57	116%	2.18	1.13	0.27	0.30
1.5	24.7	9.44	114%	2.29	0.96	0.31	0.31
2.0	24.7	9.44	114%	2.18	1.13	0.32	0.31
2.5	24.5	9.56	115%	4.79	1.17	0.35	0.34
3.0	24.5	9.59	115%	7.00	1.04	0.38	0.36
3.5	24.4	9.70	116%	16.43	1.07	0.27	0.37
4.0	24.4	9.82	118%	18.10	0.97	0.26	0.39
4.5	24.3	10.12	121%	12.37	1.14	0.20	0.34
5.0	24.2	10.13	121%	8.95	1.09	0.25	0.32

Table 1(e). Cemex – Phase 1 Pond: 2021 Water Column Profiling Data
OCT 28: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.2 m (3.9 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	19.1	9.77	106%	578	0.28	376	8.41	111
1	17.3	9.95	104%	564	0.27	367	8.48	116
2	16.8	9.83	102%	564	0.27	366	8.49	120
3	16.2	9.78	100%	562	0.27	365	8.48	125
4	16.1	9.82	100%	562	0.27	365	8.47	130
4.5	16.0	9.66	98%	561	0.27	365	8.43	136
5.0	16.0	9.72	99%	561	0.27	365	8.42	142
5.5	16.0	9.67	98%	561	0.27	365	8.41	146

(additional parameters next page)

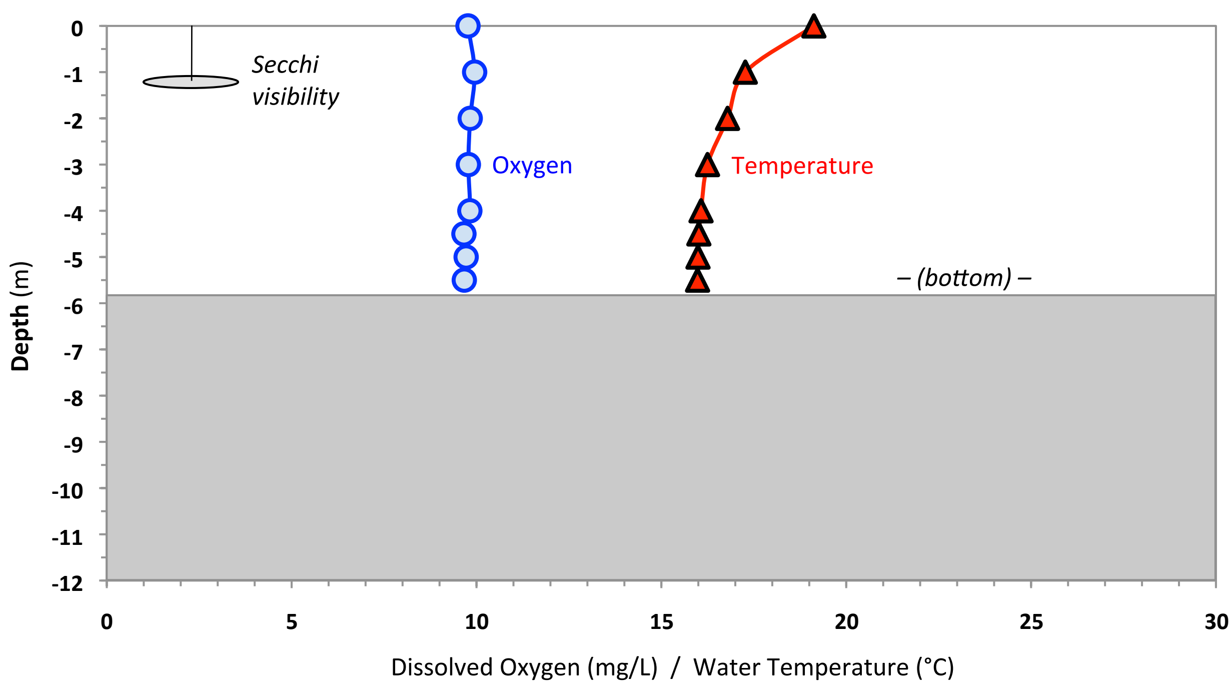


Figure 1(e). OCT 28, 2021 – Phase 1 Pond framework parameters

Table 1(e). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
OCT 28: max. depth 5.8 m (19 ft); Secchi disk water clarity: 1.2 m (3.9 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	19.1	9.77	106%	9.54	0.84	0.14	0.09
1	17.3	9.95	104%	2.56	1.14	0.14	0.10
2	16.8	9.83	102%	2.90	1.29	0.17	0.14
3	16.2	9.78	100%	2.64	1.29	0.17	0.17
4	16.1	9.82	100%	2.36	1.47	0.21	0.22
4.5	16.0	9.66	98%	1.86	1.64	0.25	0.27
5.0	16.0	9.72	99%	1.93	1.63	0.15	0.32
5.5	16.0	9.67	98%	1.96	1.78	0.14	0.28

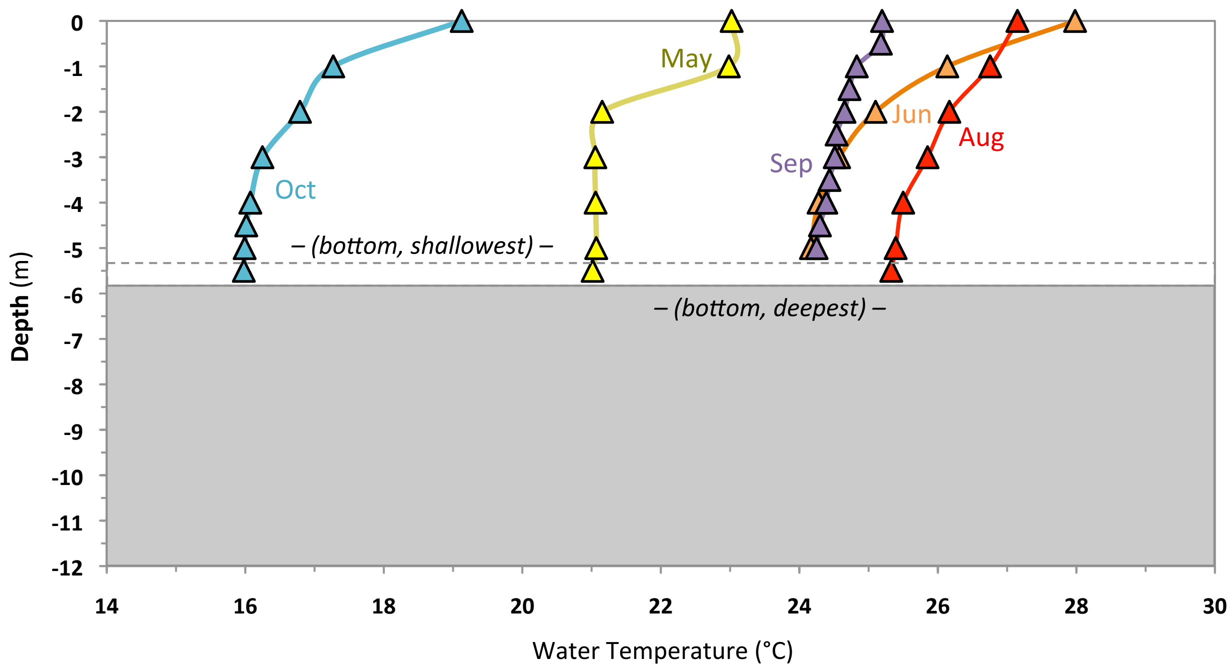


Figure 1(f). Cemex – Phase 1 Pond: 2021 May-Oct TEMPERATURE

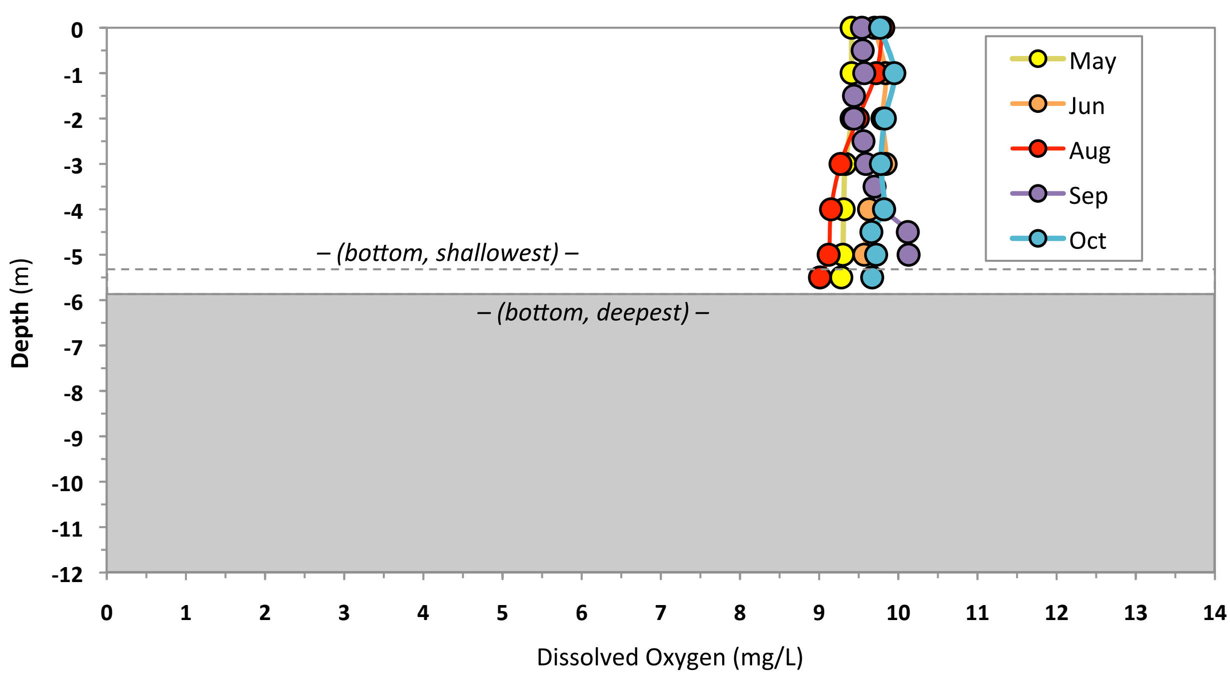


Figure 1(g). Cemex – Phase 1 Pond: 2021 May-Oct OXYGEN

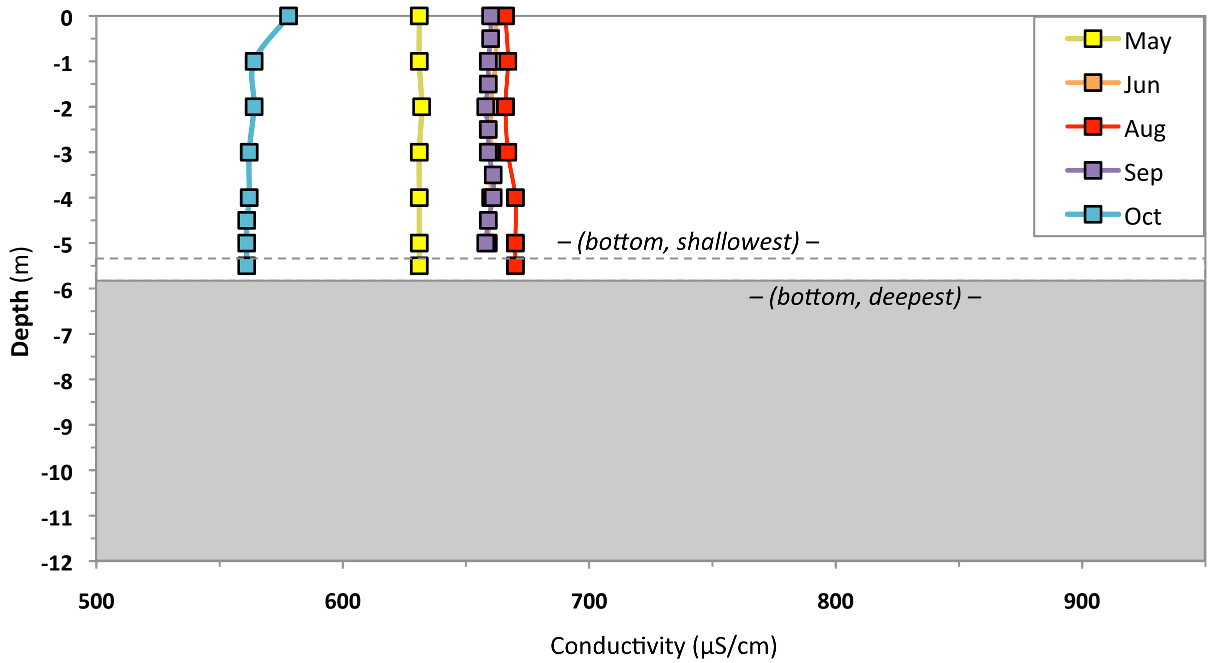


Figure 1(h). Cemex – Phase 1 Pond: 2021 May-Oct CONDUCTIVITY

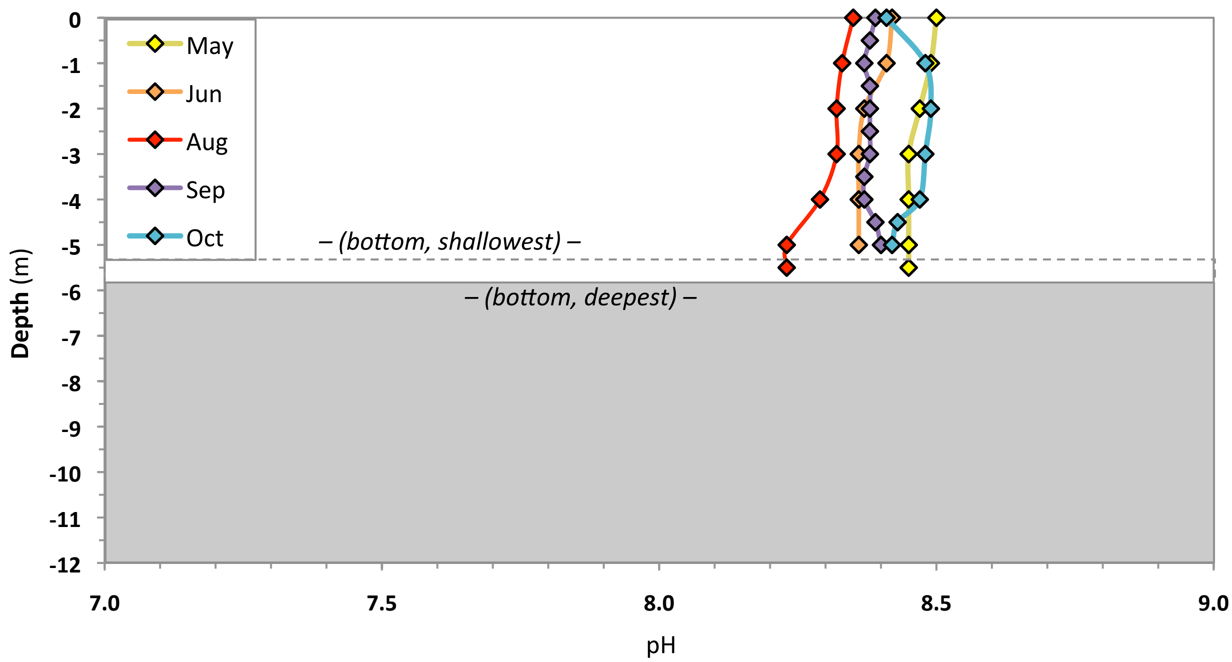


Figure 1(i). Cemex – Phase 1 Pond: 2021 May-Oct pH

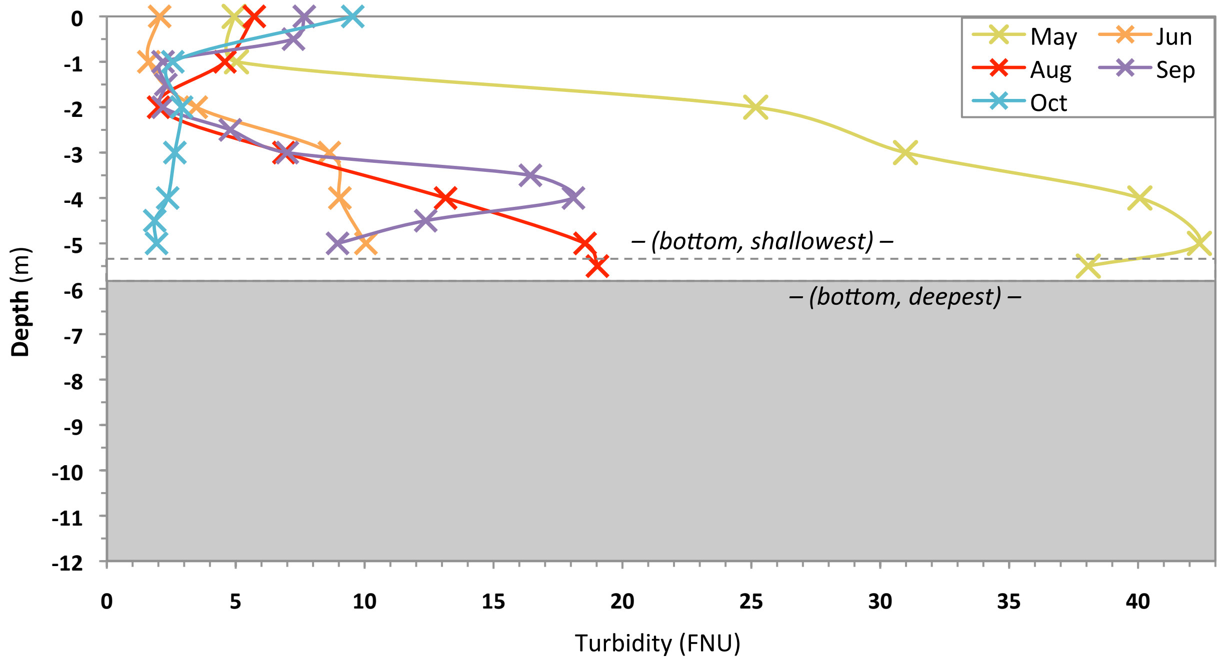


Figure 1(j). Cemex – Phase 1 Pond: 2021 May-Oct TURBIDITY

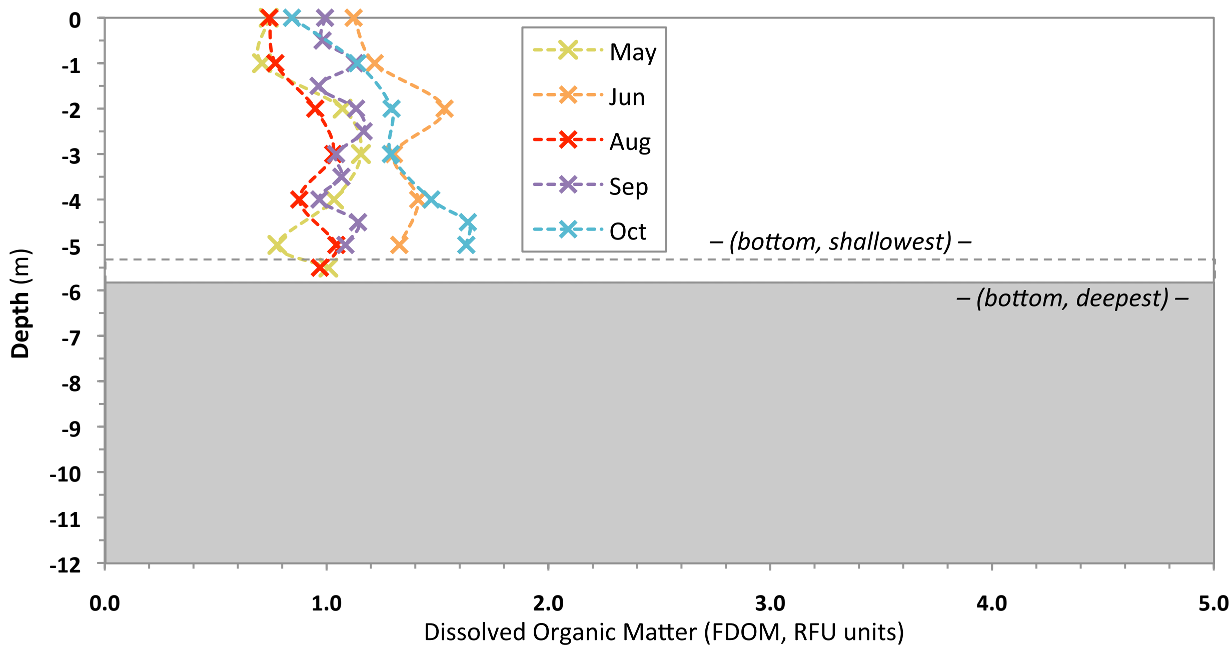


Figure 1(k). Cemex – Phase 1 Pond: 2021 DISSOLVED ORGANIC MATTER

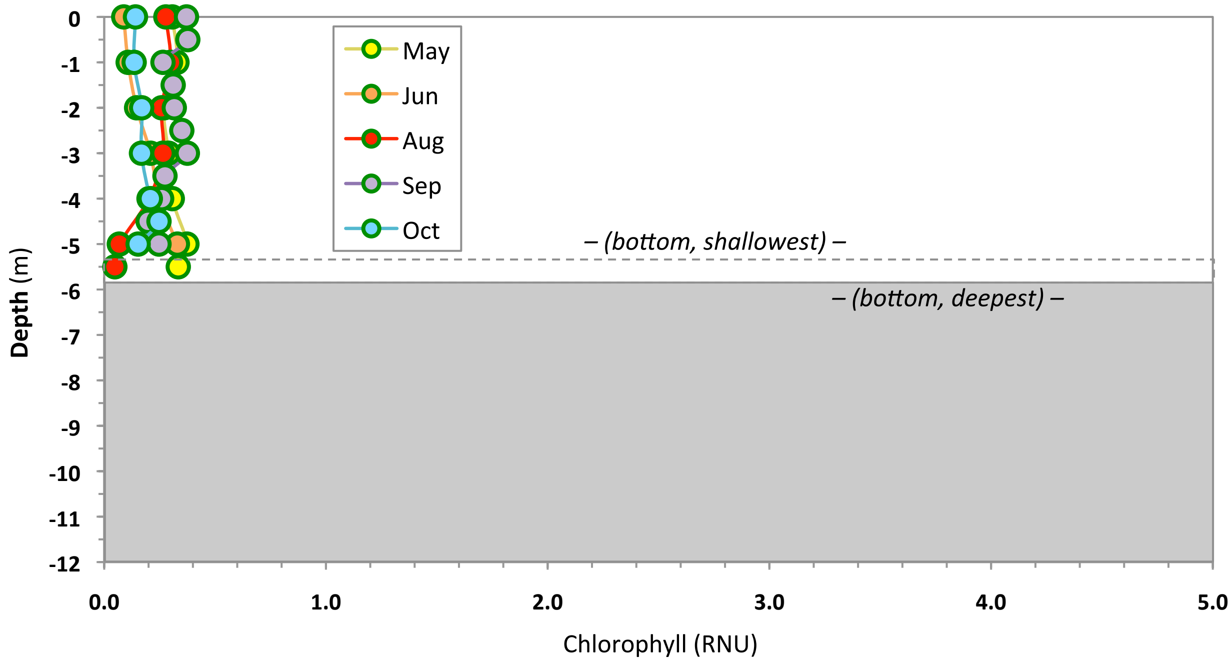


Figure 1(l). Cemex – Phase 1 Pond: 2021 May-Oct CHLOROPHYLL

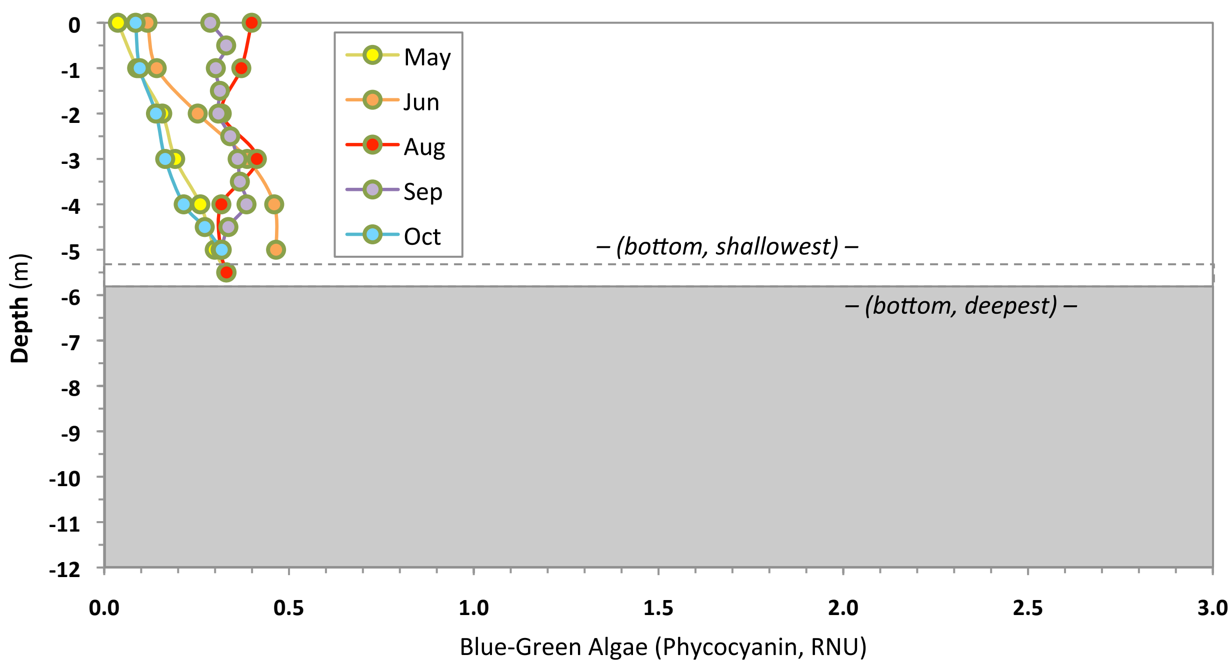


Figure 1(m). Cemex – Phase 1 Pond: 2021 May-Oct BLUE-GREEN ALGAE

2. CEMEX – PHASE 3 POND

(Google Earth 10/21/2020)

2. Cemex – Phase 3 Pond

In summary, the former Phase 3-4 Pond has been separated, with a constructed levee, into two ponds, with active mining continuing in the Phase 4 portion, and the Phase 3 basin now isolated from mining and more sheltered from wind mixing. In this new configuration, the Phase 3 Pond behaved differently through the water column in 2021. Depth remained in about the 9-10 m range (28-33 ft) but water clarity was consistently clear (5-9 m / 17-29 ft). For the first time, a significant temperature stratification developed through the summer, separating bottom water from upper waters. This can lead to depletion of oxygen in ponds with murkier water but, with the very clear conditions in the Phase 3 Pond, there was light penetration, algal photosynthesis, and oxygen production to the bottom; rather than anoxia, there were buildups of algae and oxygen. There were also relative increases in the bottom water of turbidity, dissolved organic matter, and conductivity, and significant decreases in pH. The combined Phase 3-4 Pond was identified as elevated over baseline fish mercury; the 2021 fish results for Phase 3 remained elevated. This pond may be challenging for mercury management, as the elevated fish mercury here is not linked to oxygen depletion in the bottom water.

The former Phase 3-4 Pond was separated into two ponds in 2020, using dirt infill to construct a high berm/road across the middle. Active mining continued in the eastern basin (Phase 4), and the resulting Phase 3 Pond was removed from mining activity. This year, the County required water column profiling in each of the two basins.

The Phase 3 Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 2(a) (May) through 2(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 2(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 2(f) (Temperature) through 2(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters.

Water Depth (Tables and Figs. 2(a-e): ranged between 8.7 and 10.1 m (28-33 ft) maximum depth across the 2021 May-Oct profiling.

Secchi Water Clarity (Tables and Figs. 2(a-e): was consistently high/clear, at 5.3-8.9 m (17-29 feet). Clear water conditions developed in the calm water, separated from active mining.

Temperature (Tables and Figs. 2(a-e), Fig. 2(f)): Overall range 16-28 °C (62-82 °F) between May and October. Newly separated from the former large Phase 3-4 Pond, the Phase 3 Pond had the same general depth but was more protected from prevailing winds in its new configuration, and it was no longer exposed to active mining disrupting the water column. We suspected that it would be more likely to develop a temperature stratification than before, and that was the case. A distinct thermocline formed between about 5-7 m (16-23 ft), separating cooler bottom waters from the sun-warmed upper layer from June through September. By late October, 'Fall Turnover' had occurred and the water column was again cool and mixed surface to bottom. This is the normal cycle of water bodies that become temperature-stratified in the warm season.

Dissolved Oxygen (Tables and Figs. 2(a-e), Fig. 2(g)): Despite the temperature stratification separating the water column through September, oxygen remained plentiful top to bottom. With wind protection and removal of active mining, water clarity was consistently very high, allowing strong light penetration below the thermocline, photosynthesis at depth, and production of oxygen there to counter normal oxygen loss processes. With a deeper, stratified pond, even with clear water, oxygen loss can exceed production and bottom water anoxia can result (see Syar–West). In the Cemex – Phase 3 Pond, variations from smooth oxygen profile lines on some of the dates reflect accumulations of oxygen-producing algae at and around the thermocline, with lower levels below.

Conductivity (Tables 3(a-e), Fig. 3(h)): ranged between 717 and 892 µS/cm overall. Levels were very uniform throughout the water column in May and October, with higher conductivity in May and lowest in October. Between June and September, the profiles all showed a slight decline at the thermocline and then an increase toward the bottom to levels higher than in the surface waters. These changes were in the same depth zones as the oxygen anomalies and reflect the changing seasonal dynamics after this basin was split off from the former Phase 3-4 larger pond. Overall conductivity levels in the Phase 3 Pond (and Phase 4 and the former combined Phase 3-4) were among the highest across all the ponds monitored.

Salinity (Tables 3(a-e): was fairly uniform at 0.38-0.44 ppt (parts per thousand, g/L) between May and September. After some rain dilution and fall mixing in October, salinity was lower in early November (0.35 ppt) and uniform top to bottom. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 3(a-e): were very uniform in the top 5-6 m between May and September, at 523-549 mg/L (ppm), then lower and essentially identical throughout the water column (466-467 ppm) in late October. However, consistent with the oxygen and conductivity profiles in June through September, TDS levels dropped somewhat around the thermocline and then increased toward the bottom, to levels higher than in the surface waters.

pH (Tables 2(a-e), Fig. 2(i)): as seen for many of the other water parameters, was much different in 2021 than in previous years as part of the larger Phase 3-4 Pond. In the top 5-6 m on all dates, and at all depths in May and November under fairly mixed conditions, pH was in a range similar to other years at 8.39-9.07. Levels increased (more basic) gradually between May and August, and decreased from August to November. But with the new, more isolated Pond 3 configuration and significant temperature stratification June through September, pH for the first time also developed a strong water column stratification – bottom water pH dropped to levels less basic than seen before at this site, to as low as 7.64, and significantly lower than present in the surface waters on the same dates.

Oxidation/Reduction Potential (ORP) (Tables 2(a-e): overall range 25-177, with highest levels in August and lowest levels Sep-Nov. ORP increased, relatively, with depth on all dates.

Turbidity (Tables 2(a-e), Fig. 2(j)): With the splitting of the Phase 3 basin from the active mining Phase 4 pond, turbidities measured at Phase 3 in 2021 can be attributed to natural in-pond processes rather than sediment resuspension from mining. Turbidities in the top 5-6 m (16-20 ft) were mostly under 1.0 FNU on all dates and depths. Between June and September, a layer of higher turbidities of 1.4-2.0 FNU occurred in the bottom 1-3 m (3-10 ft) of the water column.

Dissolved Organic Matter (FDOM) (Tables 2(a-e), Fig. 2(k)): The overall range was wider than in previous years (0.7-4.6 RFU, vs. generally all under 2.0 RFU before). As seen with many of the other parameters, the splitting of this pond away from active mining and into a relatively protected smaller basin led to a notable change in the dissolved organic matter profiles in 2021. Distinct accumulations were present in the bottom several meters, to 2-3 times higher levels than in upper layers, indicating a relative buildup there of decaying algal cells and other organic material.

Green Algae (Chlorophyll) (Tables 2(a-e), Fig. 2(l)): like most of the other parameters, chlorophyll profiles in 2021 were much more varied in the now seasonally stratifying, un-mined Phase 3 Pond. Large accumulations developed in the bottom waters below the thermocline, beginning in June and peaking Aug-Sep at 13-17 RFU (as compared to well under 1 RFU across all depths and dates in the larger, combined pond in 2019-2020). After fall mixing had started, levels by late October were lower through the water column (0.28-1.10 RFU).

Blue-Green Algae (Phycocyanin) (Tables 2(a-e), Fig. 2(m)): also developed deep water accumulations from June through September, like Chlorophyll but at lower absolute levels, peaking under 2.0 RFU.

Table 2(a). Cemex – Phase 3 Pond: 2021 Water Column Profiling Data
MAY 7: max. depth 10.1 m (33 ft); Secchi disk water clarity: 8.9 m (29.2 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	21.2	11.02	124%	844	0.41	549	8.47	95
1	21.2	11.08	125%	844	0.41	549	8.48	101
2	21.1	11.09	125%	844	0.41	549	8.48	104
3	20.9	11.18	125%	844	0.42	549	8.48	106
4	20.6	11.33	126%	844	0.41	549	8.49	107
5	20.6	11.41	127%	844	0.41	548	8.50	112
6	20.5	12.09	135%	842	0.41	547	8.51	114
7	20.5	11.73	131%	843	0.41	548	8.48	117
8	20.5	11.71	130%	843	0.41	548	8.52	121
9	20.3	12.10	134%	843	0.41	548	8.39	126
9.5	20.1	13.03	144%	842	0.41	547	8.39	130

(additional parameters next page)

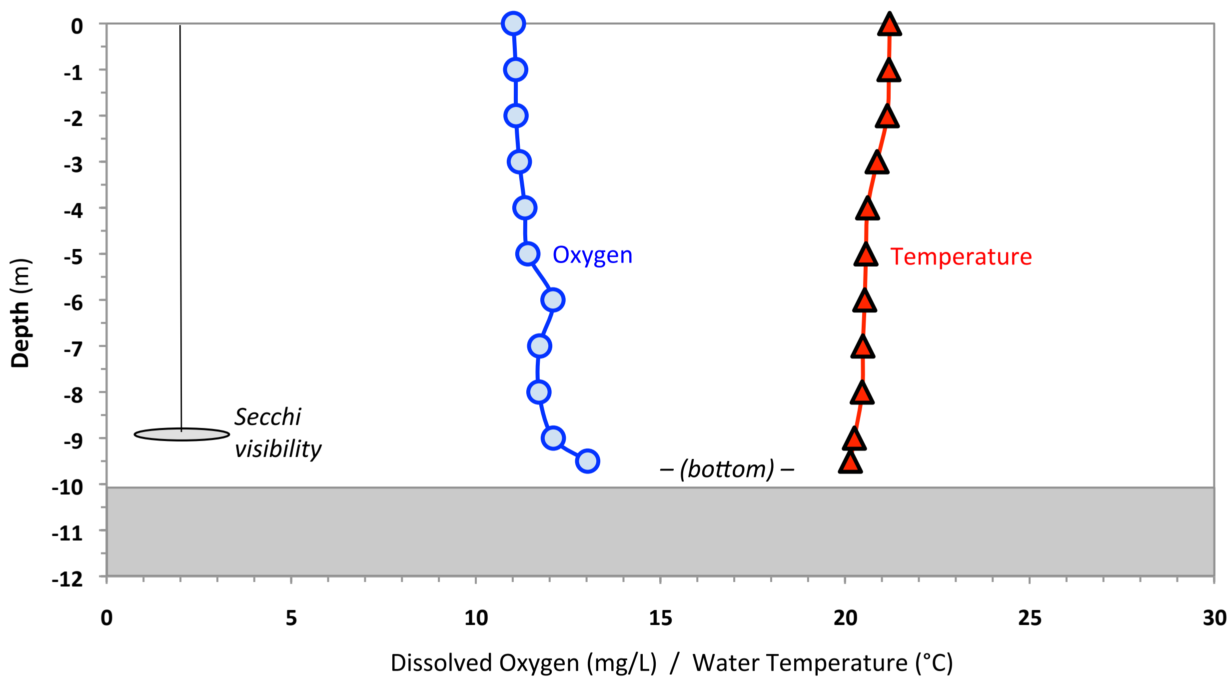


Figure 2(a). MAY 7, 2021 – Phase 3 Pond framework parameters

Table 2(a). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
MAY 7: max. depth 10.1 m (33 ft); Secchi disk water clarity: 8.9 m (29.2 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	21.2	11.02	124%	0.11	0.91	0.13	0.08
1	21.2	11.08	125%	0.14	0.74	0.16	0.10
2	21.1	11.09	125%	0.14	0.77	0.15	0.10
3	20.9	11.18	125%	0.14	0.91	0.21	0.11
4	20.6	11.33	126%	0.14	1.01	0.18	0.13
5	20.6	11.41	127%	0.13	0.99	0.20	0.16
6	20.5	12.09	135%	0.19	1.03	0.18	0.14
7	20.5	11.73	131%	0.21	1.06	0.19	0.14
8	20.5	11.71	130%	0.22	1.02	0.21	0.17
9	20.3	12.10	134%	0.26	1.33	0.22	0.14
9.5	20.1	13.03	144%	0.40	1.61	0.22	0.18

Table 2(b). Cemex – Phase 3 Pond: 2021 Water Column Profiling Data
JUN 17: max. depth 9.1 m (30 ft); Secchi disk water clarity: 6.7 m (22 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	28.3	11.61	149%	818	0.40	532	8.65	69
1	26.0	13.24	164%	807	0.39	525	8.68	85
2	25.5	12.79	157%	809	0.39	526	8.66	94
3	25.2	14.36	175%	806	0.39	524	8.70	99
4	25.1	14.38	175%	806	0.39	524	8.71	103
5	24.8	13.80	167%	804	0.39	523	8.67	108
6	24.6	13.40	161%	802	0.39	521	8.63	113
7	24.0	12.18	145%	795	0.39	517	8.41	129
8	23.7	10.75	127%	809	0.40	526	8.21	139
9.0	23.5	9.94	117%	829	0.41	539	8.04	148

(additional parameters next page)

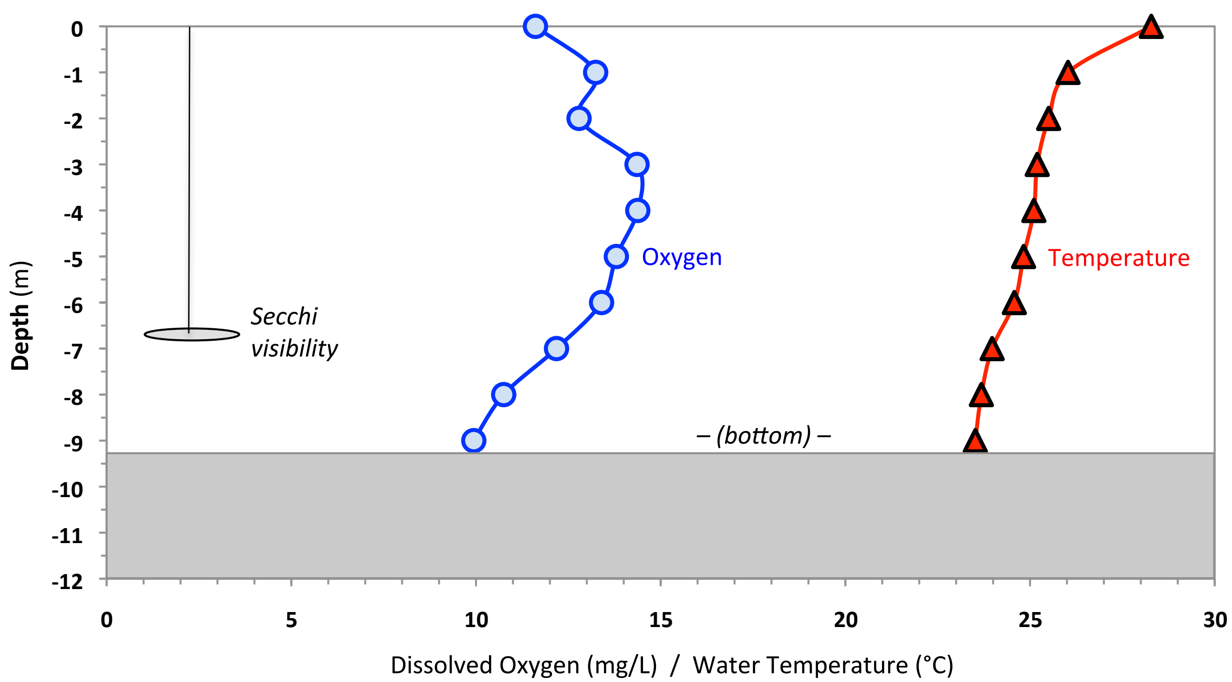


Figure 2(b). JUN 17, 2021 – Phase 3 Pond framework parameters

Table 2(b). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
JUN 17: max. depth 9.1 m (30 ft); Secchi disk water clarity: 6.7 m (22 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	(% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	28.3	11.61	149%	1.62	0.86	0.22	0.06
1	26.0	13.24	164%	0.46	0.77	0.25	0.09
2	25.5	12.79	157%	0.47	0.89	0.26	0.19
3	25.2	14.36	175%	0.55	1.01	0.27	0.23
4	25.1	14.38	175%	0.52	1.13	0.27	0.23
5	24.8	13.80	167%	0.60	1.47	0.22	0.24
6	24.6	13.40	161%	0.66	1.44	0.29	0.29
7	24.0	12.18	145%	0.83	2.20	0.31	0.36
8	23.7	10.75	127%	0.95	2.94	0.43	0.38
9.0	23.5	9.94	117%	1.69	3.16	2.77	0.87

Table 2(c). Cemex – Phase 3 Pond: 2021 Water Column Profiling Data
AUG 5: max. depth 9.4 m (31 ft); Secchi disk water clarity: 6.6 m (21.7 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	28.0	12.67	162%	812	0.39	528	9.04	110
1	28.0	12.77	164%	812	0.39	528	9.04	116
2	27.9	13.04	167%	813	0.39	528	9.06	122
3	27.1	14.95	188%	810	0.39	527	9.07	128
4	27.0	13.67	172%	812	0.40	528	9.06	132
5	26.7	13.91	174%	809	0.39	526	9.02	136
6	24.3	11.85	142%	800	0.39	520	8.35	155
7	23.1	14.34	168%	814	0.40	529	8.14	165
8	22.8	16.55	193%	879	0.43	572	7.99	171
9	22.4	13.17	152%	892	0.44	580	7.76	177

(additional parameters next page)

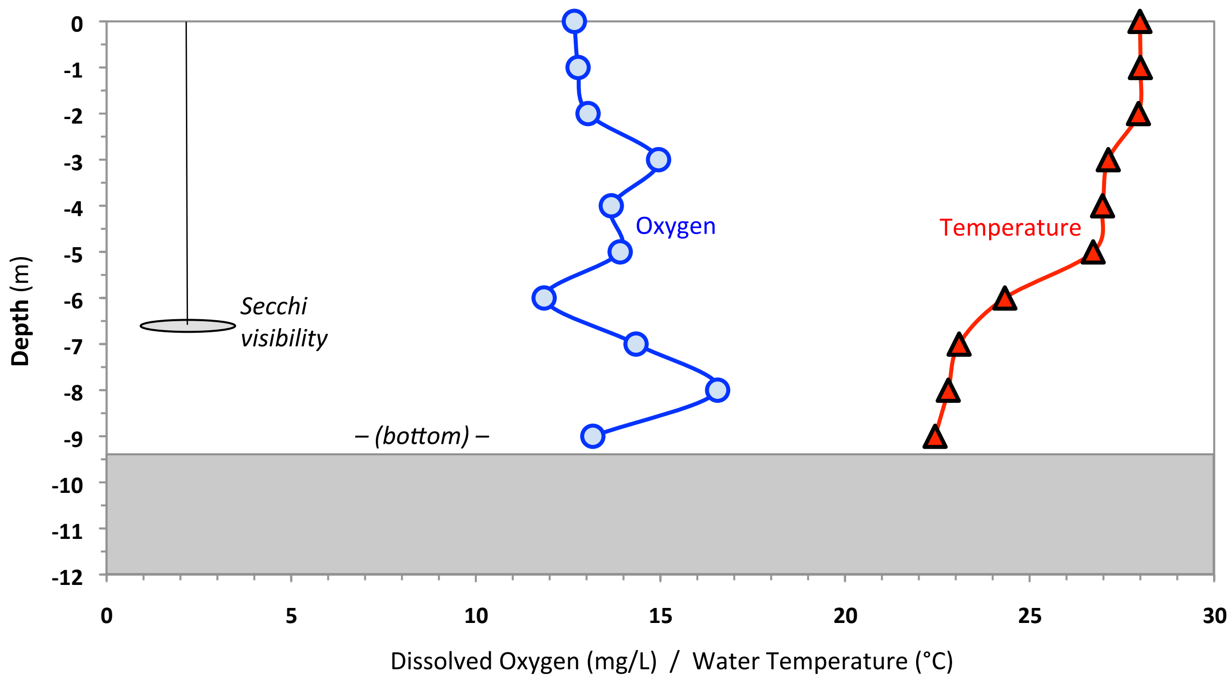


Figure 2(c). AUG 5, 2021 – Phase 3 Pond framework parameters

Table 2(c). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
AUG 5: max. depth 9.4 m (31 ft); Secchi disk water clarity: 6.6 m (21.7 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	28.0	12.67	162%	0.09	1.02	0.28	0.15
1	28.0	12.77	164%	0.05	1.23	0.29	0.16
2	27.9	13.04	167%	0.06	1.08	0.31	0.16
3	27.1	14.95	188%	0.01	1.32	0.32	0.19
4	27.0	13.67	172%	0.07	1.47	0.36	0.17
5	26.7	13.91	174%	0.13	1.43	0.56	0.24
6	24.3	11.85	142%	0.29	2.65	1.85	0.33
7	23.1	14.34	168%	1.86	2.67	13.80	1.65
8	22.8	16.55	193%	1.54	2.62	8.41	1.37
9	22.4	13.17	152%	1.08	2.46	3.18	0.71

Table 2(d). Cemex – Phase 3 Pond: 2021 Water Column Profiling Data
SEP 16: max. depth 8.7 m (28.5 ft); Secchi disk water clarity: 6.5 m (21.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	25.7	9.37	115%	812	0.40	528	8.91	25
1	25.7	9.47	116%	811	0.40	527	8.90	28
2	25.7	9.44	116%	812	0.40	528	8.88	30
3	25.4	9.40	115%	812	0.40	528	8.91	30
4	25.1	10.14	123%	813	0.40	529	8.92	31
5	25.0	10.08	122%	815	0.40	530	8.91	32
5.5	24.9	9.89	120%	816	0.40	530	8.90	34
6.0	24.1	9.06	108%	791	0.39	514	8.48	45
6.5	23.0	10.81	126%	781	0.38	508	8.23	53
7.0	22.7	10.31	120%	852	0.42	554	7.83	64
7.5	22.5	8.80	102%	864	0.42	562	7.77	65
8.0	22.3	8.56	98%	866	0.42	565	7.69	67
8.3	22.2	8.37	94%	865	0.42	564	7.64	69

(additional parameters next page)

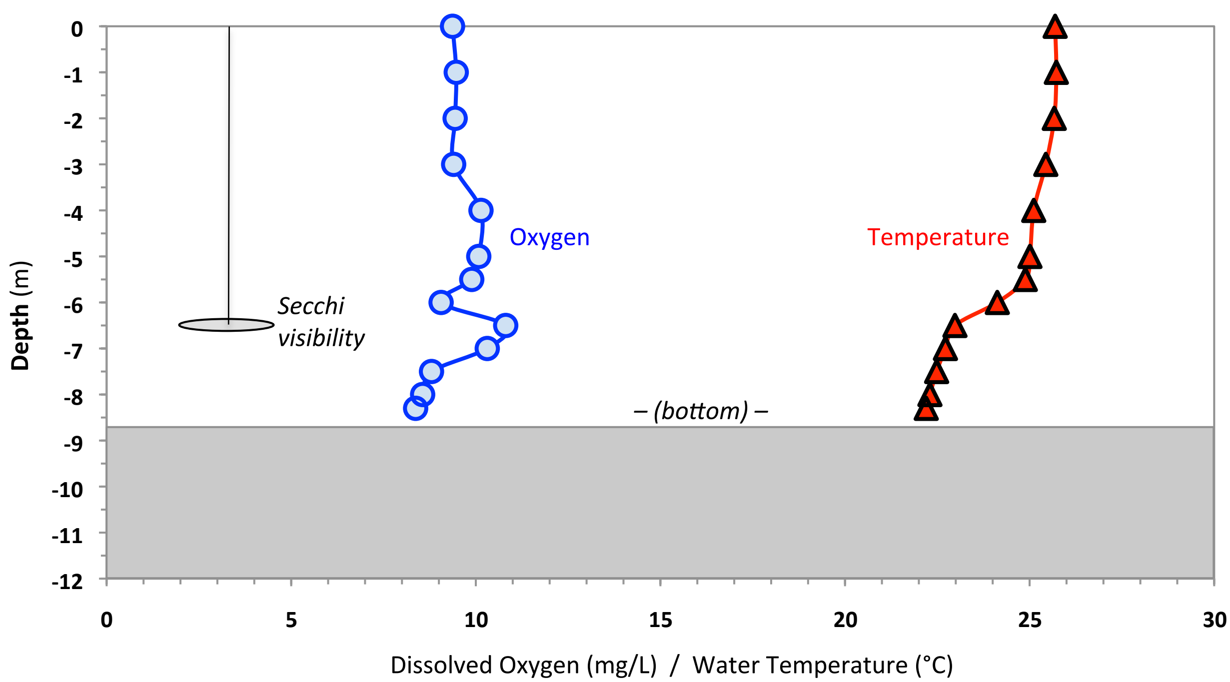


Figure 2(d). SEP 16, 2021 – Phase 3 Pond framework parameters

Table 2(d). ***(continued)* – OPTICAL PARAMETERS (with framework data for reference)**
SEP 16: max. depth 8.7 m (28.5 ft); Secchi disk water clarity: 6.5 m (21.3 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	25.7	9.37	115%	0.40	2.03	0.23	0.38
1	25.7	9.47	116%	0.30	2.07	0.26	0.23
2	25.7	9.44	116%	0.26	2.10	0.23	0.25
3	25.4	9.40	115%	0.23	2.36	0.33	0.23
4	25.1	10.14	123%	0.25	2.47	0.42	0.31
5	25.0	10.08	122%	0.26	2.69	0.82	0.33
5.5	24.9	9.89	120%	0.45	2.55	1.43	0.47
6.0	24.1	9.06	108%	1.29	3.13	16.83	1.08
6.5	23.0	10.81	126%	1.94	3.46	13.89	1.87
7.0	22.7	10.31	120%	1.45	4.56	4.67	1.16
7.5	22.5	8.80	102%	1.48	3.97	11.60	1.29
8.0	22.3	8.56	98%	1.58	4.13	12.44	1.46
8.3	22.2	8.37	94%	1.65	4.37	13.31	1.58

Table 2(e). Cemex – Phase 3 Pond: 2021 Water Column Profiling Data
OCT 28: max. depth 9.8 m (32 ft); Secchi disk water clarity: 5.3 m (17.4 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	17.4	9.10	95%	717	0.35	466	8.52	52
1	17.4	9.04	95%	717	0.35	466	8.53	58
2	17.0	8.85	92%	719	0.35	467	8.51	64
3	16.8	8.99	93%	718	0.35	466	8.52	68
4	16.7	9.02	93%	717	0.35	466	8.53	71
5	16.6	9.01	93%	717	0.35	466	8.54	74
6	16.6	8.84	91%	717	0.35	466	8.53	77
7	16.5	8.58	88%	718	0.35	467	8.52	80
8	16.5	8.34	86%	718	0.35	467	8.50	82
8.5	16.5	8.28	85%	718	0.35	467	8.49	84
9.0	16.5	8.23	84%	719	0.35	467	8.49	87
9.5	16.4	8.19	84%	719	0.35	467	8.49	88

(additional parameters next page)

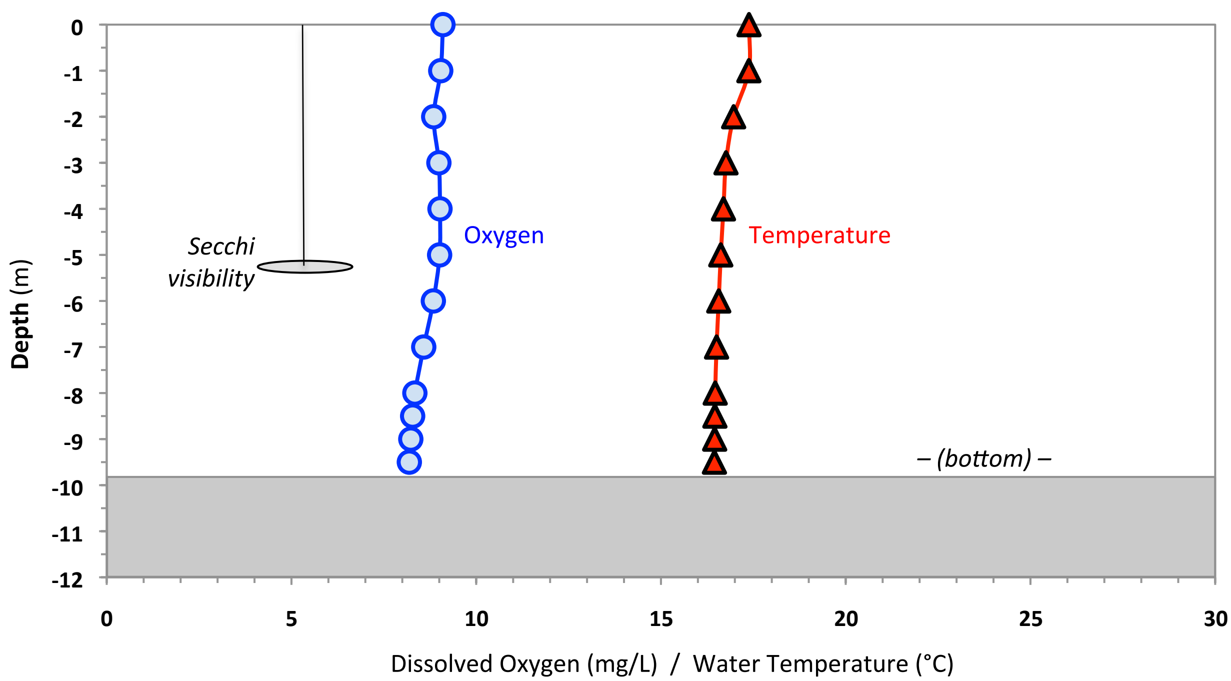


Figure 2(e). OCT 28, 2021 – Phase 3 Pond framework parameters

Table 2(e). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
OCT 28: max. depth 9.8 m (32 ft); Secchi disk water clarity: 5.3 m (17.4 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	17.4	9.10	95%	0.78	2.17	0.59	0.23
1	17.4	9.04	95%	0.76	2.29	0.76	0.25
2	17.0	8.85	92%	0.70	2.40	1.08	0.29
3	16.8	8.99	93%	0.72	2.52	1.10	0.33
4	16.7	9.02	93%	0.71	2.38	0.78	0.31
5	16.6	9.01	93%	0.67	2.55	0.94	0.36
6	16.6	8.84	91%	0.71	2.53	0.94	0.36
7	16.5	8.58	88%	0.78	2.69	0.50	0.30
8	16.5	8.34	86%	0.82	2.52	0.30	0.29
8.5	16.5	8.28	85%	0.74	2.60	0.29	0.29
9.0	16.5	8.23	84%	0.76	2.63	0.28	0.29
9.5	16.4	8.19	84%	0.85	2.64	0.28	0.30

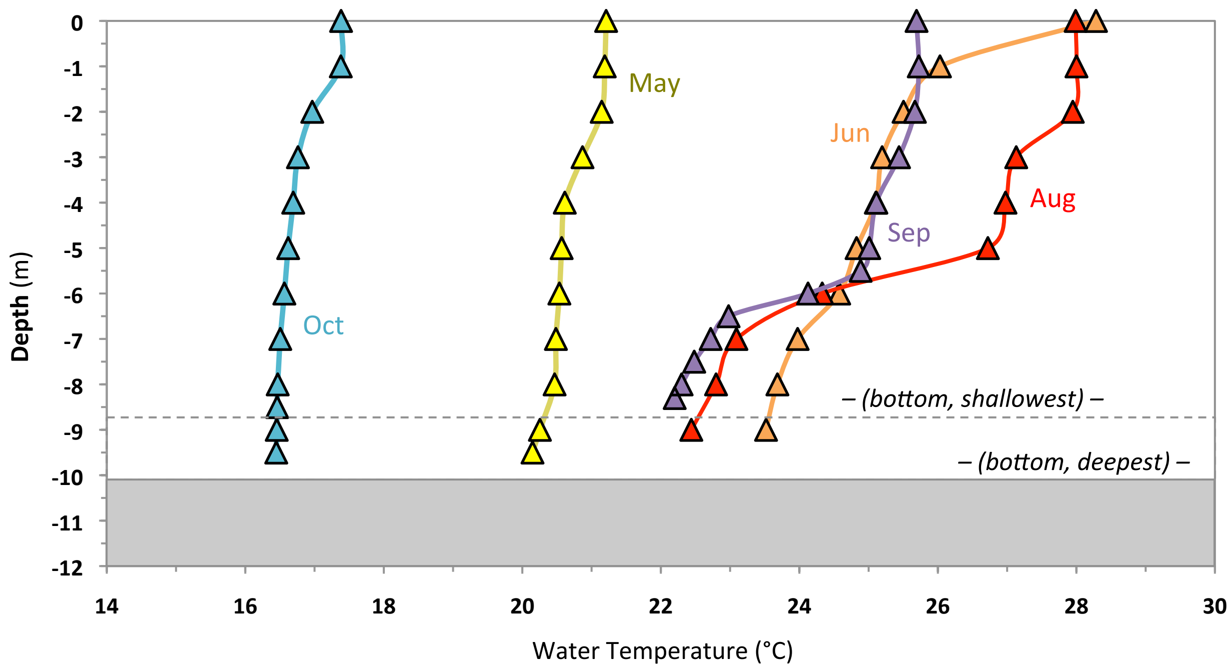


Figure 2(f). Cemex – Phase 3 Pond: 2021 May-Oct TEMPERATURE

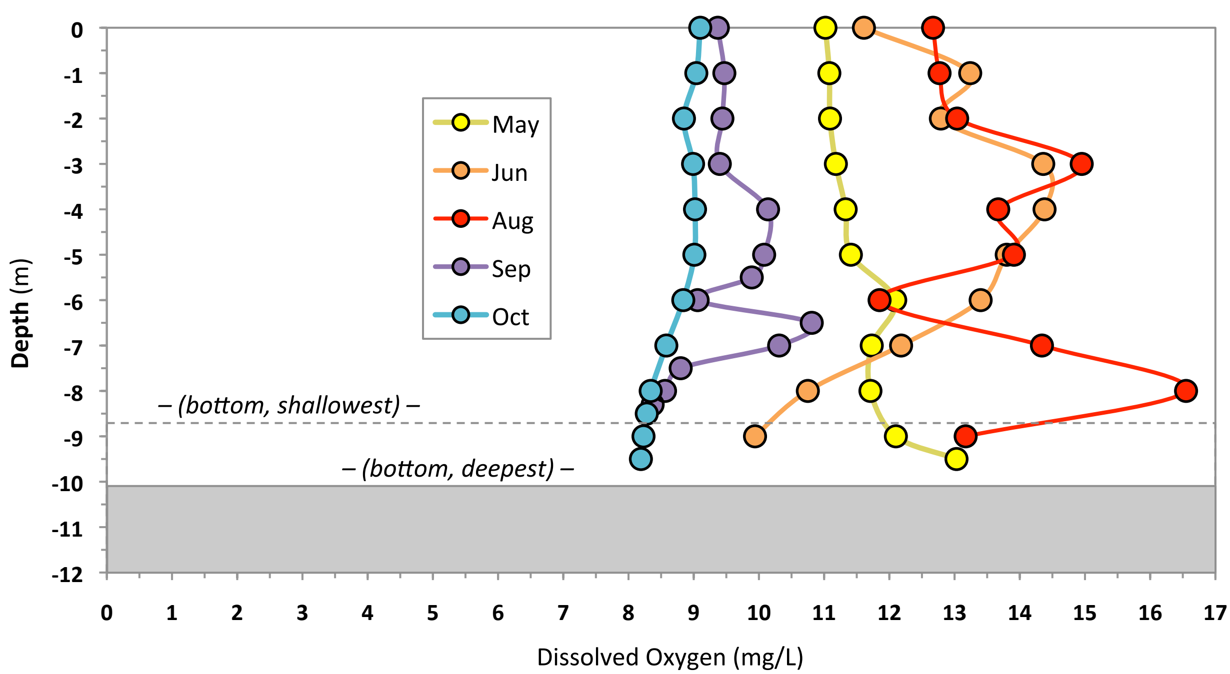


Figure 2(g). Cemex – Phase 3 Pond: 2021 May-Oct OXYGEN

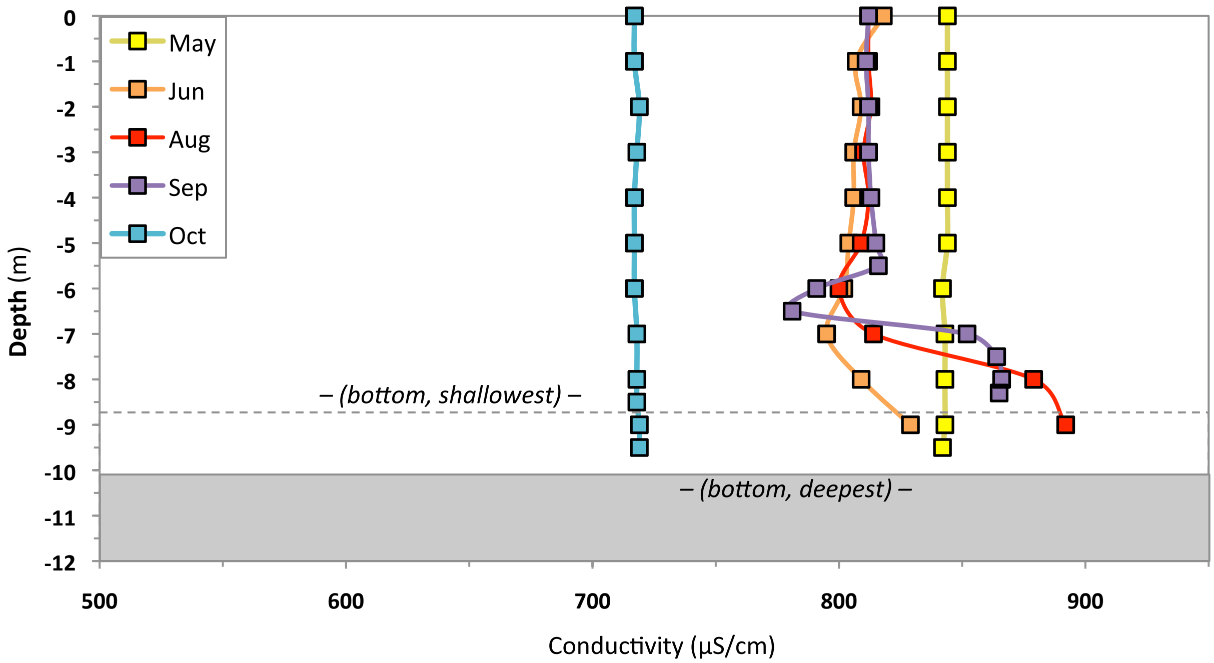


Figure 2(h). Cemex – Phase 3 Pond: 2021 May-Oct CONDUCTIVITY

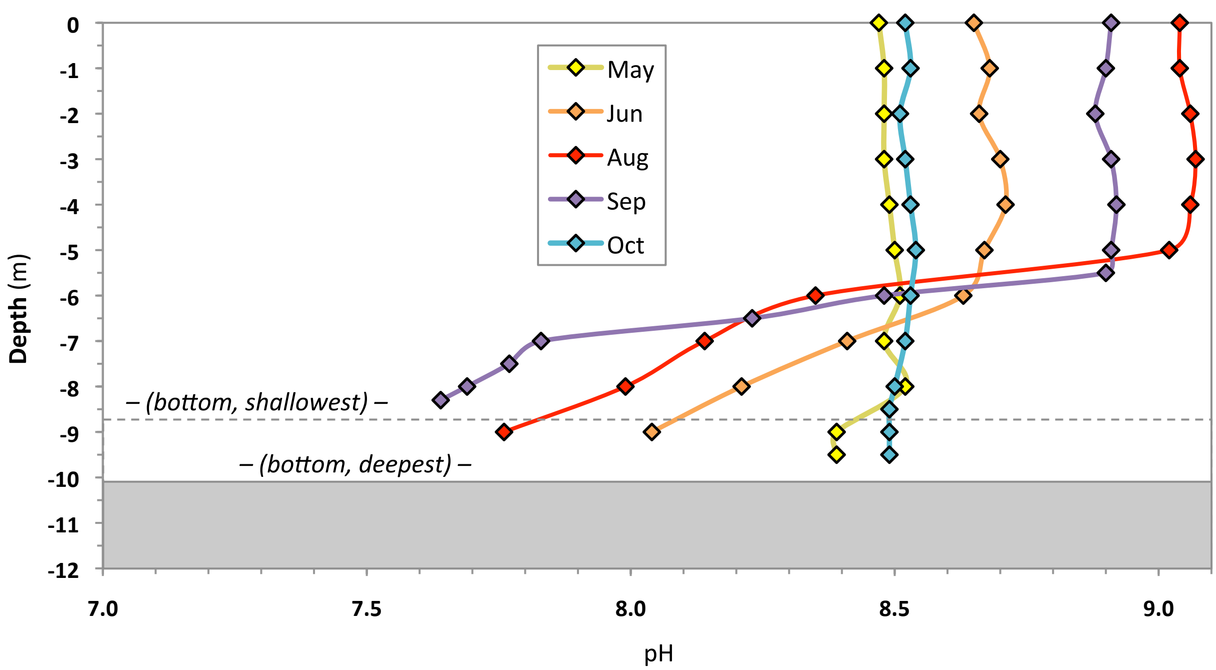


Figure 2(i). Cemex – Phase 3 Pond: 2021 May-Oct pH

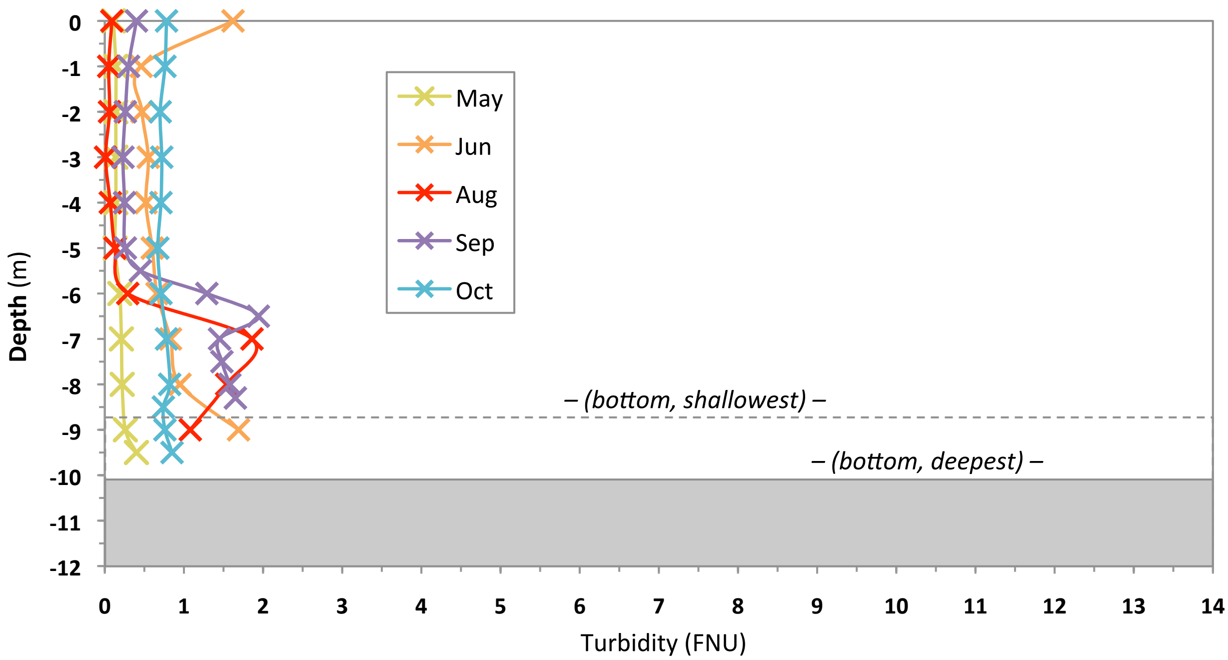


Figure 2(j). Cemex – Phase 3 Pond: 2021 May-Oct TURBIDITY

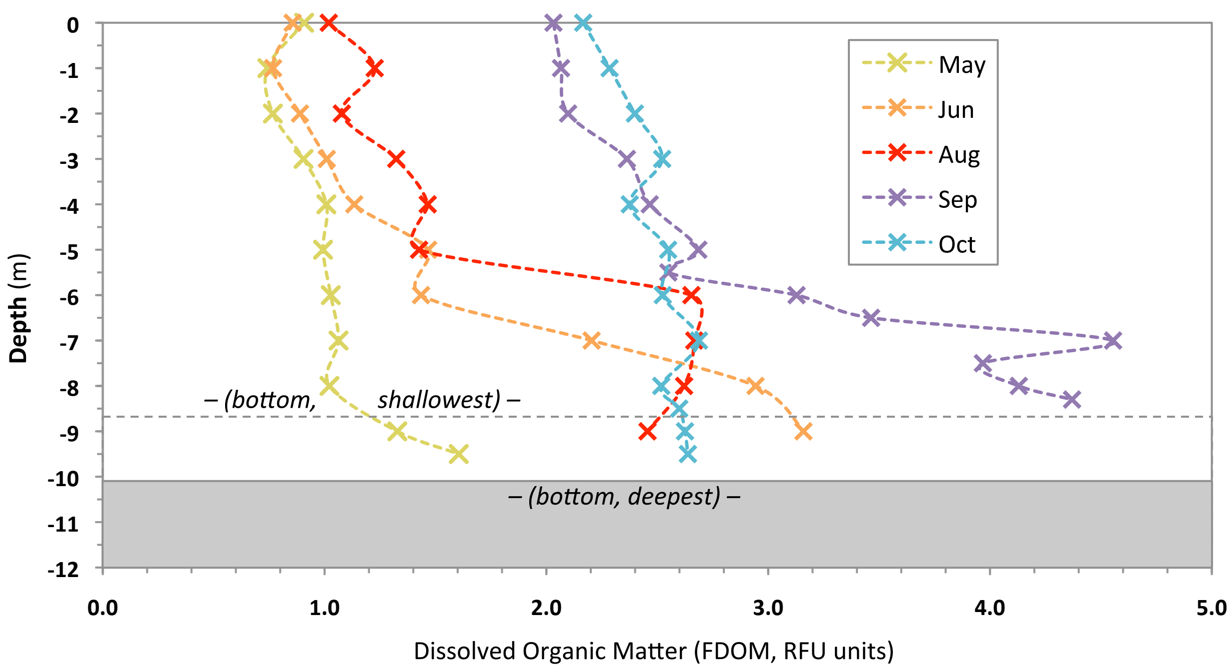


Figure 2(k). Cemex–Phase 3: 2021 May-Oct DISSOLVED ORGANIC MATTER

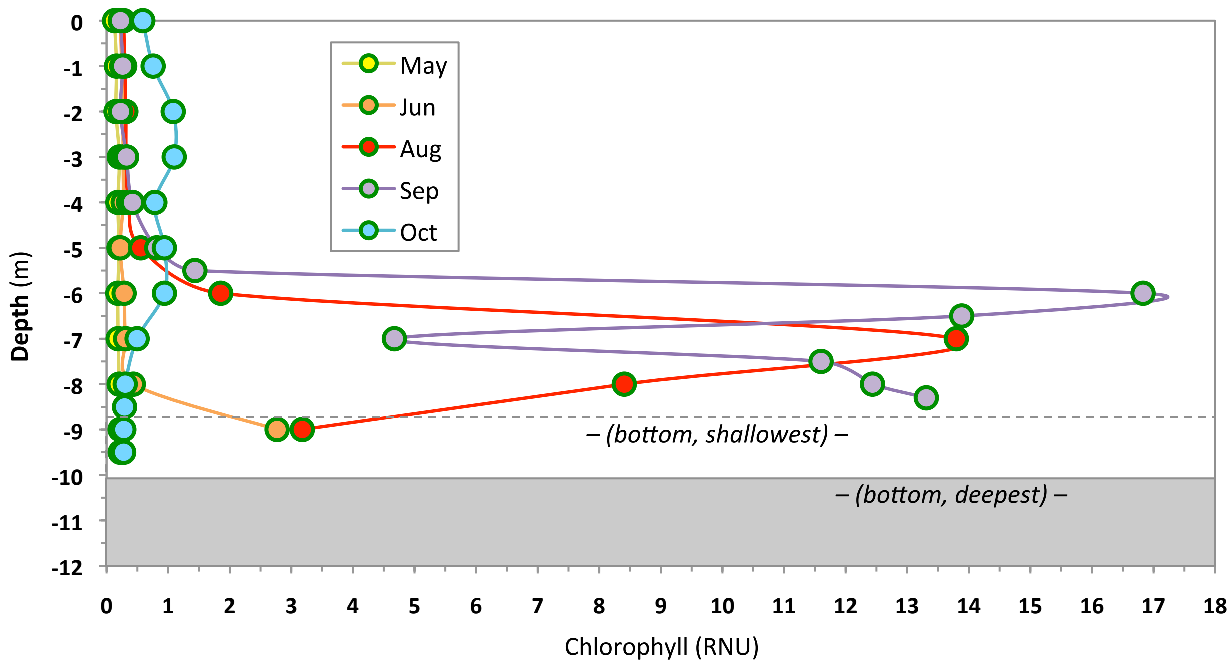


Figure 2(l). Cemex – Phase 3 Pond: 2021 May-Oct CHLOROPHYLL

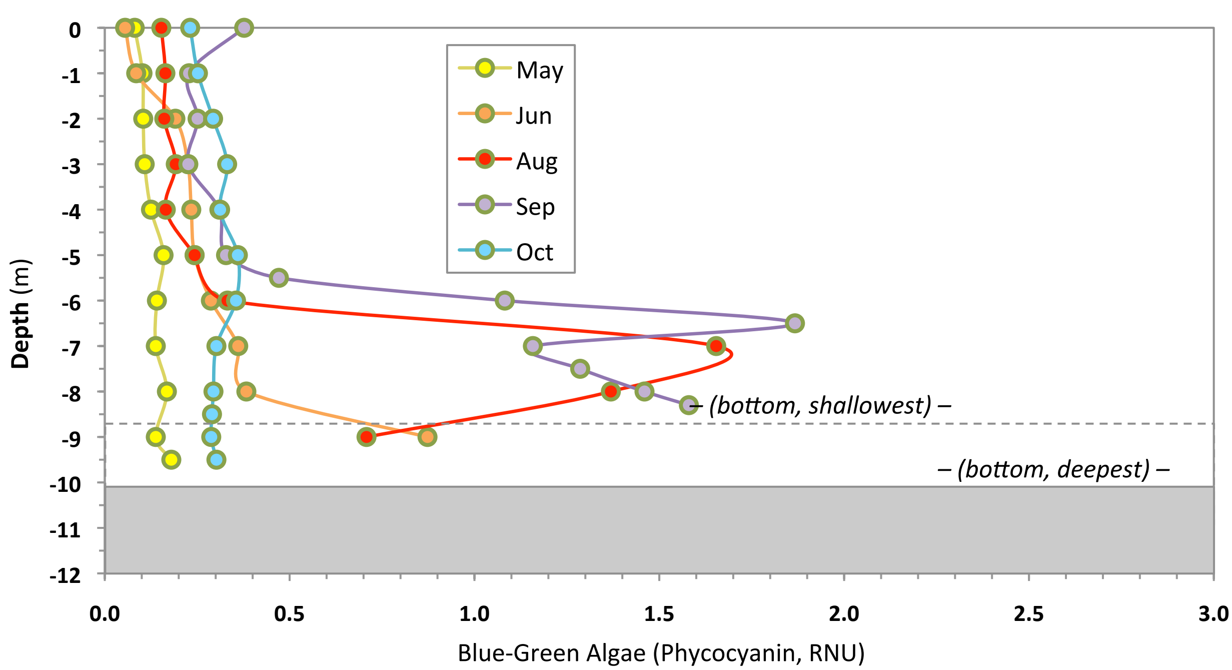


Figure 2(m). Cemex – Phase 3 Pond: 2021 May-Oct BLUE-GREEN ALGAE

3. CEMEX – PHASE 4 POND

(Google Earth 10/21/2020)

3. Cemex – Phase 4 Pond

In summary, the Cemex–Phase 3-4 Pond, an identified elevated fish-mercury pond, was separated, with a constructed levee, into two ponds; active mining continued in the Phase 4 portion. The water column of the Phase 4 Pond in 2021 behaved much like the larger pond in previous years. It remained moderately deep (8.2-9.4 m / 27-31 ft) and with moderate visibility (1.5-5.9 m / 5-19 ft). Despite being fairly deep, the Phase 4 pond remained well-mixed, likely due to its long east-west dimension allowing wind energy to reach the bottom. The active mining also contributes to water column mixing. This is similar to prior years when it was part of the larger Phase 3-4 Pond, and contrasts with the Phase 3 Pond in 2021. Because of the mixing, there was no summer stratification; most of the parameters were similar top to bottom. There was no bottom anoxia. Like the Phase 3 Pond, this pond may be challenging for mercury management. However, the fish mercury status of the stand-alone Phase 4 pond is unclear at this time, with results from the last two years shifting the site out of 'elevated over baseline' status.

The former Phase 3-4 Pond was separated into two ponds, using dirt infill to construct a high berm/road across the middle. The Phase 3 Pond was removed from mining activity. Active mining continued in the eastern, Phase 4 basin. As noted for the Phase 3 Pond, both basins are now being profiled for water column measures.

The Phase 4 Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 3(a) (May) through 3(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 3(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 3(f) (Temperature) through 3(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters.

Water Depth (Tables and Figs. 3(a-e): ranged between 8.2 and 9.4 m (27-31 ft) maximum depth across the 2021 May-Oct profiling.

Secchi Water Clarity (Tables and Figs. 3(a-e): was variable, depending on mining activity, ranging from a low of 1.5 m (5 feet) to a high of 5.9 m (19 feet).

Temperature (Tables and Figs. 3(a-e), Fig. 3(f)): Overall range 16-27 °C (61-81 °F) between May and October. Temperature stratification never set up strongly in the Phase 4 Pond, similar to earlier years when it was part of the larger Phase 3-4 Pond. Surface waters were a bit warmer than the bottom on all survey dates, by 0.3-2.7 °C (0.5-4.9 °F). As compared to the smaller, wind-protected Phase 3 Pond, Phase 4 had a longer distance for winds to act on, and active mining continuously stirred the water column. Temperatures changed over time, but across the whole water column, increasing from May to August and then cooling. The similar temperatures top to bottom show that the water mixed frequently.

Dissolved Oxygen (Tables and Figs. 3(a-e), Fig. 3(g)): was mostly above saturation levels at all depths, between 7.7 and 11.3 mg/L (ppm), which corresponded to 92-126% of saturation. Levels were broadly similar from top to bottom, with slightly higher concentrations in the lower layer on some dates and slightly lower levels there on others. It is notable – for the overall monitoring and restoration program – that oxygen increased in the bottom waters when visibility was high (and photosynthetic algae could produce oxygen to the bottom) and decreased in the bottom waters when visibilities were low, lessening light penetration, photosynthesis, and oxygen production there.

Conductivity (Tables 3(a-e), Fig. 3(h)): ranged between 719 and 880 µS/cm overall. Levels were very uniform from top to bottom on every survey date, indicating frequent mixing of the water column. Between May and August, all data hovered within the very narrow range of 871-880 µS/cm. Levels dropped somewhat in September (841-844 µS/cm) and then more substantially by early November after dilution from the first large rains (719-720 µS/cm). Overall conductivity levels in the Phase 3 Pond (and Phase 4 and the former combined Phase 3-4) continued to be among the highest across all the ponds monitored.

Salinity (Tables 3(a-e): consistent with the conductivity trend, was uniform between May and August at 0.43 ppt (parts per thousand, g/L) across all depths. This dropped slightly in September (0.41 ppt) and then more substantially by early November following rain dilution (0.35 ppt). Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 3(a-e): also consistent with the conductivity and Salinity trends, were very uniform between May and August, at 566-572 mg/L (ppm), a bit lower in September (547-549 mg/L)), and down more substantially by early November following the first significant rain dilutions (467-468 mg/L).

pH (Tables 3(a-e), Fig. 3(i)): as at the other monitored ponds, was notably very basic (non-acidic; pH > 7.00). This is a function of their mining history and the basic nature of local sediments. Water pH in the Phase 4 Pond was between 8.24 and 8.78 across all depths and dates, similar to previous years as the larger part of the combined Phase 3-4 pond. It was highest (most basic) overall in September and November. On most dates, pH was relatively a bit lower toward the bottom, though nothing like the large contrasts seen in the Phase 3 pond.

Oxidation/Reduction Potential (ORP) (Tables 3(a-e): ranged from a low of 5 mV (millivolts) at the surface in September to a high of 152 mV at the bottom in August. ORP increased toward the bottom on all dates.

Turbidity (Tables 3(a-e), Fig. 3(j)): With active mining throughout 2021 in the Phase 4 pond, turbidity was frequently high. The profiles show pulses of turbidity on several of the dates, to over 19 FNU, as recently resuspended sediments gradually sank through the water column.

Dissolved Organic Matter (FDOM) (Tables 3(a-e), Fig. 3(k)): As with many of the other parameters, this one remained similar to previous conditions in the combined Phase 3-4 Pond when active mining was also occurring near the water profiling site. Dissolved Organic Matter was similar from top to bottom on all dates and within the small overall range of 0.3-0.8 RFU from May to September. Levels were a bit higher in early November (1.0-1.3 RFU). All of these compare to accumulations of 2-5 RFU throughout the bottom several meters of the now-isolated Phase 3 Pond.

Green Algae (Chlorophyll) (Tables 3(a-e), Fig. 3(l)): in contrast with the now-isolated Phase 3 Pond, algal parameters in the active-mining Phase 4 Pond continued in a similar range and pattern as in earlier years when the two ponds were connected. The overall levels ranged between 0.08 and 0.64 RFU, all low. The profiles were similar top to bottom on all dates in this continuously mixed pond.

Blue-Green Algae (Phycocyanin) (Tables 3(a-e), Fig. 3(m)): also was similar to past years when the ponds were connected. The overall range across all depths and dates was 0.05-0.4 RFU, all low. The profiles were similar top to bottom on all dates like Chlorophyll.

Table 3(a). Cemex – Phase 4 Pond: 2021 Water Column Profiling Data
MAY 7: max. depth 9.4 m (30.7 ft); Secchi disk water clarity: 5.9 m (19.4 ft)

(% Sat. = % of saturation; μS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (μS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	21.2	10.04	113%	878	0.43	571	8.47	111
1	21.1	10.07	114%	878	0.43	571	8.48	116
2	20.8	10.14	114%	877	0.43	570	8.48	120
3	20.5	10.19	114%	877	0.43	570	8.48	123
4	20.3	10.10	112%	877	0.43	570	8.48	127
5	20.3	10.35	115%	877	0.43	570	8.41	137
6	20.2	10.30	114%	877	0.43	570	8.40	140
7	20.2	10.64	118%	875	0.43	569	8.39	143
8	20.0	10.89	120%	874	0.43	568	8.39	145
9.0	19.9	11.29	124%	873	0.43	567	8.39	148

(additional parameters next page)

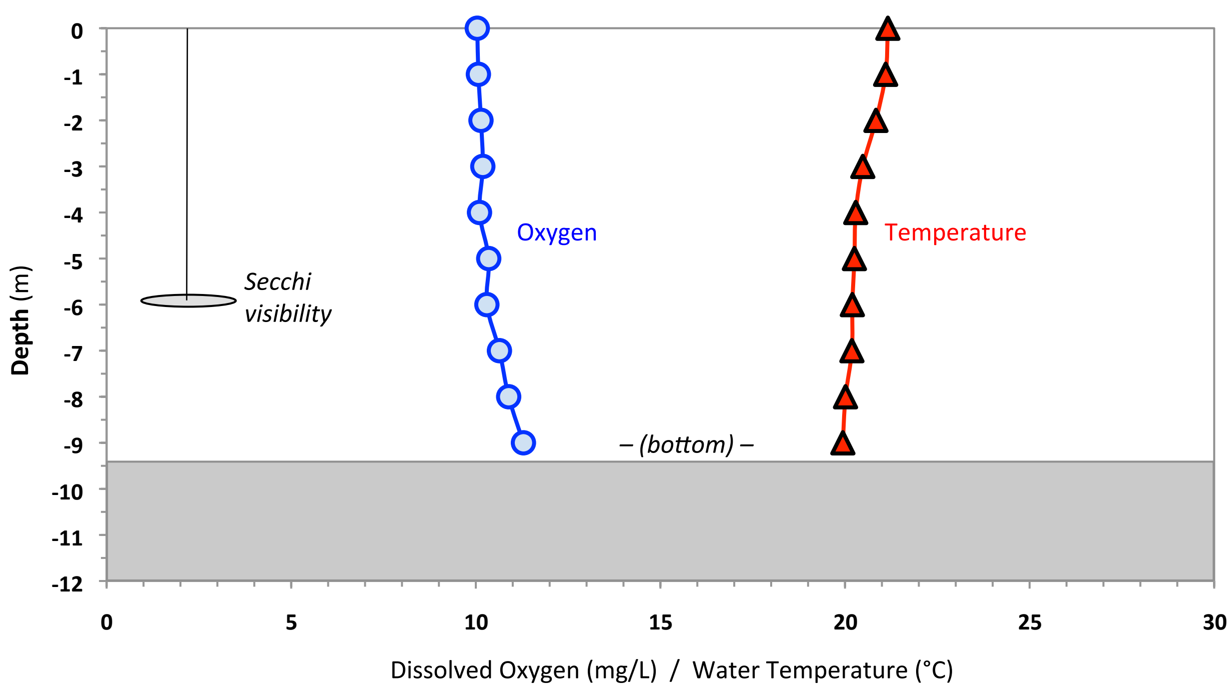


Figure 3(a). MAY 7, 2021 – Phase 4 Pond framework parameters

Table 3(a). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
MAY 7: max. depth 9.4 m (30.7 ft); Secchi disk water clarity: 5.9 m (19.4 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	21.2	10.04	113%	0.76	0.43	0.08	0.06
1	21.1	10.07	114%	0.73	0.33	0.12	0.05
2	20.8	10.14	114%	0.63	0.33	0.13	0.08
3	20.5	10.19	114%	0.63	0.39	0.14	0.08
4	20.3	10.10	112%	0.63	0.49	0.13	0.10
5	20.3	10.35	115%	0.70	0.43	0.17	0.11
6	20.2	10.30	114%	0.95	0.61	0.20	0.14
7	20.2	10.64	118%	19.30	0.56	0.32	0.22
8	20.0	10.89	120%	3.62	0.51	0.31	0.15
9.0	19.9	11.29	124%	3.60	0.54	0.33	0.19

Table 3(b). Cemex – Phase 4 Pond: 2021 Water Column Profiling Data
JUN 17: max. depth 9.1 m (30 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	26.5	9.69	121%	874	0.43	568	8.45	46
1	25.5	9.53	117%	873	0.43	567	8.44	59
2	25.2	9.41	115%	872	0.43	567	8.43	69
3	25.0	9.37	114%	871	0.43	566	8.43	77
4	24.8	9.44	114%	871	0.43	566	8.43	84
5	24.7	9.37	113%	871	0.43	566	8.43	87
6	24.5	9.20	111%	871	0.43	566	8.41	91
7	24.3	9.01	108%	871	0.43	566	8.39	95
8	24.1	8.64	103%	871	0.43	566	8.36	98
9.0	23.8	7.74	92%	871	0.43	566	8.24	107

(additional parameters next page)

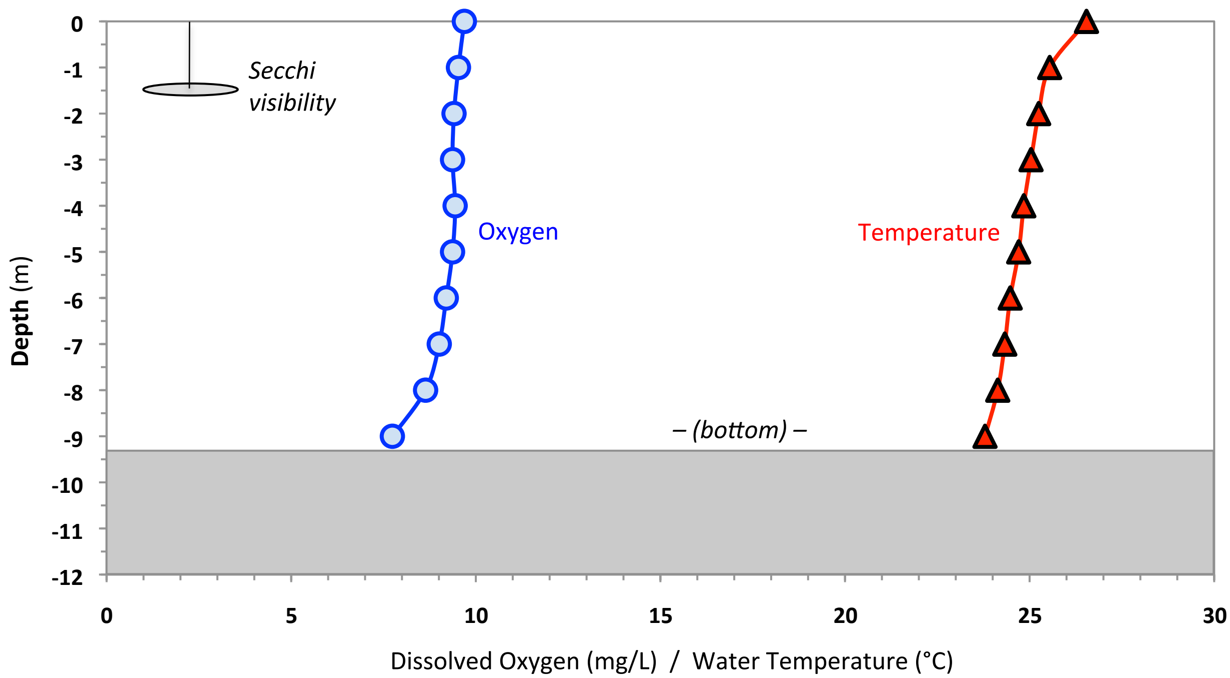


Figure 3(b). JUN 17, 2021 – Phase 4 Pond framework parameters

Table 3(b). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
JUN 17: max. depth 9.1 m (30 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	26.5	9.69	121%	1.98	0.43	0.50	0.08
1	25.5	9.53	117%	7.32	0.27	0.50	0.15
2	25.2	9.41	115%	12.32	0.30	0.54	0.26
3	25.0	9.37	114%	10.55	0.45	0.50	0.27
4	24.8	9.44	114%	6.47	0.30	0.52	0.30
5	24.7	9.37	113%	8.02	0.35	0.64	0.33
6	24.5	9.20	111%	7.53	0.50	0.53	0.32
7	24.3	9.01	108%	6.17	0.47	0.48	0.37
8	24.1	8.64	103%	5.48	0.67	0.37	0.36
9.0	23.8	7.74	92%	5.54	0.79	0.41	0.42

Table 3(c). Cemex – Phase 4 Pond: 2021 Water Column Profiling Data
AUG 5: max. depth 8.2 m (27 ft); Secchi disk water clarity: 2.6 m (8.5 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	27.3	9.14	116%	880	0.43	572	8.51	143
1	27.3	9.15	116%	880	0.43	572	8.51	145
2	27.3	9.15	116%	880	0.43	572	8.50	148
3	27.3	9.16	116%	879	0.43	572	8.51	149
4	27.2	9.16	116%	879	0.43	571	8.51	151
5	27.1	9.17	116%	879	0.43	571	8.51	151
6	27.1	9.15	115%	879	0.43	572	8.51	152
7	27.0	9.32	117%	879	0.43	571	8.51	152
8	27.0	9.26	117%	879	0.43	571	8.50	152

(additional parameters next page)

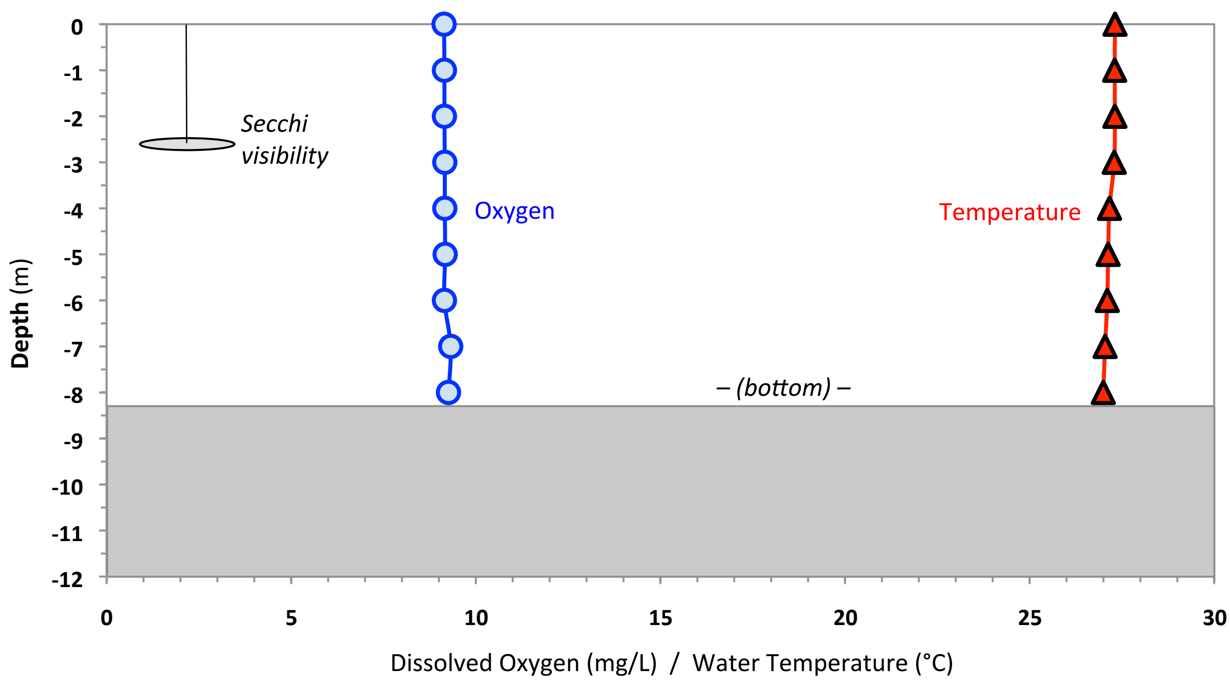


Figure 3(c). AUG 5, 2021 – Phase 4 Pond framework parameters

Table 3(c). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
AUG 5: max. depth 8.2 m (27 ft); Secchi disk water clarity: 2.6 m (8.5 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	27.3	9.14	116%	1.42	0.53	0.22	0.19
1	27.3	9.15	116%	1.43	0.56	0.31	0.21
2	27.3	9.15	116%	1.44	0.69	0.30	0.20
3	27.3	9.16	116%	1.52	0.50	0.30	0.21
4	27.2	9.16	116%	1.62	0.64	0.29	0.21
5	27.1	9.17	116%	1.33	0.79	0.30	0.23
6	27.1	9.15	115%	1.33	0.63	0.34	0.21
7	27.0	9.32	117%	2.67	0.76	0.45	0.22
8	27.0	9.26	117%	2.78	0.65	0.53	0.25

Table 3(d). Cemex – Phase 4 Pond: 2021 Water Column Profiling Data
SEP 16: max. depth 9.0 m (29.5 ft); Secchi disk water clarity: 3.3 m (10.8 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	25.6	9.27	114%	844	0.41	549	8.74	5
1	25.6	9.33	115%	844	0.41	549	8.74	12
2	25.6	9.34	115%	844	0.41	549	8.75	15
3	25.6	9.36	115%	844	0.41	549	8.75	17
4	25.4	9.55	117%	843	0.41	548	8.75	19
5	25.3	9.82	120%	843	0.41	548	8.76	20
6	25.3	10.04	122%	842	0.41	547	8.77	21
7	25.2	10.25	125%	841	0.41	547	8.78	22
7.5	25.2	10.27	125%	841	0.41	547	8.78	24
8.0	25.2	10.33	126%	841	0.41	547	8.75	27
8.5	25.2	10.35	126%	841	0.41	547	8.71	33

(additional parameters next page)

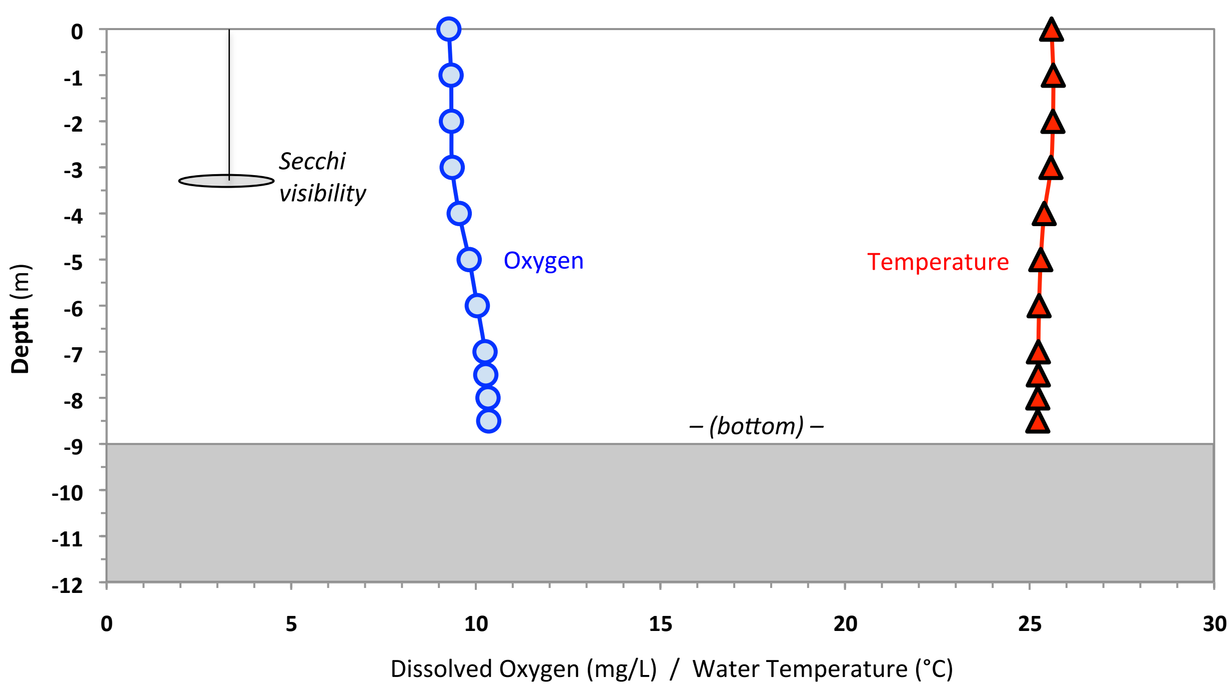


Figure 3(d). SEP 16, 2021 – Phase 4 Pond framework parameters

Table 3(d). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
SEP 16: max. depth 9.0 m (29.5 ft); Secchi disk water clarity: 3.3 m (10.8 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	25.6	9.27	114%	1.60	0.69	0.29	0.25
1	25.6	9.33	115%	1.63	0.56	0.27	0.27
2	25.6	9.34	115%	1.62	0.71	0.29	0.21
3	25.6	9.36	115%	1.65	0.71	0.30	0.24
4	25.4	9.55	117%	1.19	0.68	0.27	0.25
5	25.3	9.82	120%	1.02	0.69	0.33	0.22
6	25.3	10.04	122%	0.82	0.71	0.30	0.20
7	25.2	10.25	125%	0.82	0.70	0.33	0.25
7.5	25.2	10.27	125%	0.81	0.69	0.29	0.26
8.0	25.2	10.33	126%	0.87	0.75	0.31	0.24
8.5	25.2	10.35	126%	1.07	0.67	0.29	0.26

Table 3(e). Cemex – Phase 4 Pond: 2021 Water Column Profiling Data

OCT 28: max. depth 9.4 m (31 ft); Secchi disk water clarity: 2.8 m (9.2 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	17.7	9.98	105%	719	0.35	468	8.76	71
1	17.3	9.84	103%	720	0.35	468	8.74	76
2	17.1	9.79	102%	720	0.35	468	8.75	79
3	16.8	9.69	100%	720	0.35	468	8.74	82
4	16.7	9.60	99%	719	0.35	467	8.74	84
5	16.5	9.52	98%	719	0.35	467	8.73	87
6	16.5	9.38	96%	719	0.35	467	8.71	91
7	16.4	9.30	95%	719	0.35	467	8.70	93
8	16.4	9.24	95%	719	0.35	467	8.71	97
9	16.4	9.24	95%	719	0.35	467	8.68	99

(additional parameters next page)

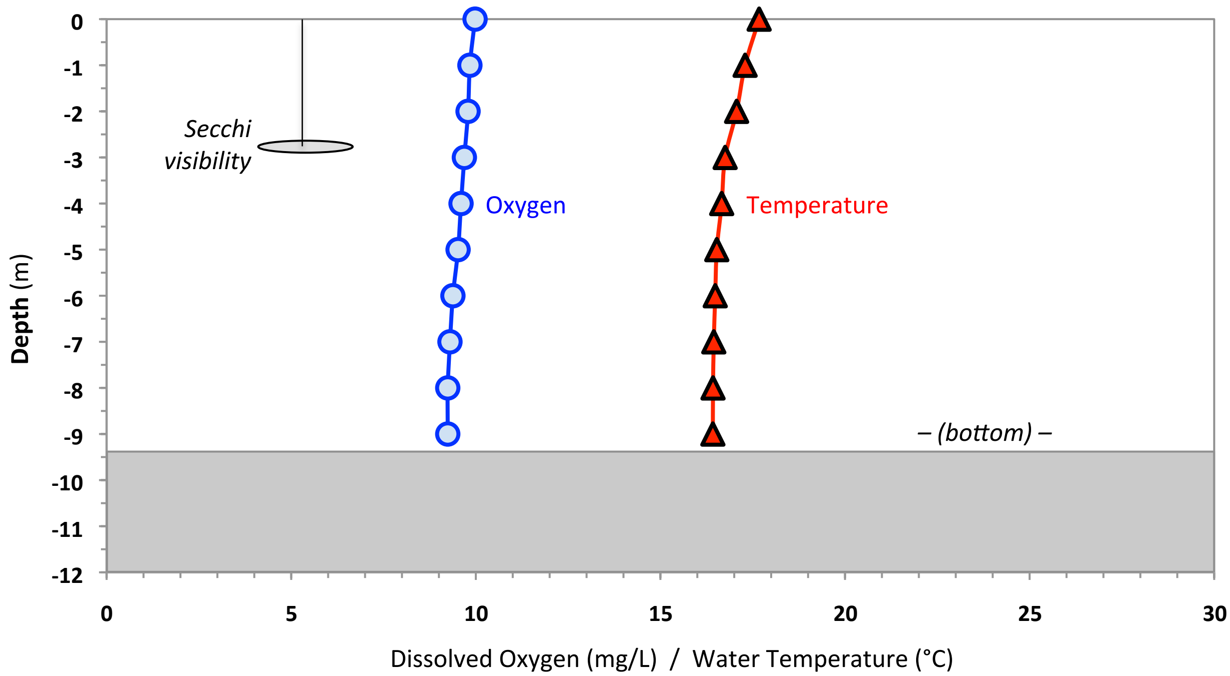


Figure 3(e). OCT 28, 2021 – Phase 4 Pond framework parameters

Table 3(e). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
OCT 28: max. depth 9.4 m (31 ft); Secchi disk water clarity: 2.8 m (9.2 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	17.7	9.98	105%	1.82	1.07	0.42	0.20
1	17.3	9.84	103%	1.78	1.21	0.32	0.22
2	17.1	9.79	102%	2.01	1.13	0.33	0.18
3	16.8	9.69	100%	3.08	1.29	0.40	0.28
4	16.7	9.60	99%	3.36	1.31	0.38	0.25
5	16.5	9.52	98%	5.57	1.15	0.44	0.27
6	16.5	9.38	96%	7.29	1.19	0.45	0.34
7	16.4	9.30	95%	5.70	1.28	0.27	0.29
8	16.4	9.24	95%	3.57	1.24	0.25	0.31
9	16.4	9.24	95%	3.69	1.28	0.26	0.30

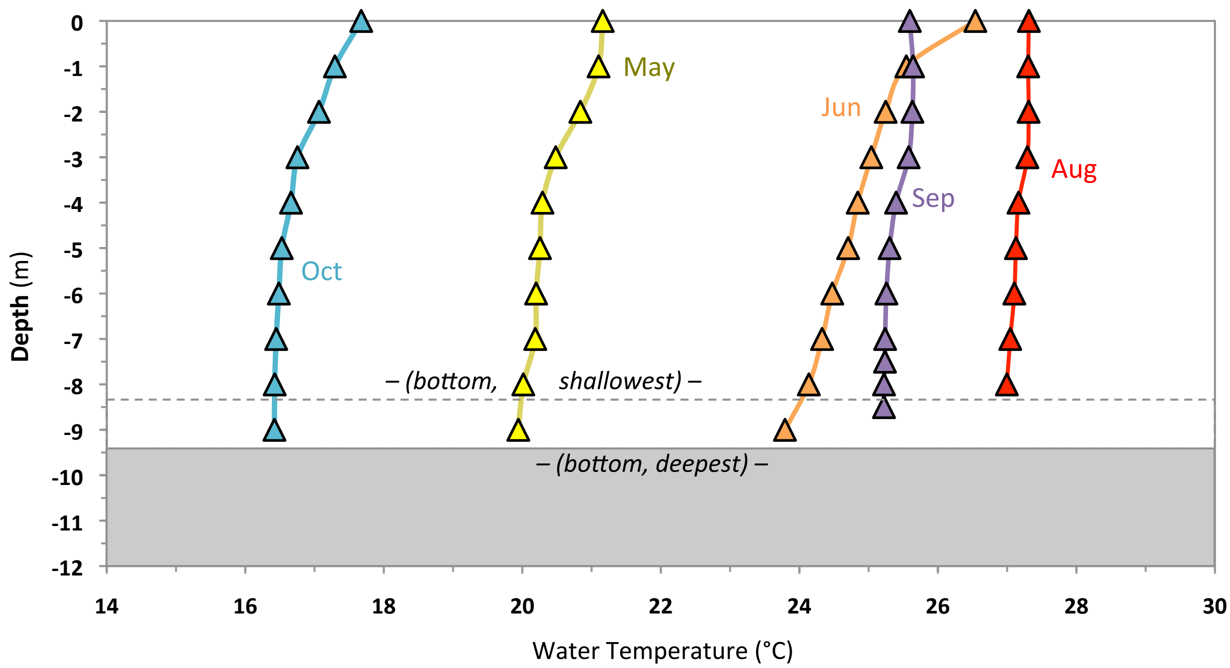


Figure 3(f). Cemex – Phase 4 Pond: 2021 May-Oct TEMPERATURE

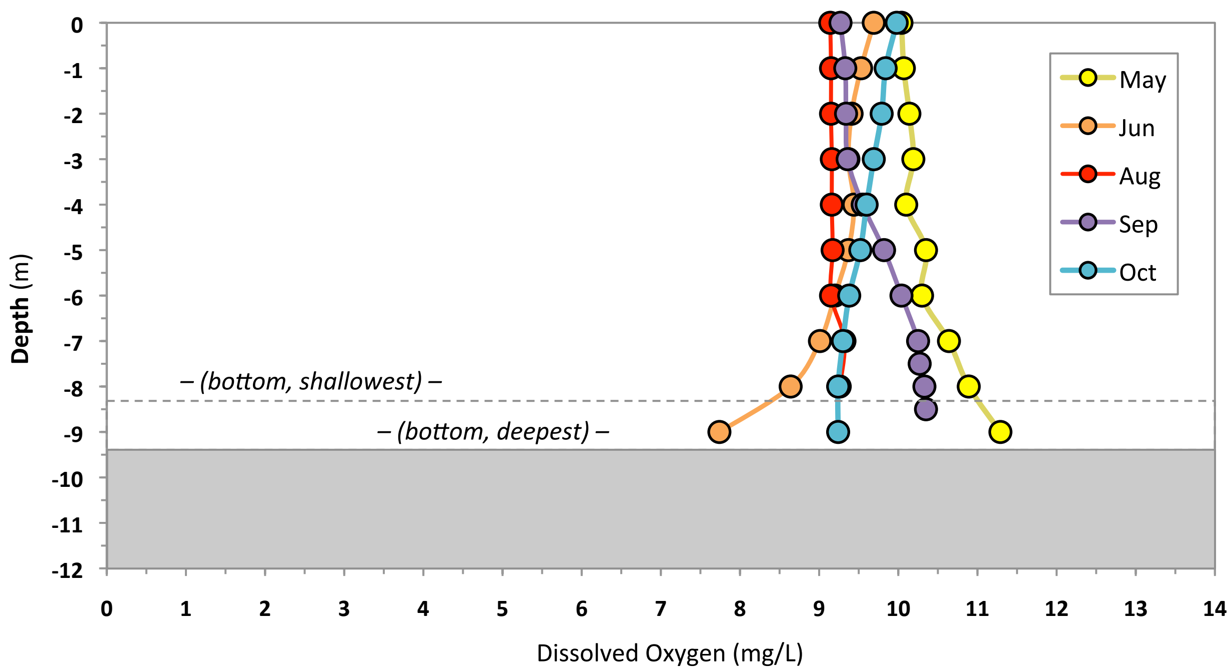


Figure 3(g). Cemex – Phase 4 Pond: 2021 May-Oct OXYGEN

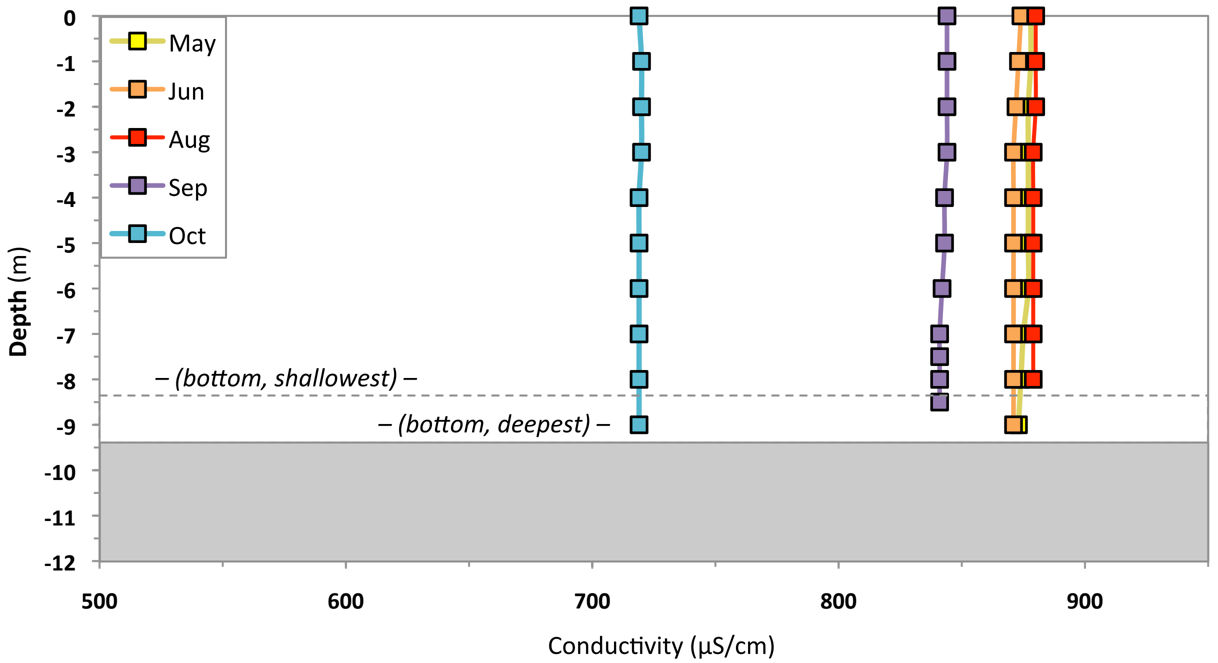


Figure 3(h). Cemex – Phase 4 Pond: 2021 May-Oct CONDUCTIVITY

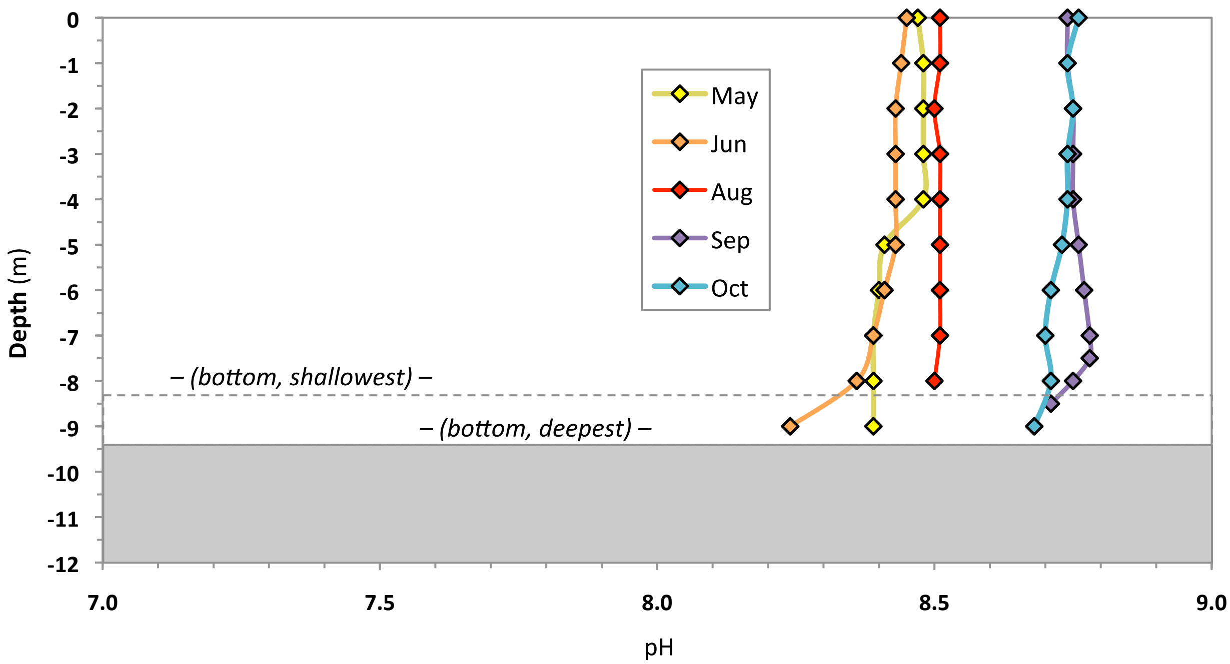


Figure 3(i). Cemex – Phase 4 Pond: 2021 May-Oct pH

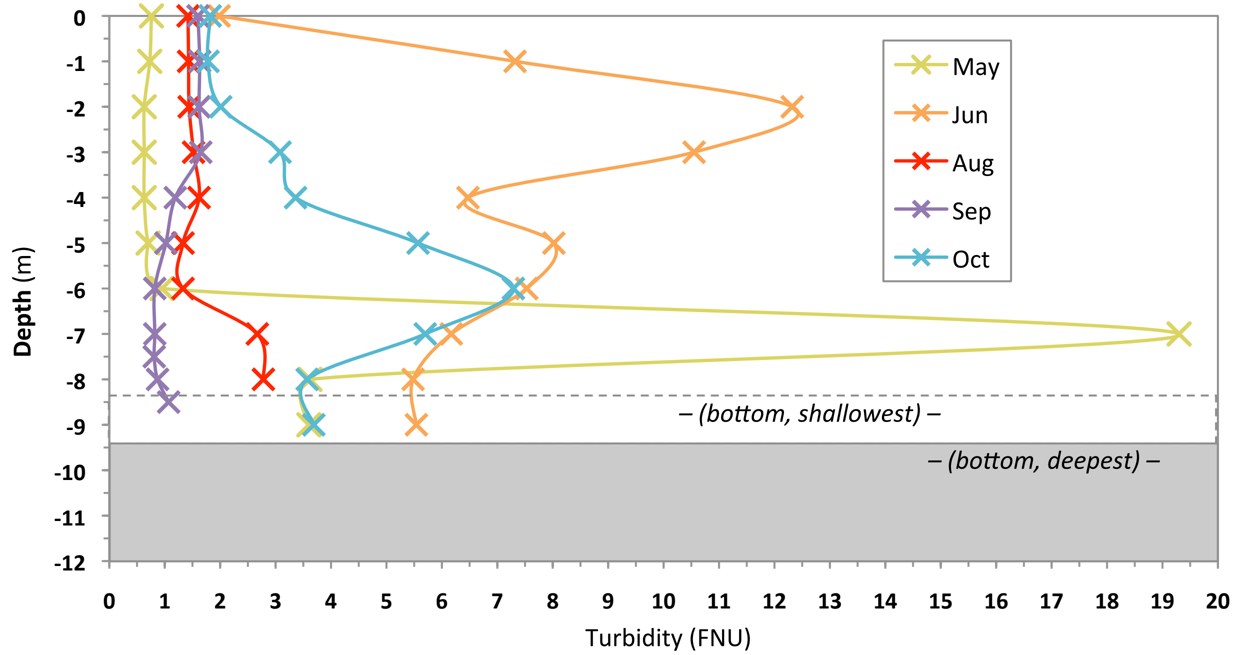


Figure 3(j). Cemex – Phase 4 Pond: 2021 May-Oct TURBIDITY

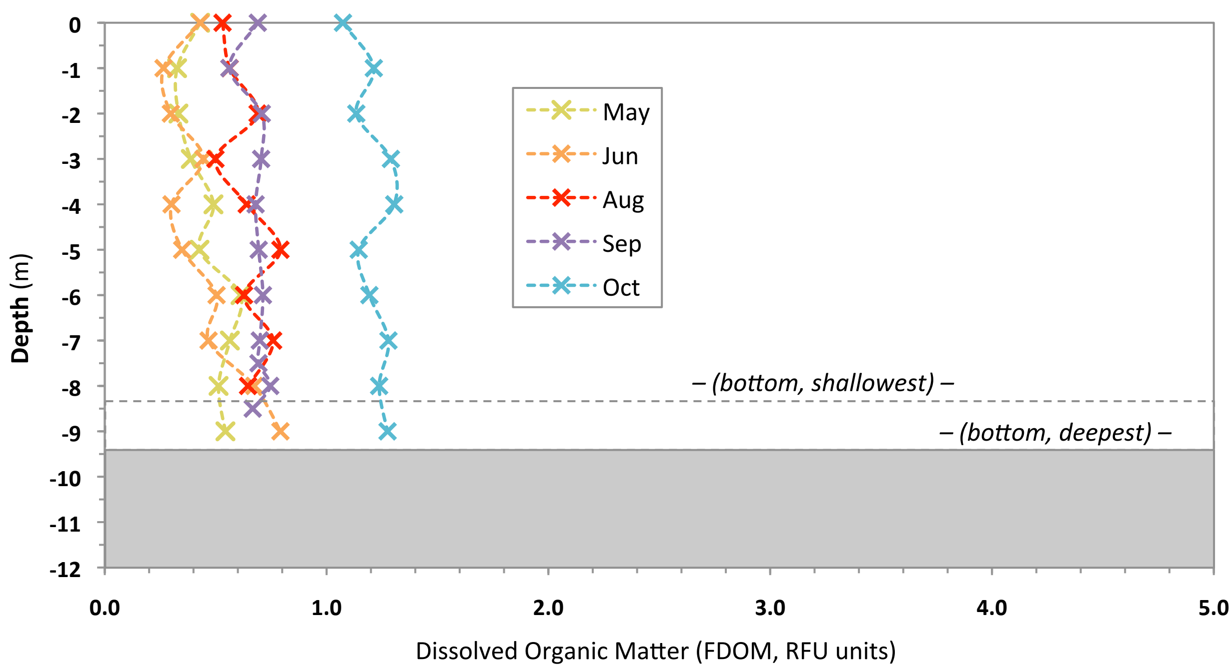


Figure 3(k). Cemex–Phase 4: 2021 May-Oct DISSOLVED ORGANIC MATTER

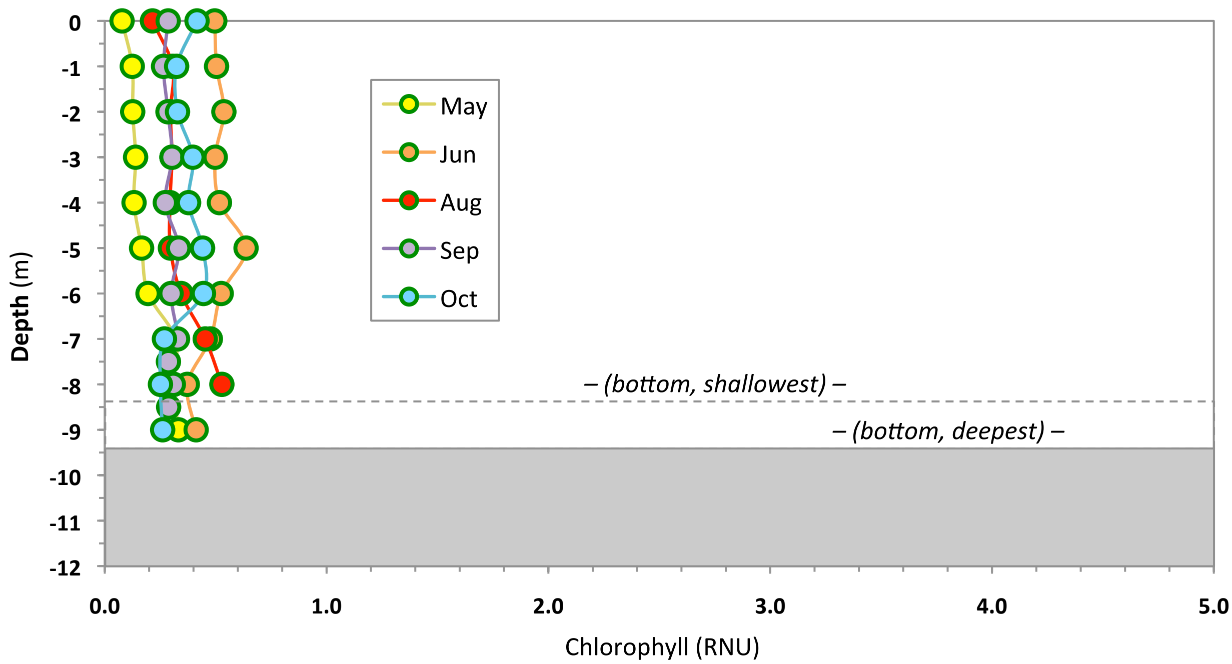


Figure 3(l). Cemex – Phase 4 Pond: 2021 May-Oct CHLOROPHYLL

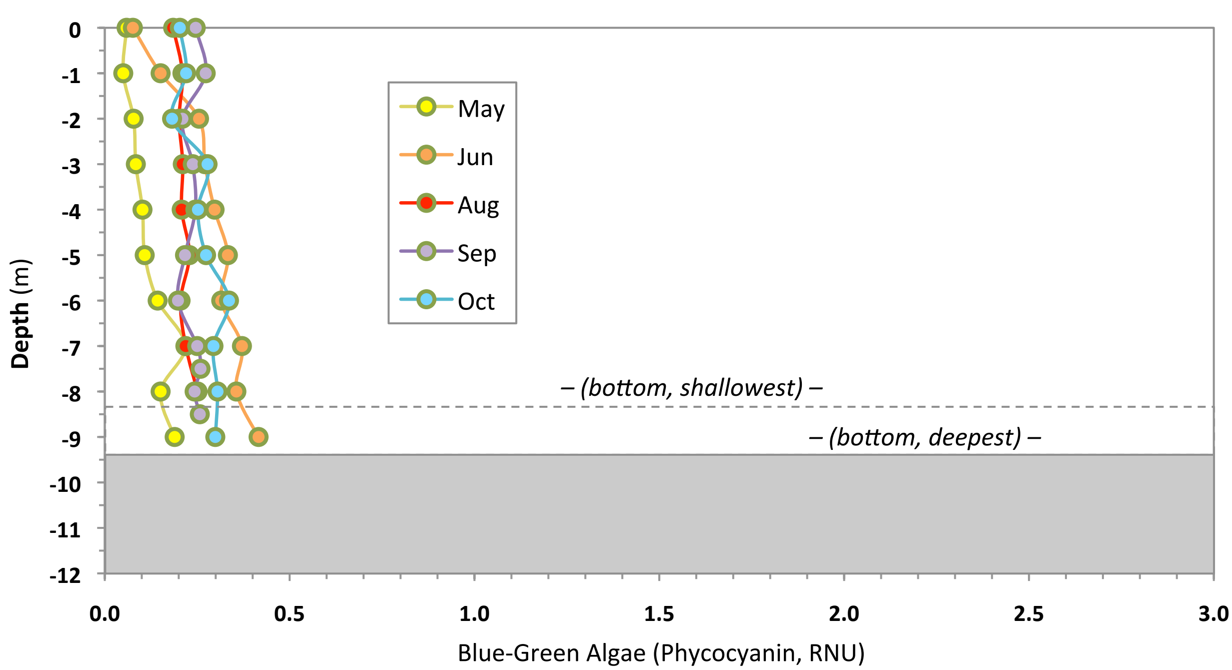


Figure 3(m). Cemex – Phase 4 Pond: 2021 May-Oct BLUE-GREEN ALGAE

4. TEICHERT – ESPARTO POND

(Google Earth 10/21/2020)

4. Teichert – Esparto Pond *(formerly Reiff and Mast)*

In summary, the Teichert–Esparto Pond was greatly impacted by the 2021 drought, with water levels dropping 6 m (20 feet) from 2020 levels and separating the pond into three disconnected, shallow ponds. Water profiling continued in the central basin, formerly Mast Northwest. The overall site has been identified as 'elevated over baseline' in fish mercury. The pond was moderately deep at the start of the season in May (9.4 m / 31 ft), but quickly dropped with the drought, eventually to 4.3 m (14 ft) by November. Water clarity continued to be very low/turbid, at 1.0-1.6 m (3-5 ft), blocking sunlight, algal photosynthesis, and oxygen production at depths below the near-surface. A temperature stratification developed through the summer, despite the shrinking water levels. With no deep oxygen production to replace oxygen naturally lost to biotic metabolism, bottom water oxygen dropped to low levels through the summer, almost certainly increasing methylmercury production and bioavailability to fish. This seasonal cycle presents a clear mercury management option, through disruption of summer anoxia. Oxygen later recovered, with surface cooling and wind mixing, by early November.

In 2020, the internal berms across this site were breached, to form an inter-connected single large pond that includes the former Reiff Pond and the two Mast basins. Water column profiling since 2020 has been done in the deepest part of the central basin (formerly Northwest Mast, as in the 2020 Google Earth photo). However, there were severe drought conditions this year and, after the May survey, water levels dropped low enough to separate the pond into three disconnected, shallow basins, in the footprints of the former Reiff and two Mast ponds. Water column profiling continued in the central basin. With the quickly changing shorelines (cliffs and soft mud flats) it became impossible to get our normal sampling boat down to the water by June. For the August through November profiles, we used an inflatable kayak.

The 2021 Teichert–Esparto Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 4(a)

(May) through 4(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 4(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 4(f) (Temperature) through 4(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters.

Water Depth (Tables and Figs. 4(a-e): began the sampling season in May at 9.4 m (31 ft), a meter *lower* than in October of the previous year. Rather than replenishing water, the winter 'rainy season' brought continued declines. With the 2021 warm season, pond water levels plummeted, eventually to 4.3 m (14 ft) by early November – down 17 feet from May and down 20 feet as compared to the same time of year in 2020.

Secchi Water Clarity (Tables and Figs. 4(a-e): was uniformly very low/turbid, at 1.0-1.6 m (3-5 ft).

Temperature (Tables and Figs. 4(a-e), Fig. 4(f)): Overall range 15-28 °C (59-83 °F) between early May and early November. Under the drought conditions, water depth declined rapidly, creating a smaller water column and separating the basins. A strong temperature stratification began to set up in May before the water levels dropped, with surface temperatures rising to over 7 °C (13 °F) warmer than cool bottom waters. As in earlier years, the bottom water temperature rose after that, showing that some mixing occurred. But, even with the declining depths, enough of a temperature gradient remained through September to allow the development of anoxia at the bottom (next section). This was stronger in 2021 in the now-disconnected and more wind-protected central index basin, as compared to last year when the basins were linked and had a larger surface for wind to act on. Later, by early November, the water column became mixed (low gradient between surface and bottom temperatures) as overall temperatures dropped to below 18 °C (< 64 °F).

Dissolved Oxygen (Tables and Figs. 4(a-e), Fig. 4(g)): despite the changing depth and temperature conditions described above, oxygen levels dropped steadily in water below 3-4 m, beginning in May and continuing through September. As discussed in previous reports, low oxygen bottom water conditions promote methylmercury production and its movement into the water from the bottom sediments, as well as mercury methylation directly in the bottom waters. Another contributing factor is the high turbidity of the water, which blocks photosynthesis and oxygen re-charge at depth here, and also blocks UV light from degrading methylmercury. These processes can significantly increase the uptake of methylmercury by fish and other aquatic organisms (and predators and fishermen that consume them). The Teichert-Esparto Pond has had among the highest fish mercury levels of the monitored ponds. By the early November survey, the water column had cooled and begun mixing top to bottom; there was ample oxygen throughout. That condition typically continues throughout the cool fall-winter months, until spring warming begins to heat the surface water.

Conductivity (Tables 4(a-e), Fig. 4(h)): in contrast with 2020, May and November levels were both relatively low, in the narrow range of 650-660 μS/cm, despite spanning a period where fully half the water column depth dried up. We were not able to get a boat onto the pond in June. Levels were again nearly uniform in August and September, but at a higher range of 761-772 μS/cm through the top 3.5 m. Below this in August, levels dropped to 738 μS/cm in the thin, anoxic bottom layer. This was the reverse of the August trend of the year before with a deeper water column, when levels increased in the seasonally anoxic bottom water. Significant October rainfall acted to dilute the pond before the November survey, leading to lower conductivity levels like to those in May.

Salinity (Tables 4(a-e): was uniform, at 0.32 ppt (parts per thousand, g/L) across all depths at the start of the season in May. As the drought conditions progressed, concentrating the salts in the remaining water, levels gradually increased to 0.38 ppt. As seen for conductivity, October rainfall acted to dilute the pond before the November survey, dropping salinity back to 0.32 ppt. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 4(a-e): followed the salinity and conductivity trends (they are linked), with similar levels in May and November (422-429 mg/L = ppm) and higher levels in August and September under drought conditions (478-502 mg/L).

pH (Tables 4(a-e), Fig. 4(i)): continued to be basic (non-acidic; pH > 7.00) in all of the monitored ponds. This is a function of their mining history and the basic nature of local sediments. Levels declined toward the bottom on all dates with water column stratification, most notably in August. This was a direct function of the reduced oxygen in the bottom water, which shifts that layer in a more acidic (less basic) direction. This was the case even as the pond depth dropped by more than half across the summer.

Oxidation/Reduction Potential (ORP) (Tables 4(a-e): ranged from 7-183 mV (millivolts) in 2021. This compares to 26-113 mV in 2020, 93-200 mV in 2019, and 100-185 mV in 2018. ORP levels were under 100 mV from May-Aug, rose to 124-183 mV in September, and finally dropped by November to the lowest levels of the year (7-36 mV). ORP was relatively highest toward the bottom on all dates.

Turbidity (Tables 4(a-e), Fig. 4(j)): This has always been one of the most turbid of the monitored ponds. With the drought declines in water levels drying the pond down to three disconnected, shallow basins, profiling continued in the central basin (formerly Mast NW). Turbidity levels were again variable through the water column, ranging from approximately 3-19 FNU across the sampling season, similar to other years. Corresponding Secchi visibilities were very low, as is to be expected, at 1.0-1.6 m (3-5 ft).

Dissolved Organic Matter (FDOM) (Tables 4(a-e), Fig. 4(k)): Levels ranged between 0.8 and 1.6 RFU on most dates and depths, similar to past years. Also as seen last year, bottom accumulations to relatively higher levels (1.8-2.4 RFU) were found on dates with the strongest temperature and oxygen stratification (Aug-Sep).

Green Algae (Chlorophyll) (Tables 4(a-e), Fig. 4(l)): had a profile similar to last year in May, when there was still 9.4 m (31 ft) of depth. Levels were low near the surface (0.6-0.7 RFU), lower near the bottom (0.3-0.4 RFU), and with a slight bulge in mid-water densities to 0.95 RFU. With the big decreases in depths after May, chlorophyll was more variable than last year. In August and September, the surface 2-3 m had very low levels, all under 0.30 RFU, but bottom accumulations an order of magnitude higher (1.61-2.63 RFU). Levels were in this higher range top to bottom when the pond was at its shallowest and was wind-mixing in early November (1.62-2.22 RFU).

Blue-Green Algae (Phycocyanin) (Tables 4(a-e), Fig. 4(m)): trends were very similar to the chlorophyll profiles above, though at lower absolute levels (0.05-0.63 RFU total range). Within these lower densities, there were similar relative profiles through the water column as seen for chlorophyll on the different dates.

Table 4(a). Teichert – Reiff Pond: 2021 Water Column Profiling Data
MAY 6: max. depth 9.4 m (31 ft); Secchi disk water clarity: 1.0 m (3.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	22.1	9.49	109%	660	0.32	429	8.63	53
1	22.2	9.49	109%	660	0.32	429	8.62	66
2	22.0	9.53	109%	660	0.32	429	8.62	72
3	20.7	9.49	106%	659	0.32	428	8.63	75
4	20.1	9.37	104%	657	0.32	427	8.62	78
5	19.3	9.05	98%	655	0.32	426	8.60	81
6	18.8	8.59	92%	655	0.32	426	8.58	83
7	18.4	8.07	86%	655	0.32	426	8.55	86
8	15.9	5.39	55%	654	0.32	425	8.33	93
9.0	14.9	4.38	43%	650	0.32	423	8.24	96

(additional parameters next page)

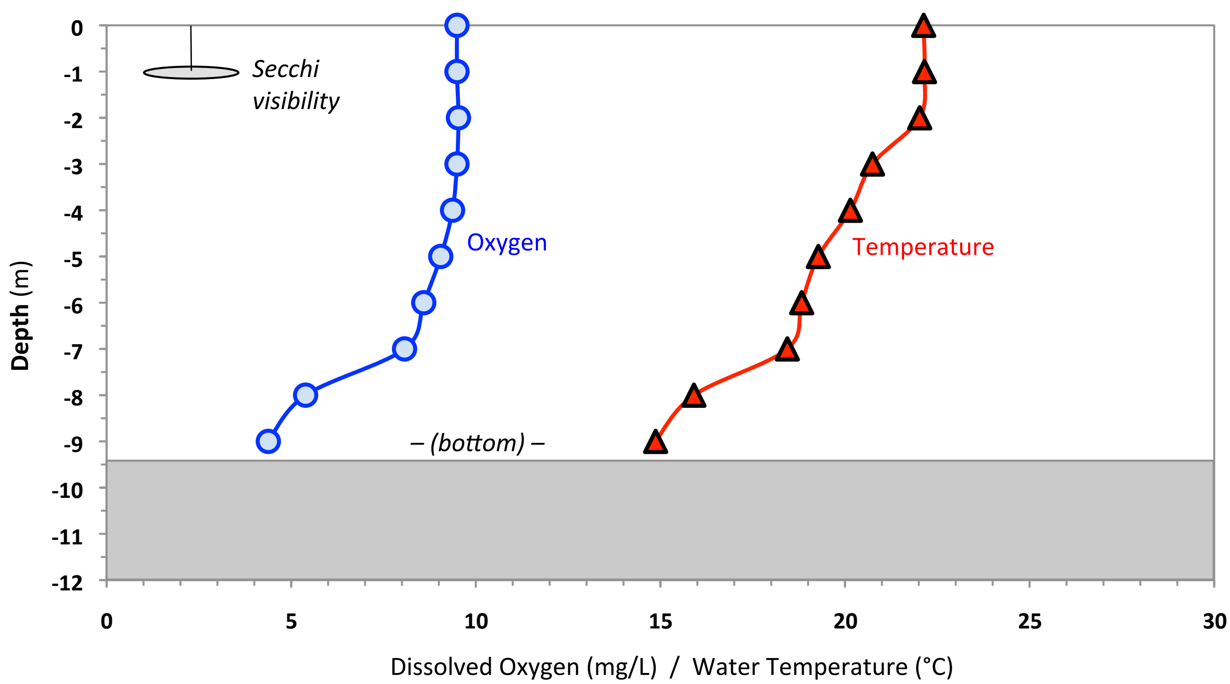


Figure 4(a). MAY 6, 2021 – Reiff Pond framework parameters

Table 4(a). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
MAY 6: max. depth 9.4 m (31 ft); Secchi disk water clarity: 1.0 m (3.3 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	22.1	9.49	109%	6.77	0.90	0.60	0.10
1	22.2	9.49	109%	6.72	1.07	0.67	0.14
2	22.0	9.53	109%	7.09	1.10	0.62	0.15
3	20.7	9.49	106%	8.35	1.14	0.78	0.17
4	20.1	9.37	104%	9.20	1.12	0.95	0.24
5	19.3	9.05	98%	5.04	1.01	0.56	0.20
6	18.8	8.59	92%	5.82	1.24	0.38	0.19
7	18.4	8.07	86%	6.81	1.08	0.39	0.30
8	15.9	5.39	55%	6.06	1.35	0.30	0.37
9.0	14.9	4.38	43%	5.90	1.44	0.29	0.45

(Late June profiles were not possible – we were unable to get the boat down to the severely drought-altered pond shore. Subsequent 2021 profiles were managed using an inflatable boat that could be carried in).

Table 4(c). Teichert – Reiff Pond: 2021 Water Column Profiling Data
AUG 3: max. depth 5.5 m (18 ft); Secchi disk water clarity: 1.4 m (4.6 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	28.2	8.32	107%	765	0.37	498	8.59	46
0.5	27.9	8.30	106%	765	0.37	497	8.60	57
1.0	27.9	8.31	106%	765	0.37	497	8.59	59
1.5	27.4	8.29	105%	765	0.37	497	8.59	60
2.0	27.0	8.28	104%	764	0.37	497	8.60	62
2.5	26.9	8.27	104%	763	0.37	496	8.60	63
3.0	26.7	8.24	103%	762	0.37	496	8.60	64
3.5	26.3	7.69	96%	761	0.37	494	8.56	66
4.0	24.9	4.95	60%	744	0.36	484	8.31	72
4.5	23.9	2.41	29%	740	0.36	481	8.04	77
5.0	23.4	0.72	9%	738	0.36	478	7.45	75

(additional parameters next page)

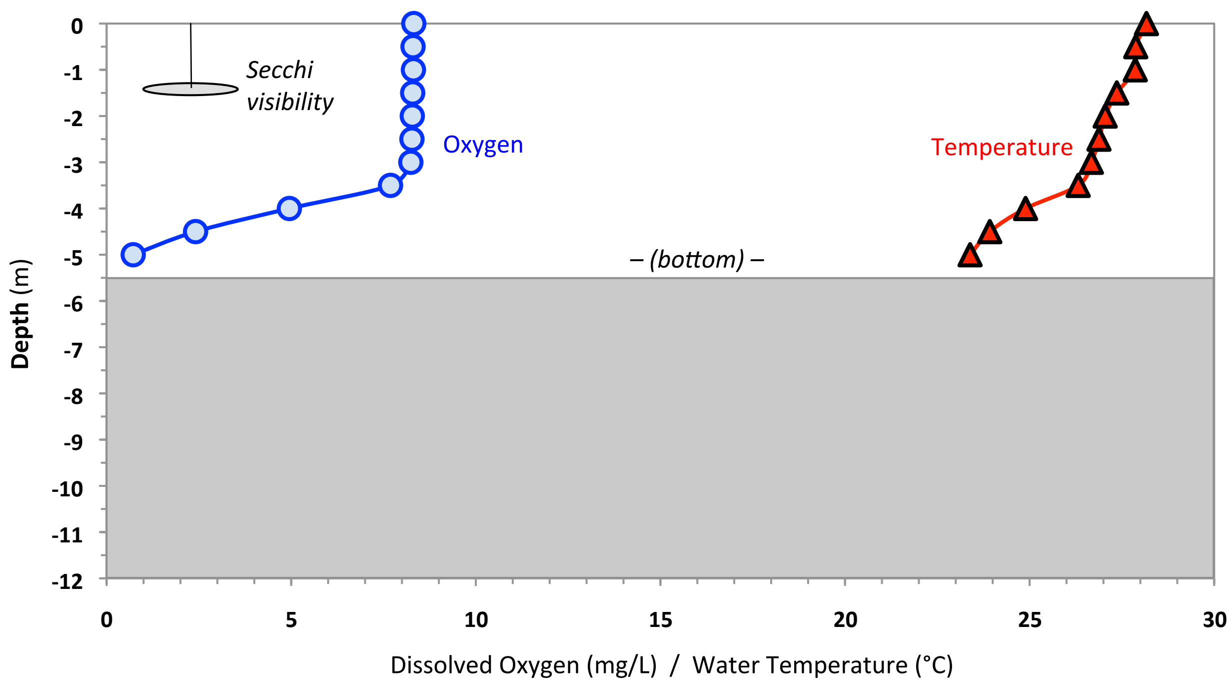


Figure 4(c). AUG 3, 2021 – Reiff Pond framework parameters

Table 4(c). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
AUG 3: max. depth 5.5 m (18 ft); Secchi disk water clarity: 1.4 m (4.6 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	28.2	8.32	107%	5.40	1.00	0.07	0.05
0.5	27.9	8.30	106%	5.10	0.90	0.06	0.06
1.0	27.9	8.31	106%	5.14	0.81	0.07	0.11
1.5	27.4	8.29	105%	5.58	0.97	0.06	0.13
2.0	27.0	8.28	104%	5.54	1.13	0.11	0.11
2.5	26.9	8.27	104%	5.64	1.11	0.17	0.16
3.0	26.7	8.24	103%	6.33	0.96	0.27	0.19
3.5	26.3	7.69	96%	17.34	1.30	0.43	0.30
4.0	24.9	4.95	60%	13.93	2.01	0.60	0.42
4.5	23.9	2.41	29%	14.79	2.15	1.82	0.57
5.0	23.4	0.72	9%	18.45	2.43	1.90	0.63

Table 4(d). Teichert – Reiff Pond: 2021 Water Column Profiling Data
SEP 14: max. depth 4.9 m (16 ft); Secchi disk water clarity: 1.3 m (4.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	27.1	9.16	115%	771	0.37	501	8.71	124
0.5	27.0	9.15	115%	771	0.37	501	8.71	134
1.0	26.4	9.33	116%	770	0.37	501	8.71	141
1.5	26.2	9.50	118%	769	0.37	500	8.72	146
2.0	26.1	9.21	114%	770	0.37	500	8.71	151
2.5	25.8	9.40	116%	769	0.37	500	8.72	155
3.0	25.5	9.37	115%	768	0.37	499	8.72	162
3.5	25.0	6.31	77%	769	0.37	500	8.55	171
4.0	24.8	4.33	52%	770	0.38	501	8.45	177
4.5	24.4	2.09	25%	772	0.38	502	8.31	183

(additional parameters next page)

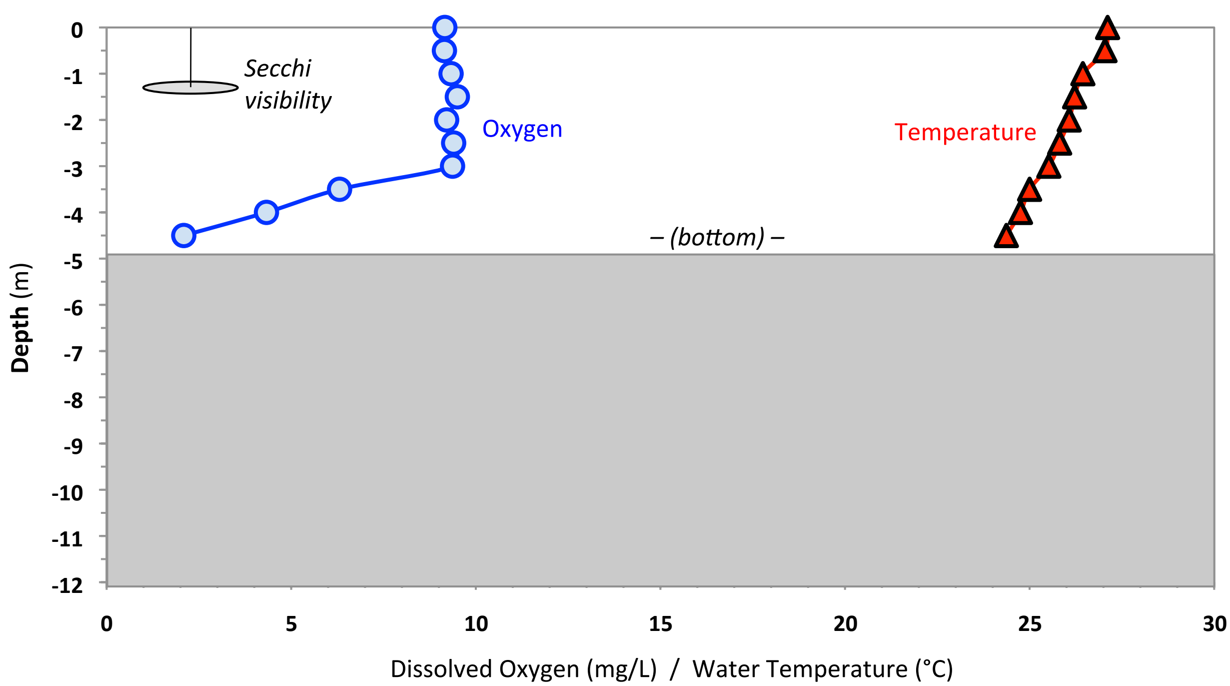


Figure 4(d). SEP 14, 2021 – Reiff Pond framework parameters

Table 4(d). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
SEP 14: max. depth 4.9 m (16 ft); Secchi disk water clarity: 1.3 m (4.3 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	27.1	9.16	115%	5.80	1.21	0.29	0.18
0.5	27.0	9.15	115%	5.60	1.26	0.27	0.17
1.0	26.4	9.33	116%	6.61	1.12	0.25	0.18
1.5	26.2	9.50	118%	7.14	1.26	0.28	0.19
2.0	26.1	9.21	114%	6.47	1.47	0.32	0.20
2.5	25.8	9.40	116%	7.56	1.44	0.86	0.23
3.0	25.5	9.37	115%	12.45	1.48	1.85	0.42
3.5	25.0	6.31	77%	7.58	1.83	1.61	0.42
4.0	24.8	4.33	52%	10.41	1.82	1.76	0.44
4.5	24.4	2.09	25%	6.51	2.14	2.63	0.47

Table 4(e). Teichert – Reiff Pond: 2021 Water Column Profiling Data
NOV 5: max. depth 4.3 m (14 ft); Secchi disk water clarity: 1.6 m (5.2 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	17.5	10.74	112%	651	0.32	423	8.81	7
0.5	17.5	10.79	113%	651	0.32	423	8.81	8
1.0	17.3	11.05	115%	650	0.32	423	8.83	12
1.5	17.2	10.85	113%	651	0.32	423	8.83	19
2.0	17.1	10.81	112%	650	0.32	423	8.84	24
2.5	17.0	10.81	112%	650	0.32	423	8.84	27
3.0	17.0	11.02	114%	650	0.32	422	8.85	30
3.5	16.9	10.81	112%	650	0.32	422	8.82	33
4.0	16.9	10.71	111%	650	0.32	423	8.82	36

(additional parameters next page)

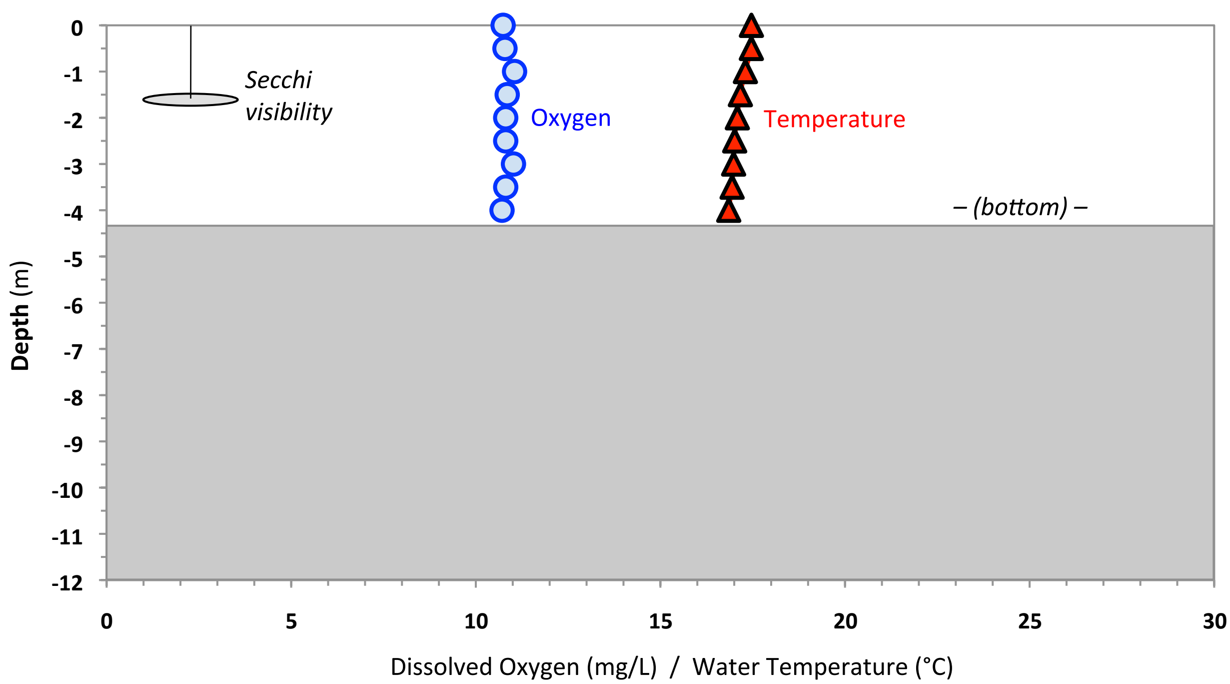


Figure 4(e). NOV 5, 2021 – Reiff Pond framework parameters

Table 4(e). ***(continued)* – OPTICAL PARAMETERS (with framework data for reference)**
NOV 5: max. depth 4.3 m (14 ft); Secchi disk water clarity: 1.6 m (5.2 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	17.5	10.74	112%	4.34	1.23	1.62	0.30
0.5	17.5	10.79	113%	4.27	1.47	1.71	0.32
1.0	17.3	11.05	115%	4.52	1.25	1.87	0.37
1.5	17.2	10.85	113%	3.65	1.44	2.16	0.44
2.0	17.1	10.81	112%	3.38	1.47	2.22	0.45
2.5	17.0	10.81	112%	3.60	1.35	2.13	0.42
3.0	17.0	11.02	114%	3.56	1.62	1.86	0.42
3.5	16.9	10.81	112%	3.87	1.42	2.06	0.44
4.0	16.9	10.71	111%	3.91	1.63	1.97	0.44

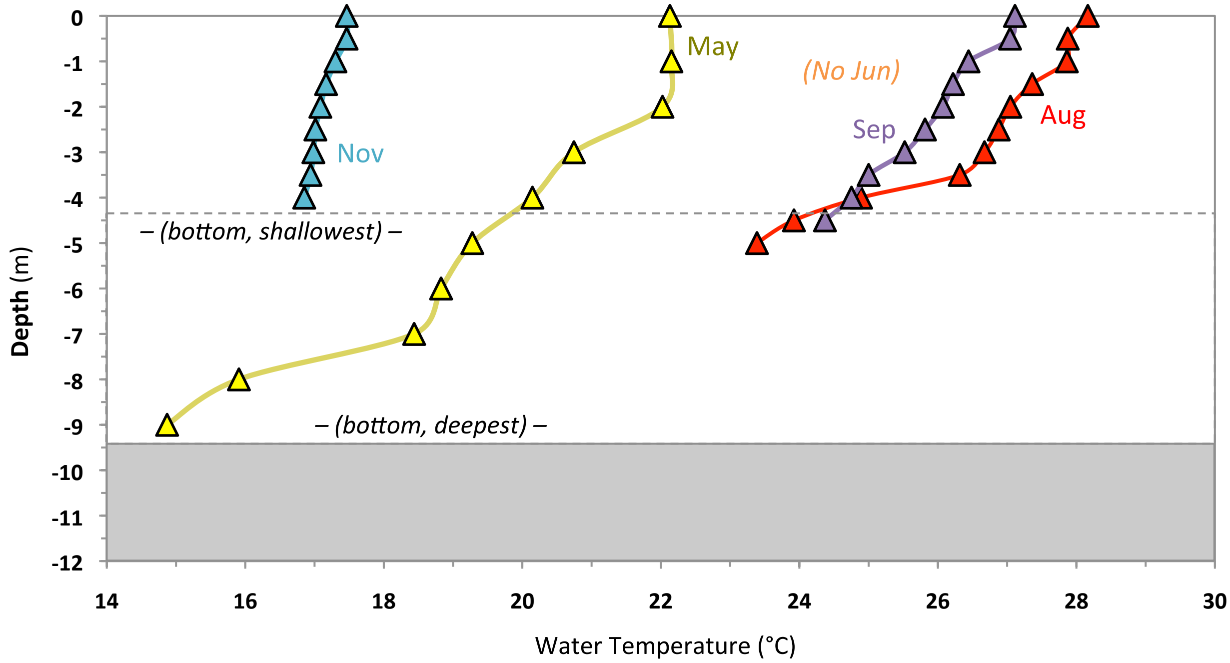


Figure 4(f). Teichert – Reiff Pond: 2021 May-Oct TEMPERATURE

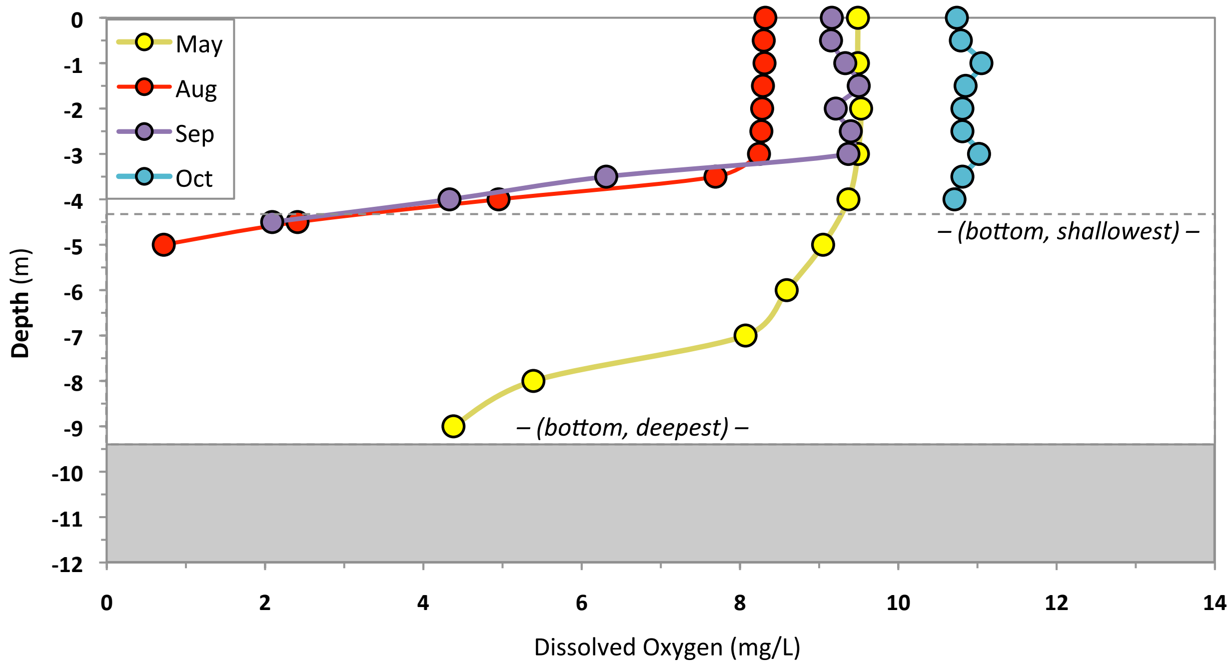


Figure 4(g). Teichert – Reiff Pond: 2021 May-Oct OXYGEN

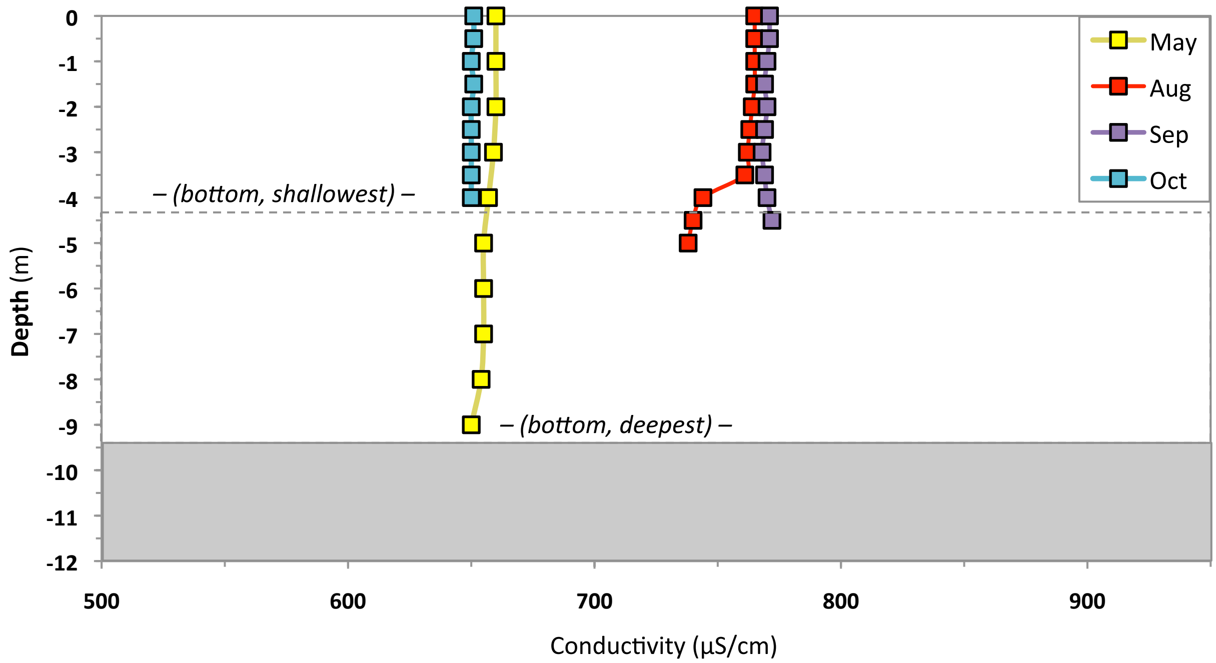


Figure 4(h). Teichert – Reiff Pond: 2021 May-Oct CONDUCTIVITY

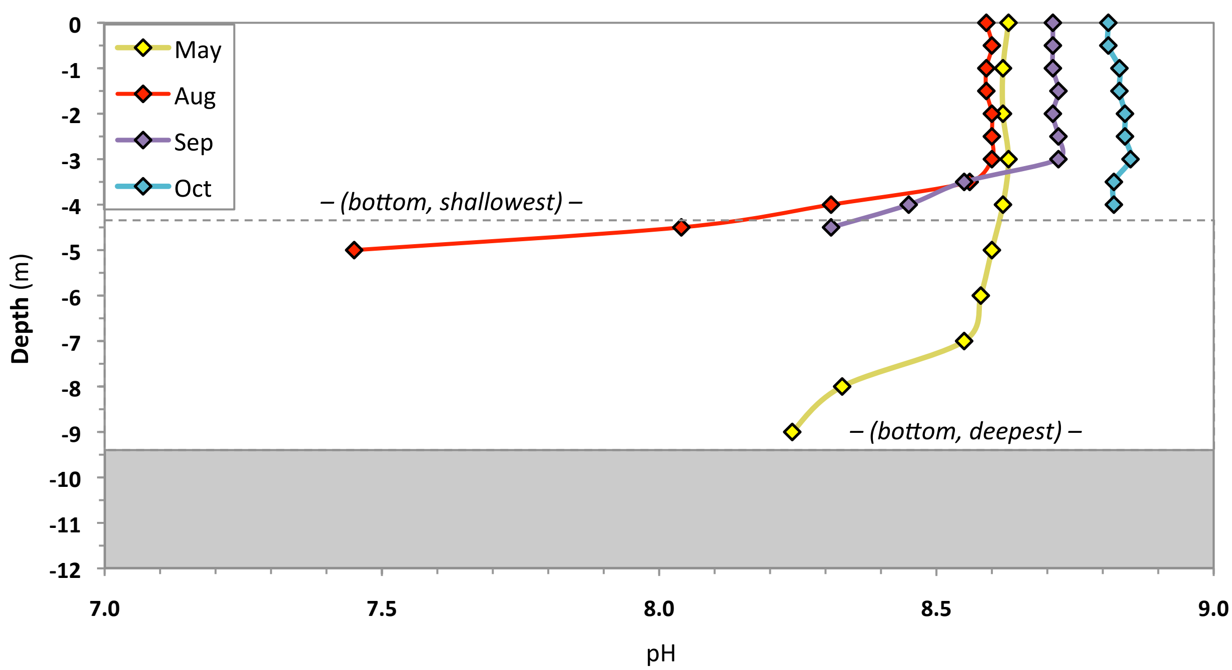


Figure 4(i). Teichert – Reiff Pond: 2021 May-Oct pH

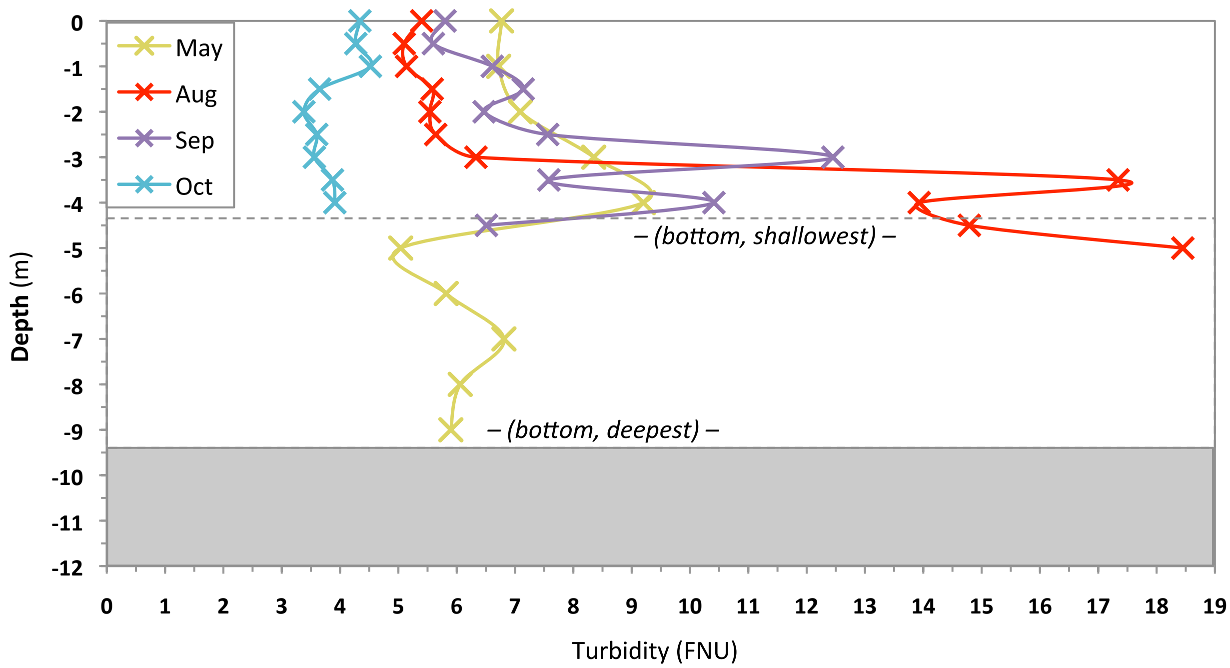


Figure 4(j). Teichert – Reiff Pond: 2021 May-Oct TURBIDITY

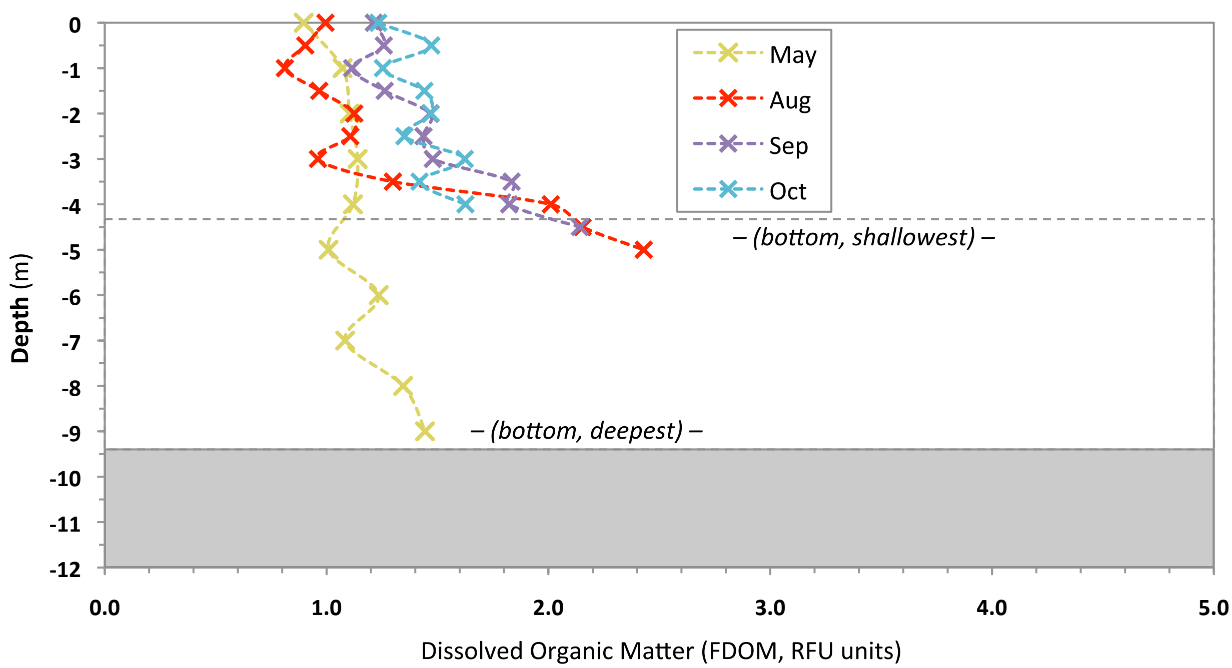


Figure 4(k). Reiff Pond: 2021 May-Oct DISSOLVED ORGANIC MATTER

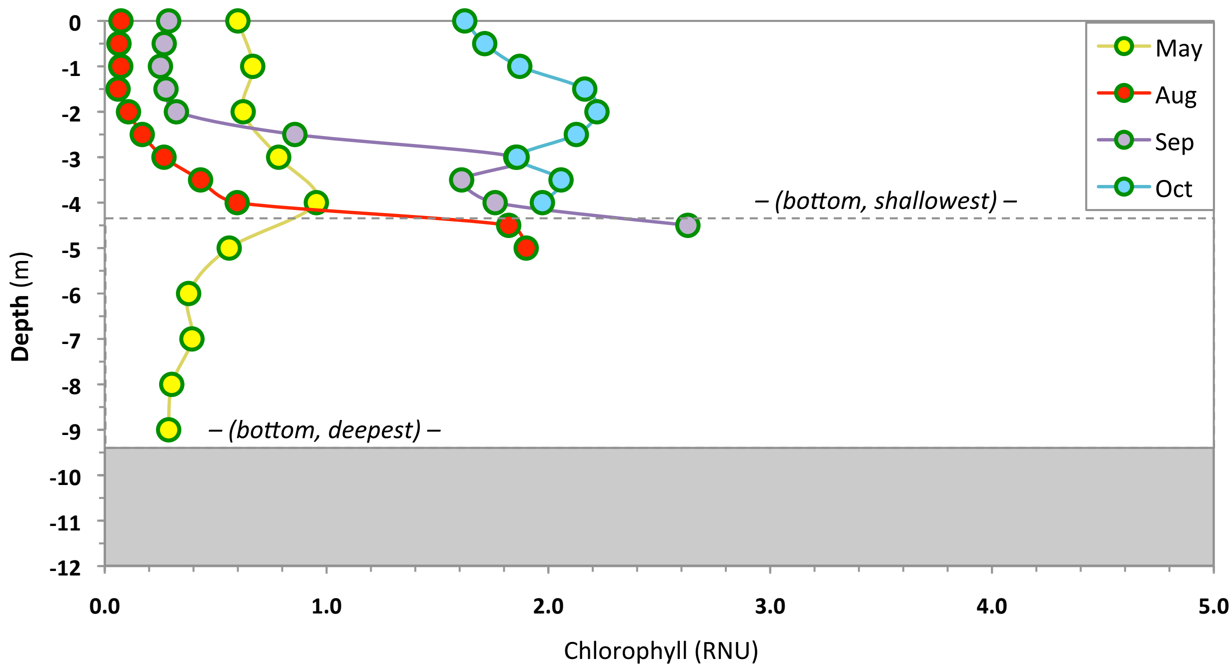


Figure 4(l). Teichert – Reiff Pond: 2021 May-Oct CHLOROPHYLL

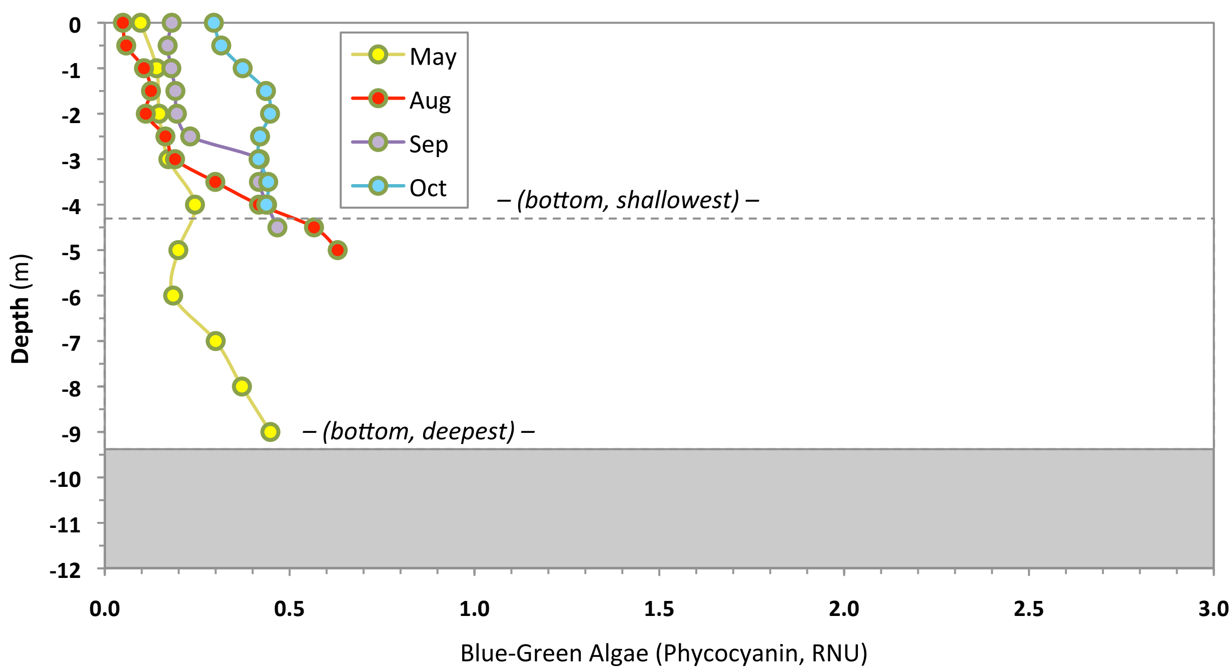


Figure 4(m). Teichert – Reiff Pond: 2021 May-Oct BLUE-GREEN ALGAE

5. TEICHERT-WOODLAND – STORZ POND

(Google Earth 10/21/2020)

5. Teichert-Woodland – Storz Pond

In summary, the Teichert–Woodland – Storz Pond, a low fish-mercury pond, was surveyed one time, mid-summer, as part of the revised monitoring ordinance guidelines that call for annual water profiling at all ponds monitored for fish mercury. Like the Teichert-Esparto site, Storz was greatly impacted by the 2021 drought. Depths dropped down to around 3 m (9-10 ft) at deepest, splitting the pond into two disconnected basins. Both sides were surveyed for these mid-summer profiles. Results were similar in each. The shallow water was very warm, but with a small temperature stratification between upper and lower water layers. At these shallow depths, there was enough light penetration for algal photosynthesis and oxygen production below the thermocline, so there was ample oxygen from top to bottom. Both basins had accumulations of algal cells and dissolved organic carbon toward the bottom. Both had high conductivity and high pH (basic), particularly the east basin.

This site has consistently had fish mercury in the 'not elevated' range and, as a result, was not flagged for additional studies like seasonal water column profiling in past years. However, the recent revision/update of the County ordinance includes a change to now conduct a single, mid-summer water profiling at every pond where fish mercury is being monitored. That was done for the first time in 2021 and is reported here. The 2021 drought conditions reduced the Storz Pond down into two, shallow, disconnected basins. We collected water column data from both sides, and report the data from each.

The 2021 Teichert-Woodland – Storz Pond results from the single, mid-summer (August) survey are first shown numerically in Table 5(a). Some of the key, driving parameters on that date are also shown together in figure form, Figure 5(a). Then profiles are plotted for each water quality parameter, in Figures 5(b) (Temperature) through 5(i) (Blue-green Algae). In these figures, the profiles for both basins are shown together, so you can see the range of values and any significant differences between basins.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters and in summary.

Water Depth (Table 5(a) and Fig. 5(a): was similarly shallow in both basins: 2.7 m (8.9 ft) in the east basin, 2.9 m (9.5 ft) in the west.

Secchi Water Clarity (Table 5(a) and Fig. 5(a): visibility was similarly low, with a green (phytoplankton) tinge, at 1.5 m (5 ft) in both basins.

Temperature (Table 5(a), Figs. 5(a) and 5(b)): Nearly identical in each basin. Very warm throughout, but with some temperature stratification: 31-32 °C (87-89 °F) in the surface meter, down (relatively) to 28 °C (83 °F) near the bottom.

Dissolved Oxygen (Table 5(a), Figs. 5(a) and 5(c)): was super-saturated at all depths in both basins, at 154-258% of saturation levels. Dissolved oxygen 'saturation' refers to the maximum oxygen that water of a given temperature will hold in equilibrium unless there is a continuous input of additional oxygen, typically from photosynthesizing algae). Within these elevated levels, oxygen in both basins peaked at mid-depth and then declined (relatively) toward the bottom.

Conductivity (Table 5(a), Fig 5(d)): was high and similar top to bottom, with levels of 934-944 μS/cm in the west basin, and 1013-1031 μS/cm in the east basin.

Salinity (Table 5(a)): was uniform within each basin, at 0.46 ppt (parts per thousand, g/L) in the west basin, and slightly higher in the east basin (0.50 ppt), consistent with the slightly higher conductivity noted above. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Table 5(a)): linked to the above two parameters, showed similar trends: similar top to bottom in each basin and slightly higher in the east side (659-670 mg/L) than the west (607-614 mg/L).

pH (Table 5(a), Fig. 5(e)): was very basic (non-acidic; pH > 7.00) like most of the other monitored ponds. Levels were approximately 8.8-8.9 in the west basin and 9.5-9.7 in the east basin.

Oxidation/Reduction Potential (ORP) (Table 5(a): was 137-144 mV (millivolts) in the west basin, and 144-171 mV in the east basin.

Turbidity (Table 5(a), Fig. 5(f)): Overall range 1.2-2.7 FNU, which is moderate and consistent with the low visibility. Similar in both basins.

Dissolved Organic Matter (FDOM) (Table 5(a), Fig. 5(g)): Similar profiles in both basins, with levels of 2.1-2.7 RFU in the surface 1-2 m, rising to 3.6-3.9 RFU toward the bottom.

Green Algae (Chlorophyll) (Table 5(a), Fig. 5(h)): Consistent with the FDOM profiles, chlorophyll levels increased significantly from surface to bottom, but in a higher range of concentrations in the west basin (5.4-9.6 RFU) than in the east (1.2-3.8 RFU).

Blue-Green Algae (Phycocyanin) (Table 5(a), Fig. 5(i)): profiles were similar to those for chlorophyll, but all in a lower range (≤ 1.1 RFU). East basin levels ranged between 0.2 RFU at the surface to 1.1 RFU near the bottom; west basin 0.6-1.1 RFU.

Table 5(a). Teichert-Woodland – Storz Pond: 2021 Water Column Profiling Data
East Basin
AUG 3: max. depth 2.7 m (8.9 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	31.7	13.60	186%	1,031	0.50	670	9.67	144
0.5	31.2	14.40	195%	1,029	0.50	669	9.65	149
1.0	29.9	16.66	221%	1,023	0.50	665	9.64	155
1.5	29.3	16.65	218%	1,021	0.50	663	9.65	160
2.0	28.6	14.07	182%	1,013	0.50	659	9.51	170
2.5	28.3	11.94	154%	1,017	0.50	661	9.62	171

(additional parameters next page)

West Basin
AUG 3: max. depth 2.9 m (9.5 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	30.9	16.02	216%	943	0.46	613	8.79	137
0.5	30.7	16.75	225%	944	0.46	614	8.81	137
1.0	29.4	19.56	257%	937	0.46	609	8.85	139
1.5	28.8	19.84	258%	934	0.46	607	8.85	140
2.0	28.6	19.55	253%	934	0.46	607	8.84	142
2.5	28.3	19.15	246%	934	0.46	607	8.79	144

(additional parameters next page)

Table 5(a). ***(continued)* – OPTICAL PARAMETERS (with framework data for reference)**

East Basin

AUG 3: max. depth 2.7 m (8.9 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	31.7	13.60	186%	1.26	2.26	1.23	0.28
0.5	31.2	14.40	195%	1.30	2.14	1.30	0.25
1.0	29.9	16.66	221%	1.48	2.66	1.96	0.42
1.5	29.3	16.65	218%	1.46	2.77	2.26	0.44
2.0	28.6	14.07	182%	2.71	3.65	3.75	1.08
2.5	28.3	11.94	154%	2.00	3.58	3.36	1.08

West Basin

AUG 3: max. depth 2.9 m (9.5 ft); Secchi disk water clarity: 1.5 m (4.9 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	30.9	16.02	216%	1.34	2.54	5.42	0.65
0.5	30.7	16.75	225%	1.36	2.59	5.94	0.68
1.0	29.4	19.56	257%	1.56	2.64	7.05	0.81
1.5	28.8	19.84	258%	1.90	3.28	7.38	0.92
2.0	28.6	19.55	253%	1.62	3.61	7.79	0.92
2.5	28.3	19.15	246%	1.76	3.87	9.55	1.09

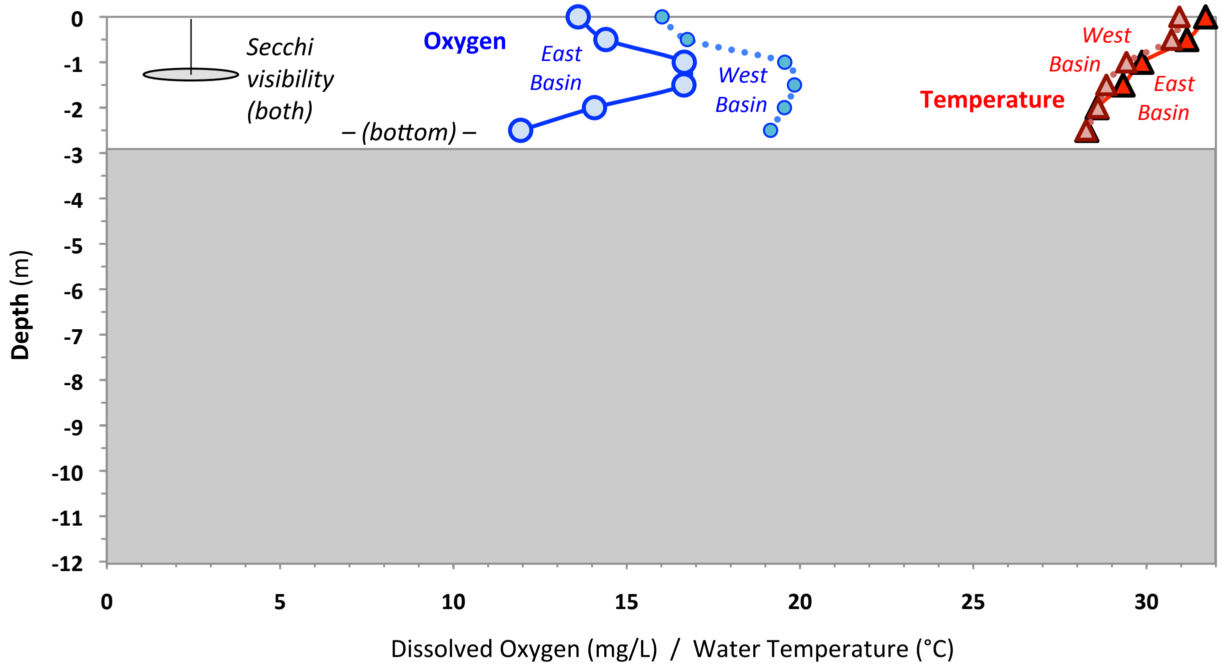


Figure 5(a). AUG 3, 2021 – Teichert–STORZ Pond framework parameters

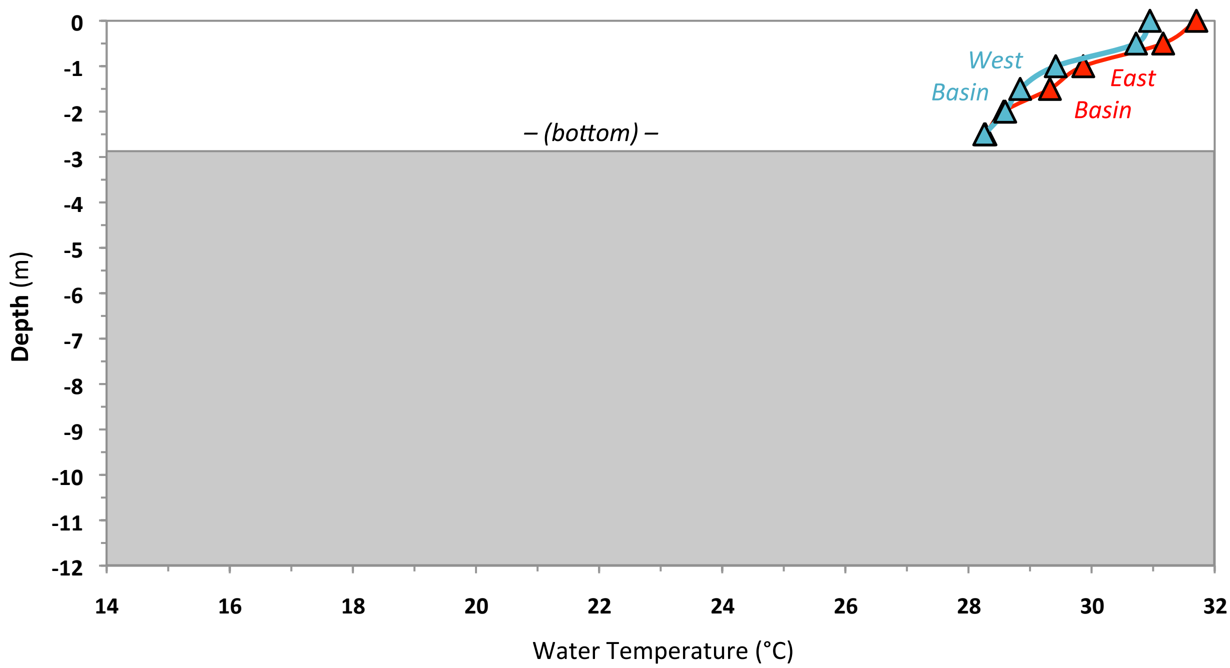


Figure 5(b). Teichert-Woodland – Storz Pond: August 2021 TEMPERATURE

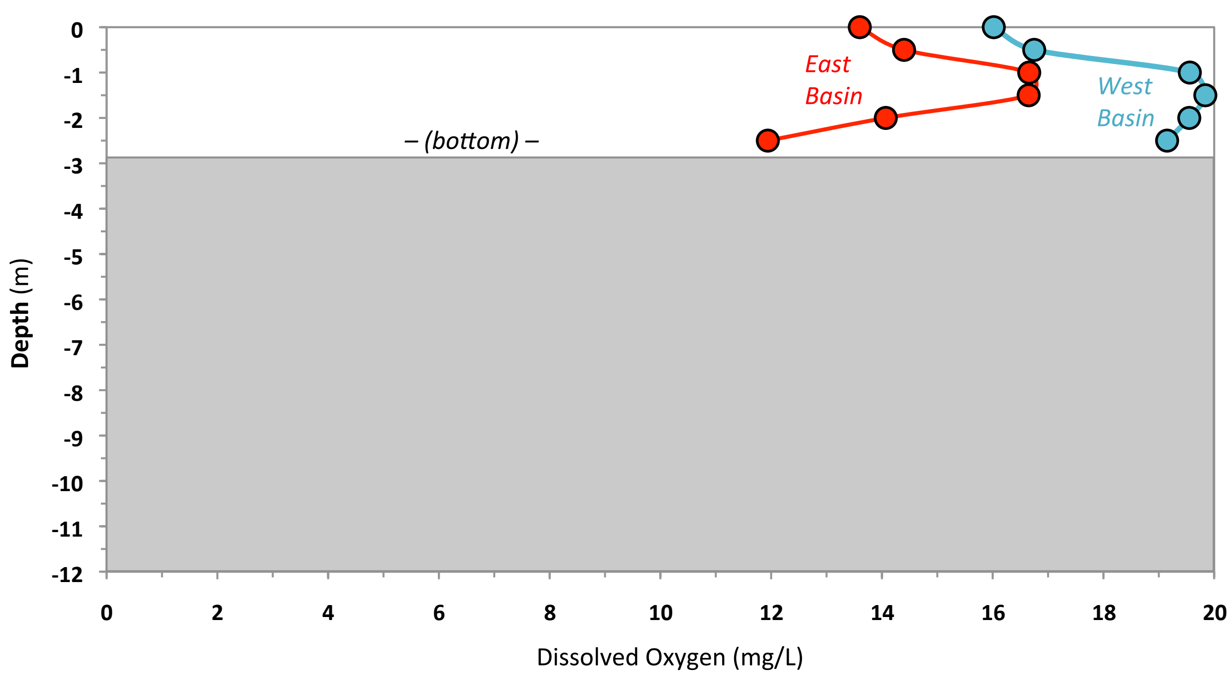


Figure 5(c). Teichert-Woodland – Storz Pond: August 2021 OXYGEN

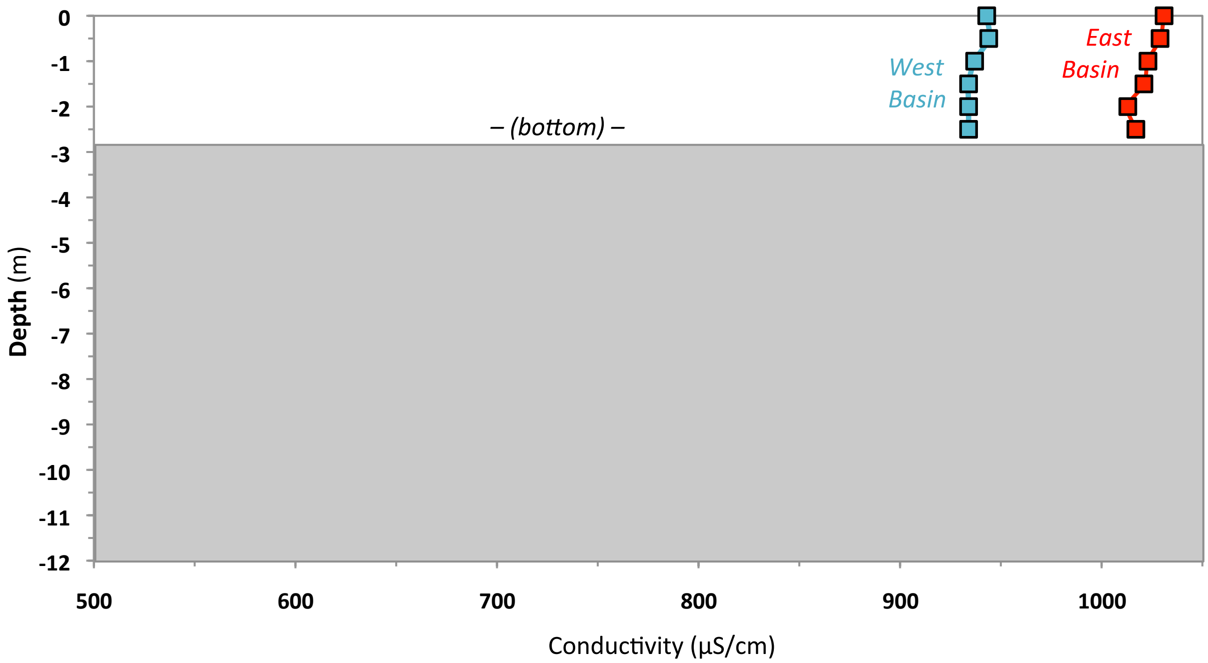


Figure 5(d). Teichert-Woodland – Storz Pond: August 2021 CONDUCTIVITY

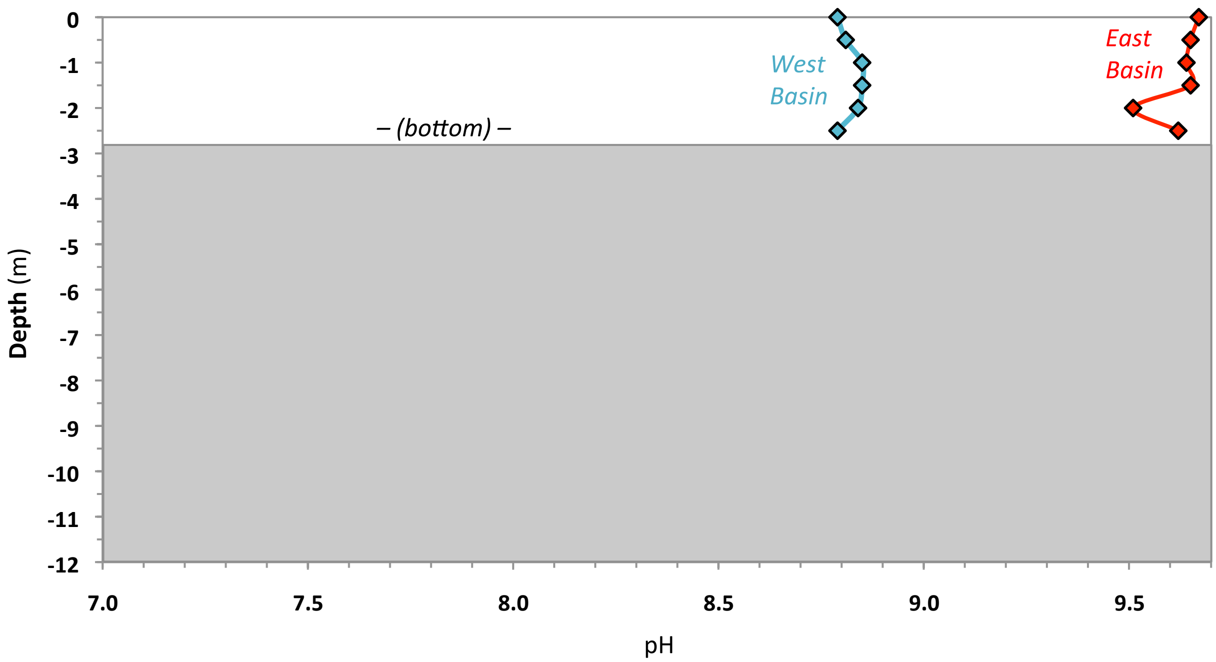


Figure 5(e). Teichert-Woodland – Storz Pond: August 2021 pH

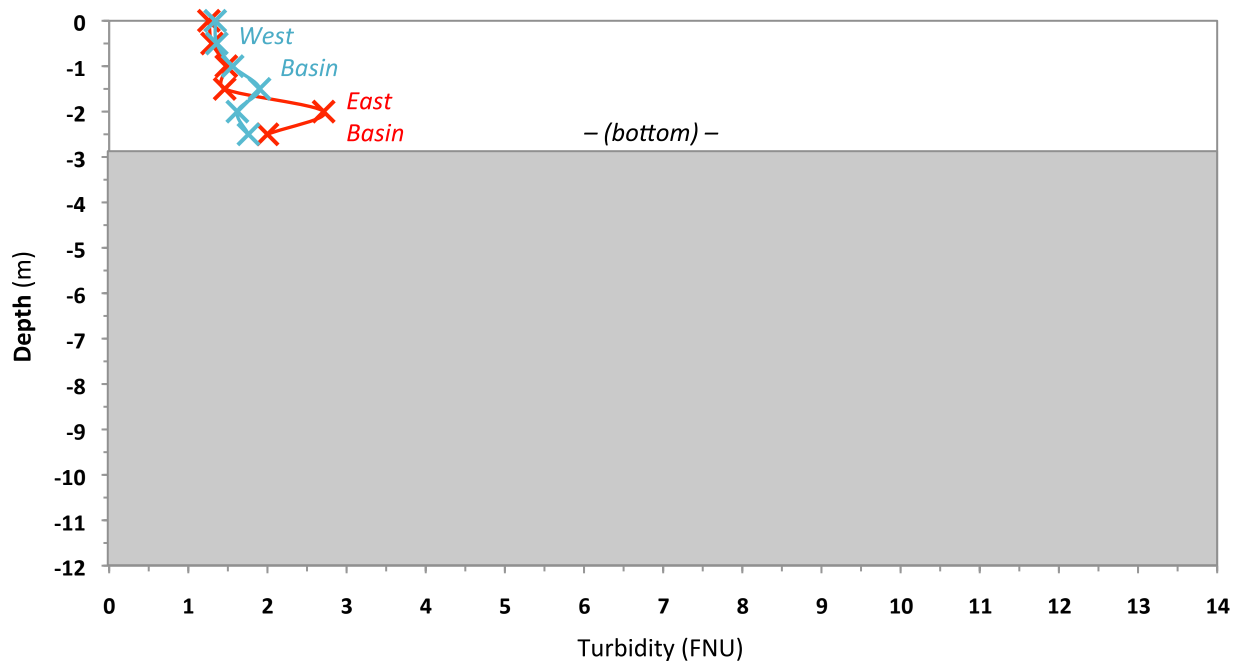


Figure 5(f). Teichert-Woodland – Storz Pond: August 2021 TURBIDITY

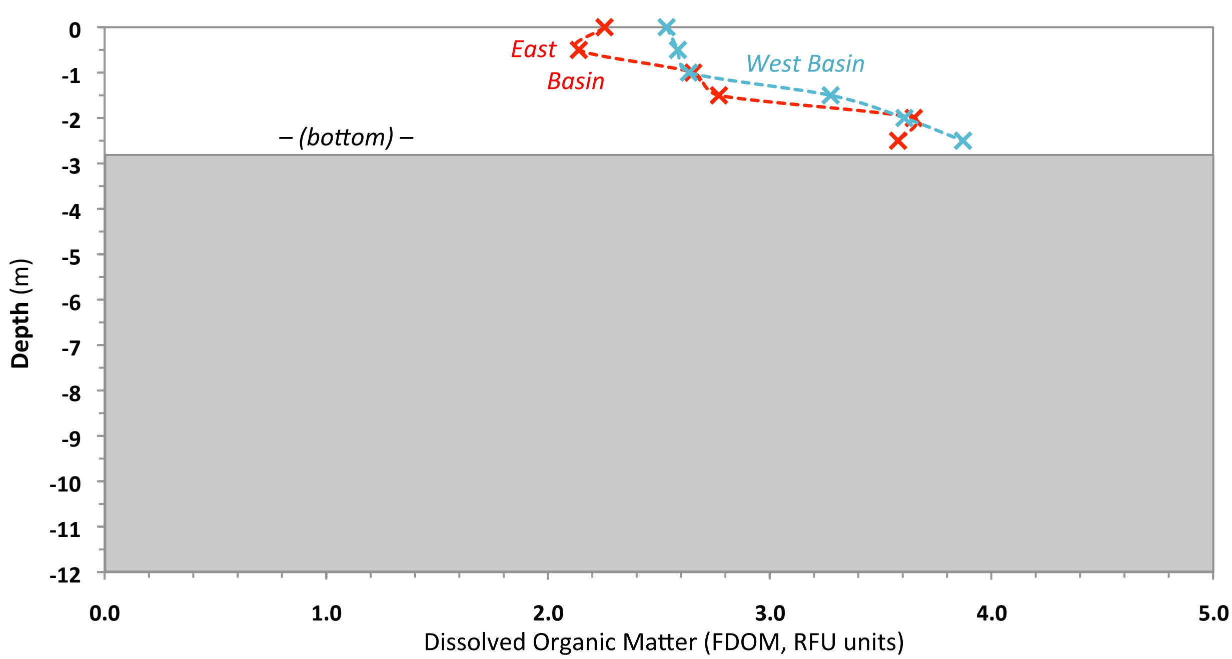


Figure 5(g). Storz Pond: August 2021 DISSOLVED ORGANIC MATTER

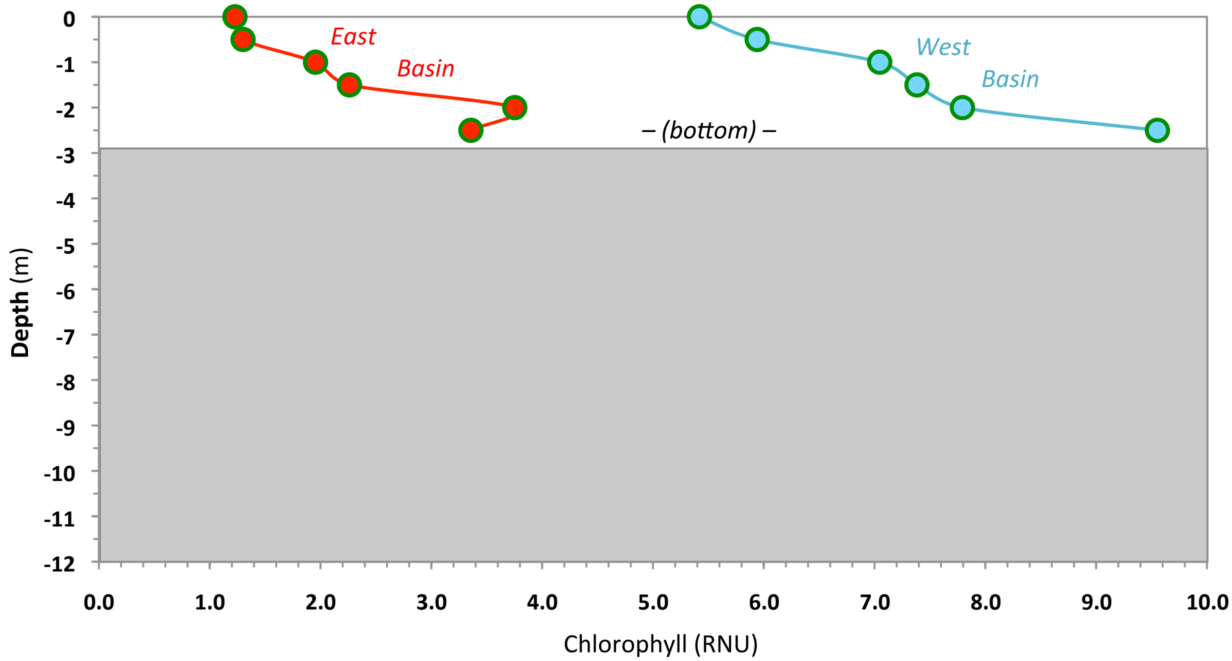


Figure 5(h). Teichert-Woodland – Storz Pond: August 2021 CHLOROPHYLL

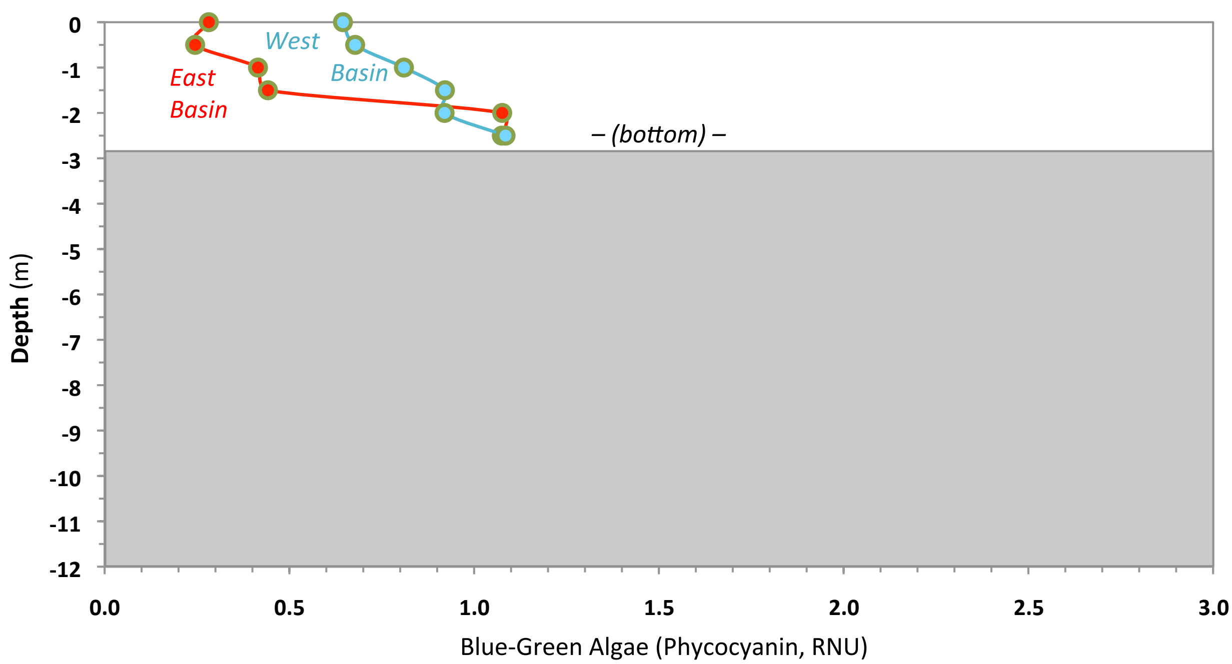


Figure 5(i). Teichert – Storz Pond: August 2021 BLUE-GREEN ALGAE

6. SYAR–B1 POND

(Google Earth 10/21/2020)

6. Syar–B1 Pond

<u>In summary</u>, the Syar–B1 Pond, one of the ponds identified as significantly 'elevated over baseline' in fish mercury, was one of the sites that was heavily impacted by the drought conditions in 2021. As compared to depths in other years in the 8-11 m range (26-36 ft), levels dried down to 3 m (10 ft) by the fall of 2021. High surrounding berms give some protection from wind mixing, and a light stratification of the water column was seen as in other years, even with the shallow depths. Oxygen levels dropped toward the bottom, but not to the extent seen in most other years. This pond, like the Teichert-Esparto Pond, has been identified as one that may get mercury management benefits from disruption of summer oxygen depletion. The 2021 profiles also found accumulations of turbidity, algal cells, and dissolved organic matter toward the bottom.

The B1 Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 6(a) (May) through 6(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 6(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 6(f) (Temperature) through 6(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters and in summary.

———

<u>Water Depth</u> (Tables and Figs. 6(a-e): began in May at 6.7 m (22 ft; 8 feet lower than the same time of year in 2020) and continued to drop through the severe drought conditions, to only 3.4 m (10 ft) by September.

Secchi Water Clarity (Tables and Figs. 6(a-e): ranged from 1.3-3.5 m (4-11 ft). This was generally lower visibility than in other years with higher water levels. With the shallower depths, winds could more readily stir bottom and near-shore sediments into the water.

Temperature (Tables and Figs. 6(a-e), Fig. 6(f)): Overall range between 17 and 28 °C (62-83 °F) between May and October. High surrounding berms give some protection from wind mixing, even with the much shallower depths. A slight thermal stratification developed, with surface waters up to 3.2 °C (6 °F) warmer than bottom water. By the early November survey, the pond was fairly mixed and cooled down to under 18 °C (63 °F).

Dissolved Oxygen (Tables and Figs. 6(a-e), Fig. 6(g)): in this pond has always shown some degree of bottom water anoxia in the warm season. In 2021, with the drastic shallowing of the water column, this was less pronounced, but oxygen still dropped significantly at depth relative to the surface layers, from May through September.

Conductivity (Tables 6(a-e), Fig. 6(h)): was again similar from top to bottom on each date, but changed as a whole across the drought period. Conductivities increased from 630-636 µS/cm in May to 694-697 µS/cm in September, then decreased in early November to their lowest levels after the large October storm inflows (606-610 µS/cm).

Salinity (Tables 6(a-e): following the conductivity trend, was nearly identical from top to bottom on each date but rose gradually as a whole across the drought period, as salts became more concentrated in the evaporating water. Salinities rose from 0.31 ppt in May to 0.34 ppt in September, then decreased to 0.30 ppt in early November after the storm dilution inputs. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 6(a-e): following the conductivity and salinity trends, were similar from top to bottom on each date. Concentrations gradually increased from 410-413 mg/L (ppm) in May to 451-453 mg/L in September, then decreased to 394-396 mg/L in early November after the storm dilution inputs. All of these levels were similar to those seen in 2019 and 2020 (400-446 mg/L) and were lower than the TDS recorded in 2018 (529-608 mg/L).

pH (Tables 6(a-e), Fig. 6(i)): as in the other ponds, was basic (non-acidic; pH > 7.00). This is a function of the mining history and the basic nature of local sediments. Water pH in the B1 Pond fell between 8.4 and 9.1 across all depths and dates. Levels were highest (most basic) from August through November, under drought-shallowed conditions when there was little to no temperature stratification or oxygen depletion. Levels were lowest (less basic) in May-June, with greater stratification and lower oxygen levels at depth.

Oxidation/Reduction Potential (ORP) (Tables 6(a-e): ranged between -6 and 122 mV (millivolts) across all depths and dates, as compared to 2020 (13-120 mV), 2019 (50-227 mV), and 2018 (46-180 mV). Levels were in a similar overall range between May and August (53-87 mV), rising to highest ORP levels in September (83-122 mV) and then dropping to lowest levels in early November (-6-21 mV). As with pH on individual dates, the ORP profile changed from surface (lower) to bottom (higher) when there was some temperature stratification and oxygen depletion.

Turbidity (Tables 6(a-e), Fig. 6(j)): The B1 Pond has no active mining or plant discharge, so water clarity here is controlled by natural phenomena, such as wind occasionally stirring up bottom sediments, and accumulations of sinking algal cells etc near the bottom. The water can become quite clear here, allowing aquatic plants to take root across most of the bottom. But with the greatly lowered water levels this year, the pond was more turbid and variable top to bottom throughout the year. Turbidity levels ranged broadly between 1 and 13 FNU.

Dissolved Organic Matter (FDOM) (Tables 6(a-e), Fig. 6(k)): The overall range across all depths and dates was 1.0-3.3 RFU. Similar to past years, a buildup to relatively highest FDOM levels for each date occurred in the bottom several meters in May and June when the pond was most stratified. With the much lower depths by August and beyond, dissolved organic matter was more mixed top to bottom, increasing to 1.5-2.0 RFU in August, 2.4-2.9 RFU in September, and 3.0-3.2 RFU in early November.

Green Algae (Chlorophyll) (Tables 6(a-e), Fig. 6(l)): was in a similar, low range between 0.1 and 0.5 RFU in the top 1-3 m on all dates. On each of the survey dates, levels also increased toward the bottom, by 2-9 fold relative to surface levels, to as high as 8.2 RFU in early November.

Blue-Green Algae (Phycocyanin) (Tables 6(a-e), Fig. 6(m)): had trends similar to chlorophyll, but at lower absolute levels (all under 1.0 RFU). Like chlorophyll, the profiles showed relative increases toward the bottom and highest overall levels in early November (0.3-0.9 RFU).

Table 6(a). Syar – B1 Pond: 2021 Water Column Profiling Data
MAY 5: max. depth 6.7 m (22 ft); Secchi disk water clarity: 2.8 m (9.2 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	22.2	9.82	113%	631	0.31	410	8.75	58
1	22.2	9.83	113%	631	0.31	410	8.75	64
2	21.7	9.92	113%	631	0.31	410	8.75	67
3	21.2	9.97	113%	630	0.31	410	8.75	72
4	20.9	9.97	112%	630	0.31	409	8.74	75
5	20.3	9.28	103%	631	0.31	410	8.70	78
6	19.8	6.71	74%	634	0.31	412	8.54	84
6.5	19.6	5.89	64%	636	0.31	413	8.47	87

(additional parameters next page)

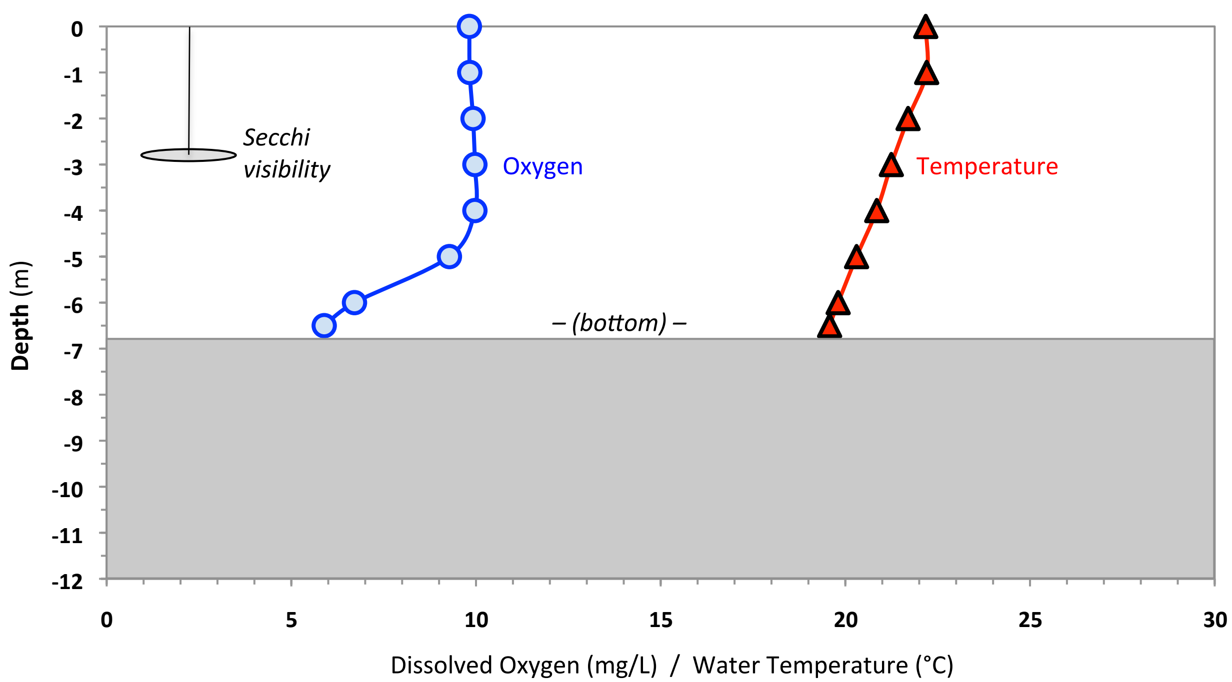


Figure 6(a). MAY 5, 2021 – B1 Pond framework parameters

Table 6(a). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
MAY 5: max. depth 6.7 m (22 ft); Secchi disk water clarity: 2.8 m (9.2 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	22.2	9.82	113%	1.48	1.01	0.59	0.14
1	22.2	9.83	113%	1.41	1.11	0.63	0.13
2	21.7	9.92	113%	1.51	1.02	0.75	0.13
3	21.2	9.97	113%	1.65	1.15	0.82	0.16
4	20.9	9.97	112%	2.25	1.15	1.07	0.20
5	20.3	9.28	103%	4.57	1.41	1.18	0.23
6	19.8	6.71	74%	12.54	1.70	2.48	0.49
6.5	19.6	5.89	64%	9.47	2.03	2.76	0.51

Table 6(b). Syar – B1 Pond: 2021 Water Column Profiling Data
JUN 18: max. depth 5.2 m (17 ft); Secchi disk water clarity: 3.5 m (11.5 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	27.6	9.75	124%	651	0.31	423	8.71	53
1	27.3	9.61	121%	653	0.31	424	8.70	55
2	26.3	9.78	121%	651	0.31	423	8.68	58
3	25.5	9.89	121%	650	0.31	422	8.68	60
4	24.9	8.70	105%	649	0.31	422	8.61	66
5.0	24.4	7.26	87%	651	0.32	423	8.55	69

(additional parameters next page)

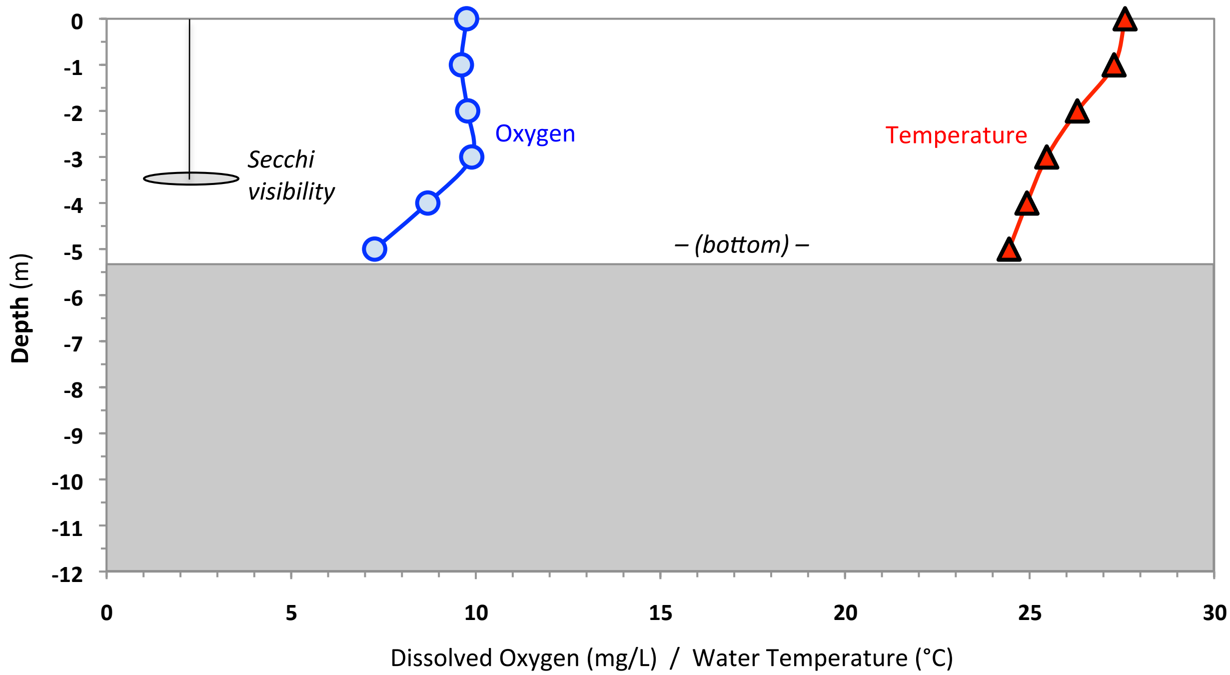


Figure 6(b). JUN 18, 2021 – B1 Pond framework parameters

Table 6(b). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
JUN 18: max. depth 5.2 m (17 ft); Secchi disk water clarity: 3.5 m (11.5 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	27.6	9.75	124%	0.87	0.96	0.21	0.13
1	27.3	9.61	121%	0.94	1.08	0.17	0.13
2	26.3	9.78	121%	1.07	0.96	0.22	0.15
3	25.5	9.89	121%	1.31	1.07	0.27	0.19
4	24.9	8.70	105%	5.26	1.62	0.56	0.32
5.0	24.4	7.26	87%	5.87	1.94	1.31	0.45

Table 6(c). Syar – B1 Pond: 2021 Water Column Profiling Data
AUG 5: max. depth 4.0 m (13 ft); Secchi disk water clarity: 1.4 m (4.6 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	28.3	9.92	128%	684	0.33	445	8.91	61
0.5	28.3	9.93	128%	684	0.33	445	8.91	63
1.0	28.3	9.95	128%	684	0.33	445	8.92	64
1.5	28.0	10.28	132%	683	0.33	444	8.93	66
2.0	27.7	9.85	126%	684	0.33	444	8.90	68
2.5	27.4	10.15	129%	681	0.33	443	8.92	70
3.0	27.2	9.41	119%	683	0.33	444	8.89	73
3.5	27.1	8.75	110%	684	0.33	444	8.86	75

(additional parameters next page)

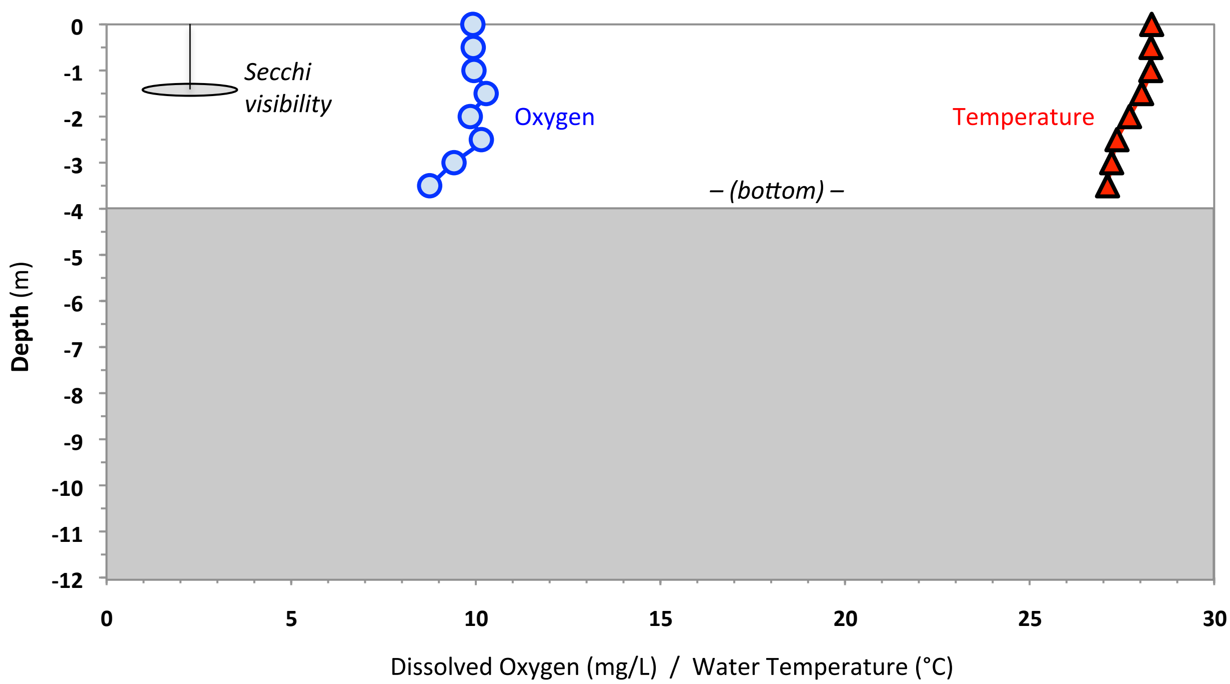


Figure 6(c). AUG 5, 2021 – B1 Pond framework parameters

Table 6(c). ***(continued)* – OPTICAL PARAMETERS (with framework data for reference)**
AUG 5: max. depth 4.0 m (13 ft); Secchi disk water clarity: 1.4 m (4.6 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	28.3	9.92	128%	4.62	1.70	0.49	0.14
0.5	28.3	9.93	128%	4.50	1.71	0.49	0.18
1.0	28.3	9.95	128%	4.57	1.48	0.48	0.19
1.5	28.0	10.28	132%	4.33	1.74	0.47	0.15
2.0	27.7	9.85	126%	4.68	1.87	0.47	0.19
2.5	27.4	10.15	129%	4.63	1.82	0.72	0.23
3.0	27.2	9.41	119%	5.81	2.03	0.91	0.28
3.5	27.1	8.75	110%	10.14	1.83	1.12	0.35

Table 6(d). Syar – B1 Pond: 2021 Water Column Profiling Data

SEP 14: max. depth 3.0 m (10 ft); Secchi disk water clarity: 1.3 m (4.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	26.9	9.18	115%	697	0.34	453	9.04	83
0.5	27.0	9.28	117%	697	0.34	453	9.04	97
1.0	26.3	9.93	123%	695	0.34	452	9.06	103
1.5	26.1	9.50	117%	694	0.34	451	9.05	112
2.0	25.8	9.23	114%	694	0.34	451	9.05	117
2.5	25.5	8.59	105%	694	0.34	451	9.04	122

(additional parameters next page)

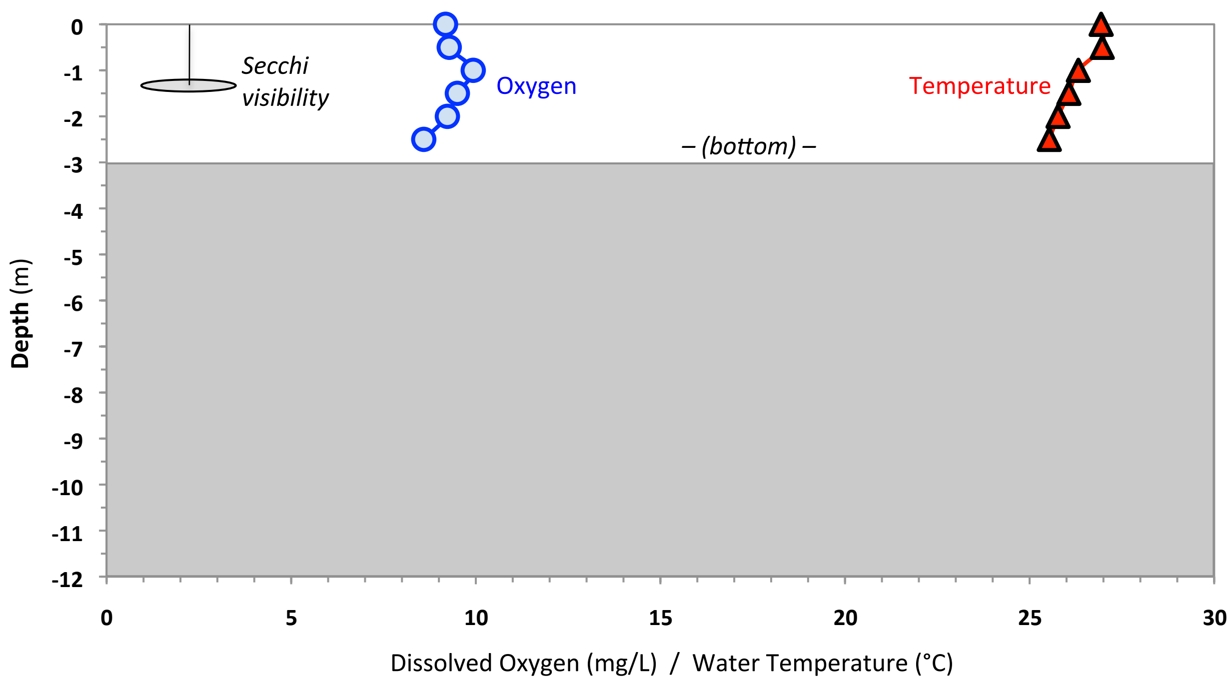


Figure 6(d). SEP 14, 2021 – B1 Pond framework parameters

Table 6(d). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
SEP 14: max. depth 3.0 m (10 ft); Secchi disk water clarity: 1.3 m (4.3 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	26.9	9.18	115%	5.58	2.54	0.69	0.15
0.5	27.0	9.28	117%	5.67	2.38	0.72	0.18
1.0	26.3	9.93	123%	4.86	2.79	0.92	0.26
1.5	26.1	9.50	117%	6.45	2.86	0.93	0.30
2.0	25.8	9.23	114%	7.74	2.73	1.32	0.39
2.5	25.5	8.59	105%	7.87	2.86	2.00	0.49

Table 6(e). Syar – B1 Pond: 2021 Water Column Profiling Data
NOV 5: max. depth 3.4 m (11 ft); Secchi disk water clarity: 1.7 m (5.6 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0.0	17.3	10.37	108%	606	0.30	394	8.87	-6
0.5	17.4	10.43	109%	610	0.30	396	8.87	-2
1.0	17.3	10.45	109%	610	0.30	396	8.88	3
1.5	17.1	10.36	108%	609	0.30	396	8.88	9
2.0	16.9	10.60	110%	608	0.30	395	8.90	14
2.5	16.8	10.45	108%	608	0.30	395	8.89	17
3.0	16.8	10.44	108%	608	0.30	395	8.90	21

(additional parameters next page)

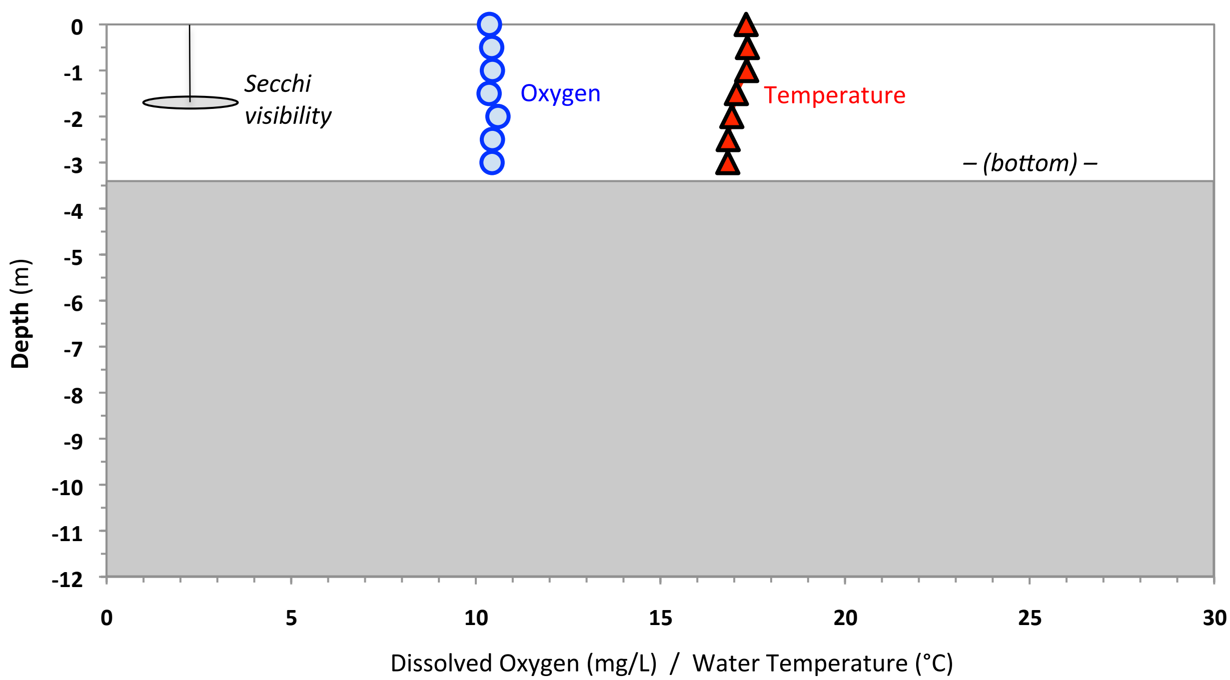


Figure 6(e). NOV 5, 2021 – B1 Pond framework parameters

Table 6(e). ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
NOV 5: max. depth 3.4 m (11 ft); Secchi disk water clarity: 1.7 m (5.6 ft)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0.0	17.3	10.37	108%	3.88	3.03	0.87	0.38
0.5	17.4	10.43	109%	3.89	3.02	0.96	0.36
1.0	17.3	10.45	109%	3.72	3.06	0.93	0.38
1.5	17.1	10.36	108%	4.18	3.17	1.44	0.41
2.0	16.9	10.60	110%	4.71	3.23	2.72	0.53
2.5	16.8	10.45	108%	6.72	3.33	2.36	0.59
3.0	16.8	10.44	108%	10.02	3.04	8.21	0.85

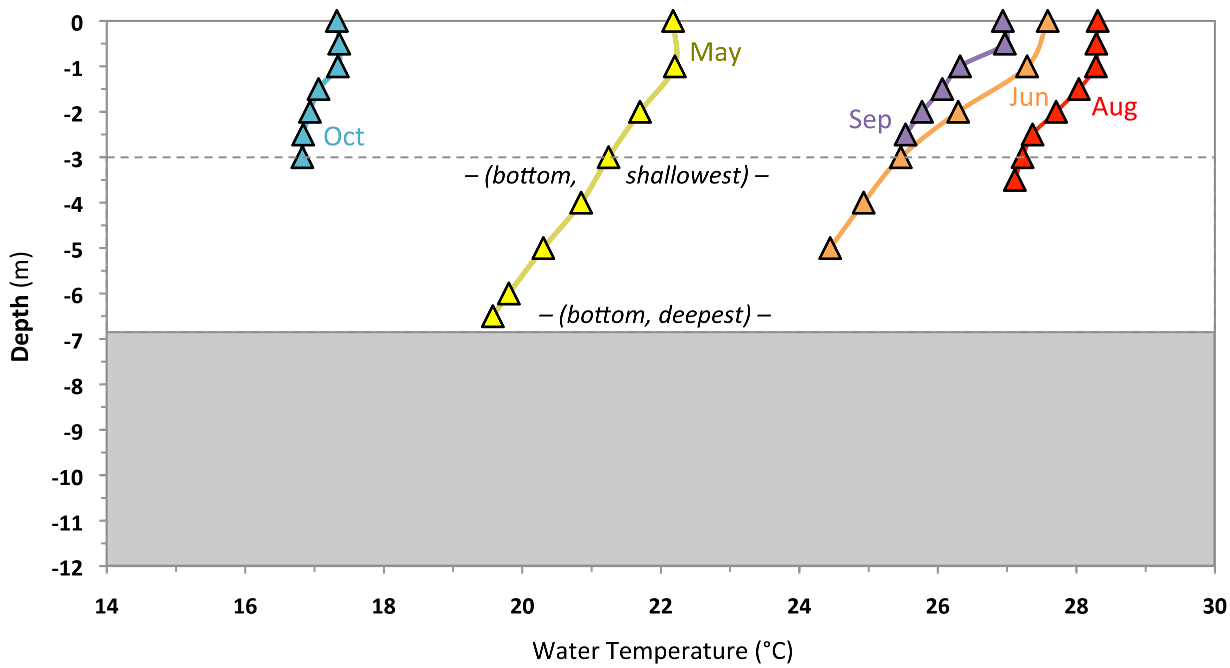


Figure 6(f). Syar – B1 Pond: 2021 May-Oct TEMPERATURE

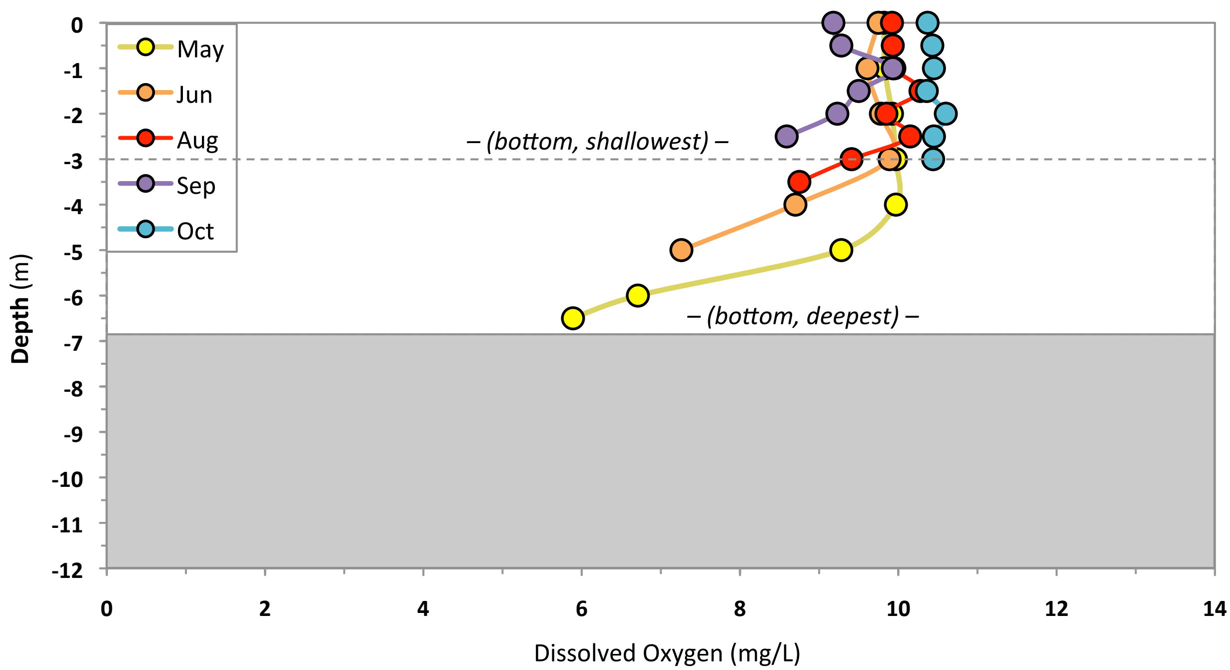


Figure 6(g). Syar – B1 Pond: 2021 May-Oct OXYGEN

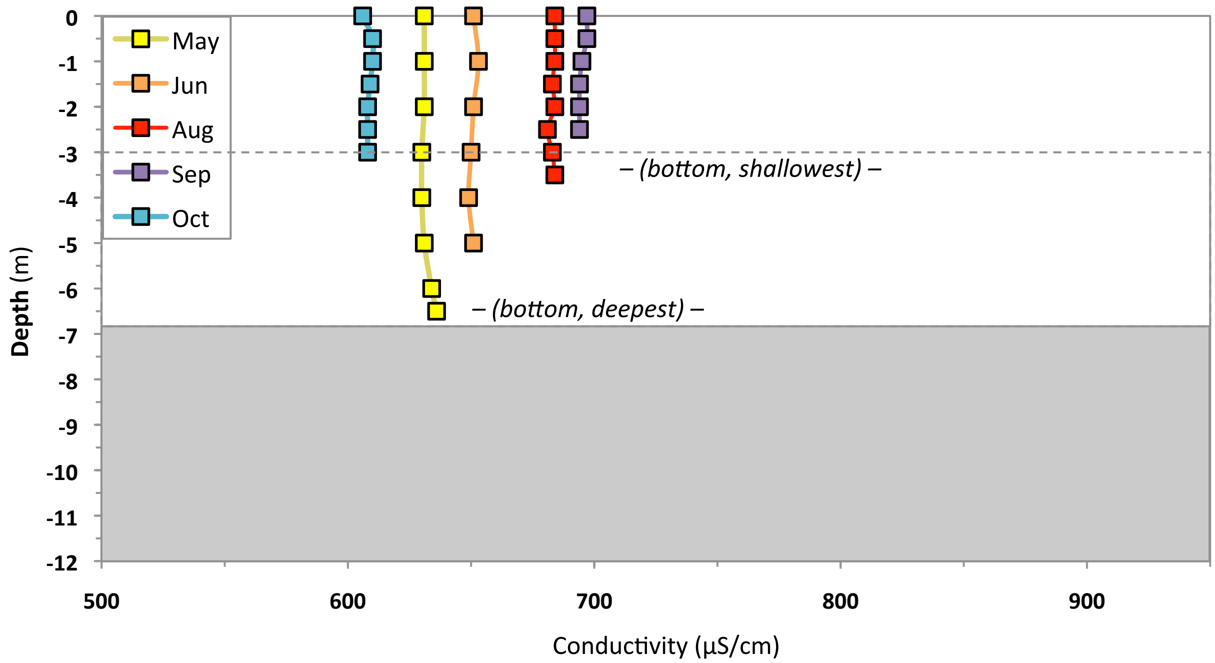


Figure 6(h). Syar – B1 Pond: 2021 May-Oct CONDUCTIVITY

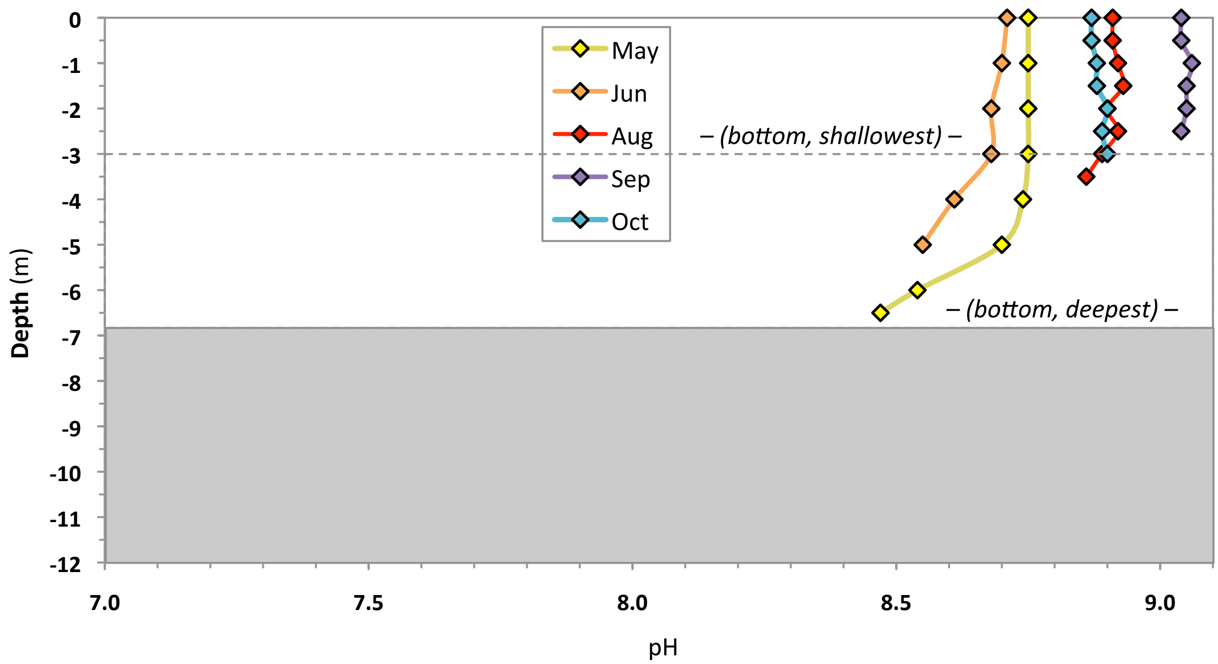


Figure 6(i). Syar – B1 Pond: 2021 May-Oct pH

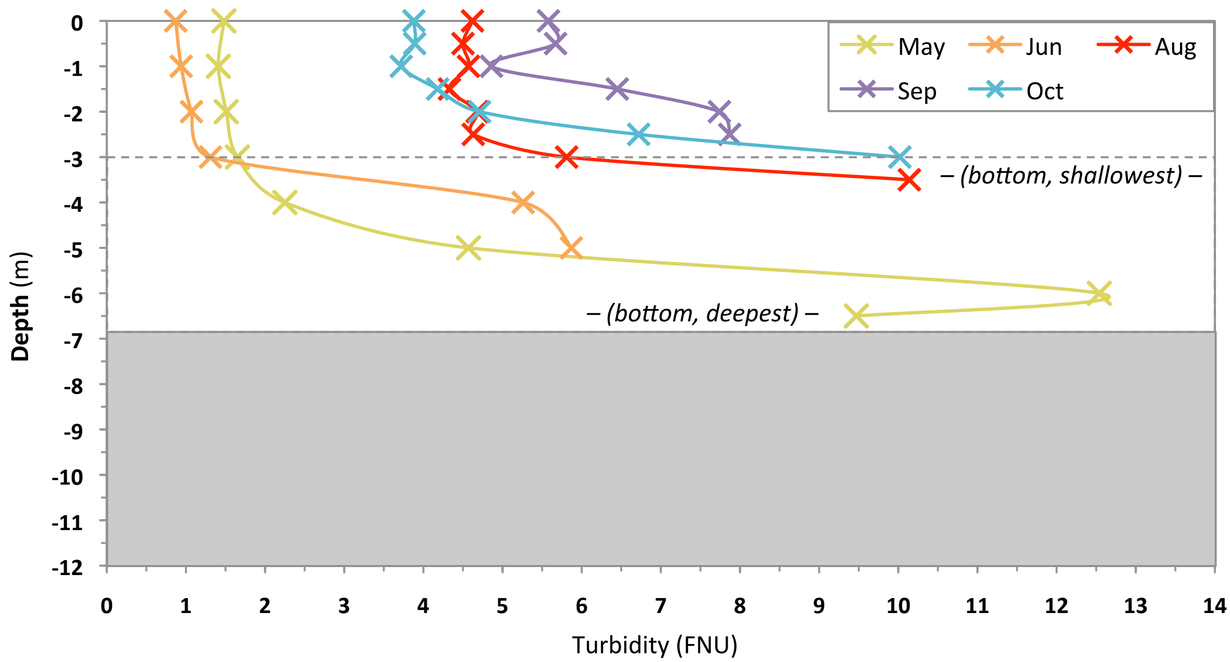


Figure 6(j). Syar – B1 Pond: 2021 May-Oct TURBIDITY

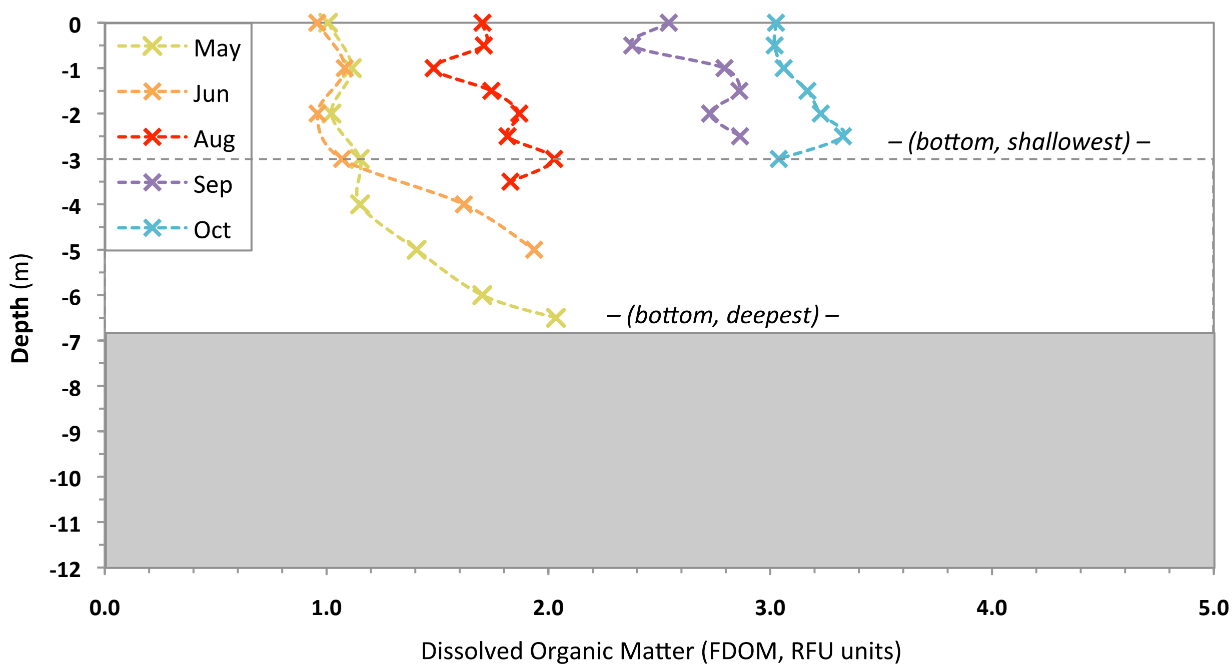


Figure 6(k). Syar–B1 Pond: 2021 May-Oct DISSOLVED ORGANIC MATTER

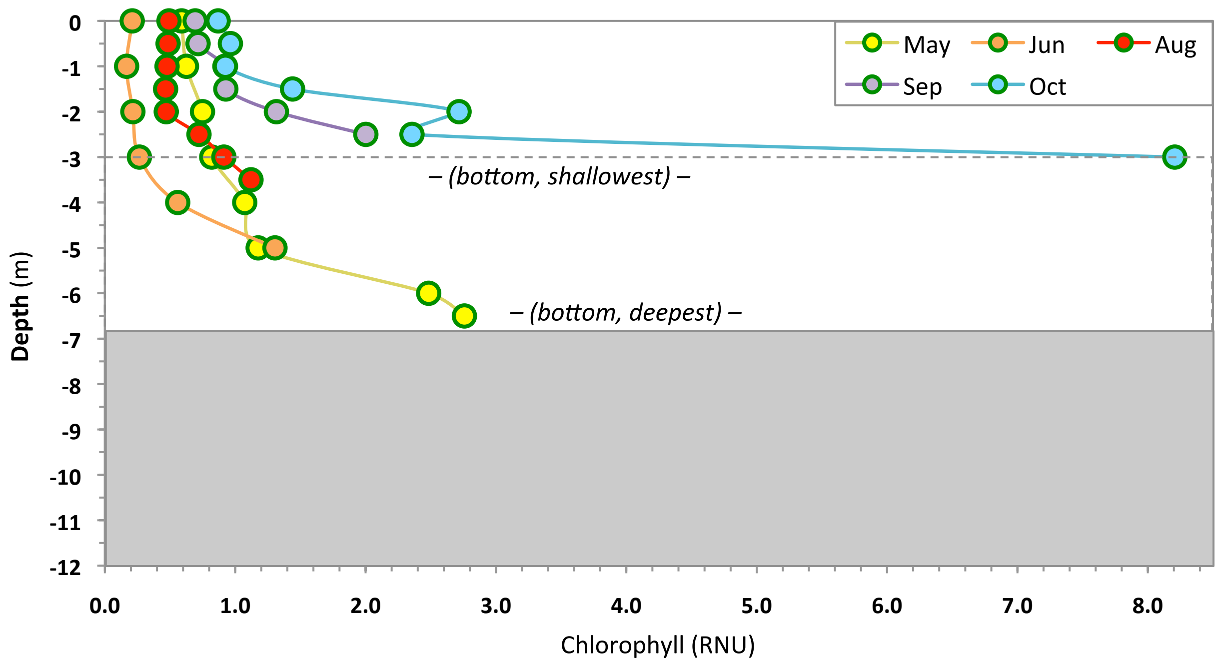


Figure 4(l). Syar – B1 Pond: 2021 May-Oct CHLOROPHYLL

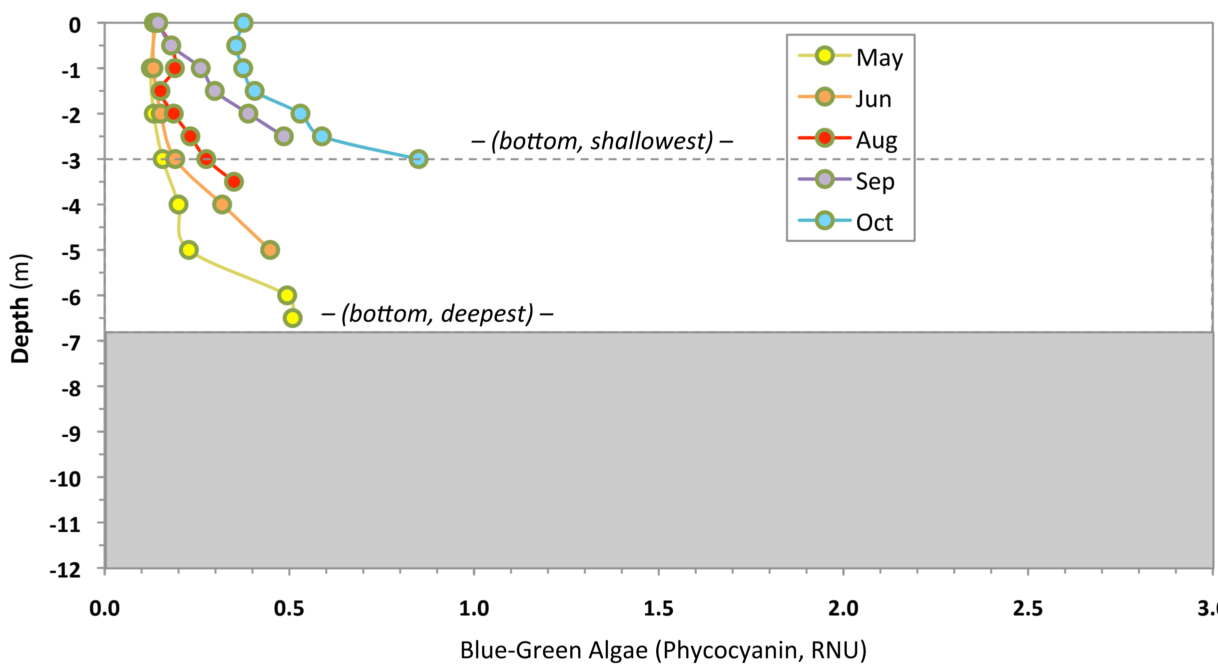


Figure 4(m). Syar – B1 Pond: 2021 May-Oct BLUE-GREEN ALGAE

7. SYAR–WEST POND

(Google Earth 10/21/2020)

7. Syar – West Pond

In summary, the Syar–West Pond was initially in the 'inconclusive' category for fish mercury but shifted into 'elevated' status in 2020. It has been monitored over the last several years to see if this significantly deeper pond would develop a stronger, more permanent thermal stratification in the warm season than the shallower ponds, with the possible depletion of oxygen in the bottom waters. Even with the drought-lowering of depths across 2021, the pond remained deep enough for this to again happen. The bottom water stayed much cooler than the surface layers, creating a 'density barrier', isolating it and leading to buildups of some water quality constituents in the bottom water and the consumption of oxygen through normal microbial metabolism – with no replenishment from above, because of the thermal barrier. Oxygen later recovered, with surface cooling and wind mixing, by early November. This 'classic warm season thermal stratification' pattern at Syar–West makes it a straightforward candidate pond for a mercury management trial, through warm season aeration of the bottom water by mixing.

The West Pond was added to the water profiling program in 2019, at first as a second control site. Fish mercury there had been borderline elevated or 'inconclusive'. However, this pond was/is an important case because it is currently the only one that is deep enough (15+ m, 50-60 feet) to develop a full thermal stratification (separation of water layers) in the warm season. If present, this could lead to extensive summer anoxia (loss of oxygen) in the bottom waters and the acceleration of methylmercury production and movement into the pond water and, eventually, the fish. Extensive seasonal bottom water anoxia has in fact been found here. As final pond restorations at several of the aggregate mining sites are planned to include depths in this range or greater, it has been important to gather information from a representative deep pond; Syar-West was added as a deep control in 2019. The 2020 monitoring found fish mercury at the site to be elevated over baseline in three or more years of five; water column profiling was shifted from Control to Required status.

Results are first shown for each survey date, one at a time. Numerical data from each of the five 2021 water profiling surveys are presented in Tables 7(a) (May) through 7(e) (early November). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 7(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 7(f) (Temperature) through 7(m) (Blue-green Algae). In these figures, the different seasonal profiles are shown together, so you can see the full range of values and the changes across the year.

Before the data tables and figures, results are first discussed below, for each of the monitored water parameters and in summary.

Water Depth (Tables and Figs. 7(a-e): is much greater in this pond as compared to the others. This is in fact why it was added to the monitoring, to provide a second reference with a configuration more like post-mining conditions projected for some of the ponds. Starting depth in May 2021 was 15.5 m (51 ft). While this continued to be much deeper than the other ponds, it was 6 feet lower than in May of the year before. Drought conditions in 2021 dropped levels further, down to 10.1 m (33 ft) by early November, an 18 foot decline.

Secchi Water Clarity (Tables and Figs. 7(a-e): remained clear as in other years, ranging from 5.3-8.6 m (17-28 ft). This pond, like Syar–B1 and Cemex–Phase 3-4, is dominated by macro aquatic plants, as compared to the murkier systems dominated by microscopic algae.

Temperature (Tables and Figs. 7(a-e), Fig. 7(f)): As in past years, this deep, relatively wind-sheltered pond developed a strong seasonal thermal stratification, with bottom water isolated from the upper water and the air. The surface 6-8 m (20-26 ft) warmed, as at the other ponds, to summer temperatures of 24-28 °C (75-83 °F). But, while most of the other ponds had their bottom waters ultimately rise to over 25 °C (77 °F), the deeper Syar–West bottom zone remained cool at 13-17 °C (56-63 °F) through August. The zone of rapid temperature change, with over 1 °C change per m, called the *thermocline*, set up at around 7-10 m depth as in other years, creating a 'density barrier' and isolating the bottom levels of the water column from above. In this drought year with much lower water column depths, the bottom water below the thermocline was a much thinner zone than in previous years. The thermocline slowly descended as usual and later, in the fall, when surface water cooled to temperatures similar to the bottom water, there was no longer a density barrier; days with high winds could mix the water column top to bottom, as seen in the early November profile. This full-lake mixing typically continues until the following spring, when the surface water is warmed again.

<u>Dissolved Oxygen</u> (Tables and Figs. 7(a-e), <u>Fig. 7(g)</u>): Bottom water oxygen depletion again occurred here, as in 2019 and 2020. From May through September, when the thermocline was strong, oxygen plummeted below the thermocline, with the bottom 2-3 meters dropping to below 2 mg/L (ppm) and below 15% of saturation between May and September. The clear water allowed sunlight to penetrate deep into the water column, allowing phytoplankton to photosynthesize and produce saturation or super-saturation levels of oxygen to as deep as 12 m (39 ft). As in prior years, the very highest oxygen levels were seen at depth, right around the thermocline, as often occurs due to a 'pile-up' of phytoplankton. Below this though, on all dates through September, oxygen levels dropped rapidly, presumably increasing methylmercury production and incorporation into the water.

<u>Conductivity</u> (Tables 7(a-e), <u>Fig. 7(h)</u>): from May to September ranged between 594 and 653 µS/cm overall, similar to previous years, with highest levels toward the bottom under the stratified conditions. After the rainfall inputs of October and normal fall water column mixing, conductivity dropped a bit lower than previously recorded here, at 537-543 µS/cm top to bottom.

<u>Salinity</u> (Tables 7(a-e): was fairly uniform from May to September, at 0.28-0.32 ppt (parts per thousand, g/L) across all water depths. Like the linked conductivity trend, after the rainfall inputs of October and normal fall water column mixing, salinity also dropped a bit lower than previously recorded here, at 0.26 µS/cm top to bottom. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 7(a-e): fell within the narrow range of 381-425 mg/L (ppm) between May and September, similar to previous years. Highest levels occurred toward the bottom under stratified conditions in those months. As seen with the conductivity and salinity trends, after the rainfall inputs of October and normal fall water column mixing, TDS also dropped a bit lower than previously recorded here, at 349-353 mg/L top to bottom.

pH (Tables 7(a-e), Fig. 7(i)): as in the other ponds, was basic (non-acidic; pH > 7.00). This is a function of the mining history and the basic nature of local sediments. From May through September, pH in the top 7 m (23 ft) fell narrowly between 8.7 and 8.8. However, with the oxygen depletion that occurred below the strong summer thermocline, as in other years, the water became significantly less basic, dropping into the range of 7.6-7.8; pH essentially tracked oxygen levels. Following the onset of fall mixing, pH throughout the water column moved to approximately 8.5.

Oxidation/Reduction Potential (ORP) (Tables 7(a-e): Just as seen last year across the period with temperature stratification (May-Sep), ORP increased gradually with depth, peaked 1-2 m above the bottom, and then dropped approaching the bottom. But with the rapidly shrinking water column in this drought year, we did not see large declines in ORP to negative values near the very bottom like last year. Instead, ORP levels across all depths and dates ranged more narrowly, between 27 and 109 mV. Levels were lowest in early November (27-40 mV), after the onset of fall mixing.

Turbidity (Tables 7(a-e), Fig. 7(j)): The Syar–West Pond remained one of the clearest of the ponds in the monitoring program. It is protected from high winds by steep, tall surrounding slopes and is by far the deepest of the ponds. Additionally, most of the shore slopes within the pond are steep. As a result, this pond is rarely disturbed by heavy wind action and associated resuspension of bottom sediments. This remained the case even as depths decreased with the drought. Turbidities were well under 1.0 FNU throughout the top 8 m or more, across the seasons until early November when levels were 0.9-1.9 FNU from top to bottom. In June through September of previous years, a 'murky layer' developed in the seasonally anoxic bottom several meters, with turbidity levels as high as 12 FNU. With the greatly decreased water levels in 2021, this bottom layer was less pronounced, with a high of 2.45 FNU at one depth/date and all other readings under 2.0 FNU.

Dissolved Organic Matter (FDOM) (Tables 7(a-e), Fig. 7(k)): Similar to the other ponds, same-date levels were consistent throughout the depths above the thermocline (= top 6-7 m May-Sep; 0.7-1.2 RFU), and similar top to bottom in late October after the pond had thoroughly mixed (1.7-2.0 RFU). Also, as in most of the other ponds, a buildup of dissolved organic matter occurred in deeper water layers when the lake was strongly stratified. This was the case on all dates before early November, despite the rapidly shrinking depth. Levels rose to over 8.0 RFU in August and September in the bottom waters.

Green Algae (Chlorophyll) (Tables 7(a-e), Fig. 7(l)): With the rapidly-dropping depths of 2021, chlorophyll readings were more variable across the upper layers and did not show large (relative) accumulations near the bottom as in other years. Moderate accumulations developed at a variety of depths across the season. The overall range across all depths and dates was 0.2-2.2 RFU.

Blue-Green Algae (Phycocyanin) (Tables 7(a-e), Fig. 7(m)): in contrast, behaved more similarly to other years, with May-September accumulations in the deep water relative to the surface 8-10 m. Upper water levels were at or below 0.4 RFU on all dates; increasing into the 0.6-1.4 range in the deeper water when the pond was stratified. These are all fairly low levels.

Table 7(a). Syar – West Pond: 2021 Water Column Profiling Data

MAY 5: max. depth 15.5 m (51 ft); Secchi disk water clarity: 5.6 m (18.4 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	22.0	10.61	122%	594	0.29	386	8.69	70
1	22.0	10.54	121%	594	0.29	386	8.68	72
2	22.0	10.52	120%	594	0.29	386	8.68	73
3	21.6	10.70	122%	594	0.29	386	8.69	75
4	21.3	10.64	120%	594	0.29	386	8.68	76
5	20.7	10.99	123%	594	0.29	386	8.69	78
6	20.1	11.30	125%	595	0.29	387	8.70	79
7	18.0	16.93	179%	588	0.29	382	8.74	83
8	15.7	16.80	169%	588	0.29	382	8.71	87
9	14.8	14.92	148%	590	0.29	384	8.66	92
10	14.3	13.23	129%	594	0.29	386	8.59	95
11	13.6	9.41	91%	597	0.29	388	8.33	100
12	13.1	6.18	59%	598	0.29	389	8.00	106
13	12.9	3.66	35%	600	0.29	390	7.78	109
14	12.9	1.47	14%	603	0.29	392	7.66	106
15.0	12.9	1.39	13%	602	0.29	392	7.65	101

Optical Parameters (with framework data for reference)
(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	22.0	10.61	122%	0.40	1.08	0.68	0.13
1	22.0	10.54	121%	0.35	1.01	0.68	0.15
2	22.0	10.52	120%	0.37	1.02	0.71	0.15
3	21.6	10.70	122%	0.33	1.08	0.56	0.14
4	21.3	10.64	120%	0.47	0.99	0.56	0.14
5	20.7	10.99	123%	1.02	1.22	0.84	0.18
6	20.1	11.30	125%	0.72	1.44	1.08	0.26
7	18.0	16.93	179%	0.93	2.92	1.09	0.32
8	15.7	16.80	169%	0.77	3.20	0.91	0.35
9	14.8	14.92	148%	0.87	3.00	1.15	0.45
10	14.3	13.23	129%	0.92	2.82	1.40	0.56
11	13.6	9.41	91%	1.01	2.74	2.06	0.75
12	13.1	6.18	59%	0.86	2.40	1.63	0.80
13	12.9	3.66	35%	0.69	2.64	1.26	0.74
14	12.9	1.47	14%	0.57	2.80	0.66	0.65
15.0	12.9	1.39	13%	0.59	2.77	0.64	0.65

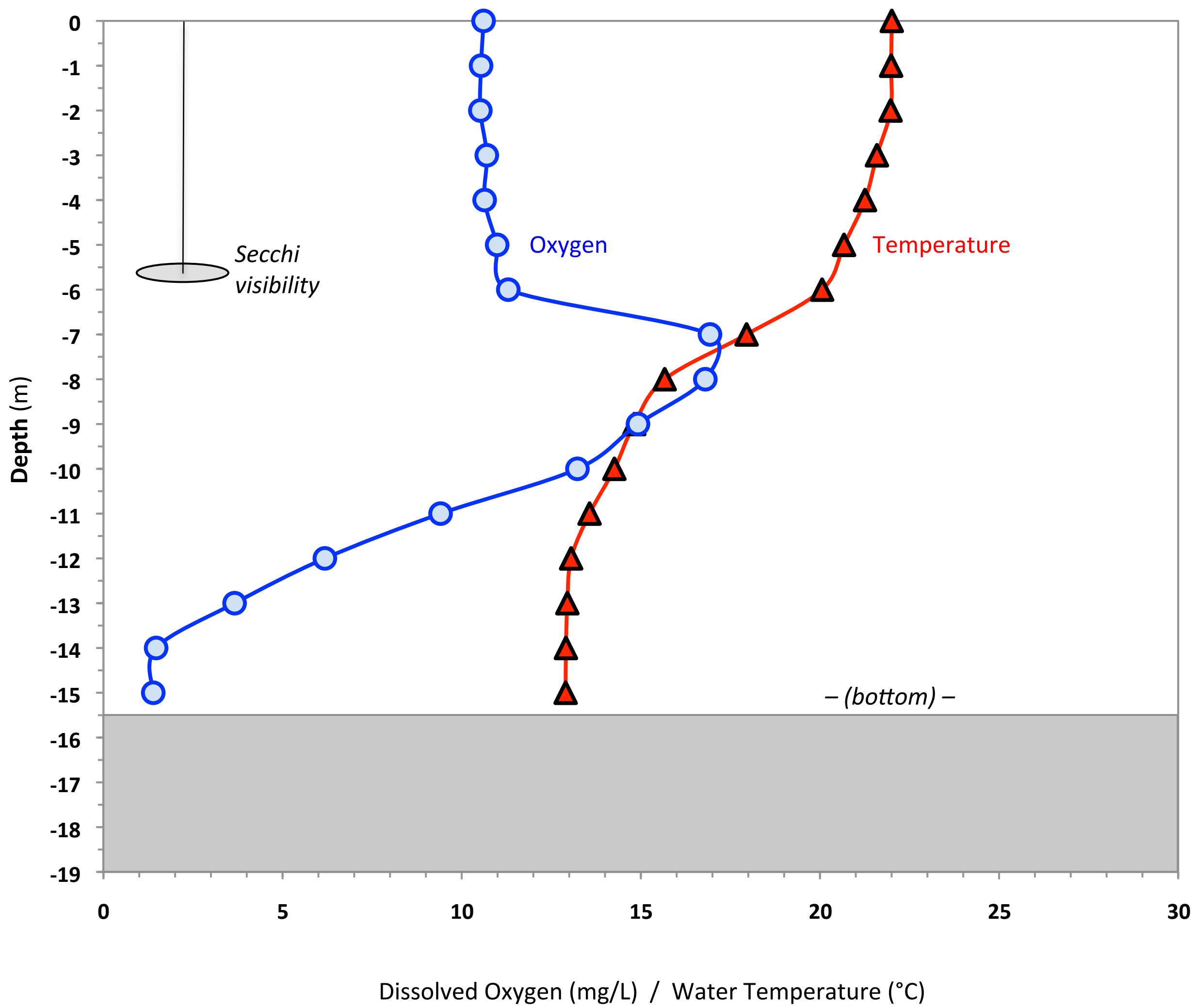


Figure 7(a). MAY 5, 2021 – West Pond framework parameters

Table 7(b). Syar – West Pond: 2021 Water Column Profiling Data

JUN 18: max. depth 14.0 m (46 ft); Secchi disk water clarity: 7.5 m (24.6 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	27.9	11.36	145%	586	0.28	381	8.81	34
1	26.8	11.98	150%	586	0.28	381	8.79	43
2	25.8	11.47	141%	588	0.28	382	8.77	47
3	25.3	11.68	142%	587	0.28	382	8.76	50
4	25.0	11.35	138%	588	0.28	382	8.75	53
5	24.6	11.11	134%	588	0.28	382	8.74	55
6	24.3	10.86	130%	589	0.28	383	8.72	57
7	23.9	10.96	130%	590	0.29	383	8.70	59
8	21.8	11.63	133%	598	0.29	389	8.54	66
9	18.8	11.11	120%	604	0.29	392	8.31	75
10	16.4	9.29	95%	605	0.30	393	8.19	79
11	15.2	2.29	23%	610	0.30	397	7.67	86
12	14.7	1.61	16%	613	0.30	399	7.69	81
13	14.5	0.87	9%	613	0.30	399	7.63	79
13.5	14.5	0.56	6%	614	0.30	399	7.64	76

Optical Parameters (with framework data for reference)
(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	27.9	11.36	145%	0.16	0.92	0.55	0.12
1	26.8	11.98	150%	0.13	0.79	0.35	0.15
2	25.8	11.47	141%	0.09	0.88	0.33	0.17
3	25.3	11.68	142%	0.11	0.78	0.37	0.22
4	25.0	11.35	138%	0.16	0.88	0.41	0.23
5	24.6	11.11	134%	0.20	1.03	0.44	0.28
6	24.3	10.86	130%	0.24	1.00	0.57	0.30
7	23.9	10.96	130%	0.27	1.26	0.61	0.36
8	21.8	11.63	133%	0.33	2.03	0.40	0.37
9	18.8	11.11	120%	0.37	3.19	0.43	0.53
10	16.4	9.29	95%	0.35	3.12	0.58	0.73
11	15.2	2.29	23%	0.42	3.28	1.02	1.04
12	14.7	1.61	16%	0.44	3.52	0.67	1.06
13	14.5	0.87	9%	0.53	3.41	0.54	1.09
13.5	14.5	0.56	6%	0.78	3.51	0.93	1.30

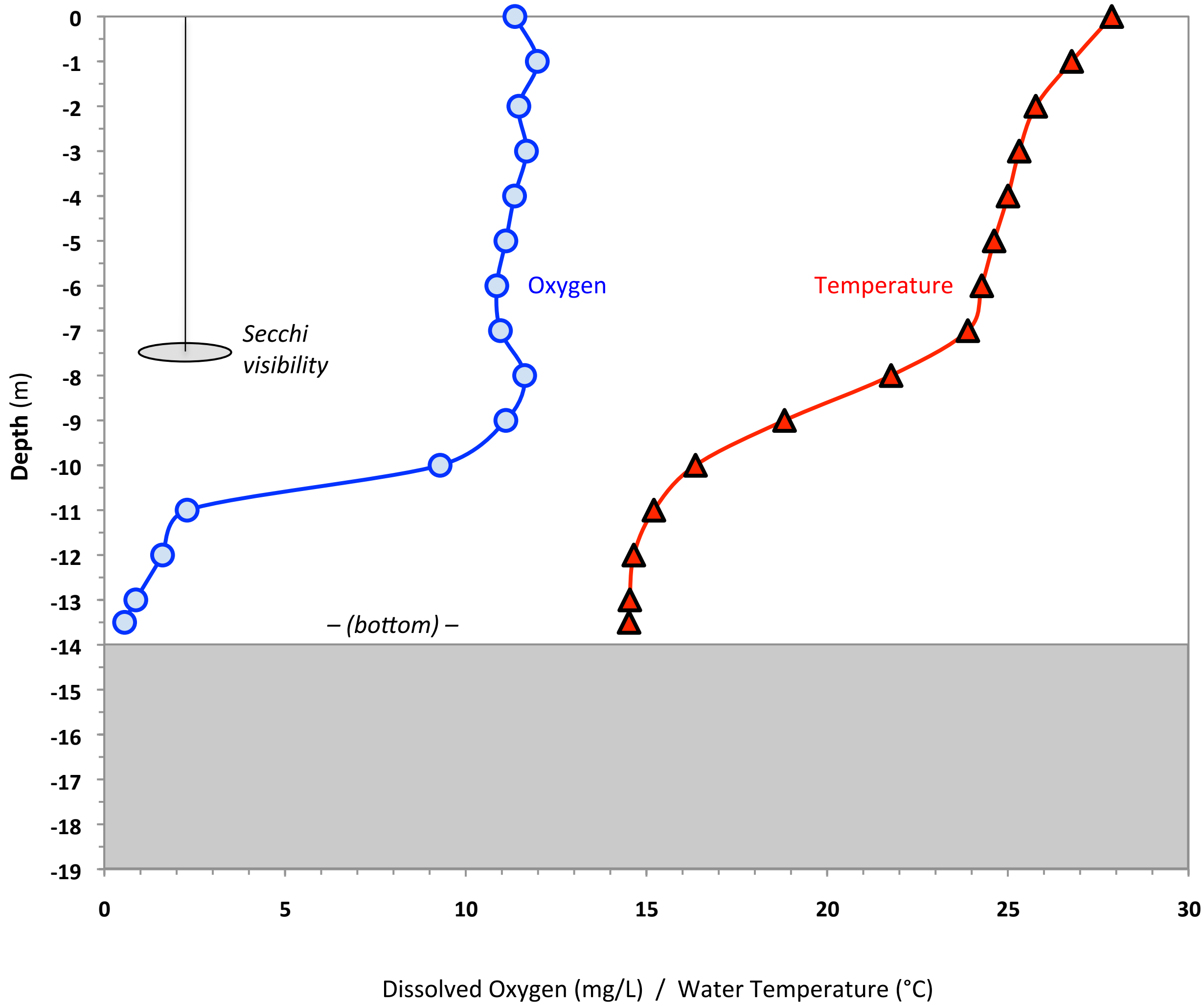


Figure 7(b). JUN 18, 2021 – West Pond framework parameters

Table 7(c). Syar – West Pond: 2021 Water Column Profiling Data
AUG 5: max. depth 11.9 m (39 ft); Secchi disk water clarity: 6.2 m (20.3 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	28.2	10.97	141%	606	0.29	394	8.81	49
1	28.2	10.98	141%	607	0.29	395	8.81	57
2	27.8	11.22	143%	607	0.29	394	8.80	63
3	27.6	11.40	145%	606	0.29	394	8.81	67
4	27.5	11.39	145%	606	0.29	394	8.81	68
5	27.5	11.41	145%	606	0.29	394	8.82	70
6	27.4	11.34	144%	606	0.29	394	8.82	71
7	27.3	11.32	143%	605	0.29	393	8.82	72
8	24.8	9.95	120%	620	0.30	403	8.46	84
9	21.2	4.35	49%	639	0.31	415	7.77	101
10	18.3	0.43	5%	645	0.31	419	7.57	104
10.5	17.8	0.28	3%	647	0.32	421	7.61	96
11.0	17.3	0.15	2%	650	0.32	422	7.62	95
11.5	16.9	0.14	1%	653	0.32	425	7.60	94

Optical Parameters (with framework data for reference)
(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	28.2	10.97	141%	0.28	0.70	0.97	0.22
1	28.2	10.98	141%	0.26	0.75	1.02	0.21
2	27.8	11.22	143%	0.30	0.76	0.89	0.17
3	27.6	11.40	145%	0.27	0.70	0.93	0.18
4	27.5	11.39	145%	0.29	0.89	0.98	0.19
5	27.5	11.41	145%	0.28	0.89	1.10	0.16
6	27.4	11.34	144%	0.34	0.72	1.12	0.20
7	27.3	11.32	143%	0.40	0.89	1.16	0.21
8	24.8	9.95	120%	0.29	2.45	0.25	0.19
9	21.2	4.35	49%	0.24	4.51	0.33	0.34
10	18.3	0.43	5%	0.58	6.44	0.59	0.62
10.5	17.8	0.28	3%	0.71	7.31	0.41	0.72
11.0	17.3	0.15	2%	1.06	7.97	0.39	0.76
11.5	16.9	0.14	1%	2.45	6.75	0.52	0.85

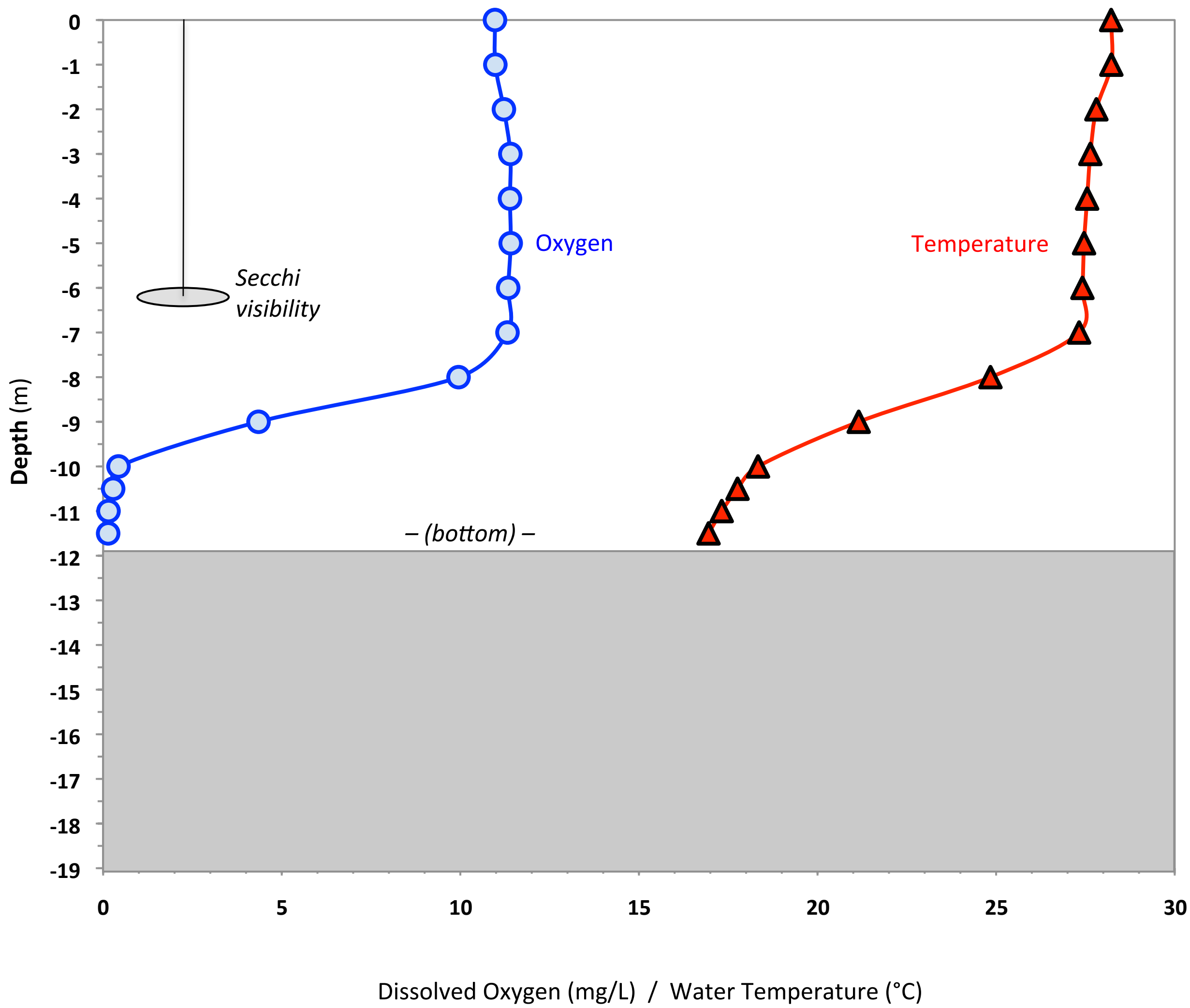


Figure 7(c). AUG 5, 2021 – West Pond framework parameters

Table 7(d). Syar – West Pond: 2021 Water Column Profiling Data

SEP 14: max. depth 10.4 m (34 ft); Secchi disk water clarity: 8.6 m (28.2 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	26.6	9.74	122%	598	0.29	389	8.78	44
1	26.5	9.48	118%	599	0.29	389	8.80	51
2	26.3	9.43	117%	598	0.29	389	8.80	58
3	26.2	9.26	115%	599	0.29	389	8.78	65
4	26.1	9.20	114%	598	0.29	389	8.76	71
5	26.1	9.13	113%	598	0.29	389	8.79	73
6	26.0	9.15	113%	599	0.29	389	8.78	75
7	26.0	9.16	113%	598	0.29	389	8.73	80
8	25.5	8.01	98%	603	0.29	392	8.54	88
8.5	24.5	5.13	62%	615	0.30	400	8.14	98
9.0	23.1	1.50	18%	626	0.30	407	7.58	104
9.5	21.6	0.95	11%	633	0.31	411	7.52	103
10.0	20.8	0.78	9%	638	0.31	415	7.51	102

Optical Parameters (with framework data for reference)

(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	26.6	9.74	122%	0.05	0.96	0.18	0.06
1	26.5	9.48	118%	0.08	0.79	0.20	0.05
2	26.3	9.43	117%	0.11	0.87	0.27	0.08
3	26.2	9.26	115%	0.12	1.01	0.22	0.13
4	26.1	9.20	114%	0.14	0.81	0.23	0.15
5	26.1	9.13	113%	0.15	1.08	0.27	0.16
6	26.0	9.15	113%	0.16	0.95	0.36	0.16
7	26.0	9.16	113%	0.26	1.09	0.60	0.21
8	25.5	8.01	98%	0.49	1.96	1.38	0.30
8.5	24.5	5.13	62%	0.65	3.75	1.13	0.33
9.0	23.1	1.50	18%	0.98	5.70	0.93	0.43
9.5	21.6	0.95	11%	0.52	7.34	1.36	0.62
10.0	20.8	0.78	9%	0.67	8.32	0.76	0.56

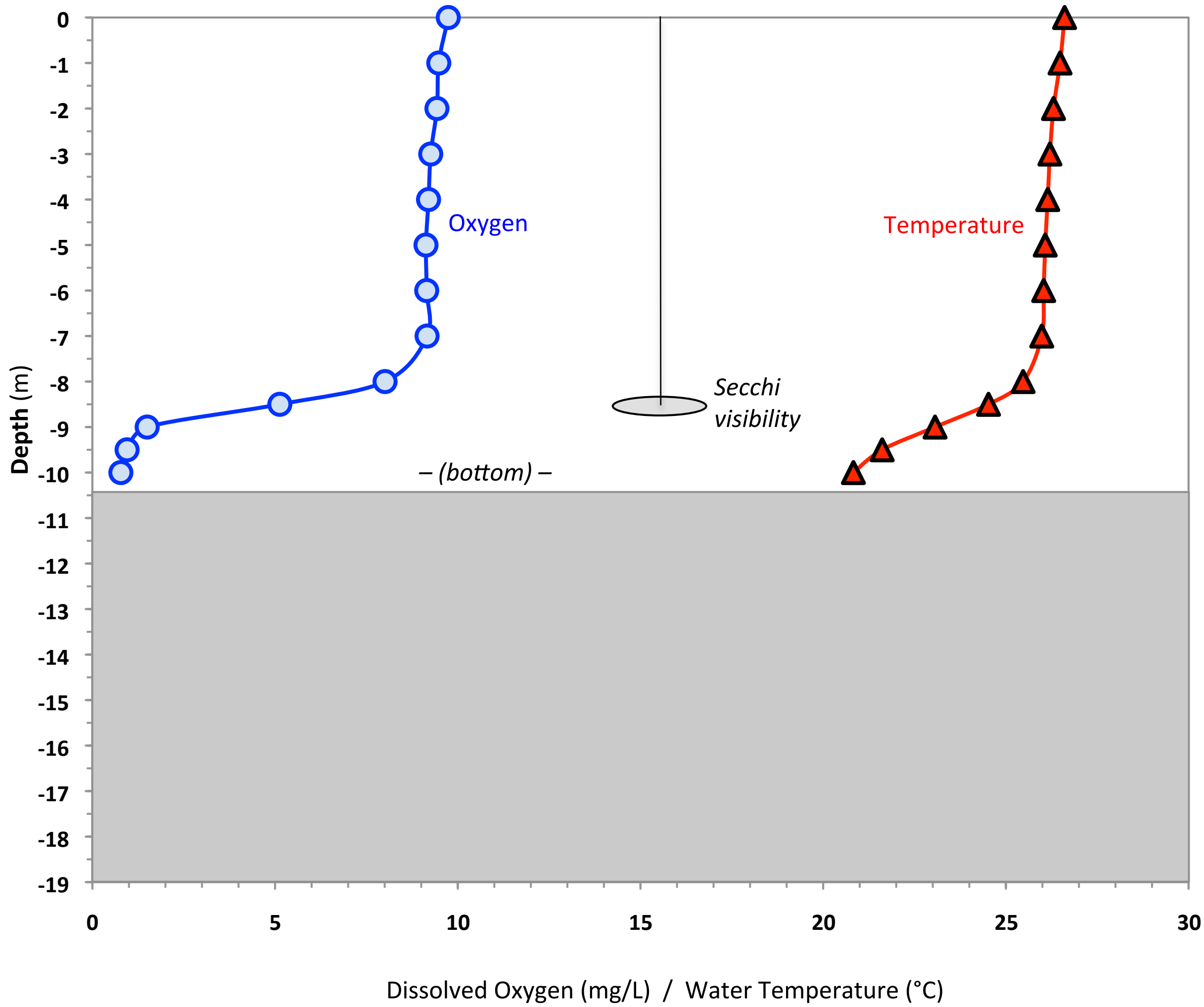


Figure 7(d). SEP 14, 2021 – West Pond framework parameters

Table 7(e). Syar – West Pond: 2021 Water Column Profiling Data
NOV 5: max. depth 10.1 m (33 ft); Secchi disk water clarity: 5.3 m (17.4 ft)

(% Sat. = % of saturation; µS = micro Siemens; ppt = parts per thousand; ORP = oxidation/reduction potential); mV = millivolts)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Conduct. (µS/cm)	Salinity (ppt)	TDS (mg/L)	pH	ORP (mV)
0	17.8	8.83	93%	543	0.26	353	8.54	27
1	17.8	8.56	90%	542	0.26	352	8.53	28
2	17.7	8.43	89%	541	0.26	351	8.53	28
3	17.5	8.41	88%	538	0.26	350	8.54	29
4	17.5	8.38	88%	537	0.26	349	8.54	30
5	17.4	8.29	87%	539	0.26	350	8.52	31
6	17.4	8.04	84%	538	0.26	350	8.48	35
7	17.4	8.11	85%	537	0.26	349	8.49	35
8.0	17.3	8.00	84%	537	0.26	349	8.47	37
8.5	17.3	7.79	81%	538	0.26	350	8.46	38
9.0	17.3	7.66	80%	538	0.26	350	8.45	39
9.5	17.3	7.58	79%	538	0.26	349	8.45	40

Optical Parameters (with framework data for reference)
(FDOM = Fluorescent Dissolved Organic Matter; BG Algae = Blue-Green Algae; FNU = Formazin Nephelometric Units; RFU = Relative Fluorescence Units)

Depth (m)	Temp. (°C)	Oxygen (mg/L)	Oxygen (% Sat.)	Turbidity (FNU)	FDOM (RFU)	Chlorophyll (RFU)	BG Algae (RFU)
0	17.8	8.83	93%	0.90	1.69	0.70	0.30
1	17.8	8.56	90%	0.85	1.73	0.60	0.30
2	17.7	8.43	89%	0.95	1.71	0.93	0.31
3	17.5	8.41	88%	0.96	1.77	1.70	0.39
4	17.5	8.38	88%	0.98	1.87	1.59	0.36
5	17.4	8.29	87%	0.93	1.77	1.20	0.39
6	17.4	8.04	84%	1.13	1.88	1.20	0.35
7	17.4	8.11	85%	0.95	1.84	0.58	0.28
8.0	17.3	8.00	84%	1.13	1.83	0.63	0.30
8.5	17.3	7.79	81%	1.51	1.88	0.61	0.27
9.0	17.3	7.66	80%	1.68	1.88	0.56	0.31
9.5	17.3	7.58	79%	1.93	1.92	0.49	0.27

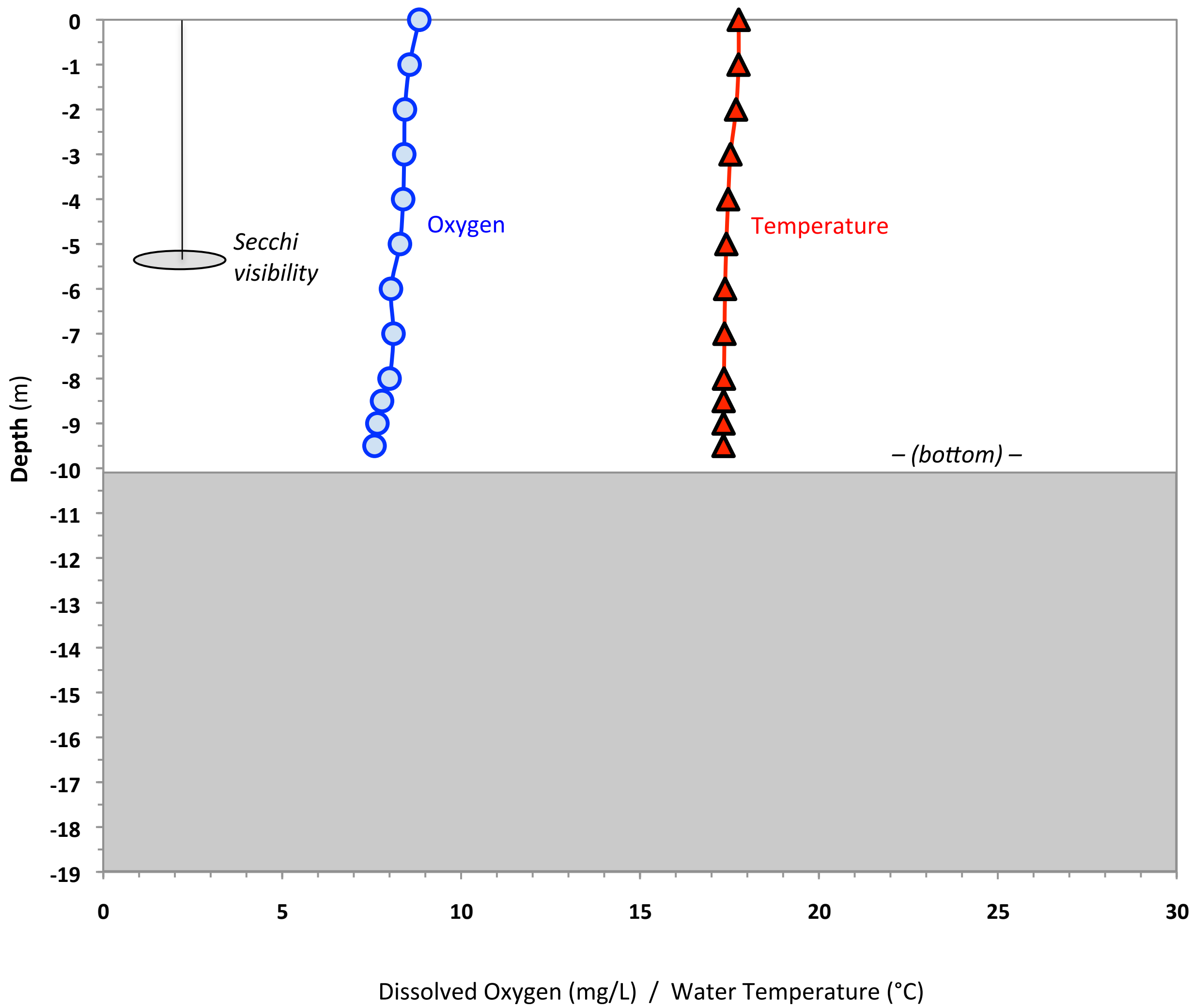


Figure 7(e). NOV 5, 2021 – West Pond framework parameters

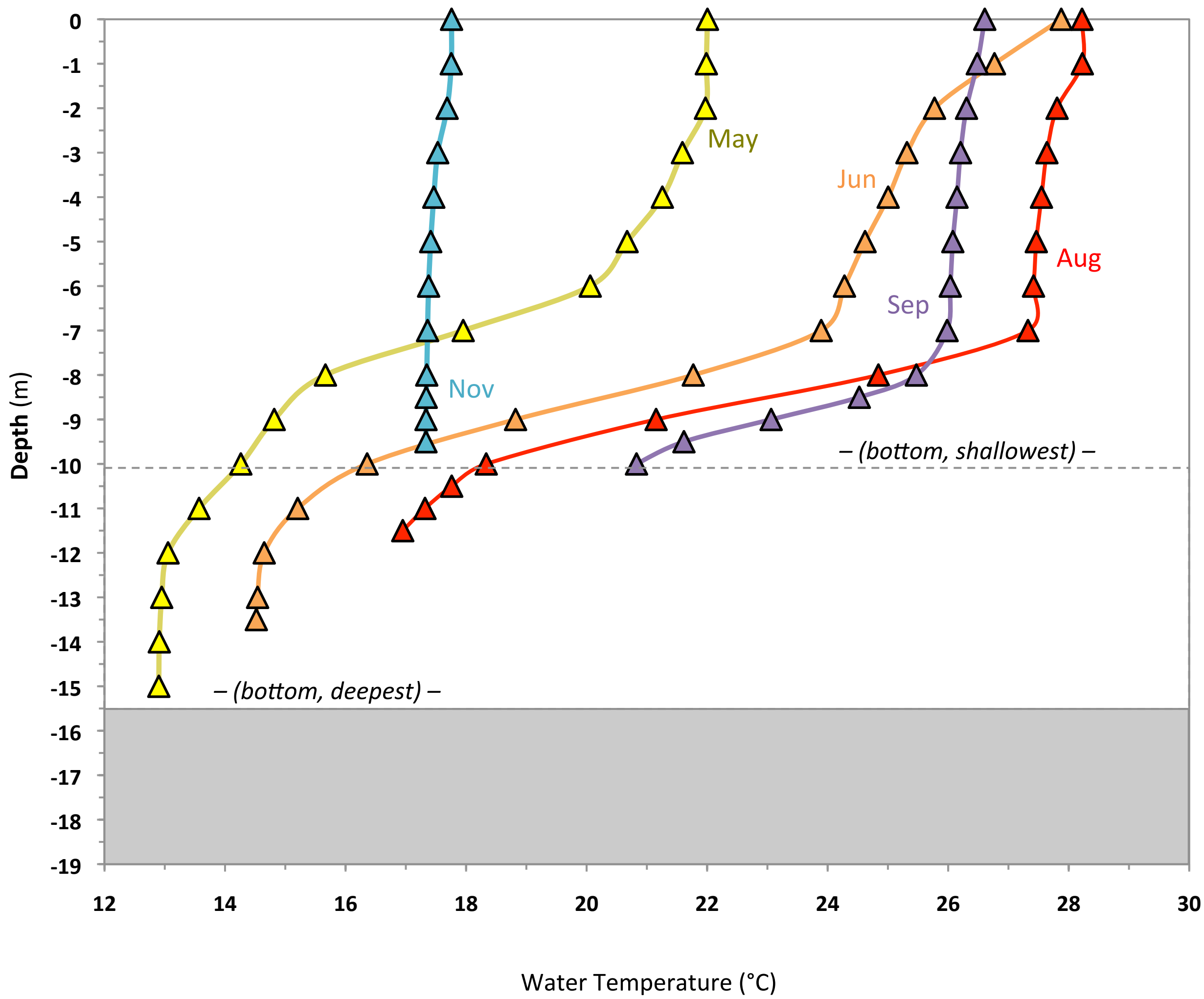


Figure 7(f). Syar – West Pond: 2021 May-Oct TEMPERATURE

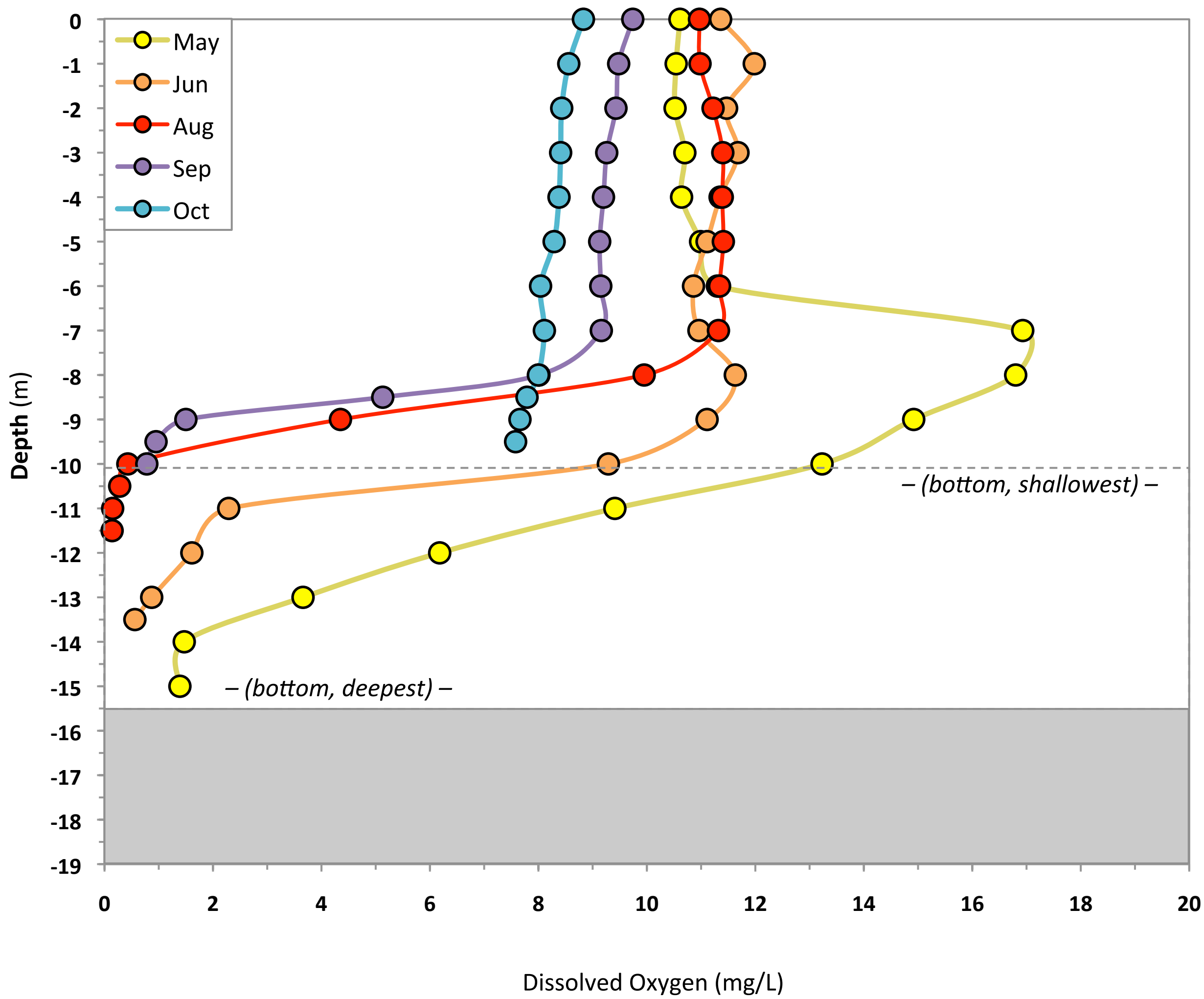


Figure 7(g). Syar – West Pond: 2021 May-Oct OXYGEN

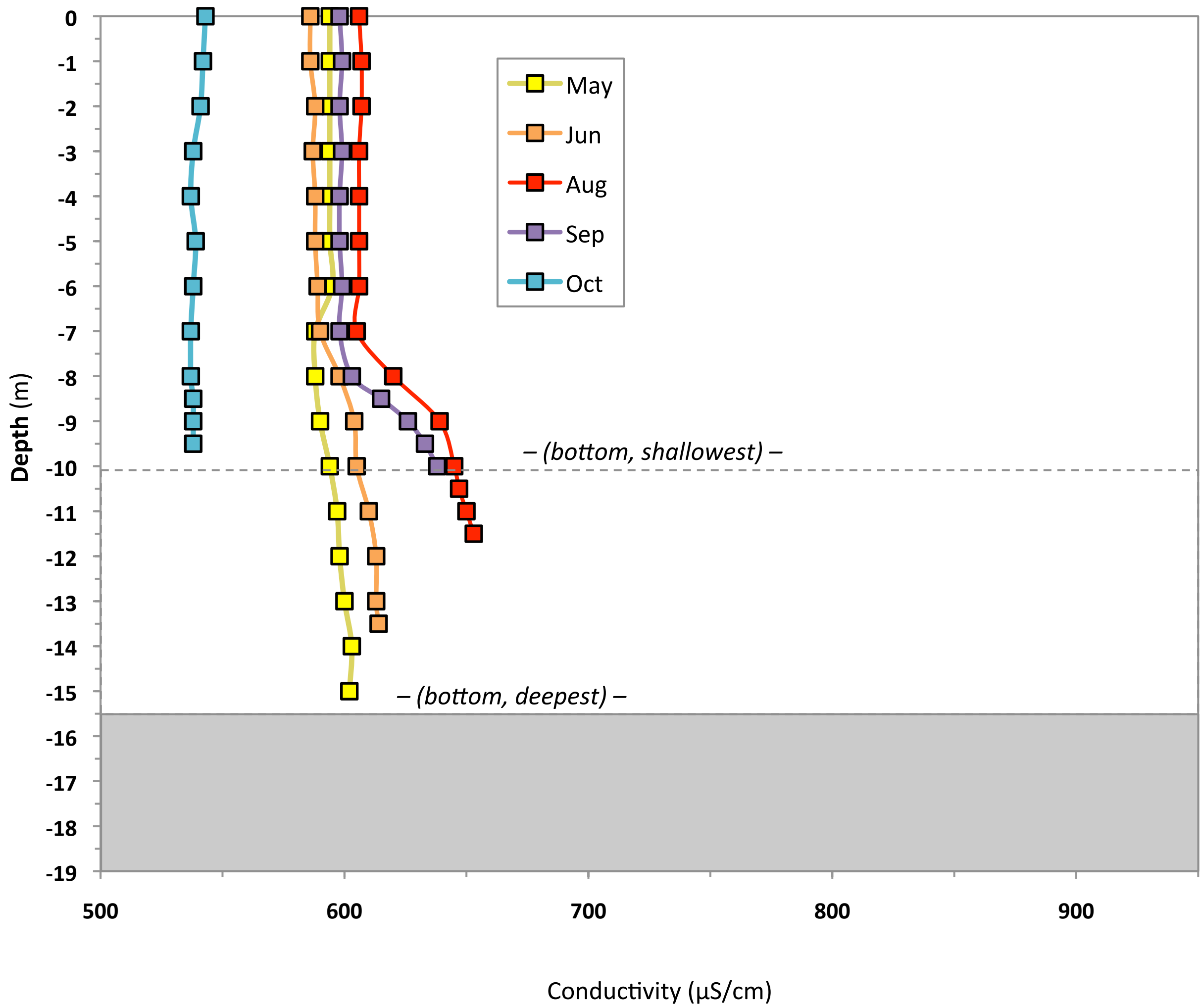


Figure 7(h). Syar – West Pond: 2021 May-Oct CONDUCTIVITY

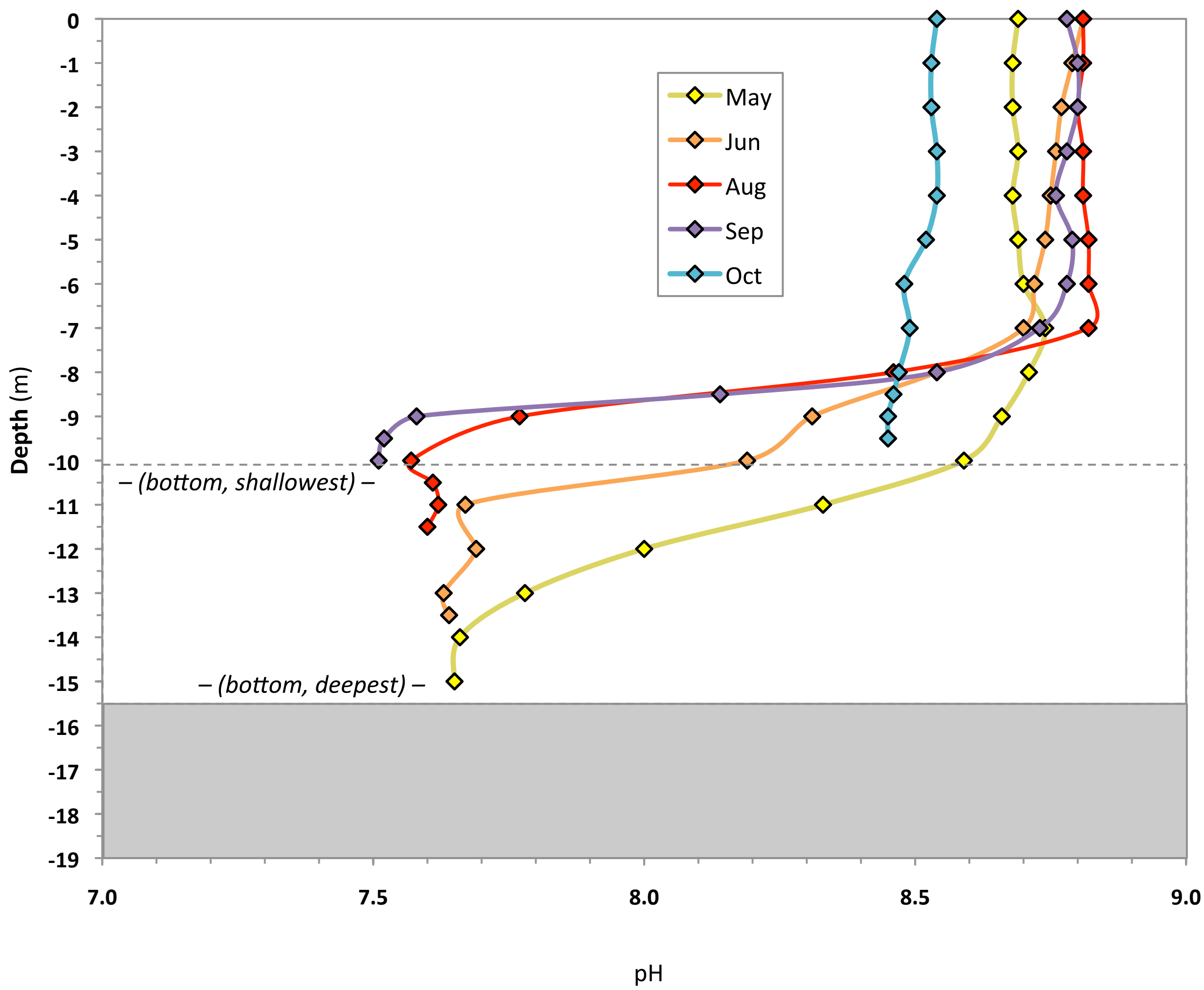


Figure 7(i). Syar – West Pond: 2021 May-Oct pH

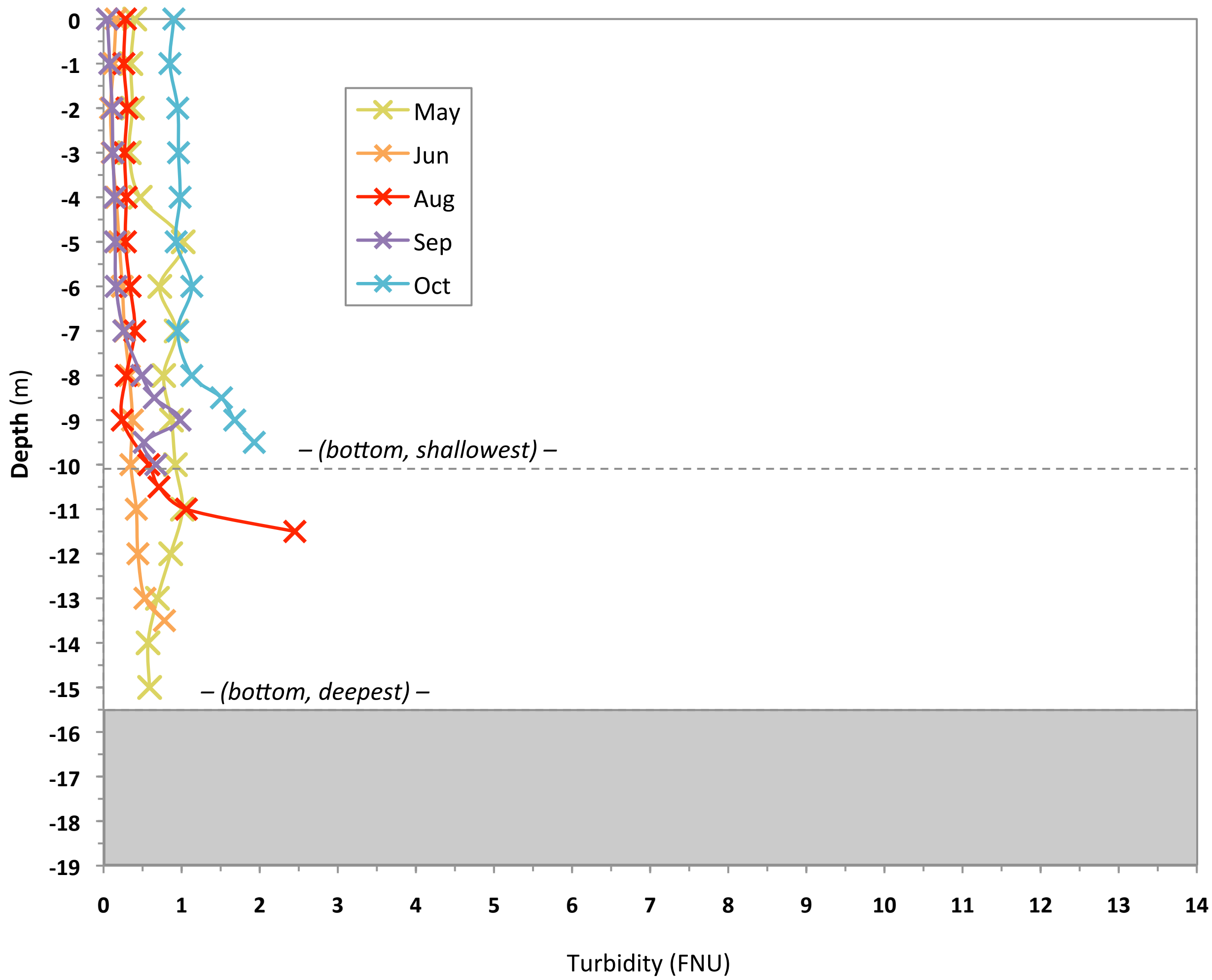


Figure 7(j). Syar – West Pond: 2021 May-Oct TURBIDITY

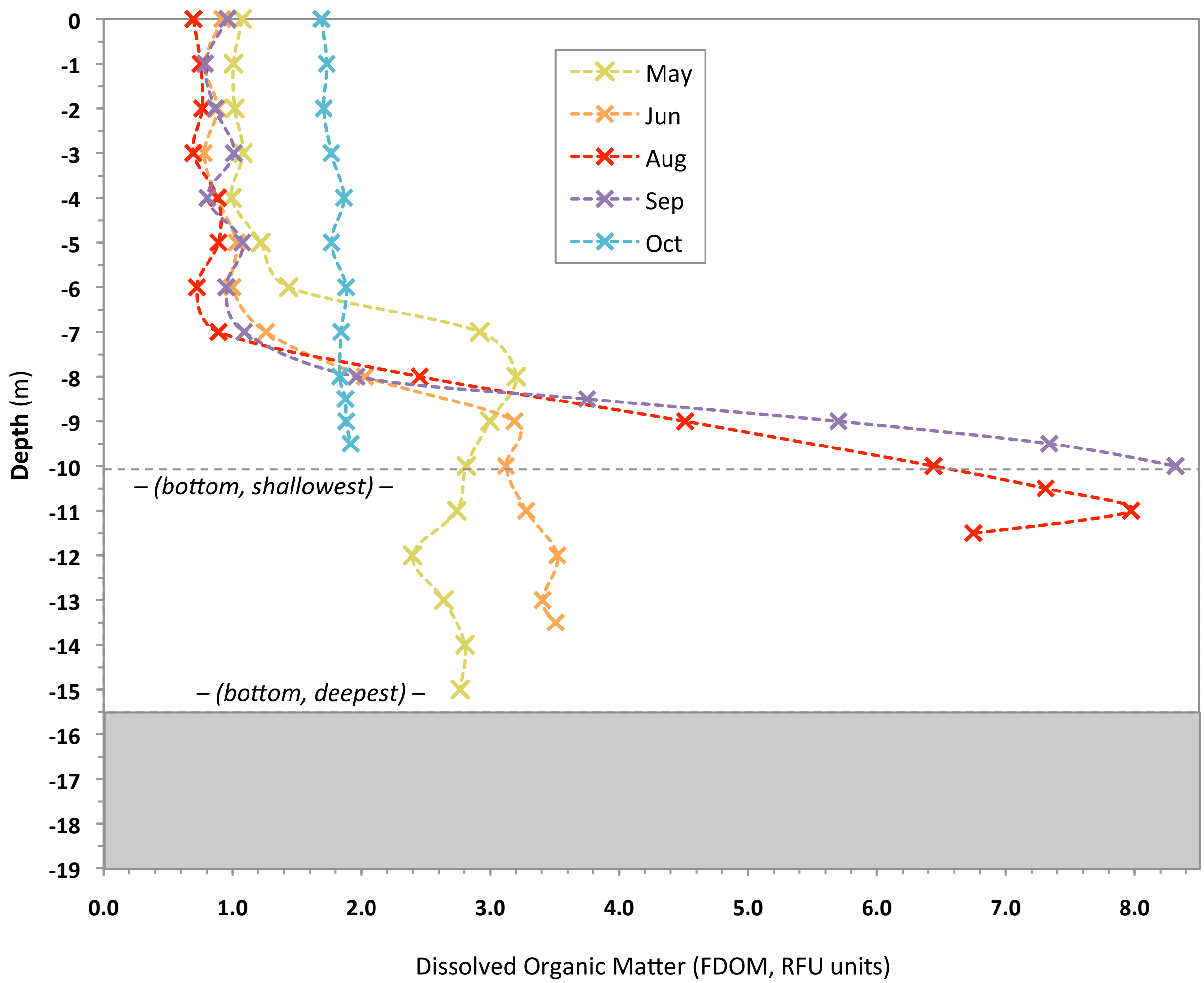


Figure 7(k). Syar – West Pond: 2021 May-Oct DISSOLVED ORGANIC MATTER

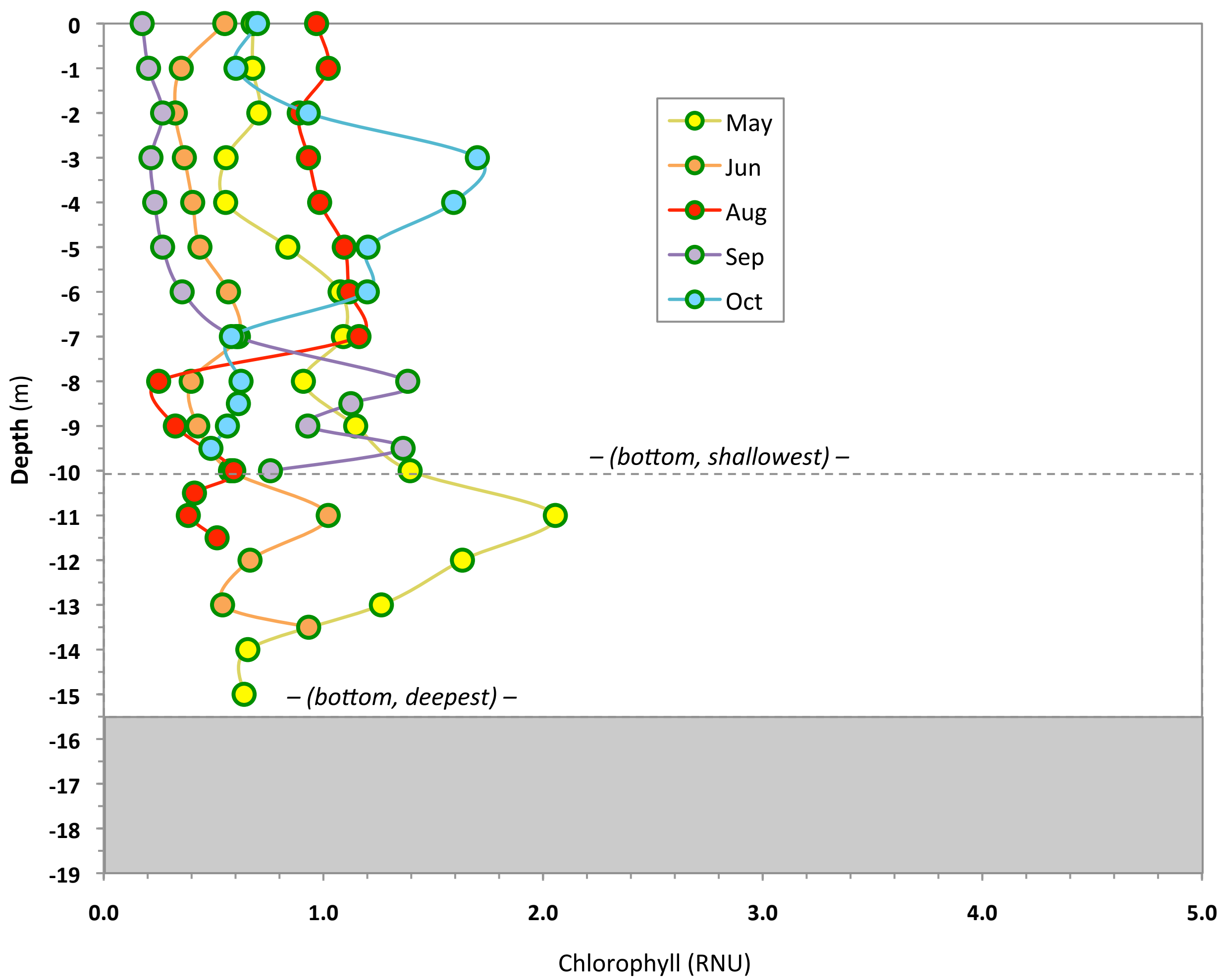


Figure 7(l). Syar – West Pond: 2021 May-Oct CHLOROPHYLL

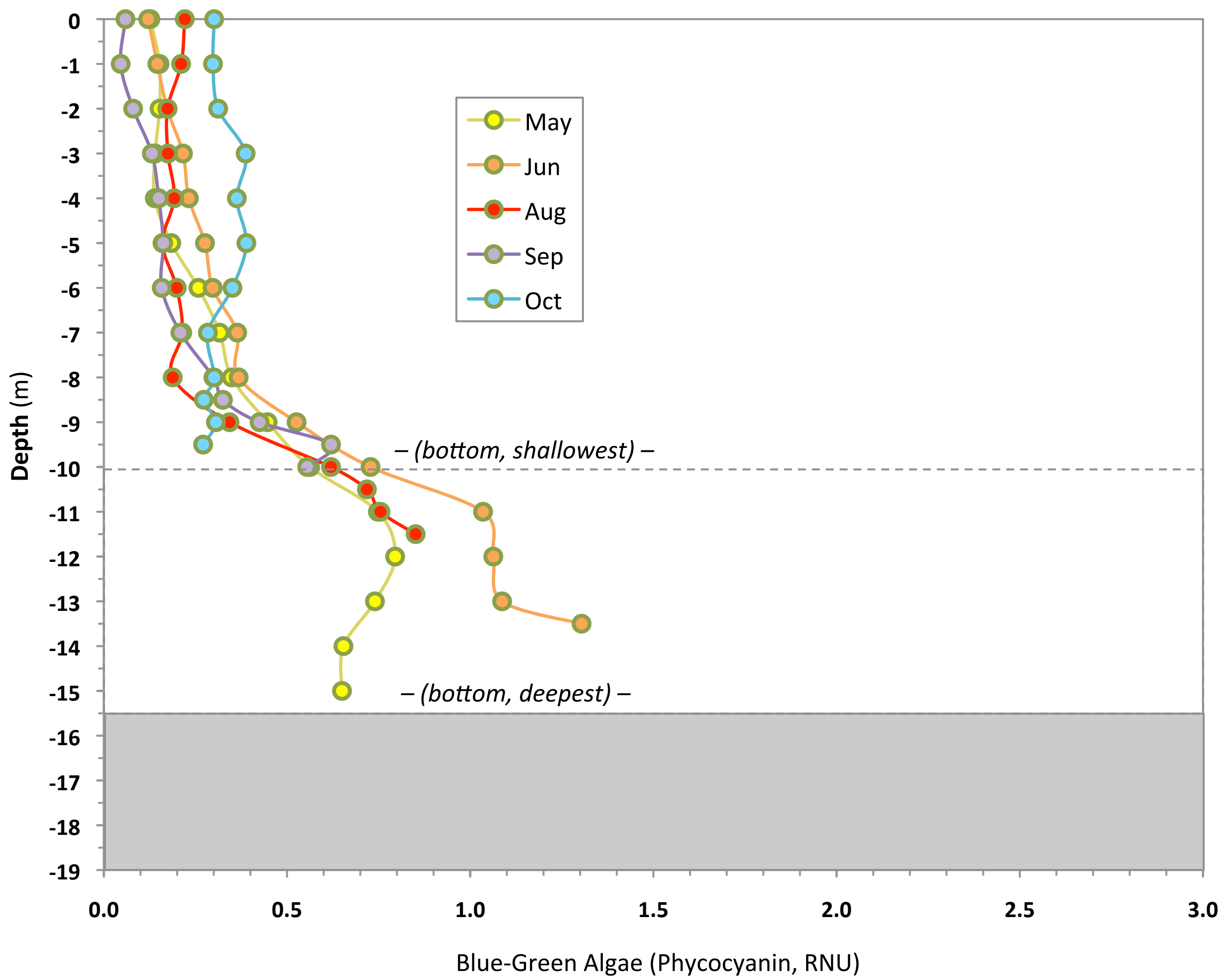


Figure 7(m). Syar – West Pond: 2021 BLUE-GREEN ALGAE

CONCLUSIONS

Table C below summarizes the 2021 water profiling data from all of the tested ponds. Many of the parameters fell within similar overall ranges. Turbidity (mainly sediment in the water) was most strongly tied to active mining or plant slurry water returns. The particle-based measures, including the algal parameters and turbidity, tended to accumulate near the bottom. Some of the greatest accumulations or changes were found in the lower water of ponds that stratified thermally. Most of the monitored ponds were too shallow to stratify completely (isolate water layers from each other) in the warm season but two, Teichert-Esparto–Reiff and Syar–B1, stratified enough for many of the measured water parameters to shift significantly, including oxygen, pH, and ORP, with deep accumulations of turbidity and algal cells.

Among the ponds identified as elevated in fish mercury – Syar-B1, Teichert-Esparto, Cemex-Phase 3, and Syar–West – there was not a single, consistent trend. The deep Syar–West pond was again found to be a site of strong seasonal water stratification and bottom water anoxia. The two most elevated ponds, Syar-B1 and Teichert-Esparto, have consistently shown evidence of seasonal water column anoxia (loss of oxygen). But that was not the case for the other elevated site, Cemex–Phase 3. However, the data provide some clues. In particular, there was notably higher salinity, dissolved solids, and conductivity (linked parameters) in the Cemex Phase 3 and Phase 4 ponds, and high water clarity / low suspended solids in Phase 3.

Seasonal bottom water anoxia was expected to be an important driver of increased methylmercury production and movement into fish in some of the ponds. That is because of the way methylmercury is produced. Methylmercury is almost entirely generated *biologically* – as a peripheral byproduct of the normal metabolism of important, naturally occurring microbes, mainly sulfur-reducers and iron-reducers. These microbes congregate just below the transition zone between oxygenated (oxic, aerobic) and anoxic conditions, where they obtain their energy by converting the oxidized forms of sulfur or iron (sulfate, ferric iron) to the reduced forms (hydrogen sulfide, ferrous iron). They do not purposely consume mercury or use it in any way. But mercury, if present, can move through their metabolic pathways – and be converted into toxic methylmercury, the form that bioaccumulates in organisms.

Table C. Summary Comparisons of 2021 Profiling Data From Each of the Tested Ponds
(ponds arranged left to right in general order of ascending fish mercury levels)

	T-Storz (1x, Aug)	Cem-1	Cem-4	Cem-3	Syar-W	Syar-B1	T-Esparto
Fish Mercury	**Not Elevated**	**Not Elevated**	Inconclusive	Elevated	Elevated	**Elevated**	**Elevated**
Active Mining?	–	–	**Yes**	–	–	–	–
Plant Slurry Inflows?	–	**Yes**	–	–	–	–	**Yes**
Pond Depth (range)	2.8 m (9 ft)	5.3-5.8 m (17-19 ft)	8.2-9.4 m (27-31 ft)	8.7-10.1 m (28-33 ft)	15.5–10.1 m (51–33 ft)	6.7–3.0 m (22–10 ft)	9.4–4.3 m (31–14 ft)
Water Clarity (avg)	1.5 m (5 ft)	1.4 m (5 ft)	3.2 m (11 ft)	6.8 m (22 ft)	6.6 m (22 ft)	2.1 m (7 ft)	1.3 m (4 ft)
Temp. Gradient (max btw top/bottom)	3.4 °C (6.1 °F)	3.8 °C (6.8 °F)	2.7 °C (4.9 °F)	5.6 °C (10.1 °F)	13.4 °C (24.1 °F)	3.2 °C (5.8 °F)	7.2 °C (13.0 °F)
Bottom Anoxia?	**NO**	**NO**	**NO**	**NO**	**YES**	Yes	**YES**
Conductivity (µS/cm)	934-1031	561-670	719-880	717-865	537-653	606-697	650-772
Salinity (ppt)	0.46-0.50	0.27-0.32	0.35-0.43	0.35-0.44	0.26-0.32	0.30-0.34	0.32-0.38
Tot Dis. Solids (mg/L)	607-670	365-436	467-572	466-580	349-425	394-453	422-502
pH	8.79-9.67	8.23-8.50	8.24-8.78	7.64-9.07	7.51-8.82	8.47-9.06	7.45-8.85
Ox.-Red. Pot. (mV)	137-171	45-199	5-152	25-177	27-109	-6-122	7-183
Turbidity (FNU)	1.30-2.71	1.63-42.4	0.63-19.3	0.05-1.94	0.05-2.45	0.87-12.5	3.38-18.5
Diss. Org. Mat. (RFU)	2.14-3.87	0.74-1.78	0.27-1.31	0.74-4.56	0.70-8.32	0.96-3.33	0.81-2.43
Chlorophyll (RFU)	1.23-9.55	0.09-0.38	0.08-0.64	0.13-16.8	0.18-2.06	0.17-8.21	0.06-2.63
Bl-Gr Algae (RFU)	0.25-1.09	0.04-0.47	0.05-0.42	0.06-1.65	0.05-1.30	0.13-0.85	0.05-0.57

Ordinarily, the oxic/anoxic transition zone and its associated natural microbes is located deep in the bottom sediments, below the pond water and below the sediment surface. Sediments beneath the transition to anoxia are typically black and have a 'rotten egg' (hydrogen sulfide) smell. When the oxic/anoxic transition zone is located deep in the sediments, any methylmercury that is produced there has a layer of oxic sediments between it and the pond water. Those sediments contain a tremendous number of potential binding sites that slow down or stop the transfer of the methylmercury into the overlying water. However, if the bottom water of the pond becomes anoxic, the oxic/anoxic transition zone moves up into the water itself – together with the mercury-methylating microbes. Under those conditions, any methylmercury that is produced can move directly into the aquatic food web.

For a water body to become seasonally anoxic in its bottom water, the bottom water must first become isolated from aerated surface layers. This normally occurs during the warm season, mainly in systems deeper than most of these ponds, when the surface approximately 6 m (20 ft) is warmed by the sun to temperatures well above that of the cool lower water. Water of different temperatures has different densities, and these are strongly resistant to mixing. This results in a warm season 'mixed surface layer' (by wind) and an isolated, cool hypolimnion (bottom waters). Warm season separation of the water column into non-mixing layers is called 'thermal stratification'. If there is a net consumption of dissolved oxygen in the hypolimnion during the time it is isolated (through normal metabolism by macro- and micro-organisms, just like we consume oxygen), the bottom water can eventually become anoxic. This will persist until the surface waters cool in the fall to a temperature and density matching the bottom layers, and strong winds can re-mix and aerate the entire water column. This annual phenomenon is known as 'fall turnover'. The water column then remains mixing and similar top to bottom until the following warm season. Long term, climate change can be expected to increase the seasonal surface warming of ponds/lakes in Yolo County, both in temperatures and duration, increasing the isolation of bottom waters and the development of seasonal anoxia.

Most of these aggregate-mining ponds – except for Syar–West – currently have depths and basin configurations that do not allow for the development of full thermal stratification across the warm season. If they did, as at Syar–West, the temperature profiles would show a nearly un-changing cool temperature in the bottom water from winter and throughout the summer, while the surface layers warmed. Instead, at the shallower ponds, the bottom temperatures eventually rose closer to surface levels, showing that there was at least occasional mixing from above. Despite this, the relatively smaller temperature gradients that persisted were enough to allow significant drops in dissolved oxygen at two of the shallow ponds – the same two that have the highest fish mercury levels (Teichert-Esparto–Reiff and Syar–B1). The deep Syar-West Pond, with full seasonal stratification and bottom water anoxia, was identified last year as another elevated fish-mercury site. In contrast, at the low fish-mercury Cemex-Phase 1 Pond, there was no seasonal anoxia. These four cases were all consistent with the factor of deep water anoxia correlating with elevated fish mercury, and vice-versa.

However, the Cemex–Phase 3-4 Pond was also an elevated fish mercury site, but it continued to show no sign of bottom anoxia. This illustrates the complex, potentially multi-factor nature of mercury cycling in aquatic systems. All of these ponds occupy former depositional zones impacted by historic mercury mining upstream in the watershed; all contain sediment inorganic mercury at concentrations and bioavailabilities sufficient to lead to problem levels of methylmercury production and movement into fish – under certain conditions. Seasonal bottom water anoxia appears to be one important factor.

Additionally, the observed differences in general water clarity (Secchi disk visibility) were almost certainly linked to differences in fish bioaccumulation of methylmercury. However, there are multiple factors linked to water clarity, some of which can influence the cycle in opposite directions. Low clarity / highly turbid water, which by definition contains a lot of suspended particles, also contains a lot of alternate binding sites for methylmercury, potentially making it less available for uptake into the food web. However, low clarity / high turbidity also acts to block sunlight from reaching below the top meter or two of water, shutting down algal photosynthesis and the production of dissolved oxygen. This can accelerate the development of bottom water anoxia and methylmercury production. In contrast, high clarity / low turbidity water, which contains fewer suspended particles, has far fewer alternate binding sites for methylmercury to be deflected to. Even if the total amount of aqueous methylmercury is lower in a clearwater system, the lack of competing binding sites can result in a higher proportion of it accumulating in the food web. In a competing effect, though, high water clarity also brings sunlight, photosynthesis, and oxygen production to much greater depths, potentially all the way to the bottom of some of these relatively shallow ponds, keeping bottom water oxygenated and driving methylmercury production down into the sediments. Additionally, methylmercury can be broken down or 'de-methylated' by ultraviolet light, the component of sunlight that gives us sunburns and degrades things left out in the sun. With high water clarity, this can become an important methylmercury removal process, a 'natural remediation'. In contrast, at the very turbid ponds with slurry inflows, sunlight-based de-methylation of mercury is blocked. It is likely that these and additional related effects played a role in the differences seen in ultimate mercury accumulations in fish of the different ponds. After mining and reclamation is completed, many of the current ponds can be expected to become clearer water systems, which will affect these processes.

We went into detail here about some of the many processes that can be in effect – around this single issue of water clarity – to give you a sense of how the methylmercury cycle can be complex, sometimes confusing, and often different in different aquatic systems. Rather than being a straightforward function of physical chemistry, it also hinges on biological processes, each with its own set of factors.

At this point in the water profiling program, seasonal bottom water anoxia – or its absence – appears to be an important link to the observed fish mercury trends. Since seasonal anoxia is known to enhance the production of methylmercury and its movement into fish, management approaches that disrupt that pattern may reduce the problem. This is something to consider for ponds identified as elevated in fish mercury and requiring management. The profiling results to-date support management approaches that could provide summer mixing and the disruption of bottom water anoxia – specifically for ponds that require mercury management and that have seasonal anoxia. The case of Cemex–Phase 3 Pond though, with elevated fish mercury but no seasonal anoxia, is a reminder that there may not be any single 'magic bullet' management approach; different approaches may be needed at different sites. Many different physical, chemical, and biological factors can influence the mercury cycle in each pond. Seasonal anoxia is the most straightforward one to tackle – when it is present. When it isn't, and fish mercury is still elevated, other mechanisms will need to be identified for possible alternate management approaches. This water column profiling is an important step to better understand the options.

REFERENCES CITED

Slotton, D.G., and S.M. Ayers. (2018-2020). Cache Creek Off-Channel Aggregate Mining Ponds – *(Annual Water Profiling Reports, 2018-2020). Reports for Yolo County*. 53-118 pp.

Slotton, D.G., and S.M. Ayers. (2015-2021). Cache Creek Off-Channel Aggregate Mining Ponds – *(Annual Fish Mercury Monitoring Reports, 2015-2021). Reports for Yolo County*. 61-135 pp.

Slotton, D.G. 2021. Lower Cache Creek Off-Channel Mining – Mercury Monitoring Protocols, 2021 Revision. *Document for Yolo County*, April 2021, 21 pp.

Yolo County Code, Title 10. Chapter 5 (Surface Mining Reclamation), Section 10.5.517 – Mercury Bioaccumulation in Fish. 2019 Revision.