**CACHE CREEK OFF-CHANNEL**
**AGGREGATE MINING PONDS –**

# 2020

# WATER COLUMN PROFILING

**FINAL Report**


*Monitoring and Report by*

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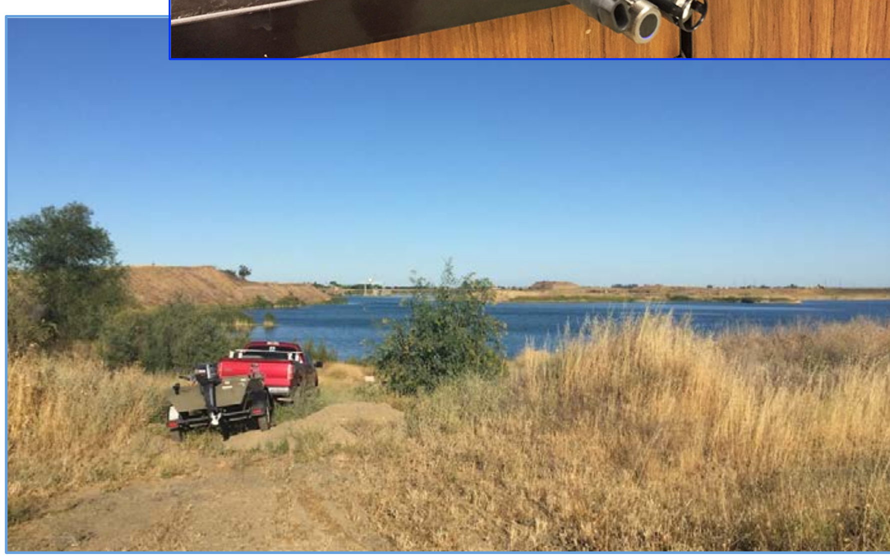

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## SUMMARY BULLET POINTS

- Water testing was conducted in 2020 at five Yolo County off-channel, aggregate-mining ponds. These were all ponds currently being monitored for fish mercury, per County Ordinance. Three ponds were identified as significantly elevated in fish mercury in 3 or more years, relative to Cache Creek comparison samples. These were Syar-B1, Teichert-Reiff, and Cemex-Phase 3-4. A fourth pond, Cemex-Phase 1, was also chosen for water testing, as a relatively low-mercury Control site. Water testing began at these 4 ponds in 2018, 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. A fifth pond, Syar-West, was added to the water profiling in 2019, to test a deeper system representative of future restoration plans at several of the sites.

**<u>Water Profiling Summary – All Sites, 2015-2020</u>**

<table>
<tr><th><u>Pit Sites</u></th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th></tr>
<tr><td>Cemex – Phase 1 (control)</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Cemex – Phase 3-4</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Teichert-Esparto – Reiff</td><td></td><td></td><td></td><td>✓</td><td>✓</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></tr>
<tr><td>Syar – B1</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Syar – West (deep control)</td><td></td><td></td><td></td><td></td><td>✓</td><td>✓</td></tr>
</table>

- 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 late October. 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).

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

- 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 6 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 pond, the control site Cemex–Phase 1, 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, turbid (cloudy water) from processing plant slurry discharges, and fairly well-mixed with similar water temperatures top to bottom. There was little temperature stratification, and no bottom anoxia. 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 3-4** Pond, an identified 'elevated fish mercury' pond, was found in 2020 to be of moderate depth (10-11 m / 32-35 ft) and moderate water clarity (1.5-5.5 m / 5-23 ft. Formerly one of the clearest water ponds in the larger eastern basin (Phase 4) where the index station is, visibilities decreased as mining shifted to that area. A strong temperature stratification began to develop in May, but this quickly broke down and the pond remained well mixed for the rest of the year, despite its depth. This was likely due to its long east-west dimension allowing wind energy to reach the bottom. The active mining also contributes to water column mixing. Because of the mixing, there was no summer stratification and no bottom anoxia, as in previous years. On the one date when there was a stratification (May), the water was clear enough to allow light penetration, algal photosynthesis, and oxygen production all the way to the bottom; rather than anoxia, there was a buildup of oxygen. Dissolved organic matter and water column algae were all in low-moderate ranges. This particular pond may be challenging for mercury management, as the elevated fish mercury here is not linked to oxygen levels in the bottom water. The pond did differ from the other monitored ponds though, in having higher salinity, dissolved solids, and conductivity. During 2020 this site was gradually divided, with a constructed berm between the Phase 3 and Phase 4 parts. Future profiling will be done in both ponds.

- **Teichert–Esparto** Pond: The levees dividing the former Teichert-Esparto – Reiff and Mast Ponds were purposely breached by Teichert in 2020, creating a single larger pond. Reiff Pond was identified as highly elevated in fish mercury, and continues to be considered 'elevated over baseline' in this new, expanded pond configuration. The deepest part of the combined pond was moderately deep across 2020, at about 11 m (35 feet), deeper than the former separate Reiff Pond. Water clarity remained very low/turbid, at 0.5-1.7 m (1.6-5.6 ft), blocking sunlight, algal photosynthesis, and oxygen production at depths below the near-surface. A temperature stratification developed through the summer, peaking in August. With no deep oxygen production to replace oxygen naturally lost to biotic metabolism, bottom water oxygen levels dropped essentially to zero, 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, from September on. This seasonal cycle presents a clear mercury management option, through disruption of summer anoxia.

- The **Syar–B1** Pond, one of the ponds identified as significantly 'elevated over baseline' in fish mercury, was found in 2020 to be of medium depth (8-9 m / 26-31 ft), inactive (re mining) and fairly clear, similar to previous years. High surrounding berms give some protection from wind mixing, and a very light stratification of the water column was seen, though less than in other years. Bottom waters, though not going fully anoxic this year, became significantly reduced in oxygen during much of the warm season, likely enhancing methylmercury exposure levels as in other years. This pond, like the Teichert-Esparto Pond, may also get mercury management benefits from disruption of summer oxygen depletion. The 2020 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 this year. It has been monitored since 2019 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. This was found to be the case. 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 October. This 'classic warm season thermal stratification' pattern at Syar–West makes it a straightforward candidate pond for a possible 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 Ordinance (Yolo County Code, 2019 – recently updated) 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-Esparto – Reiff (now part of Teichert-Esparto Pond), and Cemex-Phase 3-4. 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 chemical and physical constituents measured in the water columns of the ponds are detailed below in Methods.

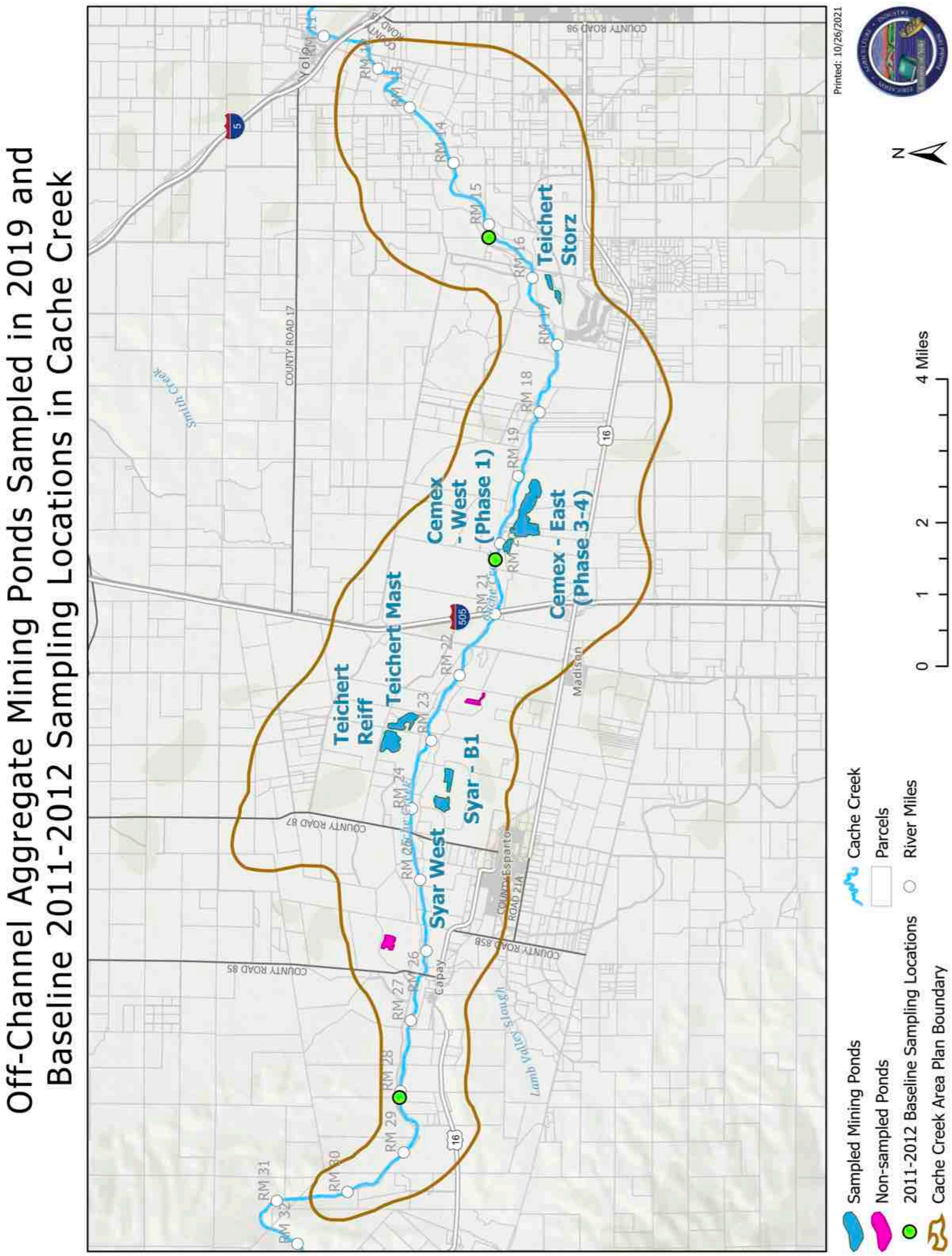
For each of the profiled ponds and each survey date (5 total between May and October), a table of the survey data is presented, together with a figure depicting the water column with several key, foundational parameters including temperature, dissolved oxygen, maximum depth, and Secchi water clarity. Then, for each pond, water column profiles are shown of individual parameters across all 5 surveys in May-October 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 | 2018 |
| **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 | – |
| **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, 2015-2020

| Pit Sites | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Cemex – Phase 1 | ≤ | ≤ | ≤ | ≤ | ≤ | ≤ |
| Cemex – Phase 3-4 | > | > | > | > | > | ≤ |
| Teichert-Esparto – Reiff | INC | > | > | > | > | > |
| Teichert-Esparto – Mast | | | > | INC | > | |
| Teichert-Woodland – Storz | | | INC | ≤ | ≤ | ≤ |
| Syar – B1 | > | > | > | > | > | > |
| Syar – West | | | > | ≤ | > | > |

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

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

| Pit Sites | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Cemex – Phase 1 *(control)* | | | | ✓ | | |
| Cemex – Phase 3-4 | | | | ✓ | | |
| Teichert-Esparto – Reiff | | | | ✓ | | |
| Teichert-Esparto – Mast | | | | | | |
| Teichert-Woodland – Storz | | | | | | |
| Syar – B1 | | | | ✓ | | |
| Syar – West *(deep control)* | | | | ✓ | | |

### Reports Completed

| Report | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Fish Mercury Monitoring | Final | Final | Final | Final | Final | Draft |
| **Water Column Profiling** | | | | Final | Final | Draft |
| Bottom Sediments (1x) | | | | Final | | |

## METHODS

Water column profiling was conducted from our sampling boat, 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. 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 2020 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, turbid (cloudy water) from processing plant slurry discharges, and fairly well-mixed with similar water temperatures top to bottom. There was little temperature stratification, and no bottom anoxia. 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 2020 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.

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Water Depth (Tables and Figs. 1(a-e)): ranged narrowly between 5.5 and 6.3 m (18-21 ft) across the 2020 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 1.6-2.4 m (5-8 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 developed between May and September, with surface waters warming 1.2-2.7 °C (2-5 °F) warmer than bottom water. However, the increases in bottom water temperatures during 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. The water column became fully mixed (low/no gradient between surface and bottom temperatures) by October, with cool temperatures top to bottom.

Dissolved Oxygen (Tables and Figs. 1(a-e), Fig. 1(g)): remained at or above saturation levels throughout the season, between 8.6 and 10.3 mg/L (ppm). This corresponded to between 98% and 131% 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 narrowly between 654 and 717 µS/cm overall. Levels were quite uniform through the water column, but changing together with time.

Salinity (Tables 1(a-e)): was nearly unchanging, at 0.32-0.35 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 narrowly between 425-465 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 fell between 8.07 and 8.92 across all depths and dates in 2020. Levels increased (more basic) across the summer, then decreased to lowest levels by late October.

Oxidation/Reduction Potential (ORP) (Tables 1(a-e)): stayed within the range of 48-124 mV (millivolts) across all depths and dates, similar to previous years.

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 23 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 0.3 and 2.0 RFU, with lowest levels in May (0.4-0.6 RFU), highest in June (1.3-2.0 RFU), and similar intermediate levels at all depths from August to October (1.1-1.5 RFU).

Green Algae (Chlorophyll) (Tables 1(a-e), Fig. 1(l)): Similar to last year, 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 0.30 RFU (0.06-0.27 RFU).

Blue-Green Algae (Phycocyanin) (Tables 1(a-e), Fig. 1(m)): were present at levels similar to the green algae Across all depths and dates, Phycocyanin ranged between 0.07-0.45 RFU. Levels were similar top to bottom on most dates, changing together over time.

**Table 1(a). Cemex – Phase 1 Pond: 2020 Water Column Profiling Data**
**MAY 2:** max. depth 5.5 m (18 ft); Secchi disk water clarity: 2.4 m (7.9 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** | 22.8 | 9.66 | 113% | 717 | 0.35 | 466 | 8.39 | 124 |
| **1** | 22.3 | 9.81 | 113% | 716 | 0.35 | 465 | 8.35 | 121 |
| **2** | 22.0 | 9.88 | 113% | 715 | 0.35 | 465 | 8.31 | 120 |
| **3** | 21.7 | 9.88 | 113% | 715 | 0.35 | 465 | 8.30 | 120 |
| **4** | 21.5 | 9.86 | 112% | 715 | 0.35 | 465 | 8.28 | 120 |
| **5** | 21.3 | 9.95 | 113% | 714 | 0.35 | 464 | 8.27 | 121 |

*(additional parameters next page)*

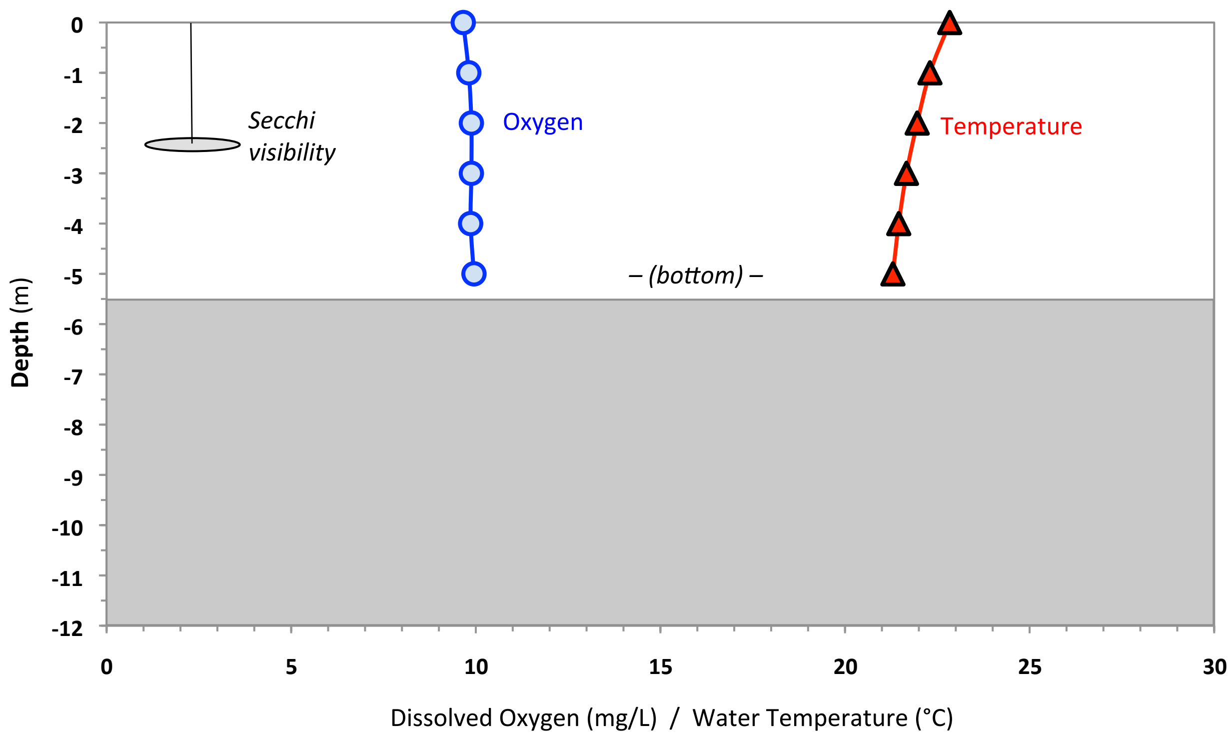


**Figure 1(a). MAY 2, 2020 – Phase 1 Pond framework parameters**

**Table 1(a).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**MAY 2:** max. depth 5.5 m (18 ft); Secchi disk water clarity: 2.4 m (7.9 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** | 22.8 | 9.66 | 113% | 0.78 | 0.46 | 0.23 | 0.07 |
| **1** | 22.3 | 9.81 | 113% | 3.98 | 0.37 | 0.26 | 0.15 |
| **2** | 22.0 | 9.88 | 113% | 6.41 | 0.41 | 0.22 | 0.22 |
| **3** | 21.7 | 9.88 | 113% | 8.16 | 0.57 | 0.25 | 0.25 |
| **4** | 21.5 | 9.86 | 112% | 9.71 | 0.54 | 0.27 | 0.32 |
| **5** | 21.3 | 9.95 | 113% | 9.68 | 0.63 | 0.20 | 0.28 |

**Table 1(b). Cemex – Phase 1 (West) Pond: 2020 Water Column Profiling Data**
**<u>JUN 16</u>**: max. depth 5.8 m (19 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** | 24.6 | 9.53 | 115% | 654 | 0.32 | 425 | 8.58 | 119 |
| **1** | 24.6 | 9.55 | 115% | 654 | 0.32 | 425 | 8.58 | 120 |
| **2** | 24.3 | 9.51 | 114% | 654 | 0.32 | 425 | 8.57 | 120 |
| **3** | 23.8 | 9.49 | 113% | 654 | 0.32 | 425 | 8.57 | 121 |
| **4** | 23.5 | 9.39 | 111% | 656 | 0.32 | 427 | 8.53 | 123 |
| **5** | 23.3 | 9.27 | 109% | 657 | 0.32 | 427 | 8.51 | 124 |

*(additional parameters next page)*

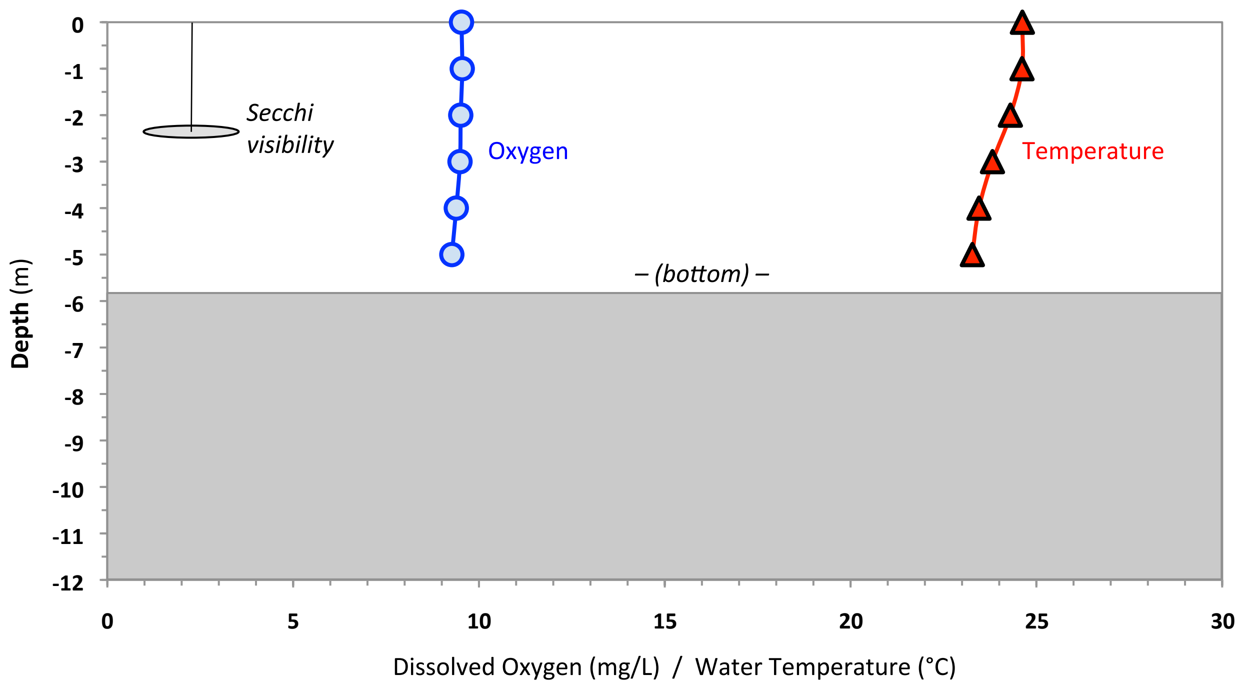


**Figure 1(b). JUN 16, 2020 – Phase 1 Pond framework parameters**

**Table 1(b).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**JUN 16**: max. depth 5.8 m (19 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** | 24.6 | 9.53 | 115% | 1.86 | 1.29 | 0.23 | 0.17 |
| **1** | 24.6 | 9.55 | 115% | 1.79 | 1.36 | 0.21 | 0.15 |
| **2** | 24.3 | 9.51 | 114% | 1.98 | 1.65 | 0.20 | 0.16 |
| **3** | 23.8 | 9.49 | 113% | 2.67 | 1.96 | 0.09 | 0.14 |
| **4** | 23.5 | 9.39 | 111% | 9.03 | 1.63 | 0.09 | 0.20 |
| **5** | 23.3 | 9.27 | 109% | 10.43 | 1.73 | 0.08 | 0.17 |

**Table 1(c). Cemex – Phase 1 (West) Pond: 2020 Water Column Profiling Data**
**AUG 3:** max. depth 6.3 m (21 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** | 27.6 | 10.30 | 131% | 660 | 0.32 | 429 | 8.85 | 73 |
| **1** | 27.1 | 9.36 | 118% | 664 | 0.32 | 432 | 8.80 | 74 |
| **2** | 26.8 | 9.16 | 115% | 665 | 0.32 | 433 | 8.77 | 76 |
| **3** | 26.3 | 9.01 | 112% | 666 | 0.32 | 433 | 8.77 | 78 |
| **4** | 26.1 | 8.91 | 110% | 666 | 0.32 | 433 | 8.73 | 81 |
| **5** | 26.0 | 8.89 | 110% | 665 | 0.32 | 432 | 8.72 | 83 |
| **6.0** | 25.9 | 8.71 | 107% | 665 | 0.32 | 433 | 8.68 | 86 |

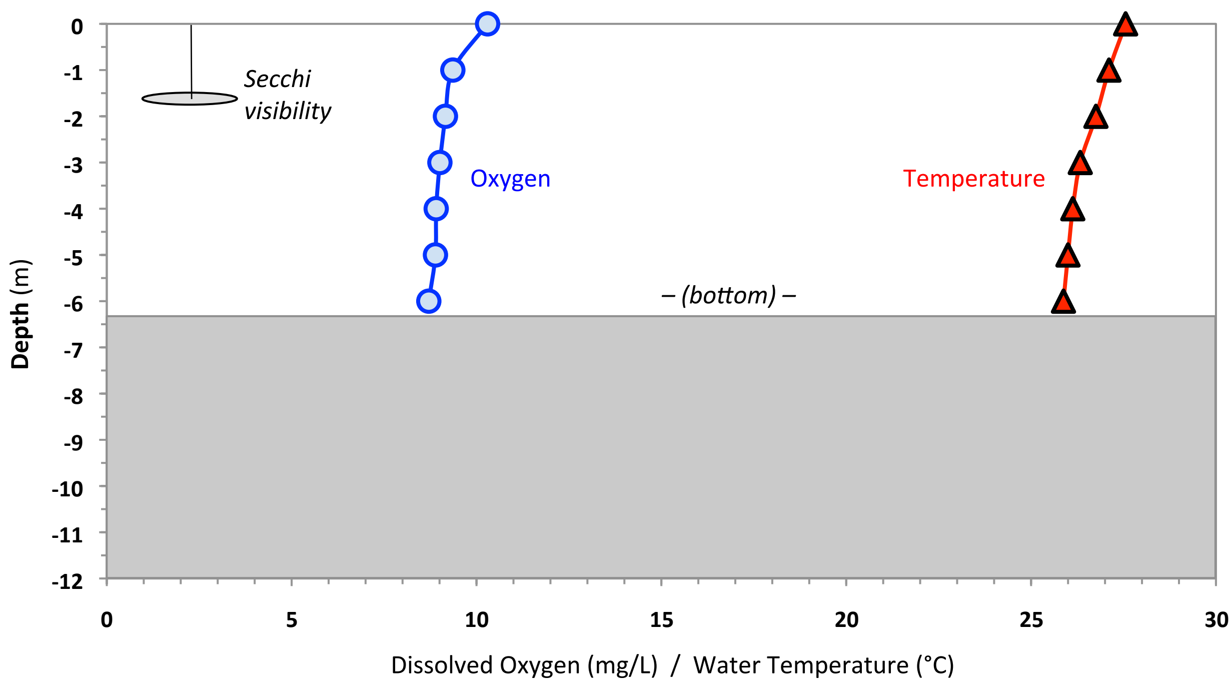


**Figure 1(c). AUG 3, 2020 – Phase 1 Pond framework parameters**

**Table 1(c).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**AUG 3:** max. depth 6.3 m (21 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** | 27.6 | 10.30 | 131% | 3.37 | 1.17 | 0.12 | 0.32 |
| **1** | 27.1 | 9.36 | 118% | 4.72 | 1.10 | 0.18 | 0.37 |
| **2** | 26.8 | 9.16 | 115% | 9.24 | 1.36 | 0.18 | 0.39 |
| **3** | 26.3 | 9.01 | 112% | 12.30 | 1.23 | 0.20 | 0.43 |
| **4** | 26.1 | 8.91 | 110% | 16.91 | 1.13 | 0.18 | 0.40 |
| **5** | 26.0 | 8.89 | 110% | 15.09 | 1.30 | 0.14 | 0.41 |
| **6.0** | 25.9 | 8.71 | 107% | 23.18 | 1.22 | 0.18 | 0.44 |

**Table 1(d). Cemex – Phase 1 (West) Pond: 2020 Water Column Profiling Data**
**SEP 20:** max. depth 6.2 m (20.5 ft); Secchi disk water clarity: 1.8 m (5.9 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** | 23.1 | 9.23 | 108% | 682 | 0.33 | 443 | 8.92 | 54 |
| **1** | 23.1 | 9.22 | 108% | 682 | 0.33 | 443 | 8.76 | 50 |
| **2** | 22.9 | 9.26 | 108% | 682 | 0.33 | 443 | 8.70 | 49 |
| **3** | 22.5 | 9.03 | 105% | 682 | 0.33 | 443 | 8.63 | 48 |
| **4** | 22.3 | 9.02 | 104% | 683 | 0.33 | 444 | 8.60 | 48 |
| **5** | 22.0 | 8.67 | 99% | 684 | 0.33 | 444 | 8.57 | 49 |
| **5.8** | 21.9 | 8.58 | 98% | 684 | 0.33 | 445 | 8.54 | 49 |

*(additional parameters next page)*

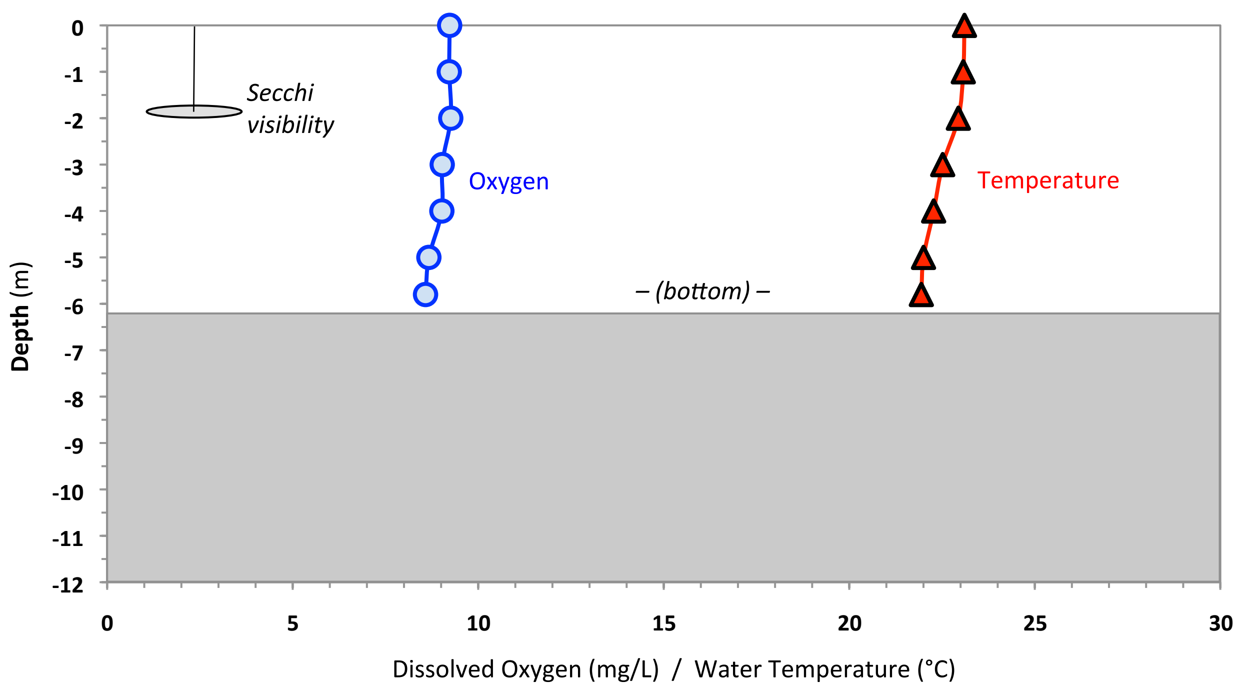


**Figure 1(d). SEP 20, 2020 – Phase 1 Pond framework parameters**

**Table 1(d).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**SEP 20:** max. depth 6.2 m (20.5 ft); Secchi disk water clarity: 1.8 m (5.9 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** | 23.1 | 9.23 | 108% | 2.23 | 1.25 | 0.06 | 0.08 |
| **1** | 23.1 | 9.22 | 108% | 2.32 | 1.17 | 0.06 | 0.14 |
| **2** | 22.9 | 9.26 | 108% | 2.03 | 1.36 | 0.07 | 0.15 |
| **3** | 22.5 | 9.03 | 105% | 1.61 | 1.37 | 0.09 | 0.15 |
| **4** | 22.3 | 9.02 | 104% | 3.61 | 1.45 | 0.12 | 0.20 |
| **5** | 22.0 | 8.67 | 99% | 4.09 | 1.43 | 0.12 | 0.21 |
| **5.8** | 21.9 | 8.58 | 98% | 4.61 | 1.40 | 0.09 | 0.21 |

**Table 1(e). Cemex – Phase 1 (West) Pond: 2020 Water Column Profiling Data**
**OCT 26:** max. depth 5.9 m (19.5 ft); Secchi disk water clarity: 2.2 m (7.2 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** | 15.8 | 10.16 | 103% | 675 | 0.33 | 439 | 8.15 | 55 |
| **1** | 15.8 | 10.17 | 103% | 675 | 0.33 | 439 | 8.13 | 54 |
| **2** | 15.8 | 10.15 | 103% | 675 | 0.33 | 439 | 8.11 | 53 |
| **3** | 15.8 | 10.15 | 103% | 675 | 0.33 | 439 | 8.10 | 53 |
| **4** | 15.8 | 10.14 | 103% | 675 | 0.33 | 439 | 8.09 | 52 |
| **5** | 15.8 | 10.14 | 103% | 675 | 0.33 | 439 | 8.08 | 51 |
| **5.5** | 15.8 | 10.15 | 103% | 675 | 0.33 | 439 | 8.07 | 49 |

*(additional parameters next page)*

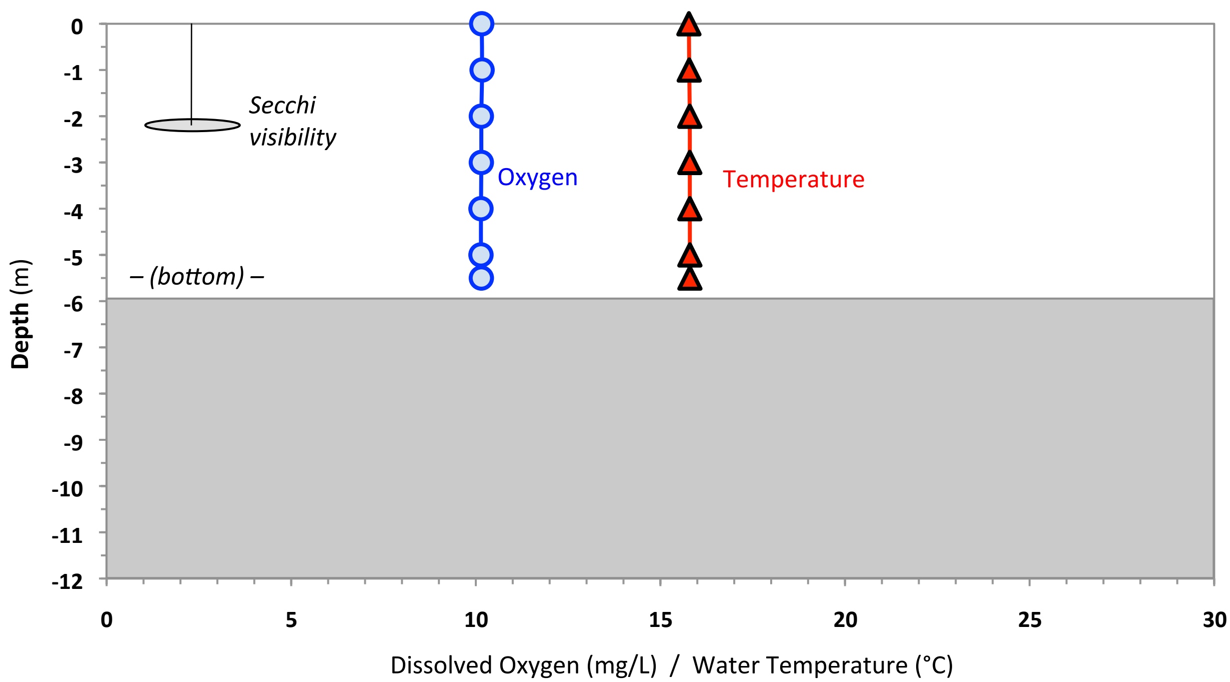


**Figure 1(e). OCT 26, 2020 – Phase 1 Pond framework parameters**

**Table 1(e).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**OCT 26:** max. depth 5.9 m (19.5 ft); Secchi disk water clarity: 2.2 m (7.2 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** | 15.8 | 10.16 | 103% | 2.80 | 1.18 | 0.26 | 0.41 |
| **1** | 15.8 | 10.17 | 103% | 2.84 | 1.17 | 0.26 | 0.44 |
| **2** | 15.8 | 10.15 | 103% | 2.85 | 1.23 | 0.23 | 0.45 |
| **3** | 15.8 | 10.15 | 103% | 2.87 | 1.25 | 0.22 | 0.45 |
| **4** | 15.8 | 10.14 | 103% | 2.82 | 1.21 | 0.21 | 0.45 |
| **5** | 15.8 | 10.14 | 103% | 2.86 | 1.10 | 0.20 | 0.44 |
| **5.5** | 15.8 | 10.15 | 103% | 2.93 | 1.18 | 0.22 | 0.39 |

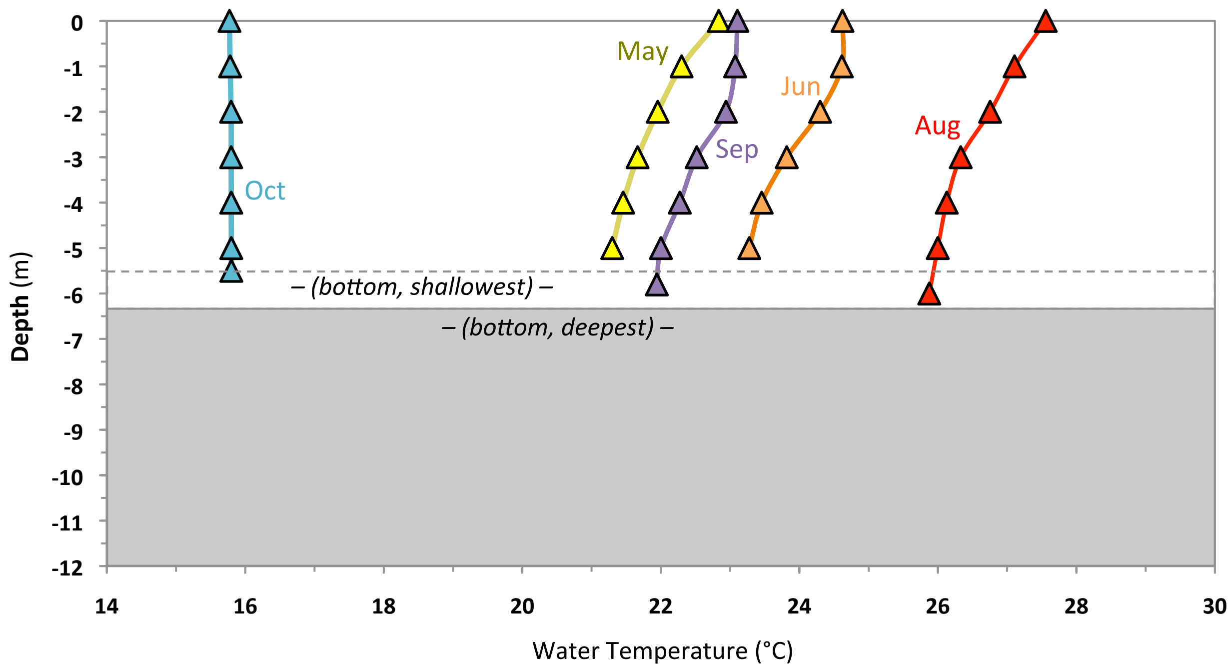


**Figure 1(f). Cemex – Phase 1 Pond: 2020 May-Oct TEMPERATURE**

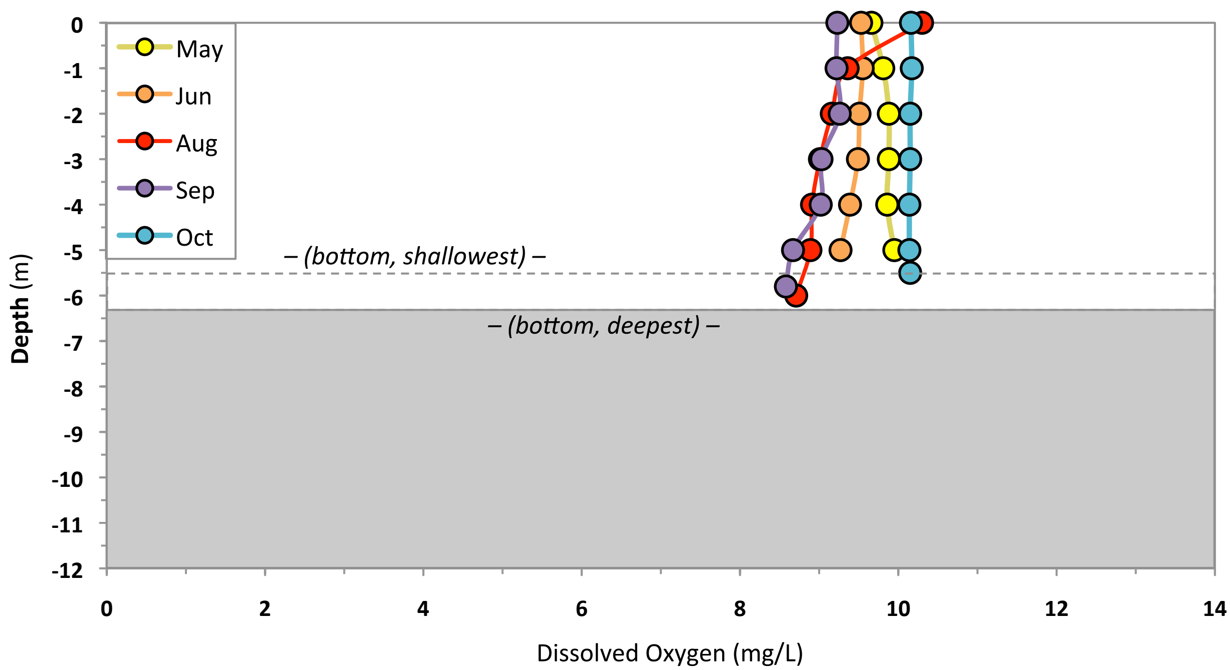


**Figure 1(g). Cemex – Phase 1 Pond: 2020 May-Oct OXYGEN**

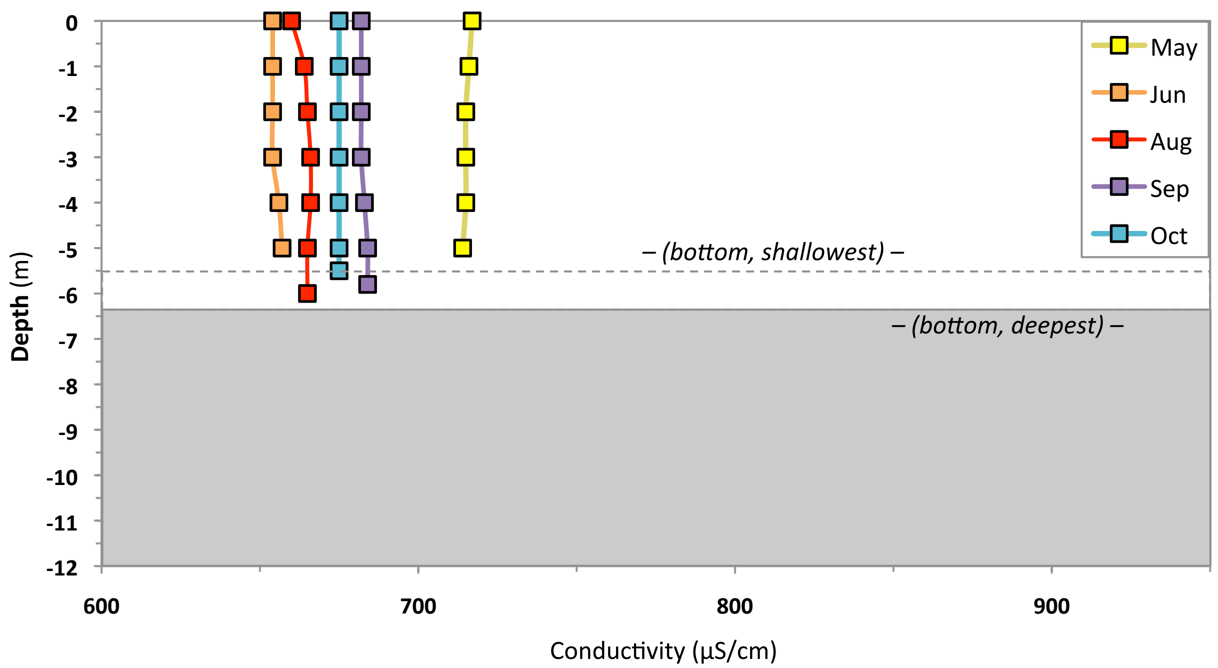


**Figure 1(h). Cemex – Phase 1 Pond: 2020 May-Oct CONDUCTIVITY**

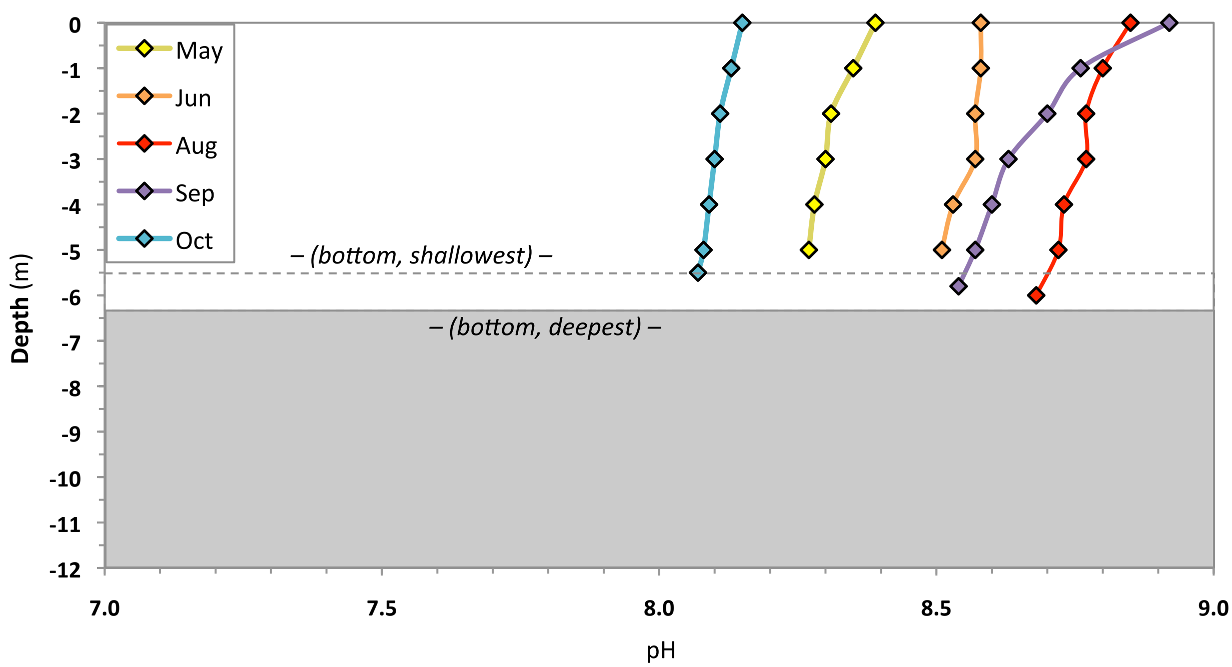


**Figure 1(i). Cemex – Phase 1 Pond: 2020 May-Oct pH**

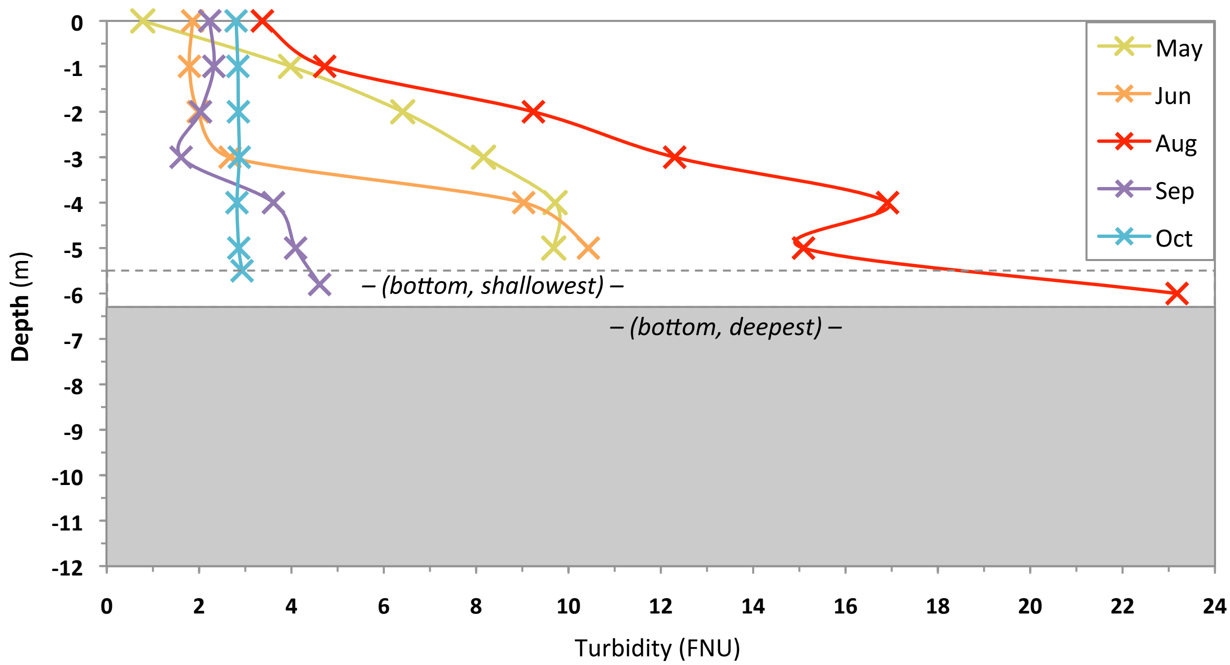


**Figure 1(j). Cemex – Phase 1 Pond: 2020 May-Oct TURBIDITY**

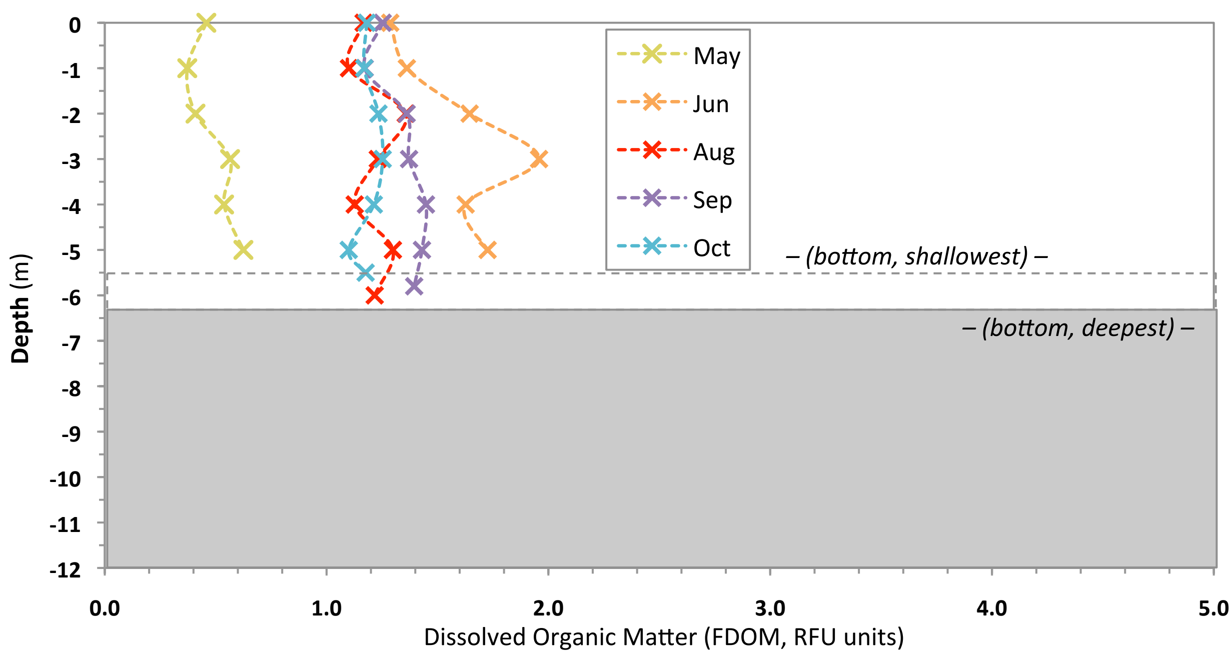


**Figure 1(k). Cemex – Phase 1 Pond: 2020 DISSOLVED ORGANIC MATTER**

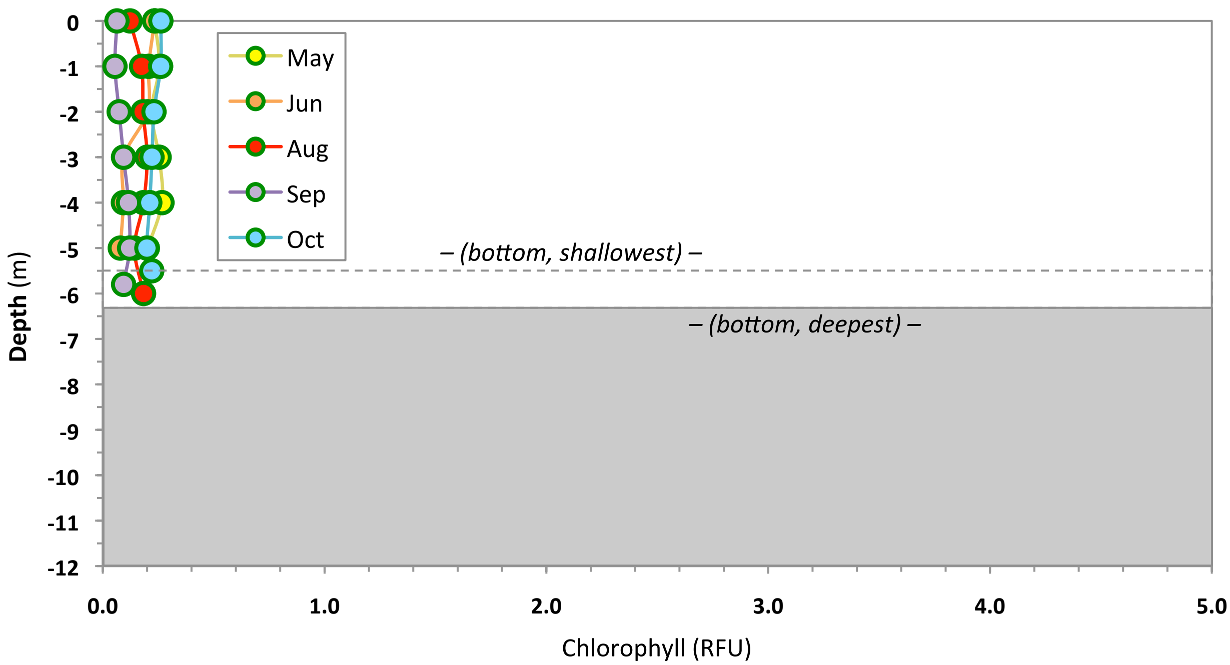


**Figure 1(l). Cemex – Phase 1 Pond: 2020 May-Oct CHLOROPHYLL**

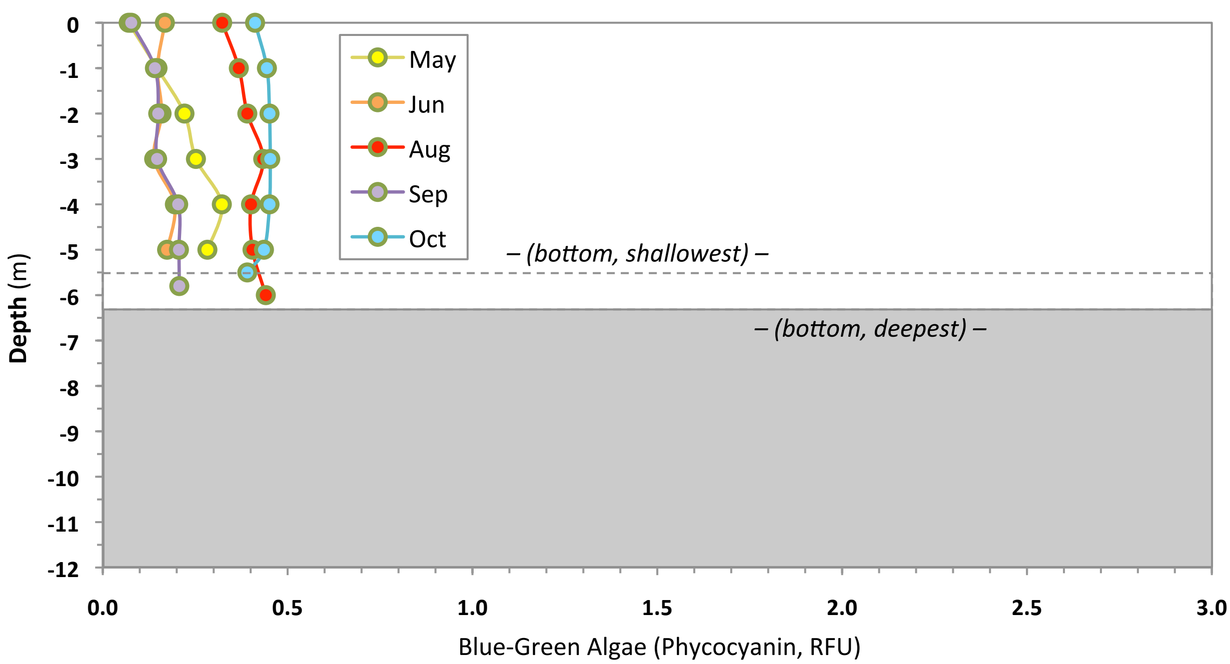


**Figure 1(m). Cemex – Phase 1 Pond: 2020 May-Oct BLUE-GREEN ALGAE**

## 2. CEMEX–PHASE 3-4 POND


*(Google Earth 10/21/2020)*

## 2. Cemex–Phase 3-4 Pond

**In summary,** the Cemex–Phase 3-4 Pond, an identified 'elevated fish mercury' pond, was found in 2020 to be of moderate depth (10-11 m / 32-35 ft) and moderate water clarity (1.5-5.5 m / 5-23 ft. Formerly one of the clearest water ponds in the larger eastern basin (Phase 4) where the index station is, visibilities decreased as mining shifted to that area. A strong temperature stratification began to develop in May, but this quickly broke down and the pond remained well mixed for the rest of the year, despite its depth. This was likely due to its long east-west dimension allowing wind energy to reach the bottom. The active mining also contributes to water column mixing. Because of the mixing, there was no summer stratification and no bottom anoxia, as in previous years. On the one date when there was a stratification (May), the water was clear enough to allow light penetration, algal photosynthesis, and oxygen production all the way to the bottom; rather than anoxia, there was a buildup of oxygen. Dissolved organic matter and water column algae were all in low-moderate ranges. This particular pond may be challenging for mercury management, as the elevated fish mercury here is not linked to oxygen levels in the bottom water. The pond did differ from the other monitored ponds though, in having higher salinity, dissolved solids, and conductivity. During 2020 this site was gradually divided, with a constructed berm between the Phase 3 and Phase 4 parts. Future profiling will be done in both ponds.

The Phase 3-4 Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2020 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).

In 2020, a dividing berm was gradually built across this pond, eventually separating it into two parts, as can be seen in the October 2020 Google Earth photo above. Routine water column profiling in 2020 continued at the existing index site in the Phase 4 section during this gradual conversion. Beginning in 2021, both parts will be tested.

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 and in summary.

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Water Depth (Tables and Figs. 2(a-e): ranged between 9.9 and 10.7 m (32-35 ft) maximum depth across the 2020 May-Oct profiling.

Secchi Water Clarity (Tables and Figs. 2(a-e): was again variable this year, ranging from a low of 1.5 m (5 feet) to a high of 5.5 m (23 feet). This was a function of mining activity in the east basin (where the water is profiled), as compared to dates before mid-2019, when mining was confined to the west end.

Temperature (Tables and Figs. 2(a-e), Fig. 2(f)): Overall range 17-28 °C (63-82 °F) between May and October. Despite the greater depth of this pond, as compared to the Phase 1 Pond, the temperature data show a very similar trend. A thermal stratification began to develop in May, with surface waters warming to 5.3 °C (9.5 °F) higher than the bottom water. But this degraded in June and beyond, with the bottom water temperature increasing to levels close to those at the surface. This indicated frequent mixing of the water column, likely a function of the long east-west dimension letting wind energy reach to the bottom. The whole water column cooled between August and October, continuing to remain well mixed.

Dissolved Oxygen (Tables and Figs. 2(a-e), Fig. 2(g)): in May through August was at or above saturation levels ("super-saturated") at all depths, between 8.6 and 18.4 mg/L (ppm), which corresponded to 102-190% of saturation. Most of these levels were 'super-saturated', due to algal photosynthesis when the water was relatively clear (Secchi visibility 1.5-5.5 m = 5-18 ft). Oxygen depletion in the bottom waters never developed, as the water column remained fairly well mixed and not stratifying significantly during the warm season after May. Additionally, the clear water allowed oxygen-generating photosynthesis all the way to the bottom. In fact, in May when there was a temperature stratification, the *opposite* of oxygen depletion occurred (Fig. 2(g)) and higher oxygen levels built up toward the bottom. From June on, the temperature profiles show the water column was well mixed; the oxygen profiles became consistent top to bottom.

Conductivity (Tables 2(a-e), Fig. 2(h)): ranged narrowly between 858 and 919 μS/cm overall. Levels were somewhat lower at depth in May, and were then somewhat lower and very uniform throughout the water column in August through October. Overall conductivity levels in the Phase 3-4 Pond remained the highest across all the ponds monitored.

Salinity (Tables 2(a-e): was very uniform at 0.42-0.45 ppt (parts per thousand, g/L) across all depths and sampling dates. This was the most saline among the ponds monitored. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 2(a-e): ranged narrowly between 552 and 598 mg/L (ppm). As with the related parameters of conductivity and salinity, these were higher levels than found in the other monitored ponds.

pH (Tables 2(a-e), Fig. 2(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 3-4 Pond was similar top to bottom on each date, shifting together over time. May pH (8.26-8.43) became more basic in June (8.56-8.63) and August (8.98-9.26), then decreased in September (8.62-8.84) and October (8.14-8.16). The overall pH range of 8.14-9.26 across all depths and dates varied a bit wider than in prior years.

Oxidation/Reduction Potential (ORP) (Tables 2(a-e): between May and August ranged from 71-128 mV (millivolts) across all depths. September and October levels were lower, at 31-36 mV.

Turbidity (Tables 2(a-e), Fig. 2(j)): ranged between 0.5 and 2.5 FNU on May-Sep profiling dates, with the whole water column more turbid with fall mixing in late October (4.6-5.2 FNU).

Dissolved Organic Matter (FDOM) (Tables 2(a-e), Fig. 2(k)): Levels were low, between 0.3 and 1.1 RFU in the top 7 m on all dates, and all the way to the 10+ m bottom between June and October. In early May, the bottom several meters showed small accumulations in the 1.1-1.6 RFU range, indicating a relative buildup there of decaying algal cells and other organic material.

Green Algae (Chlorophyll) (Tables 2(a-e), Fig. 2(l)): was uniformly low (0.18-0.56 RFU) and was generally consistent from top to bottom on each date. Within that range, levels were a bit higher in October.

Blue-Green Algae (Phycocyanin) (Tables 2(a-e), Fig. 2(m)): like Chlorophyll, was low from top to bottom throughout the season (0.05-0.50 RFU).

## Table 2(a). Cemex – Phase 3-4 Pond: 2020 Water Column Profiling Data

**MAY 2:** max. depth 10.7 m (35 ft); Secchi disk water clarity: 2.7 m (8.9 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** | 22.2 | 10.44 | 120% | 919 | 0.45 | 598 | 8.43 | 94 |
| **1** | 21.4 | 10.33 | 117% | 920 | 0.45 | 598 | 8.40 | 97 |
| **2** | 21.1 | 10.34 | 117% | 919 | 0.45 | 597 | 8.38 | 99 |
| **3** | 21.0 | 10.34 | 116% | 919 | 0.45 | 598 | 8.35 | 102 |
| **4** | 20.9 | 10.43 | 117% | 919 | 0.45 | 597 | 8.31 | 105 |
| **5** | 20.8 | 10.45 | 117% | 918 | 0.45 | 597 | 8.29 | 108 |
| **6** | 20.5 | 10.83 | 121% | 918 | 0.45 | 597 | 8.26 | 114 |
| **7** | 19.0 | 16.59 | 179% | 909 | 0.45 | 591 | 8.31 | 118 |
| **8** | 17.8 | 16.98 | 179% | 908 | 0.45 | 590 | 8.29 | 123 |
| **9** | 17.1 | 18.16 | 189% | 904 | 0.45 | 588 | 8.34 | 128 |
| **10** | 16.9 | 18.36 | 190% | 904 | 0.45 | 587 | 8.34 | 128 |

*(additional parameters next page)*

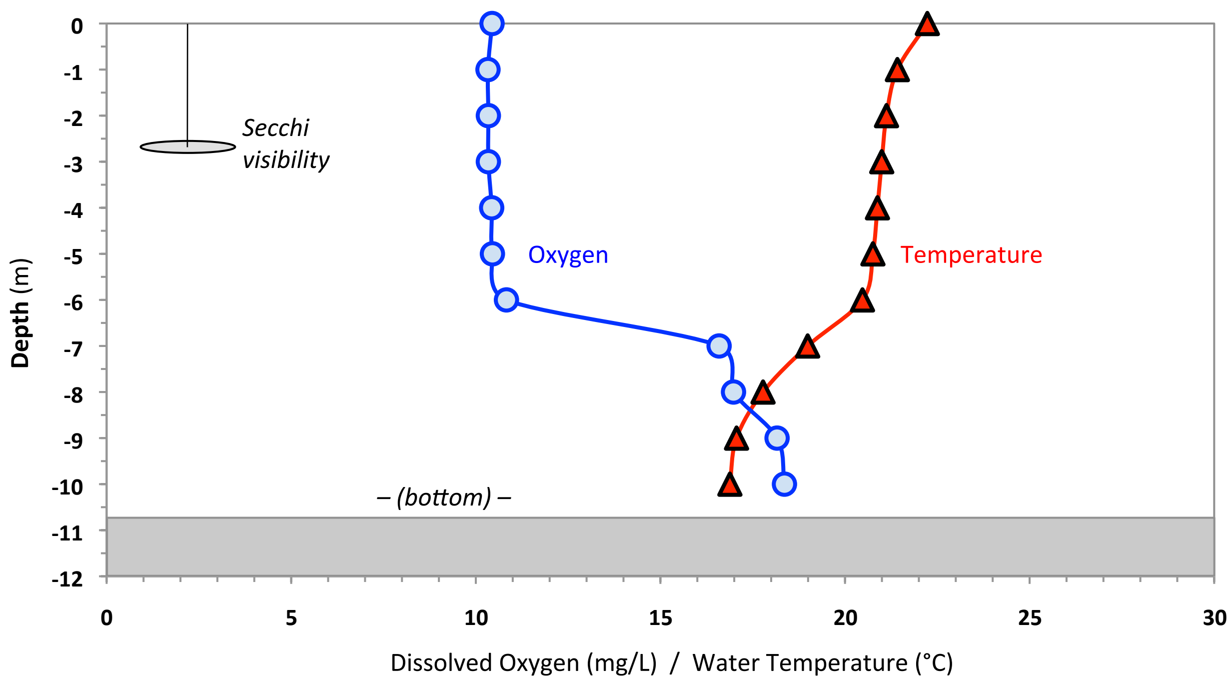


**Figure 2(a). MAY 2, 2020 – Phase 3-4 Pond framework parameters**

**Table 2(a).** ***(continued)* – OPTICAL PARAMETERS (with framework data for reference)**
**MAY 2:** max. depth 10.7 m (35 ft); Secchi disk water clarity: 2.7 m (8.9 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** | 22.2 | 10.44 | 120% | 1.35 | 0.48 | 0.18 | 0.16 |
| **1** | 21.4 | 10.33 | 117% | 1.47 | 0.33 | 0.22 | 0.20 |
| **2** | 21.1 | 10.34 | 117% | 1.51 | 0.48 | 0.27 | 0.24 |
| **3** | 21.0 | 10.34 | 116% | 1.69 | 0.43 | 0.25 | 0.29 |
| **4** | 20.9 | 10.43 | 117% | 1.62 | 0.37 | 0.28 | 0.31 |
| **5** | 20.8 | 10.45 | 117% | 1.63 | 0.58 | 0.35 | 0.31 |
| **6** | 20.5 | 10.83 | 121% | 1.58 | 0.57 | 0.38 | 0.35 |
| **7** | 19.0 | 16.59 | 179% | 1.10 | 1.10 | 0.35 | 0.40 |
| **8** | 17.8 | 16.98 | 179% | 0.90 | 1.29 | 0.47 | 0.50 |
| **9** | 17.1 | 18.16 | 189% | 0.91 | 1.41 | 0.59 | 0.46 |
| **10** | 16.9 | 18.36 | 190% | 0.86 | 1.55 | 0.43 | 0.50 |

**Table 2(b). Cemex – Phase 3-4 Pond: 2020 Water Column Profiling Data**
**JUN 16:** max. depth 10.4 m (34 ft); Secchi disk water clarity: 4.6 m (15.1 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** | 24.1 | 9.67 | 115% | 849 | 0.42 | 552 | 8.63 | 71 |
| **1** | 24.2 | 9.70 | 116% | 849 | 0.42 | 552 | 8.62 | 72 |
| **2** | 24.1 | 9.66 | 115% | 850 | 0.42 | 552 | 8.61 | 74 |
| **3** | 24.0 | 9.44 | 112% | 851 | 0.42 | 553 | 8.60 | 77 |
| **4** | 23.9 | 9.32 | 111% | 852 | 0.42 | 554 | 8.59 | 79 |
| **5** | 23.8 | 9.28 | 110% | 852 | 0.42 | 554 | 8.58 | 82 |
| **6** | 23.7 | 9.21 | 109% | 852 | 0.42 | 554 | 8.57 | 84 |
| **7** | 23.7 | 9.17 | 109% | 853 | 0.42 | 554 | 8.57 | 86 |
| **8** | 23.7 | 9.16 | 108% | 853 | 0.42 | 554 | 8.56 | 92 |
| **9** | 23.7 | 9.12 | 108% | 853 | 0.42 | 554 | 8.56 | 92 |
| **10** | 23.7 | 9.08 | 108% | 853 | 0.42 | 554 | 8.56 | 93 |

*(additional parameters next page)*

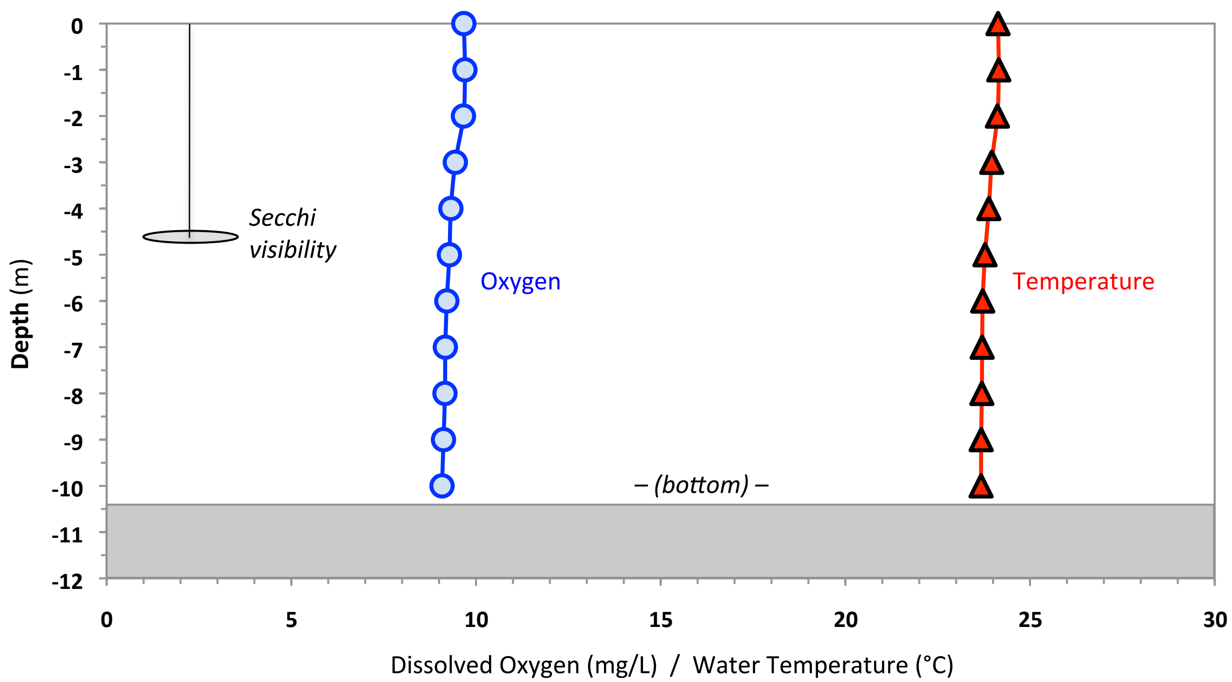


**Figure 2(b). JUN 16, 2020 – Phase 3-4 Pond framework parameters**

**Table 2(b).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**JUN 16:** max. depth 10.4 m (34 ft); Secchi disk water clarity: 4.6 m (15.1 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** | 24.1 | 9.67 | 115% | 0.59 | 0.85 | 0.33 | 0.05 |
| **1** | 24.2 | 9.70 | 116% | 0.59 | 1.01 | 0.36 | 0.08 |
| **2** | 24.1 | 9.66 | 115% | 0.60 | 0.82 | 0.35 | 0.11 |
| **3** | 24.0 | 9.44 | 112% | 0.77 | 0.88 | 0.38 | 0.09 |
| **4** | 23.9 | 9.32 | 111% | 1.15 | 1.09 | 0.43 | 0.12 |
| **5** | 23.8 | 9.28 | 110% | 1.34 | 1.14 | 0.49 | 0.14 |
| **6** | 23.7 | 9.21 | 109% | 2.12 | 1.02 | 0.52 | 0.13 |
| **7** | 23.7 | 9.17 | 109% | 2.36 | 0.99 | 0.55 | 0.17 |
| **8** | 23.7 | 9.16 | 108% | 2.41 | 1.04 | 0.53 | 0.17 |
| **9** | 23.7 | 9.12 | 108% | 2.43 | 0.97 | 0.54 | 0.12 |
| **10** | 23.7 | 9.08 | 108% | 2.34 | 0.90 | 0.53 | 0.13 |

**Table 2(c). Cemex – Phase 3-4 Pond: 2020 Water Column Profiling Data**
**AUG 3:** max. depth 10.4 m (34 ft); Secchi disk water clarity: 5.5 m (18 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** | 27.5 | 10.45 | 133% | 861 | 0.42 | 560 | 9.26 | 101 |
| **1** | 27.5 | 10.44 | 133% | 861 | 0.42 | 560 | 9.16 | 101 |
| **2** | 27.5 | 10.51 | 134% | 861 | 0.42 | 559 | 9.11 | 101 |
| **3** | 27.5 | 10.61 | 135% | 860 | 0.42 | 559 | 9.09 | 101 |
| **4** | 27.4 | 10.54 | 134% | 860 | 0.42 | 559 | 9.05 | 102 |
| **5** | 27.3 | 10.27 | 130% | 860 | 0.42 | 559 | 9.02 | 103 |
| **6** | 27.3 | 10.17 | 129% | 860 | 0.42 | 559 | 9.01 | 104 |
| **7** | 27.2 | 10.10 | 128% | 861 | 0.42 | 559 | 9.00 | 105 |
| **8** | 27.2 | 10.09 | 127% | 860 | 0.42 | 559 | 8.98 | 106 |
| **9** | 27.2 | 10.05 | 127% | 860 | 0.42 | 559 | 8.98 | 107 |
| **9.5** | 27.1 | 9.96 | 126% | 860 | 0.42 | 559 | 8.98 | 108 |

*(additional parameters next page)*

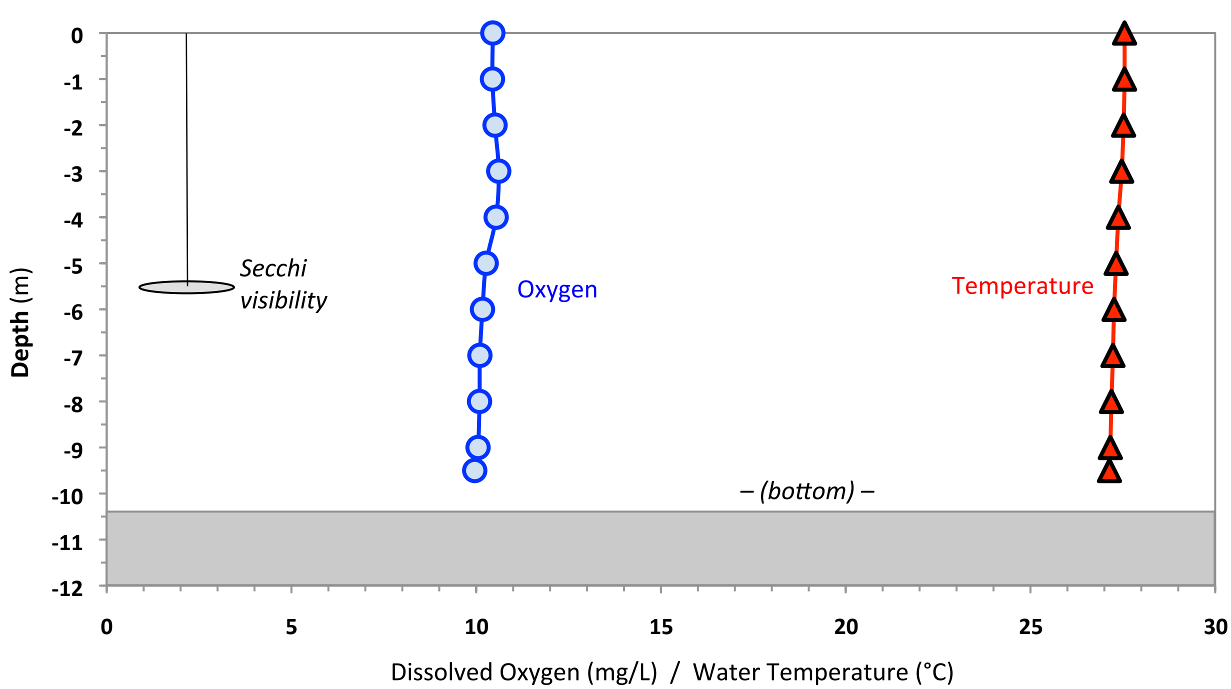


**Figure 2(c). AUG 3, 2020 – Phase 3-4 Pond framework parameters**

**Table 2(c).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**AUG 3:** max. depth 10.4 m (34 ft); Secchi disk water clarity: 5.5 m (18 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** | 27.5 | 10.45 | 133% | 1.08 | 0.41 | 0.37 | 0.15 |
| **1** | 27.5 | 10.44 | 133% | 1.06 | 0.31 | 0.40 | 0.19 |
| **2** | 27.5 | 10.51 | 134% | 1.07 | 0.49 | 0.42 | 0.20 |
| **3** | 27.5 | 10.61 | 135% | 1.06 | 0.35 | 0.37 | 0.18 |
| **4** | 27.4 | 10.54 | 134% | 1.11 | 0.45 | 0.32 | 0.22 |
| **5** | 27.3 | 10.27 | 130% | 1.00 | 0.53 | 0.40 | 0.22 |
| **6** | 27.3 | 10.17 | 129% | 1.04 | 0.52 | 0.40 | 0.23 |
| **7** | 27.2 | 10.10 | 128% | 1.04 | 0.41 | 0.42 | 0.22 |
| **8** | 27.2 | 10.09 | 127% | 1.11 | 0.56 | 0.39 | 0.24 |
| **9** | 27.2 | 10.05 | 127% | 1.16 | 0.57 | 0.35 | 0.21 |
| **9.5** | 27.1 | 9.96 | 126% | 1.20 | 0.53 | 0.39 | 0.26 |

**Table 2(d). Cemex – Phase 3-4 Pond: 2020 Water Column Profiling Data**
**SEP 20:** max. depth 10.1 m (33 ft); Secchi disk water clarity: 4.4 m (14.4 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** | 24.5 | 8.73 | 105% | 859 | 0.42 | 558 | 8.84 | 32 |
| **1** | 24.3 | 8.75 | 105% | 859 | 0.42 | 558 | 8.73 | 31 |
| **2** | 24.1 | 8.78 | 105% | 859 | 0.42 | 558 | 8.70 | 32 |
| **3** | 24.0 | 8.70 | 104% | 860 | 0.42 | 559 | 8.68 | 33 |
| **4** | 24.0 | 8.68 | 103% | 860 | 0.42 | 559 | 8.67 | 33 |
| **5** | 23.9 | 8.63 | 102% | 859 | 0.42 | 558 | 8.66 | 34 |
| **6** | 23.9 | 8.66 | 103% | 858 | 0.42 | 558 | 8.65 | 34 |
| **7** | 23.8 | 8.64 | 103% | 858 | 0.42 | 558 | 8.64 | 35 |
| **8** | 23.8 | 8.65 | 103% | 858 | 0.42 | 558 | 8.63 | 35 |
| **9** | 23.8 | 8.58 | 102% | 858 | 0.42 | 558 | 8.62 | 35 |

*(additional parameters next page)*

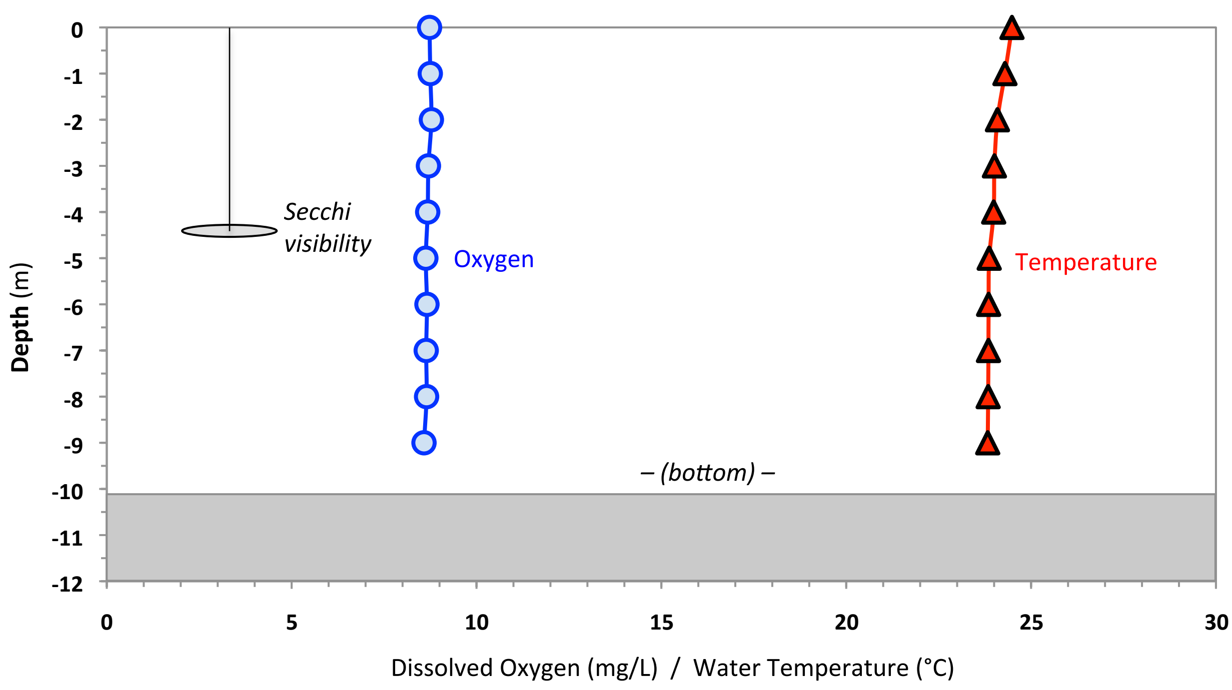


**Figure 2(d). SEP 20, 2020 – Phase 3-4 Pond framework parameters**

**Table 2(d).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**SEP 20:** max. depth 10.1 m (33 ft); Secchi disk water clarity: 4.4 m (14.4 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** | 24.5 | 8.73 | 105% | 0.56 | 0.89 | 0.24 | 0.05 |
| **1** | 24.3 | 8.75 | 105% | 0.67 | 1.02 | 0.30 | 0.12 |
| **2** | 24.1 | 8.78 | 105% | 0.92 | 0.88 | 0.33 | 0.19 |
| **3** | 24.0 | 8.70 | 104% | 1.21 | 0.92 | 0.31 | 0.16 |
| **4** | 24.0 | 8.68 | 103% | 1.27 | 0.88 | 0.33 | 0.15 |
| **5** | 23.9 | 8.63 | 102% | 1.08 | 1.13 | 0.22 | 0.15 |
| **6** | 23.9 | 8.66 | 103% | 1.07 | 1.12 | 0.20 | 0.14 |
| **7** | 23.8 | 8.64 | 103% | 1.03 | 1.12 | 0.23 | 0.15 |
| **8** | 23.8 | 8.65 | 103% | 1.09 | 1.06 | 0.21 | 0.13 |
| **9** | 23.8 | 8.58 | 102% | 1.20 | 1.04 | 0.25 | 0.13 |

**Table 2(e). Cemex – Phase 3-4 Pond: 2020 Water Column Profiling Data**
**OCT 26:** max. depth 9.9 m (32.5 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** | 17.5 | 9.62 | 101% | 872 | 0.43 | 567 | 8.16 | 36 |
| **1** | 17.5 | 9.61 | 101% | 872 | 0.43 | 567 | 8.16 | 36 |
| **2** | 17.5 | 9.60 | 101% | 873 | 0.43 | 567 | 8.16 | 35 |
| **3** | 17.6 | 9.60 | 101% | 872 | 0.43 | 567 | 8.15 | 35 |
| **4** | 17.5 | 9.59 | 101% | 873 | 0.43 | 567 | 8.15 | 35 |
| **5** | 17.5 | 9.60 | 101% | 873 | 0.43 | 567 | 8.15 | 35 |
| **6** | 17.5 | 9.61 | 101% | 873 | 0.43 | 567 | 8.15 | 35 |
| **7** | 17.5 | 9.62 | 101% | 873 | 0.43 | 567 | 8.15 | 35 |
| **8** | 17.5 | 9.61 | 101% | 873 | 0.43 | 567 | 8.15 | 35 |
| **9** | 17.6 | 9.60 | 101% | 872 | 0.43 | 567 | 8.15 | 35 |
| **9.5** | 17.6 | 9.59 | 101% | 873 | 0.43 | 567 | 8.14 | 36 |

*(additional parameters next page)*

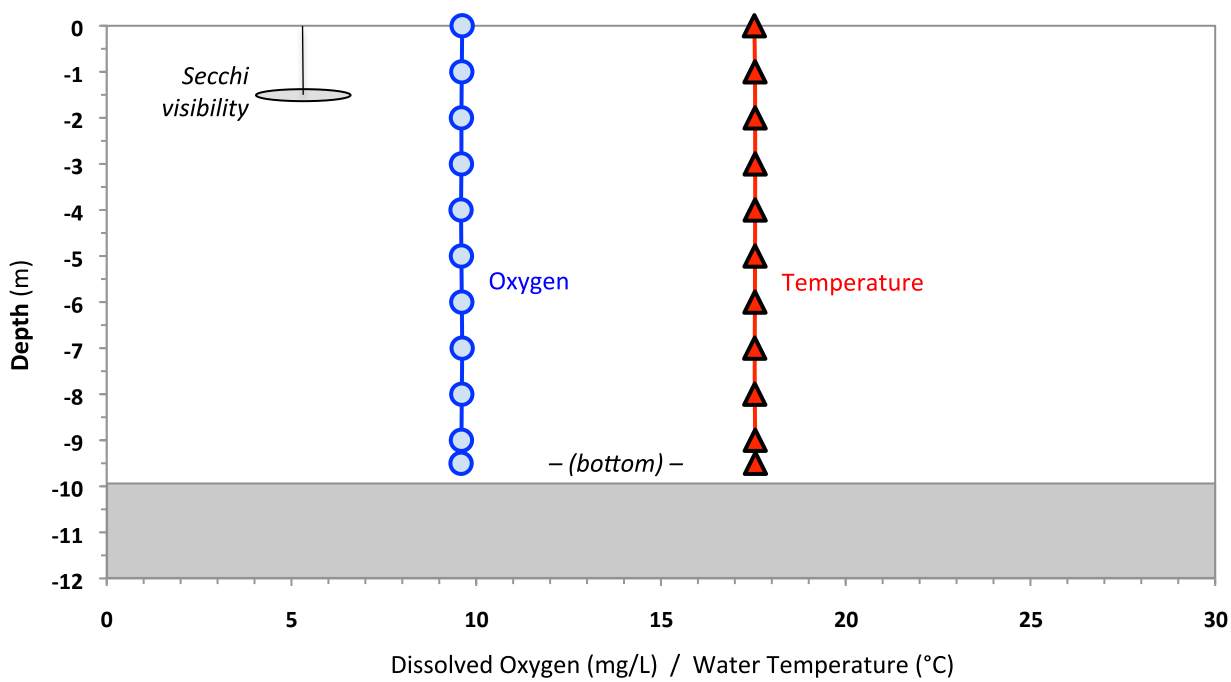


**Figure 2(e). OCT 26, 2020 – Phase 3-4 Pond framework parameters**

**Table 2(e).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**OCT 26:** max. depth 9.9 m (32.5 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** | 17.5 | 9.62 | 101% | 4.59 | 0.95 | 0.56 | 0.36 |
| **1** | 17.5 | 9.61 | 101% | 4.88 | 0.80 | 0.54 | 0.41 |
| **2** | 17.5 | 9.60 | 101% | 4.88 | 0.83 | 0.56 | 0.38 |
| **3** | 17.6 | 9.60 | 101% | 5.07 | 0.91 | 0.56 | 0.33 |
| **4** | 17.5 | 9.59 | 101% | 5.08 | 0.98 | 0.53 | 0.33 |
| **5** | 17.5 | 9.60 | 101% | 5.36 | 0.97 | 0.49 | 0.34 |
| **6** | 17.5 | 9.61 | 101% | 5.15 | 0.91 | 0.52 | 0.37 |
| **7** | 17.5 | 9.62 | 101% | 5.15 | 0.80 | 0.55 | 0.37 |
| **8** | 17.5 | 9.61 | 101% | 5.21 | 0.84 | 0.54 | 0.36 |
| **9** | 17.6 | 9.60 | 101% | 4.75 | 1.01 | 0.54 | 0.35 |
| **9.5** | 17.6 | 9.59 | 101% | 4.68 | 0.83 | 0.54 | 0.37 |

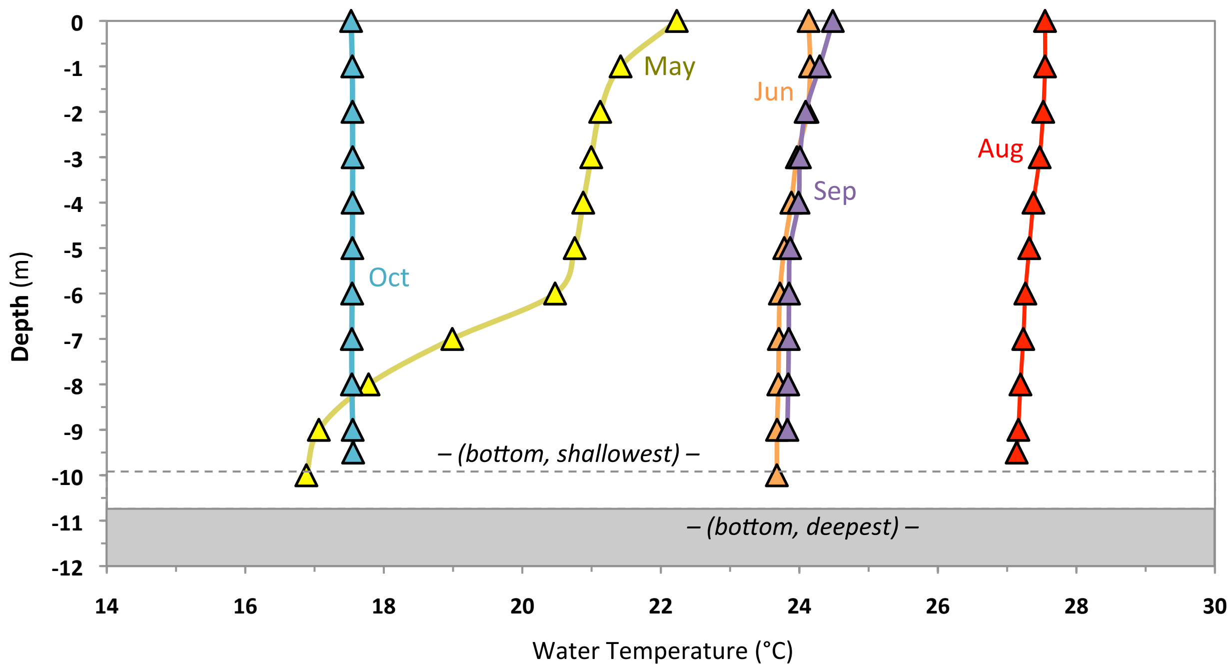


**Figure 2(f). Cemex – Phase 3-4 Pond: 2020 May-Oct TEMPERATURE**

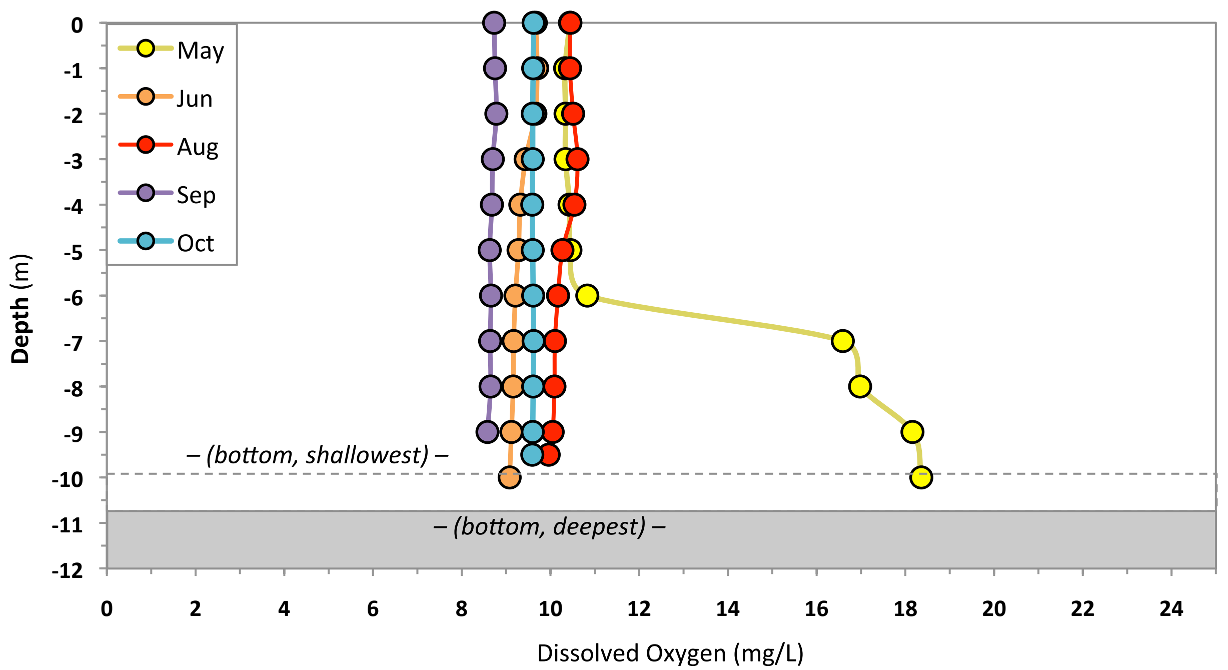


**Figure 2(g). Cemex – Phase 3-4 Pond: 2020 May-Oct OXYGEN**

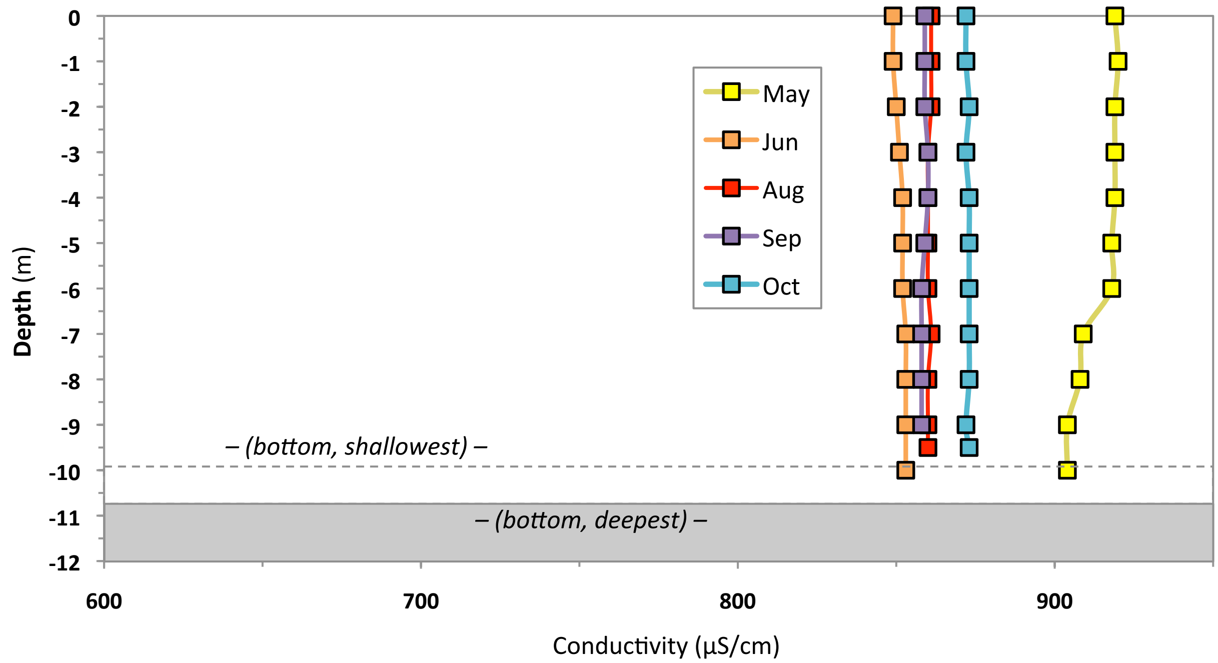


**Figure 2(h). Cemex – Phase 3-4 Pond: 2020 May-Oct CONDUCTIVITY**

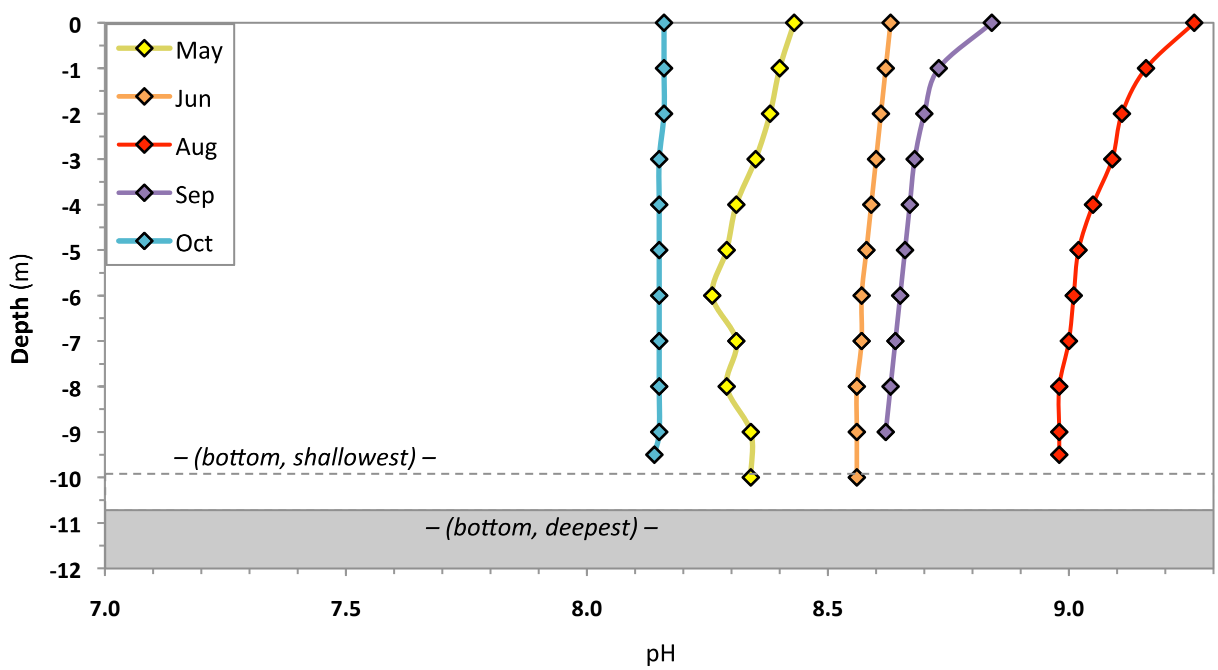


**Figure 2(i). Cemex – Phase 3-4 Pond: 2020 May-Oct pH**

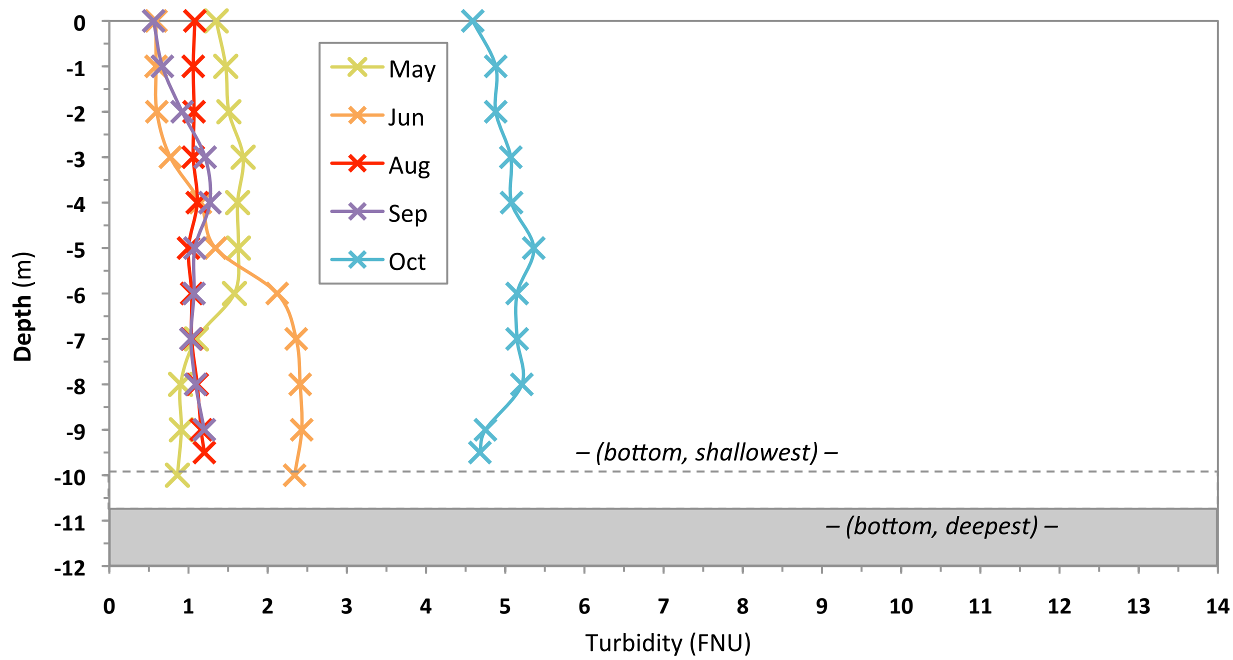


**Figure 2(j). Cemex – Phase 3-4 Pond: 2020 May-Oct TURBIDITY**

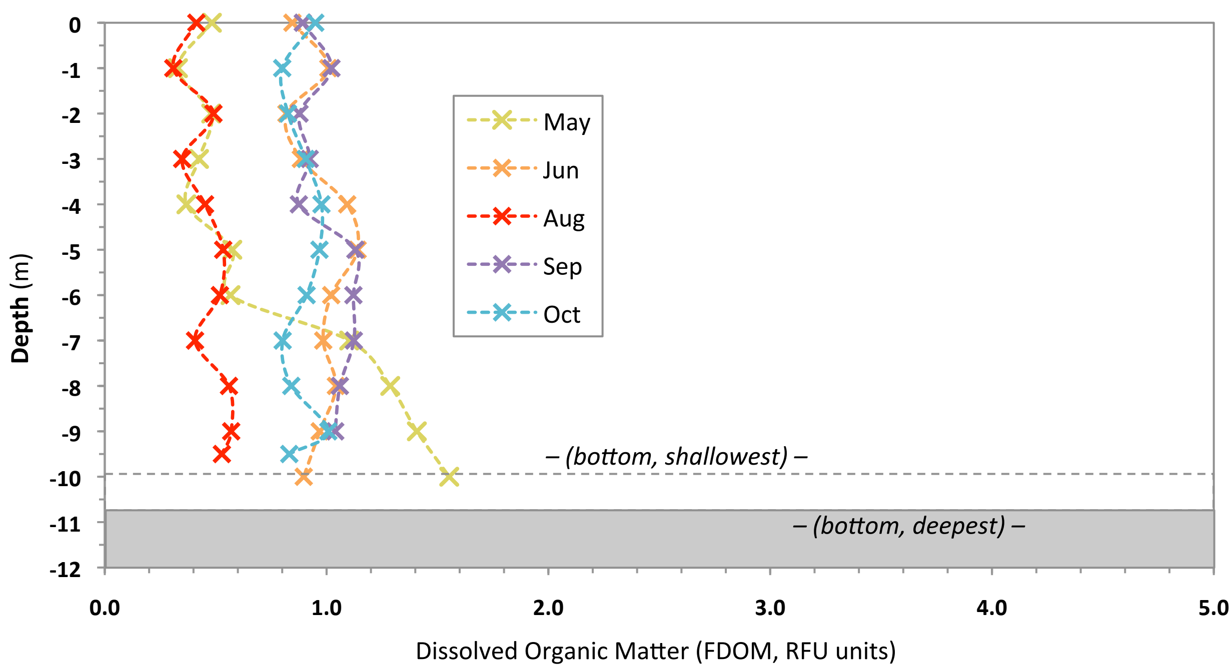


**Figure 2(k). Cemex–Phase 3-4: 2020 May-Oct DISSOLVED ORGANIC MATTER**

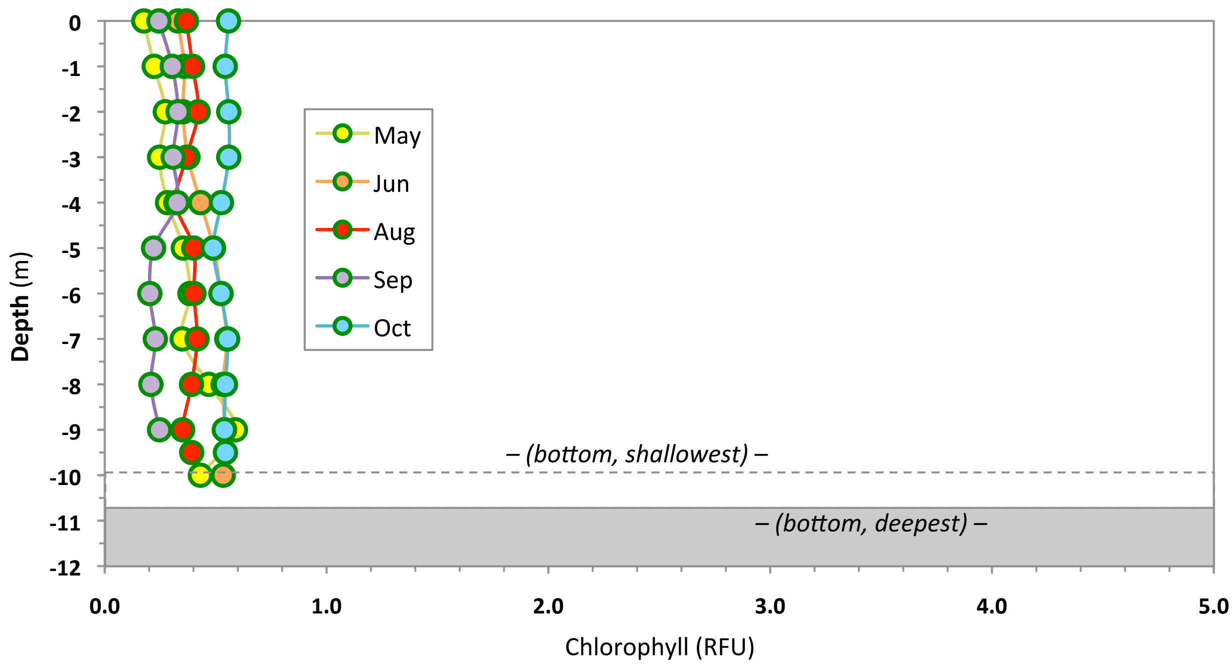


**Figure 2(l). Cemex – Phase 3-4 Pond: 2020 May-Oct CHLOROPHYLL**

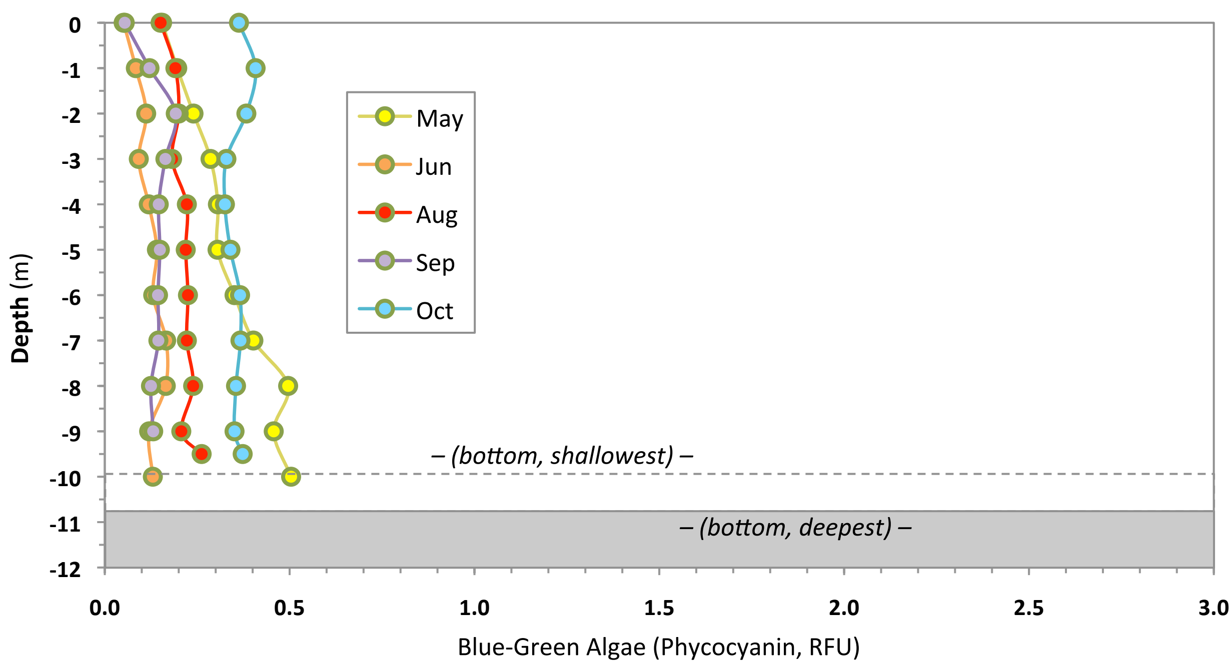


**Figure 2(m). Cemex – Phase 3-4 Pond: 2020 May-Oct BLUE-GREEN ALGAE**

# 3. TEICHERT – ESPARTO POND


*(Google Earth 10/21/2020)*

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

**In summary,** the levees dividing the former Teichert-Esparto – Reiff and Mast Ponds were purposely breached by Teichert in 2020, creating a single larger pond. Reiff Pond was identified as highly elevated in fish mercury, and continues to be considered 'elevated over baseline' in this new, expanded pond configuration. The deepest part of the combined pond was moderately deep across 2020, at about 11 m (35 feet), deeper than the former separate Reiff Pond. Water clarity remained very low/turbid, at 0.5-1.7 m (1.6-5.6 ft), blocking sunlight, algal photosynthesis, and oxygen production at depths below the near-surface. A temperature stratification developed through the summer, peaking in August. With no deep oxygen production to replace oxygen naturally lost to biotic metabolism, bottom water oxygen levels dropped essentially to zero, almost certainly increasing methylmercury production and bioavailability to fish. Oxygen later recovered, with surface cooling and wind mixing, from September on. This seasonal cycle presents a clear mercury management option, through disruption of summer anoxia.

In early 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 was shifted to the deepest part of the central basin (formerly Northwest Mast).

The Esparto Pond results are first shown for each survey date, one at a time. Numerical data from each of the five 2020 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 and in summary.

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Water Depth (Tables and Figs. 3(a-e): at the new, deeper, central location dropped slowly (through normal evaporation) from 11.3 m (37 ft) in May to 10.4 m (34 ft) in September and October.

Secchi Water Clarity (Tables and Figs. 3(a-e): was uniformly low/turbid, at 0.5-1.7 m (1.6-5.6 ft).

Temperature (Tables and Figs. 3(a-e), Fig. 3(f)): Overall range 15-28 °C (59-82 °F) between early May and late October. With the extended depths in the larger, breached pond, a moderate thermal stratification set up between May and August, with bottom waters up to 4.5 °C (8 °F) cooler than surface water. This physically isolated the lower water, allowing oxygen to become depleted. Later, in the fall, the water column became well mixed (low gradient between surface and bottom temperatures) as overall temperatures dropped to below 16 °C (< 60 °F). In August and September, we profiled the water column in both deep basins of the new large pond and found them to be very similar (Tables and Figs. 3(c) and 3(d)).

Dissolved Oxygen (Tables and Figs. 3(a-e), Fig. 3(g)): with the extended depths of the combined pond and the stronger thermocline, as discussed above, oxygen levels plummeted to under 0.2 mg/L and under 2% of saturation throughout the bottom waters by the August survey. We tested the water in both deep basins and found closely matching trends (Tables and Figs. 3(c-d)). These are levels that fish cannot survive in and, most relevant to this mercury-monitoring program, it creates conditions that 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 Esparto Pond has had among the highest fish mercury levels of the monitored ponds. Following the August maximum, the pond apparently began mixing sometime in September and the whole water column was oxygenated. That condition will typically continue throughout the cool fall-winter months, until spring warming begins to heat the surface water.

Conductivity (Tables 3(a-e), Fig. 3(h)): was at its highest at the beginning of the season in May (675-682 µS/cm) and then was lower and steady through the water column for the rest of the surveys (628-644 µS/cm). The one exception to this was in August, when conductivities in the anoxic hypolimnion (bottom waters) increased steadily toward the bottom.

Salinity (Tables 3(a-e): was very uniform, at 0.30-0.33 ppt (parts per thousand, g/L) across all depths and dates in 2020. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 3(a-e): was within the fairly narrow range of 413-443 mg/L (ppm) across all dates and depths.

pH (Tables 3(a-e), Fig. 3(i)): was 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. Water pH in the Esparto Pond spanned a wider range in the deeper, combined pond as compared to previous years, with an overall range of 7.99-9.25. 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.

Oxidation/Reduction Potential (ORP) (Tables 3(a-e): ranged from 26-113 mV (millivolts) in 2020. This was a lower overall range than in 2019 (93-200 mV) and 2018 (100-185 mV). ORP levels decreased gradually from May to November. ORP was relatively highest toward the bottom on all dates.

Turbidity (Tables 3(a-e), Fig. 3(j)): Teichert–Esparto is one of the ponds that regularly receives aggregate plant slurry discharge. Also, the wide, shallow surrounding landscape results in a lot of wind hitting the surface and stirring up shoreline sediments. It has always been one of the most turbid of the monitored ponds. Turbidity levels were again variable through the water column, ranging from approximately 2-22 FNU across the sampling season, similar to other years. Corresponding Secchi visibilities were very low, as is to be expected, at 0.5-1.7 m (1-6 ft).

Dissolved Organic Matter (FDOM) (Tables 3(a-e), Fig. 3(k)): Levels were similar throughout the water column on most dates, in the 0.7-1.9 RFU range overall. In August, there was a distinct change between the surface 6 m (0.6-0.8 RFU) and the bottom several meters (to 1.9 RFU), consistent with the temperature and oxygen profiles which were most stratified then.

Green Algae (Chlorophyll) (Tables 3(a-e), Fig. 3(l)): on all dates was similarly low near the surface and near the bottom, in the range of 0.2-0.7 RFU. Between May and September, there was a small bulge in green algae densities in the middle depths to the 0.7-1.2 RFU range, with one relative spike to about 3 RFU at 3 m in May.

Blue-Green Algae (Phycocyanin) (Tables 3(a-e), Fig. 3(m)): was low throughout, with RFU levels < 0.55 at all depths between May and September, increasing toward the bottom. With fall mixing, blue-green algae were similar top to bottom, at slightly denser levels around 0.70 RFU.

**Table 3(a). Teichert – Esparto Pond: 2020 Water Column Profiling Data**
**MAY 5**: max. depth 11.3 m (37 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** | 22.1 | 9.36 | 108% | 678 | 0.33 | 441 | 8.50 | 106 |
| **1** | 22.1 | 9.37 | 108% | 678 | 0.33 | 440 | 8.42 | 105 |
| **2** | 22.1 | 9.38 | 108% | 677 | 0.33 | 440 | 8.38 | 105 |
| **3** | 20.9 | 10.28 | 115% | 675 | 0.33 | 439 | 8.42 | 106 |
| **4** | 20.3 | 9.78 | 108% | 676 | 0.33 | 440 | 8.36 | 107 |
| **5** | 19.8 | 8.63 | 95% | 680 | 0.33 | 442 | 8.26 | 108 |
| **6** | 19.8 | 8.46 | 93% | 680 | 0.33 | 442 | 8.21 | 109 |
| **7** | 19.7 | 8.39 | 92% | 680 | 0.33 | 442 | 8.17 | 110 |
| **8** | 19.5 | 8.29 | 91% | 681 | 0.33 | 442 | 8.15 | 111 |
| **9** | 19.5 | 8.20 | 90% | 681 | 0.33 | 443 | 8.13 | 112 |
| **10** | 19.4 | 8.01 | 87% | 681 | 0.33 | 443 | 8.11 | 112 |
| **11** | 19.4 | 7.93 | 86% | 682 | 0.33 | 443 | 8.09 | 113 |

*(additional parameters next page)*

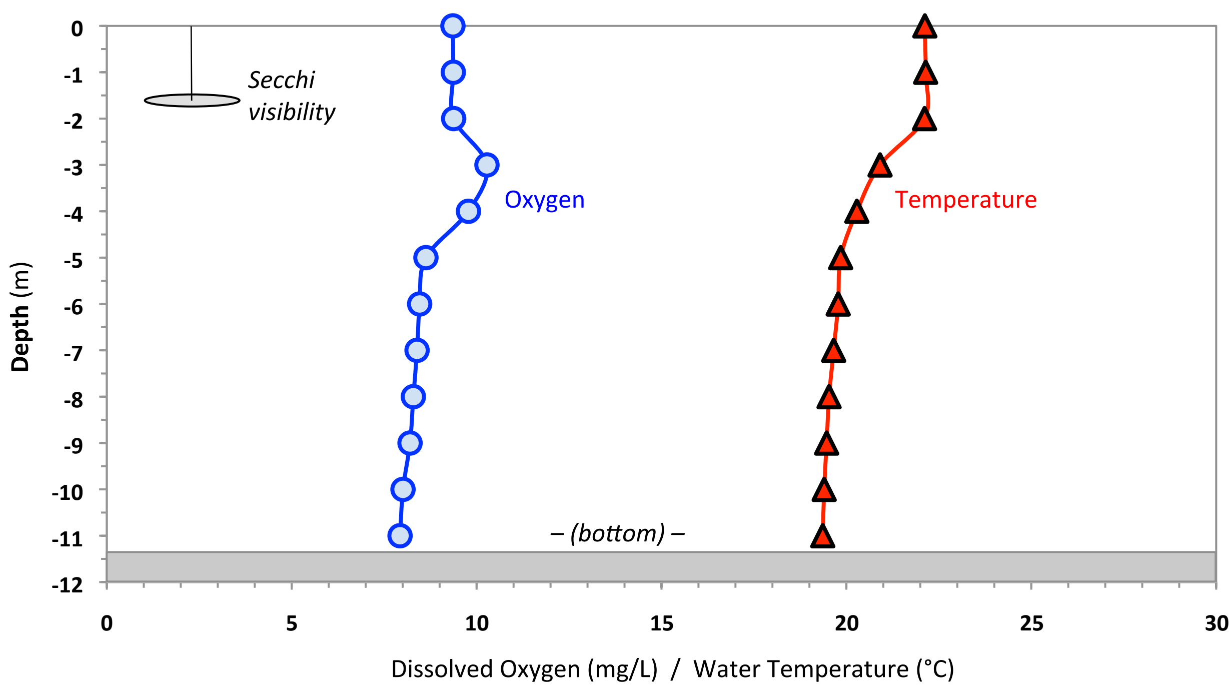


**Figure 3(a). MAY 5, 2020 – Esparto Pond framework parameters**

**Table 3(a).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**MAY 5**: max. depth 11.3 m (37 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** | 22.1 | 9.36 | 108% | 5.77 | 0.81 | 0.46 | 0.05 |
| **1** | 22.1 | 9.37 | 108% | 5.60 | 0.78 | 0.85 | 0.18 |
| **2** | 22.1 | 9.38 | 108% | 5.59 | 0.74 | 1.03 | 0.24 |
| **3** | 20.9 | 10.28 | 115% | 9.92 | 0.82 | 2.92 | 0.53 |
| **4** | 20.3 | 9.78 | 108% | 6.16 | 1.02 | 1.03 | 0.32 |
| **5** | 19.8 | 8.63 | 95% | 7.38 | 0.94 | 0.93 | 0.37 |
| **6** | 19.8 | 8.46 | 93% | 8.28 | 1.07 | 0.96 | 0.41 |
| **7** | 19.7 | 8.39 | 92% | 7.64 | 0.95 | 1.17 | 0.46 |
| **8** | 19.5 | 8.29 | 91% | 8.35 | 1.06 | 0.86 | 0.44 |
| **9** | 19.5 | 8.20 | 90% | 8.75 | 1.03 | 0.52 | 0.44 |
| **10** | 19.4 | 8.01 | 87% | 19.73 | 0.87 | 0.42 | 0.47 |
| **11** | 19.4 | 7.93 | 86% | 21.39 | 1.03 | 0.37 | 0.50 |

**Table 3(b). Teichert – Esparto Pond: 2020 Water Column Profiling Data**
**JUN 18**: max. depth 11 m (36 ft); Secchi disk water clarity: 1.1 m (3.6 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** | 24.4 | 8.55 | 103% | 631 | 0.31 | 410 | 9.00 | 89 |
| **1** | 24.2 | 8.55 | 102% | 631 | 0.31 | 410 | 8.95 | 89 |
| **2** | 24.0 | 8.56 | 102% | 630 | 0.31 | 410 | 8.90 | 90 |
| **3** | 22.8 | 8.47 | 99% | 629 | 0.31 | 409 | 8.92 | 91 |
| **4** | 22.7 | 8.43 | 98% | 629 | 0.31 | 409 | 8.91 | 91 |
| **5** | 22.5 | 8.35 | 97% | 629 | 0.31 | 409 | 8.80 | 93 |
| **6** | 22.5 | 8.31 | 96% | 629 | 0.31 | 409 | 8.79 | 94 |
| **7** | 22.5 | 8.19 | 95% | 629 | 0.31 | 409 | 8.76 | 94 |
| **8** | 22.4 | 8.17 | 94% | 628 | 0.31 | 408 | 8.75 | 95 |
| **9** | 22.4 | 8.15 | 94% | 628 | 0.30 | 408 | 8.73 | 96 |
| **10** | 22.4 | 8.13 | 94% | 628 | 0.30 | 408 | 8.72 | 96 |
| **10.8** | 22.4 | 8.10 | 94% | 628 | 0.30 | 408 | 8.71 | 97 |

*(additional parameters next page)*

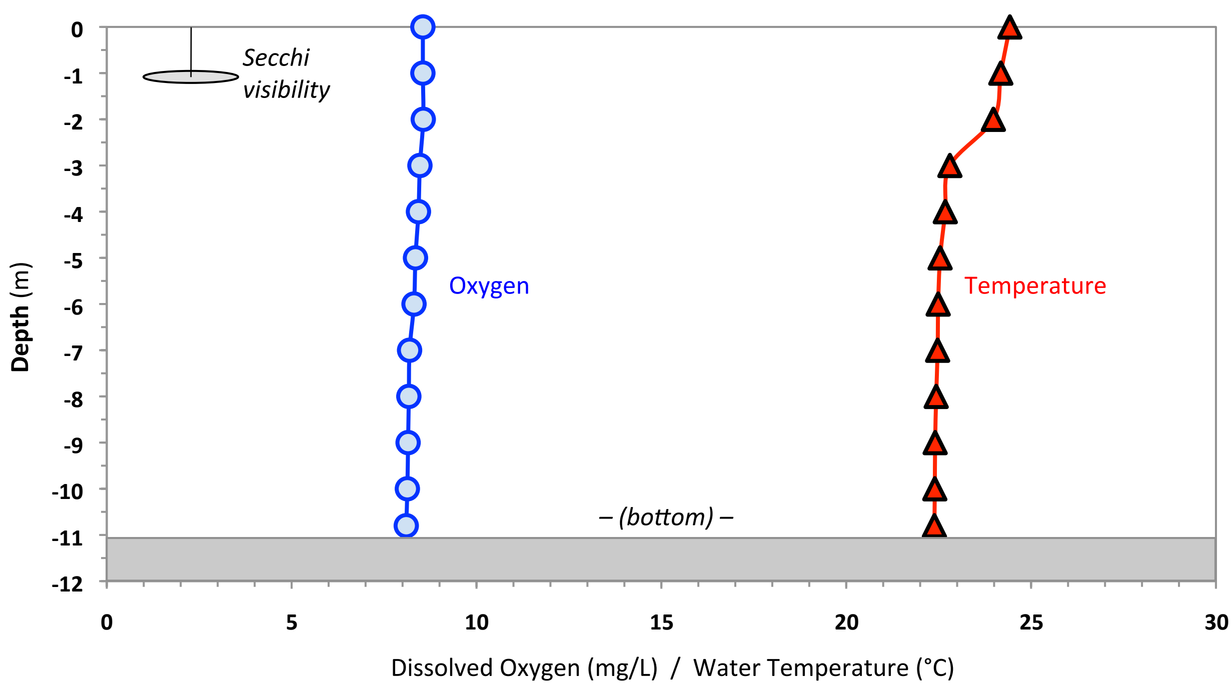


**Figure 3(b). JUN 18, 2020 – Esparto Pond framework parameters**

**Table 3(b).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**JUN 18**: max. depth 11 m (36 ft); Secchi disk water clarity: 1.1 m (3.6 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** | 24.4 | 8.55 | 103% | 5.65 | 1.17 | 0.47 | 0.14 |
| **1** | 24.2 | 8.55 | 102% | 5.64 | 1.32 | 0.56 | 0.18 |
| **2** | 24.0 | 8.56 | 102% | 6.44 | 1.19 | 0.63 | 0.19 |
| **3** | 22.8 | 8.47 | 99% | 13.27 | 1.55 | 1.20 | 0.30 |
| **4** | 22.7 | 8.43 | 98% | 11.11 | 1.53 | 1.08 | 0.30 |
| **5** | 22.5 | 8.35 | 97% | 10.18 | 1.44 | 0.99 | 0.33 |
| **6** | 22.5 | 8.31 | 96% | 9.22 | 1.33 | 1.09 | 0.31 |
| **7** | 22.5 | 8.19 | 95% | 11.91 | 1.61 | 0.95 | 0.34 |
| **8** | 22.4 | 8.17 | 94% | 12.39 | 1.55 | 0.76 | 0.33 |
| **9** | 22.4 | 8.15 | 94% | 13.08 | 1.35 | 0.73 | 0.32 |
| **10** | 22.4 | 8.13 | 94% | 14.63 | 1.39 | 0.61 | 0.32 |
| **10.8** | 22.4 | 8.10 | 94% | 16.58 | 1.49 | 0.66 | 0.32 |

**Table 3(c). Teichert – Esparto Pond: 2020 Water Column Profiling Data *(Central Basin)***
**AUG 4**: max. depth 10.7 m (35 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** | 27.5 | 8.71 | 110% | 643 | 0.31 | 418 | 8.90 | 50 |
| **1** | 27.5 | 8.72 | 111% | 643 | 0.31 | 418 | 8.87 | 50 |
| **2** | 27.5 | 8.71 | 110% | 643 | 0.31 | 418 | 8.85 | 50 |
| **3** | 27.1 | 8.55 | 108% | 643 | 0.31 | 418 | 8.83 | 52 |
| **4** | 26.9 | 8.47 | 106% | 644 | 0.31 | 418 | 8.81 | 53 |
| **5** | 26.8 | 8.04 | 101% | 644 | 0.31 | 419 | 8.78 | 54 |
| **6** | 26.5 | 6.84 | 85% | 646 | 0.31 | 420 | 8.69 | 57 |
| **7** | 25.5 | 0.99 | 12% | 656 | 0.32 | 426 | 8.22 | 64 |
| **8** | 24.5 | 0.20 | 2% | 664 | 0.32 | 432 | 8.10 | 68 |
| **9** | 23.4 | 0.15 | 2% | 670 | 0.33 | 435 | 8.05 | 70 |
| **10** | 23.0 | 0.13 | 2% | 673 | 0.33 | 438 | 7.99 | 69 |

*(additional parameters next page)*

**Table 3(c). *(continued) – Comparison Data from Southeast Basin***
**AUG 4**: max. depth 10.4 m (34 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** | 28.3 | 9.32 | 120% | 646 | 0.31 | 420 | 8.83 | 58 |
| **1** | 28.3 | 9.35 | 120% | 646 | 0.31 | 420 | 8.83 | 59 |
| **2** | 28.0 | 9.52 | 122% | 645 | 0.31 | 419 | 8.84 | 59 |
| **3** | 27.0 | 9.90 | 125% | 643 | 0.31 | 418 | 8.90 | 61 |
| **4** | 26.8 | 9.71 | 122% | 643 | 0.31 | 418 | 8.83 | 65 |
| **5** | 26.7 | 9.08 | 114% | 644 | 0.31 | 419 | 8.80 | 67 |
| **6** | 26.3 | 6.48 | 81% | 648 | 0.31 | 421 | 8.66 | 70 |
| **7** | 24.2 | 0.32 | 4% | 653 | 0.32 | 424 | 8.14 | 79 |
| **8** | 22.9 | 0.19 | 2% | 654 | 0.32 | 425 | 8.02 | 30 |
| **9** | 22.3 | 0.16 | 2% | 657 | 0.32 | 427 | 7.91 | -70 |
| **10** | 22.0 | 0.14 | 2% | 659 | 0.32 | 428 | 7.83 | -112 |

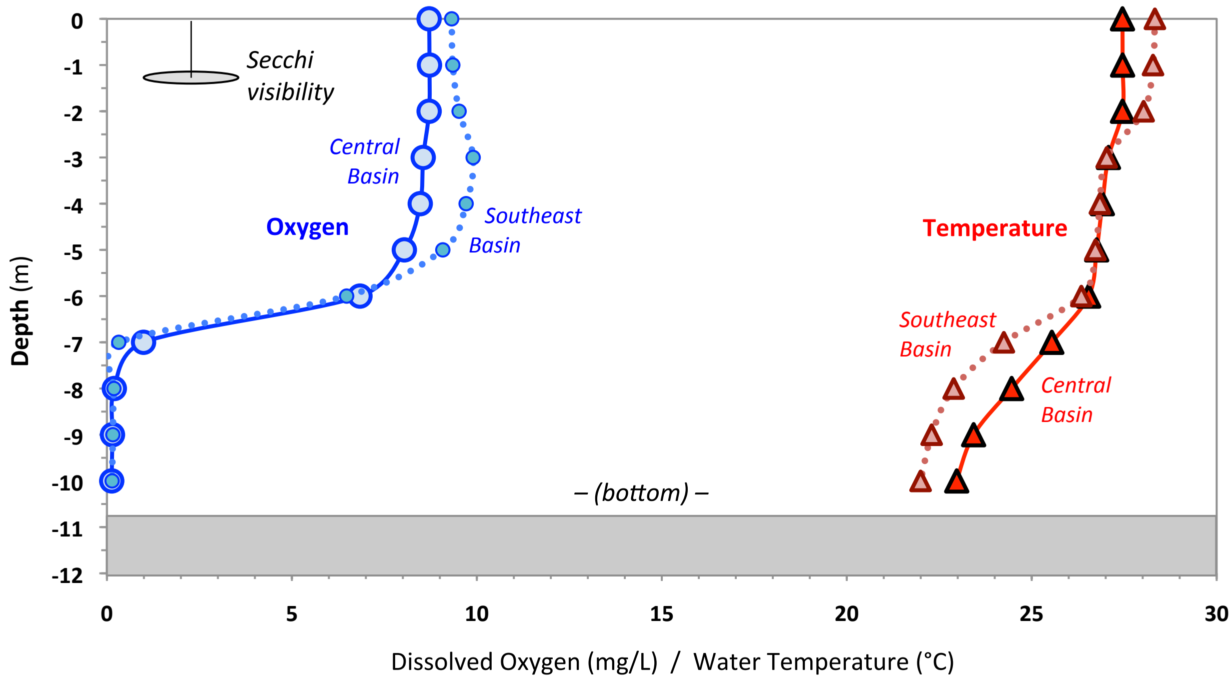


**Figure 3(c). AUG 4, 2020 – Esparto Pond framework parameters, both basins**

**Table 3(c).** ***(continued)* – OPTICAL PARAMETERS *(Central Basin)***
**AUG 4**: max. depth 10.7 m (35 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** | 27.5 | 8.71 | 110% | 5.95 | 0.79 | 0.42 | 0.18 |
| **1** | 27.5 | 8.72 | 111% | 5.68 | 0.61 | 0.59 | 0.17 |
| **2** | 27.5 | 8.71 | 110% | 5.79 | 0.79 | 0.53 | 0.17 |
| **3** | 27.1 | 8.55 | 108% | 5.33 | 0.72 | 0.62 | 0.22 |
| **4** | 26.9 | 8.47 | 106% | 5.83 | 0.76 | 0.81 | 0.24 |
| **5** | 26.8 | 8.04 | 101% | 7.16 | 0.67 | 0.77 | 0.26 |
| **6** | 26.5 | 6.84 | 85% | 5.63 | 0.84 | 0.59 | 0.24 |
| **7** | 25.5 | 0.99 | 12% | 6.70 | 1.20 | 0.78 | 0.29 |
| **8** | 24.5 | 0.20 | 2% | 8.93 | 1.49 | 0.30 | 0.30 |
| **9** | 23.4 | 0.15 | 2% | 2.48 | 1.82 | 0.22 | 0.28 |
| **10** | 23.0 | 0.13 | 2% | 1.61 | 1.91 | 0.23 | 0.34 |

**Table 3(c).** ***(continued)* – *Comparison Data from Southeast Basin***
**AUG 4**: max. depth 10.4 m (34 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** | 28.3 | 9.32 | 120% | 4.72 | 0.49 | 1.21 | 0.25 |
| **1** | 28.3 | 9.35 | 120% | 4.72 | 0.62 | 1.46 | 0.26 |
| **2** | 28.0 | 9.52 | 122% | 5.12 | 0.69 | 1.61 | 0.29 |
| **3** | 27.0 | 9.90 | 125% | 5.14 | 0.56 | 1.88 | 0.35 |
| **4** | 26.8 | 9.71 | 122% | 5.38 | 0.65 | 2.03 | 0.45 |
| **5** | 26.7 | 9.08 | 114% | 6.69 | 0.54 | 2.23 | 0.51 |
| **6** | 26.3 | 6.48 | 81% | 8.00 | 0.92 | 2.32 | 0.52 |
| **7** | 24.2 | 0.32 | 4% | 6.52 | 2.00 | 1.30 | 0.57 |
| **8** | 22.9 | 0.19 | 2% | 4.27 | 2.22 | 0.62 | 0.44 |
| **9** | 22.3 | 0.16 | 2% | 4.93 | 2.18 | 0.44 | 0.49 |
| **10** | 22.0 | 0.14 | 2% | 4.74 | 2.55 | 0.43 | 0.49 |

**Table 3(d). Teichert – Esparto Pond: 2020 Water Column Profiling Data *(Central Basin)***
**SEP 20**: max. depth 10.4 m (34 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** | 24.0 | 9.29 | 111% | 636 | 0.31 | 413 | 9.25 | 36 |
| **1** | 23.8 | 9.33 | 111% | 636 | 0.31 | 413 | 9.12 | 37 |
| **2** | 23.4 | 9.59 | 113% | 635 | 0.31 | 413 | 9.12 | 38 |
| **3** | 23.2 | 9.64 | 113% | 635 | 0.31 | 413 | 9.05 | 39 |
| **4** | 23.1 | 9.36 | 110% | 635 | 0.31 | 413 | 9.02 | 39 |
| **5** | 23.0 | 9.04 | 106% | 635 | 0.31 | 413 | 8.99 | 40 |
| **6** | 22.9 | 8.79 | 102% | 635 | 0.31 | 413 | 8.95 | 41 |
| **7** | 22.9 | 8.61 | 100% | 635 | 0.31 | 413 | 8.92 | 42 |
| **8** | 22.8 | 8.44 | 98% | 636 | 0.31 | 413 | 8.89 | 42 |
| **9** | 22.8 | 8.40 | 98% | 636 | 0.31 | 413 | 8.87 | 43 |
| **10** | 22.8 | 8.35 | 97% | 636 | 0.31 | 413 | 8.85 | 43 |

*(additional parameters next page)*

**Table 3(c). *(continued) – Comparison Data from Southeast Basin***
**SEP 20**: max. depth 10.4 m (34 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** | 23.7 | 9.07 | 107% | 636 | 0.31 | 414 | 8.81 | 60 |
| 1 | 23.6 | 9.05 | 107% | 636 | 0.31 | 413 | 8.82 | 60 |
| 2 | 23.3 | 9.07 | 107% | 636 | 0.31 | 413 | 8.83 | 61 |
| 3 | 23.2 | 9.08 | 106% | 635 | 0.31 | 413 | 8.82 | 61 |
| 4 | 23.1 | 9.03 | 106% | 636 | 0.31 | 413 | 8.82 | 61 |
| 5 | 22.9 | 8.89 | 104% | 635 | 0.31 | 413 | 8.82 | 62 |
| 6 | 22.9 | 8.77 | 102% | 635 | 0.31 | 413 | 8.81 | 62 |
| 7 | 22.8 | 8.38 | 97% | 635 | 0.31 | 413 | 8.78 | 62 |
| 8 | 22.7 | 8.08 | 94% | 636 | 0.31 | 413 | 8.75 | 63 |
| 9 | 22.7 | 7.87 | 92% | 636 | 0.31 | 414 | 8.72 | 63 |
| 10 | 22.7 | 7.55 | 88% | 637 | 0.31 | 414 | 8.69 | 64 |

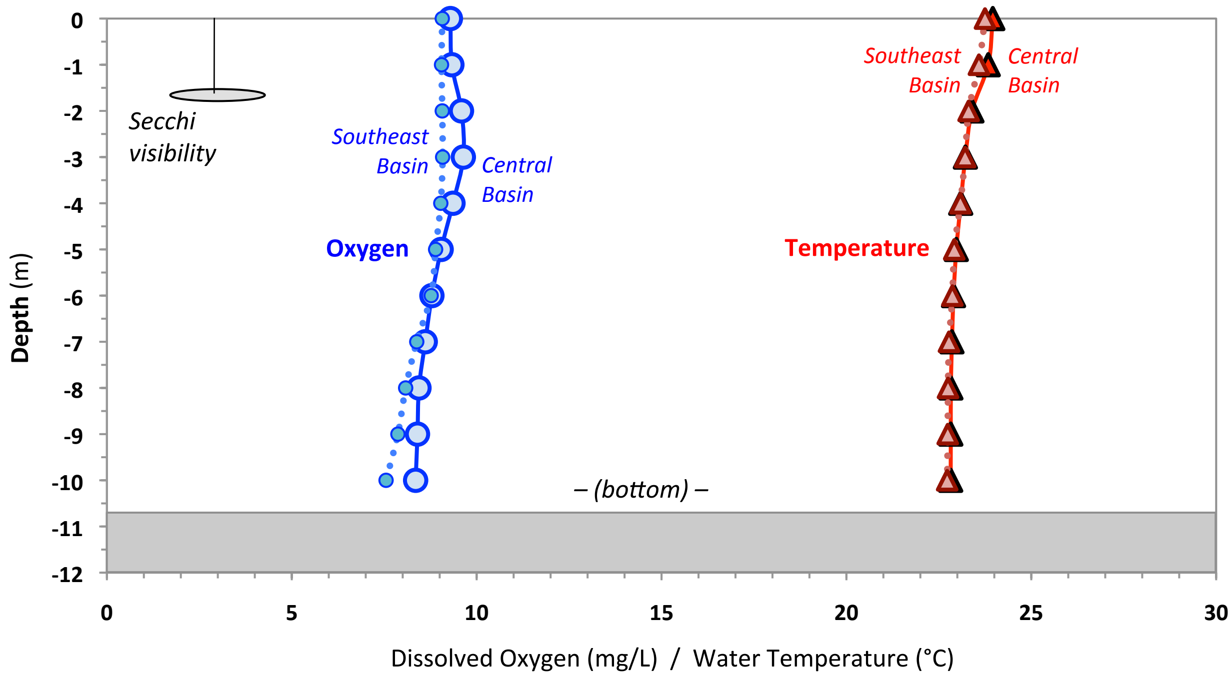


**Figure 3(d). SEP 20, 2020 – Esparto Pond framework parameters *(both basins)***

**Table 3(d).** ***(continued)* – OPTICAL PARAMETERS *(central basin)***
**SEP 20**: max. depth 10.4 m (34 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** | 24.0 | 9.29 | 111% | 3.81 | 0.89 | 0.30 | 0.19 |
| **1** | 23.8 | 9.33 | 111% | 3.95 | 0.93 | 0.41 | 0.19 |
| **2** | 23.4 | 9.59 | 113% | 4.59 | 0.97 | 0.96 | 0.28 |
| **3** | 23.2 | 9.64 | 113% | 5.37 | 1.06 | 1.16 | 0.33 |
| **4** | 23.1 | 9.36 | 110% | 6.13 | 1.20 | 1.13 | 0.37 |
| **5** | 23.0 | 9.04 | 106% | 6.65 | 1.22 | 0.93 | 0.30 |
| **6** | 22.9 | 8.79 | 102% | 6.22 | 1.05 | 0.63 | 0.26 |
| **7** | 22.9 | 8.61 | 100% | 7.02 | 1.05 | 0.47 | 0.24 |
| **8** | 22.8 | 8.44 | 98% | 9.65 | 1.11 | 0.43 | 0.24 |
| **9** | 22.8 | 8.40 | 98% | 9.24 | 1.06 | 0.39 | 0.25 |
| **10** | 22.8 | 8.35 | 97% | 10.05 | 1.05 | 0.35 | 0.26 |

**Table 3(d).** ***(continued)* – *Comparison Data from Southeast Basin***
**SEP 20**: max. depth 10.4 m (34 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** | 23.7 | 9.07 | 107% | 2.60 | 1.11 | 0.34 | 0.17 |
| **1** | 23.6 | 9.05 | 107% | 2.49 | 1.01 | 0.41 | 0.15 |
| **2** | 23.3 | 9.07 | 107% | 2.48 | 1.18 | 0.36 | 0.18 |
| **3** | 23.2 | 9.08 | 106% | 2.42 | 1.02 | 0.46 | 0.19 |
| **4** | 23.1 | 9.03 | 106% | 2.75 | 1.07 | 1.21 | 0.26 |
| **5** | 22.9 | 8.89 | 104% | 3.09 | 1.25 | 1.53 | 0.32 |
| **6** | 22.9 | 8.77 | 102% | 3.00 | 1.21 | 1.76 | 0.38 |
| **7** | 22.8 | 8.38 | 97% | 3.23 | 1.20 | 1.24 | 0.30 |
| **8** | 22.7 | 8.08 | 94% | 5.44 | 1.11 | 1.01 | 0.30 |
| **9** | 22.7 | 7.87 | 92% | 6.94 | 1.24 | 0.66 | 0.25 |
| **10** | 22.7 | 7.55 | 88% | 10.77 | 1.29 | 0.94 | 0.31 |

**Table 3(e). Teichert – Esparto Pond: 2020 Water Column Profiling Data**
**OCT 26**: max. depth 10.4 m (34 ft); Secchi disk water clarity: 0.5 m (1.6 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** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.18 | 26 |
| **1** | 15.3 | 9.85 | 99% | 641 | 0.31 | 416 | 8.17 | 26 |
| **2** | 15.4 | 9.85 | 99% | 641 | 0.31 | 416 | 8.16 | 26 |
| **3** | 15.4 | 9.85 | 99% | 641 | 0.31 | 416 | 8.16 | 26 |
| **4** | 15.4 | 9.85 | 99% | 641 | 0.31 | 416 | 8.15 | 27 |
| **5** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.15 | 27 |
| **6** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.15 | 27 |
| **7** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.15 | 27 |
| **8** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.15 | 27 |
| **9** | 15.4 | 9.84 | 99% | 641 | 0.31 | 416 | 8.15 | 28 |
| **10** | 15.3 | 9.84 | 99% | 641 | 0.31 | 417 | 8.14 | 28 |

*(additional parameters next page)*

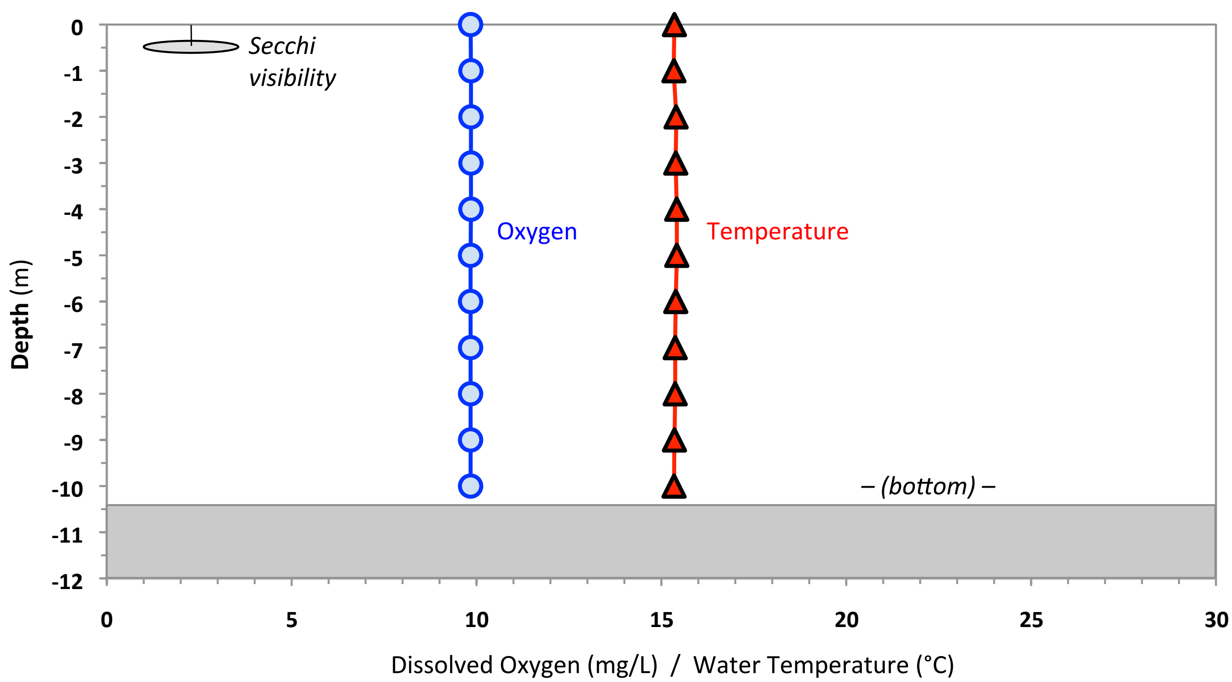


**Figure 3(e). OCT 26, 2020 – Esparto Pond framework parameters**

**Table 3(e).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**OCT 26**: max. depth 10.4 m (34 ft); Secchi disk water clarity: 0.5 m (1.6 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** | 15.4 | 9.84 | 99% | 19.82 | 1.21 | 0.66 | 0.57 |
| **1** | 15.3 | 9.85 | 99% | 18.61 | 1.13 | 0.71 | 0.58 |
| **2** | 15.4 | 9.85 | 99% | 19.19 | 1.28 | 0.70 | 0.61 |
| **3** | 15.4 | 9.85 | 99% | 19.60 | 1.24 | 0.71 | 0.62 |
| **4** | 15.4 | 9.85 | 99% | 19.59 | 1.08 | 0.75 | 0.63 |
| **5** | 15.4 | 9.84 | 99% | 19.49 | 1.04 | 0.69 | 0.61 |
| **6** | 15.4 | 9.84 | 99% | 20.01 | 1.13 | 0.74 | 0.61 |
| **7** | 15.4 | 9.84 | 99% | 18.59 | 1.27 | 0.73 | 0.59 |
| **8** | 15.4 | 9.84 | 99% | 19.81 | 1.28 | 0.72 | 0.61 |
| **9** | 15.4 | 9.84 | 99% | 20.64 | 1.10 | 0.70 | 0.59 |
| **10** | 15.3 | 9.84 | 99% | 20.92 | 1.23 | 0.71 | 0.60 |

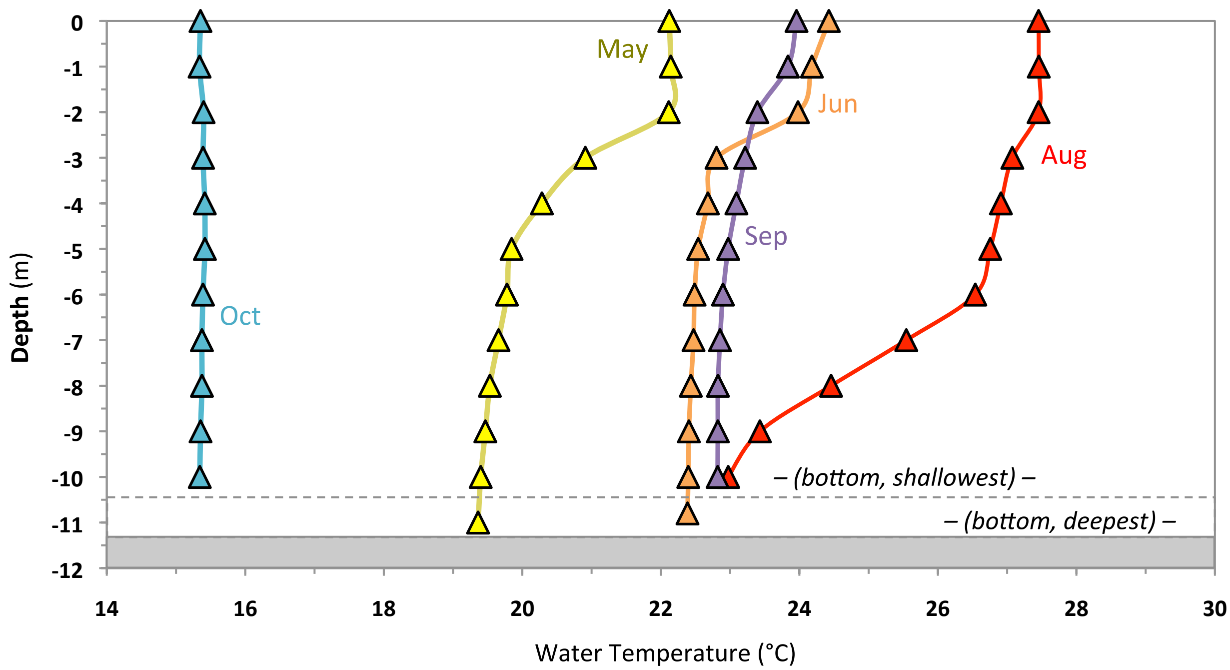


**Figure 3(f). Teichert – Esparto Pond: 2020 May-Oct TEMPERATURE**

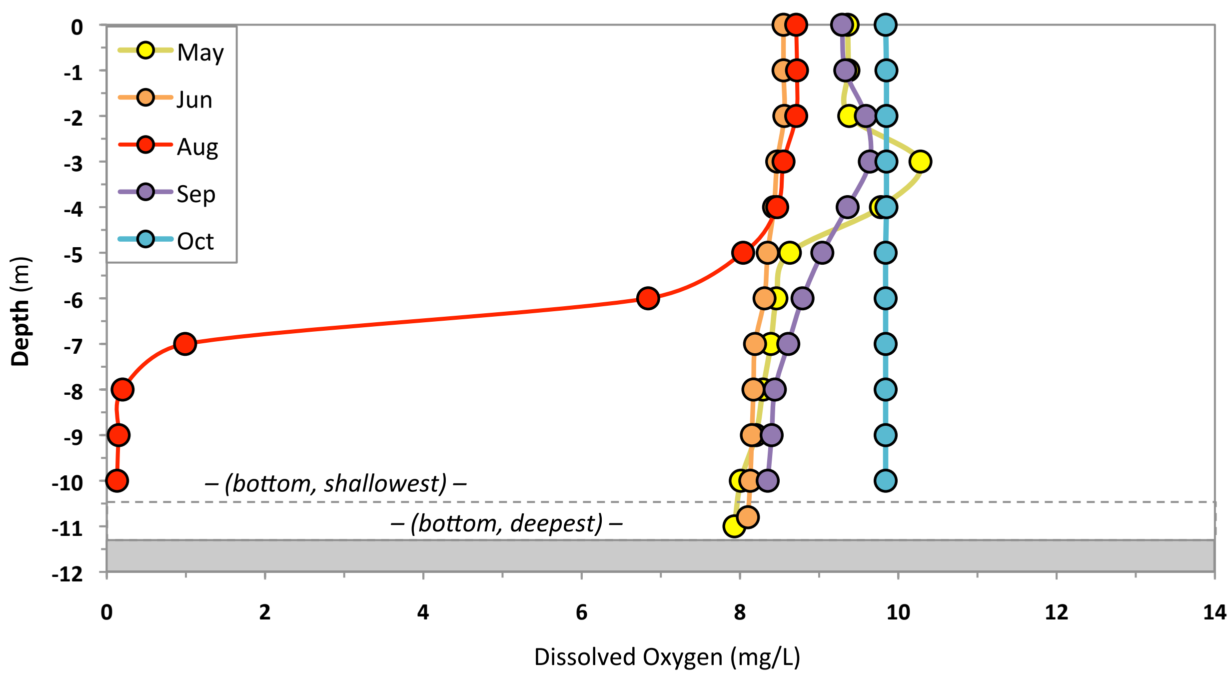


**Figure 3(g). Teichert – Esparto Pond: 2020 May-Oct OXYGEN**

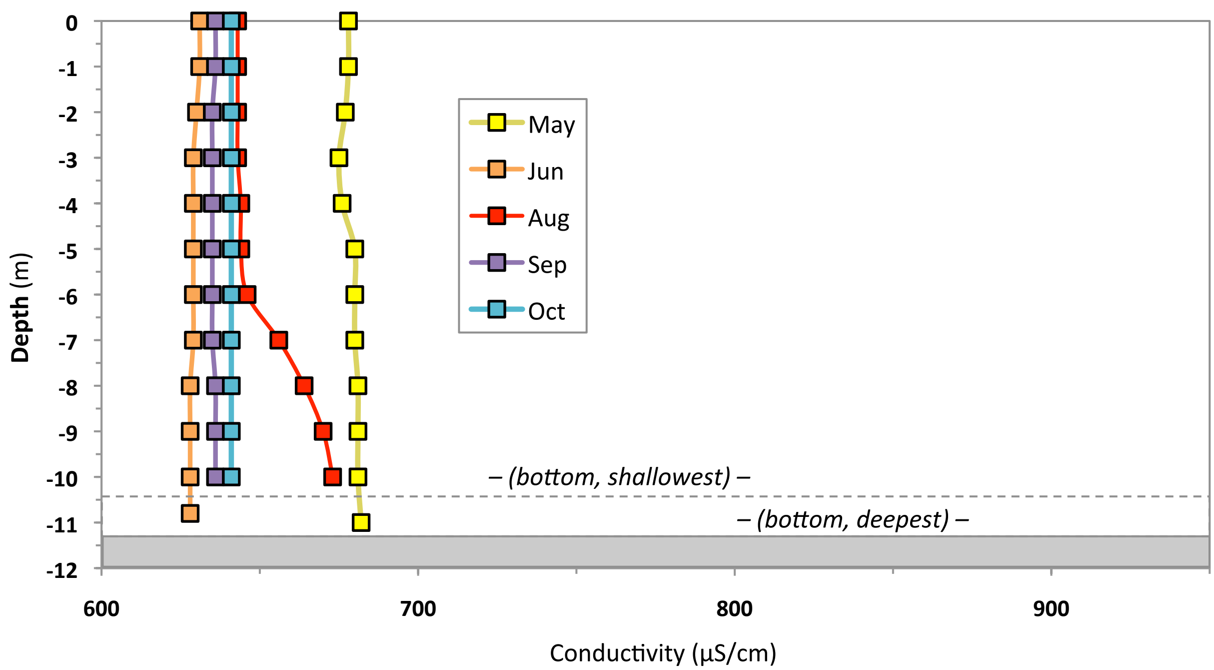


**Figure 3(h). Teichert – Esparto Pond: 2020 May-Oct CONDUCTIVITY**

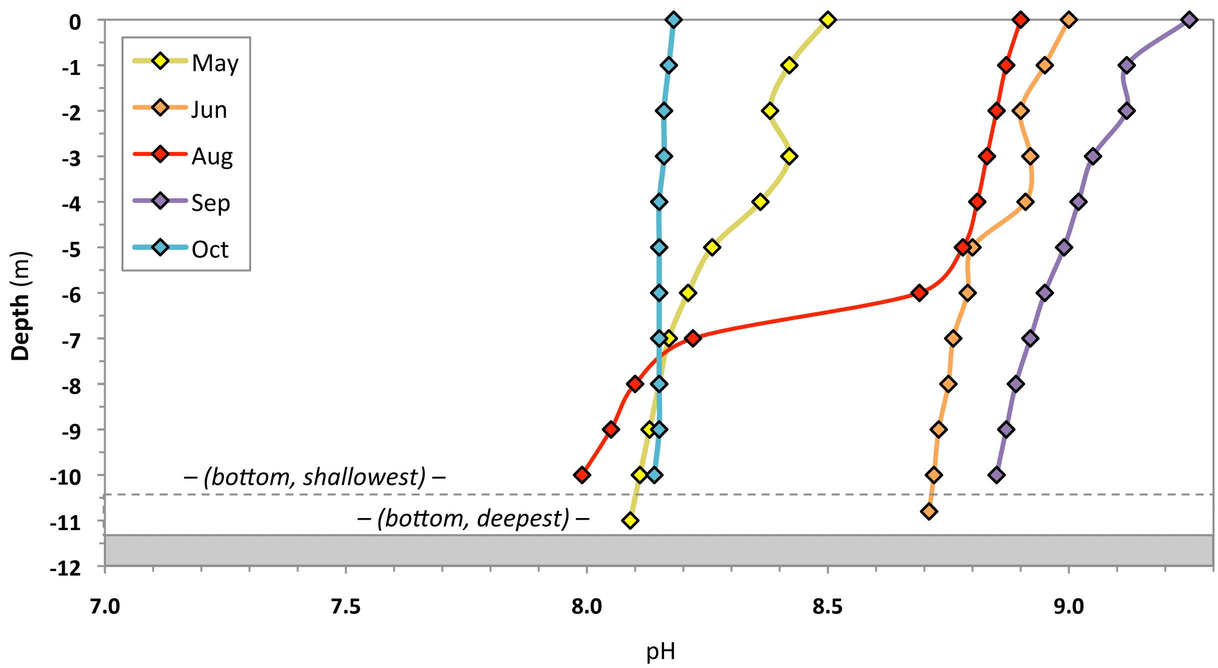


**Figure 3(i). Teichert – Esparto Pond: 2020 May-Oct pH**

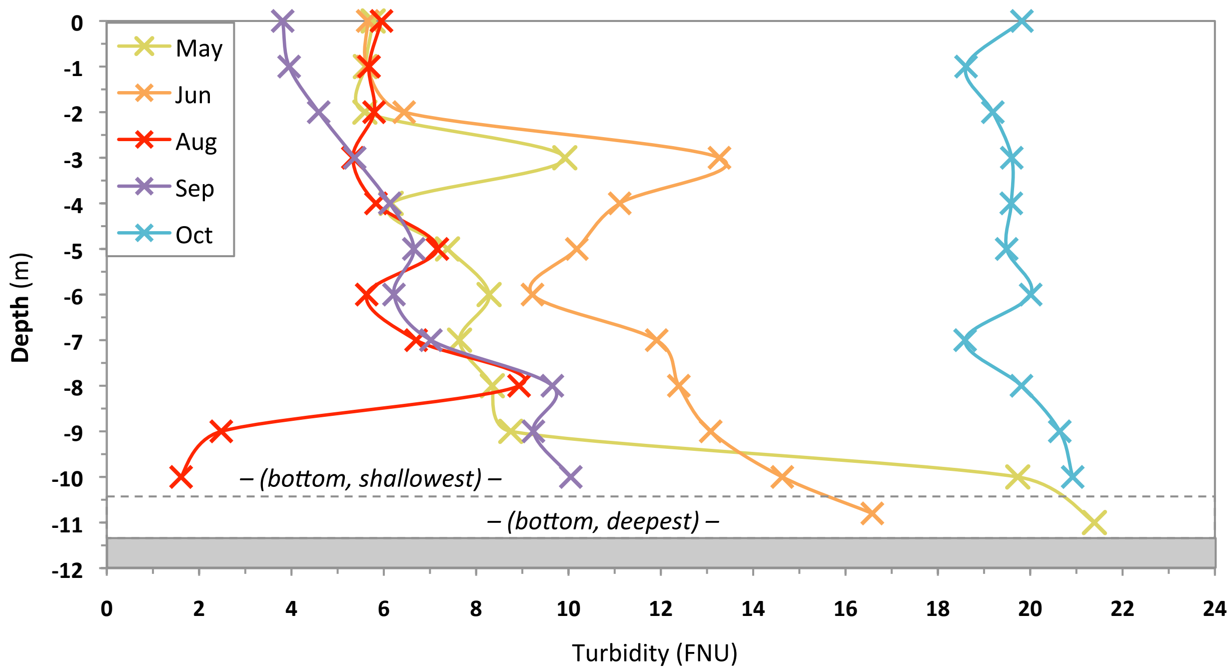


**Figure 3(j). Teichert – Esparto Pond: 2020 May-Oct TURBIDITY**

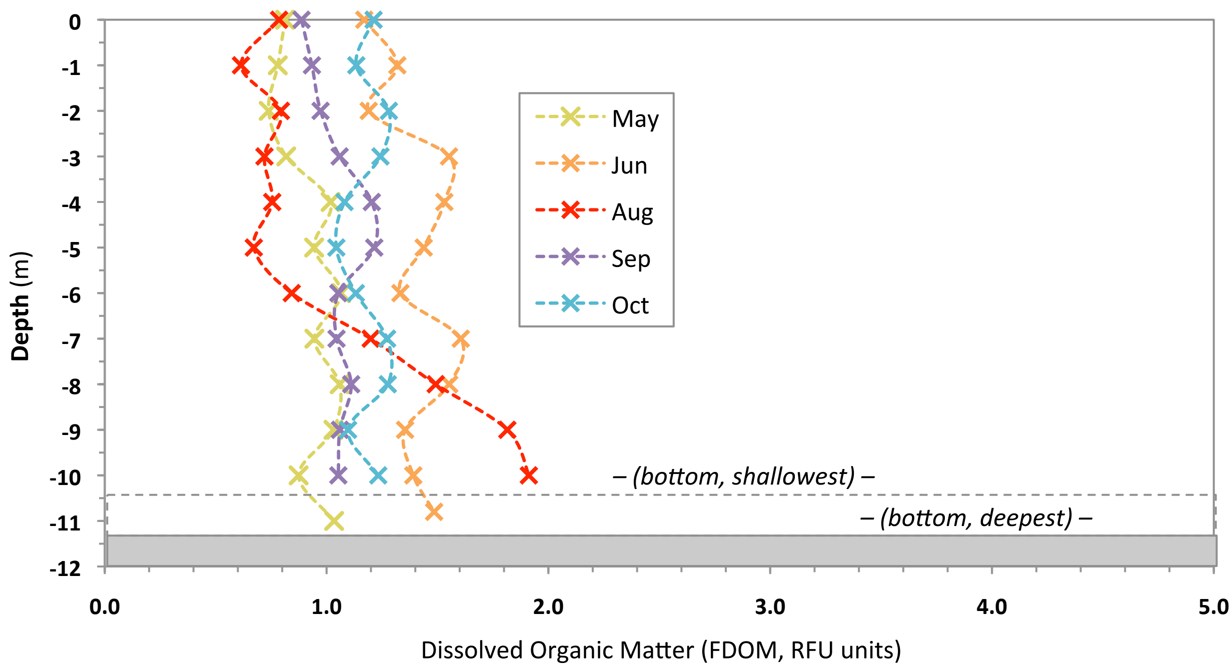


**Figure 3(k). Esparto Pond: 2020 May-Oct DISSOLVED ORGANIC MATTER**

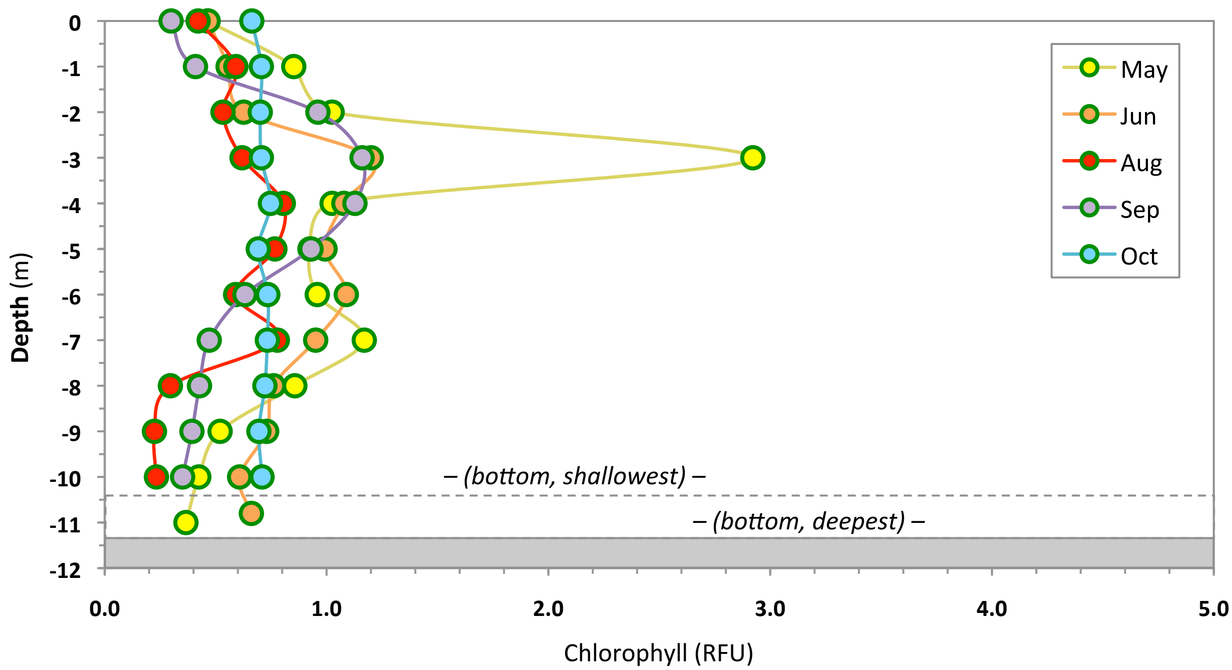


**Figure 3(l). Teichert – Esparto Pond: 2020 May-Oct CHLOROPHYLL**

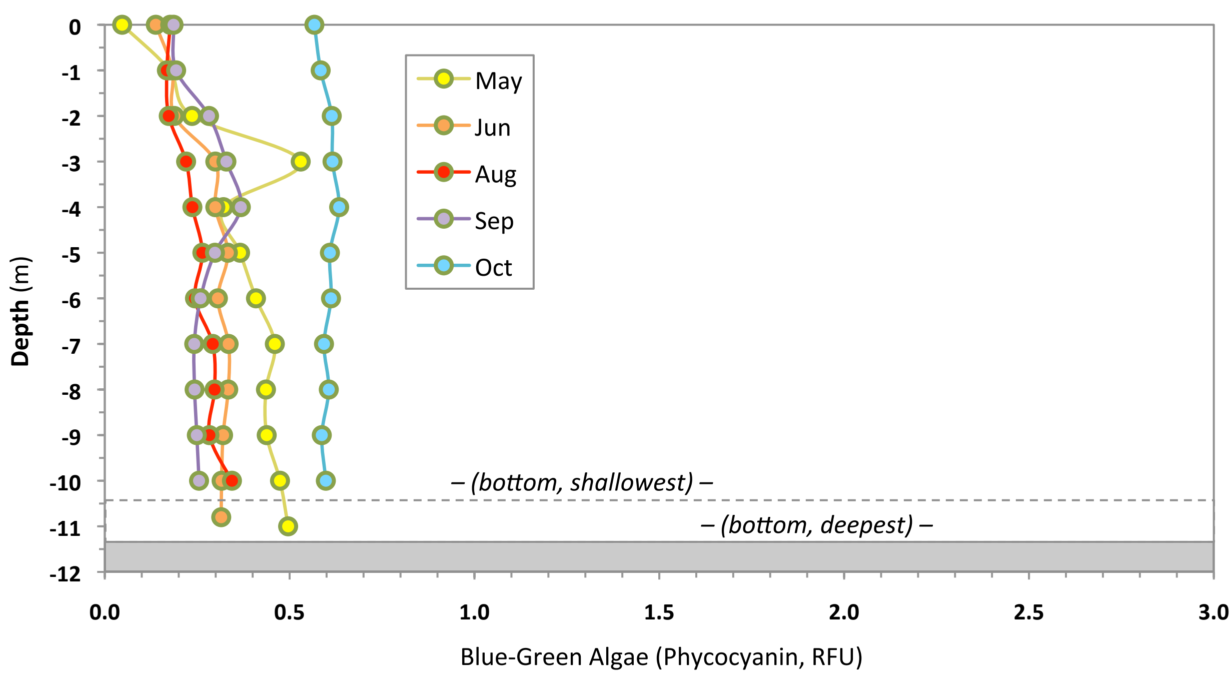


**Figure 3(m). Teichert – Esparto Pond: 2020 May-Oct BLUE-GREEN ALGAE**

# 4. SYAR – B1 POND


*(Google Earth 10/21/2020)*

## 4. 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 found in 2020 to be of medium depth (8-9 m / 26-31 ft), inactive (re mining) and fairly clear, similar to previous years. High surrounding berms give some protection from wind mixing, and a very light stratification of the water column was seen, though less than in other years. Bottom waters, though not going fully anoxic this year, became significantly reduced in oxygen during much of the warm season, likely enhancing methylmercury exposure levels as in other years. This pond, like the Teichert-Esparto Pond, may also get mercury management benefits from disruption of summer oxygen depletion. The 2020 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 2020 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 and in summary.

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<u>Water Depth</u> (Tables and Figs. 4(a-e): began in May at 9.3 m (30.5 ft) and dropped through the season, from normal evaporation, to 7.9 m (26 ft).

Secchi Water Clarity (Tables and Figs. 4(a-e): was 6.4 m (21 ft) in May, declining across the season to 2.6 m (8.5 ft). This pond, like Cemex Phase 3-4, has been dominated by macro aquatic plants, as compared to the murkier systems dominated by microscopic algae. This is because enough sunlight can reach the bottom to allow various aquatic plants to take root and grow upwards. This isn't possible in ponds with low water clarity.

Temperature (Tables and Figs. 4(a-e), Fig. 4(f)): Overall range between 17 and 29 °C (63-84 °F) between May and October. High surrounding berms give some protection from wind mixing. A slight thermal stratification developed, with surface waters up to 3 °C (5 °F) warmer than bottom water. By the late October survey, the pond was thoroughly mixed and cooled down to under 18 °C (63 °F).

Dissolved Oxygen (Tables and Figs. 4(a-e), Fig. 4(g)): in the top 6 m remained near or above saturation levels throughout the season. Below this depth, some oxygen depletion was found in the May, August, and September surveys, with levels dropping to 71-88% of saturation. It is notable that, like Reiff Pond, the BI Pond has been one of the ponds with the most elevated bass mercury levels.

Conductivity (Tables 4(a-e), Fig. 4(h)): ranged narrowly between 616 and 657 µS/cm overall.

Salinity (Tables 4(a-e): was nearly identical, at 0.30-0.32 ppt (parts per thousand, g/L) across all dates and water depths. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

Total Dissolved Solids (TDS) (Tables 4(a-e): fell within the narrow range of 400-427 mg/L (ppm) across all dates and water depths. This was similar to 2019 (411-446 mg/L) and lower than 2018 (529-608 mg/L).

pH (Tables 4(a-e), Fig. 4(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 8.2 and 9.1 across all depths and dates. Levels increased (more basic) through the summer and later dropped (less basic) in the fall. On individual dates, differences in pH were apparent between surface and bottom waters in proportion to the degree of temperature stratification and oxygen depletion toward the bottom, with the largest surface to bottom differences in May.

Oxidation/Reduction Potential (ORP) (Tables 4(a-e): ranged between 13 and 120 mV (millivolts) across all depths and dates, as compared to years before the basins were combined: 2019 (50-227 mV) and 2018 (46-180 mV). Levels were consistently at the higher end of this range in May-June (112-120 mV), dropping in Aug-Nov to levels all less than 60 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 4(a-e), Fig. 4(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. Turbidity levels were under 1.5 FNU in the top 6 m May through September, with a 'murky layer' up to 8 FNU in the bottom meter or two, as in other years. During the windier and shallower fall sampling in late October, the whole water column had turbidities of 3-4 FNU.

Dissolved Organic Matter (FDOM) (Tables 4(a-e), Fig. 4(k)): Like most of the other ponds, levels were similar throughout the upper water layers on each sampling date. The overall range across all depths was 0.8-2.4 RFU, similar to last year. Also as seen last year and in some of the other ponds, a buildup to relatively highest FDOM levels for each date occurred in the bottom several meters when the pond was partially stratified (May-Sep). During fall mixing, dissolved organic matter was stirred through the water column at the top end of the seasonal range (2.1-2.3 RFU).

Green Algae (Chlorophyll) (Tables 4(a-e), Fig. 4(l)): profiles were similar to the dissolved organic matter profiles (above), with consistent, lowest levels (0.3-0.5 RFU) toward the surface in May-Aug when the water was most stratified, and relative accumulations toward the bottom (to 1.4 RFU). The pattern continued in September, but in a higher range (0.9-2.2 RFU overall). During fall mixing and the late October survey, chlorophyll was erratic through the water column at the top end of the seasonal range this year (2.0-3.8 RFU).

Blue-Green Algae (Phycocyanin) (Tables 4(a-e), Fig. 4(m)): was low throughout, especially between early May and mid September (< 0.4 RFU across the top 5-8 m, with slight buildups in the 0.4-0.6 RFU range toward the bottom). As seen with the above parameters, between May and September somewhat higher levels built up toward the bottom (0.4-0.6 RFU) and throughout the water column in late October.

**Table 4(a). Syar – B1 Pond: 2020 Water Column Profiling Data**
**MAY 5:** max. depth 9.3 m (30.5 ft); Secchi disk water clarity: 6.4 m (21 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** | 21.9 | 10.71 | 122% | 652 | 0.32 | 424 | 8.68 | 112 |
| **1** | 21.8 | 10.73 | 123% | 652 | 0.32 | 423 | 8.67 | 112 |
| **2** | 21.8 | 10.76 | 123% | 652 | 0.32 | 423 | 8.66 | 112 |
| **3** | 21.5 | 10.82 | 123% | 651 | 0.32 | 423 | 8.65 | 113 |
| **4** | 20.8 | 10.73 | 120% | 651 | 0.32 | 423 | 8.64 | 114 |
| **5** | 20.8 | 10.76 | 120% | 651 | 0.32 | 423 | 8.64 | 114 |
| **6** | 20.6 | 10.72 | 120% | 651 | 0.32 | 423 | 8.64 | 114 |
| **7** | 20.0 | 11.07 | 122% | 652 | 0.32 | 424 | 8.50 | 117 |
| **8** | 19.4 | 9.88 | 108% | 654 | 0.32 | 425 | 8.35 | 119 |
| **9** | 19.1 | 8.12 | 88% | 657 | 0.32 | 427 | 8.20 | 120 |

*(additional parameters next page)*

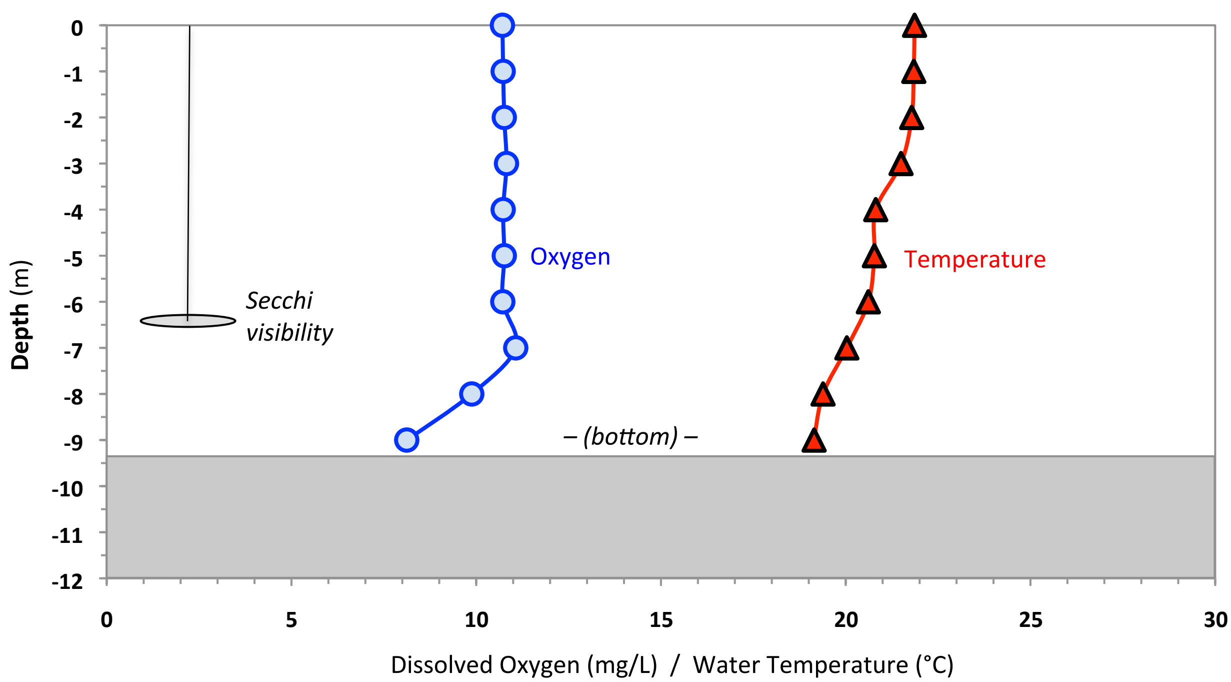


**Figure 4(a). MAY 5, 2020 – B1 Pond framework parameters**

**Table 4(a).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**MAY 5:** max. depth 9.3 m (30.5 ft); Secchi disk water clarity: 6.4 m (21 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** | 21.9 | 10.71 | 122% | 0.50 | 0.94 | 0.32 | 0.23 |
| **1** | 21.8 | 10.73 | 123% | 0.54 | 0.89 | 0.32 | 0.24 |
| **2** | 21.8 | 10.76 | 123% | 0.54 | 0.97 | 0.35 | 0.22 |
| **3** | 21.5 | 10.82 | 123% | 0.56 | 1.00 | 0.34 | 0.28 |
| **4** | 20.8 | 10.73 | 120% | 0.60 | 0.97 | 0.33 | 0.28 |
| **5** | 20.8 | 10.76 | 120% | 0.58 | 1.07 | 0.35 | 0.28 |
| **6** | 20.6 | 10.72 | 120% | 0.74 | 1.05 | 0.41 | 0.29 |
| **7** | 20.0 | 11.07 | 122% | 1.72 | 1.85 | 0.55 | 0.36 |
| **8** | 19.4 | 9.88 | 108% | 6.93 | 2.35 | 1.08 | 0.51 |
| **9** | 19.1 | 8.12 | 88% | 6.56 | 2.32 | 3.22 | 0.57 |

**Table 4(b). Syar – B1 Pond: 2020 Water Column Profiling Data**
**JUN 18:** max. depth 8.5 m (28 ft); Secchi disk water clarity: 3.7 m (12.1 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** | 24.6 | 8.95 | 108% | 618 | 0.30 | 402 | 9.07 | 112 |
| **1** | 24.6 | 8.97 | 108% | 618 | 0.30 | 402 | 9.06 | 112 |
| **2** | 24.3 | 9.00 | 108% | 618 | 0.30 | 402 | 9.06 | 112 |
| **3** | 23.7 | 9.22 | 109% | 616 | 0.30 | 401 | 9.09 | 112 |
| **4** | 23.6 | 8.94 | 106% | 616 | 0.30 | 400 | 9.08 | 113 |
| **5** | 23.5 | 8.91 | 105% | 616 | 0.30 | 400 | 9.06 | 113 |
| **6** | 23.5 | 8.87 | 105% | 616 | 0.30 | 400 | 9.04 | 113 |
| **7** | 23.4 | 8.72 | 103% | 616 | 0.30 | 400 | 9.03 | 114 |
| **8** | 23.4 | 8.56 | 101% | 616 | 0.30 | 400 | 9.01 | 114 |

*(additional parameters next page)*

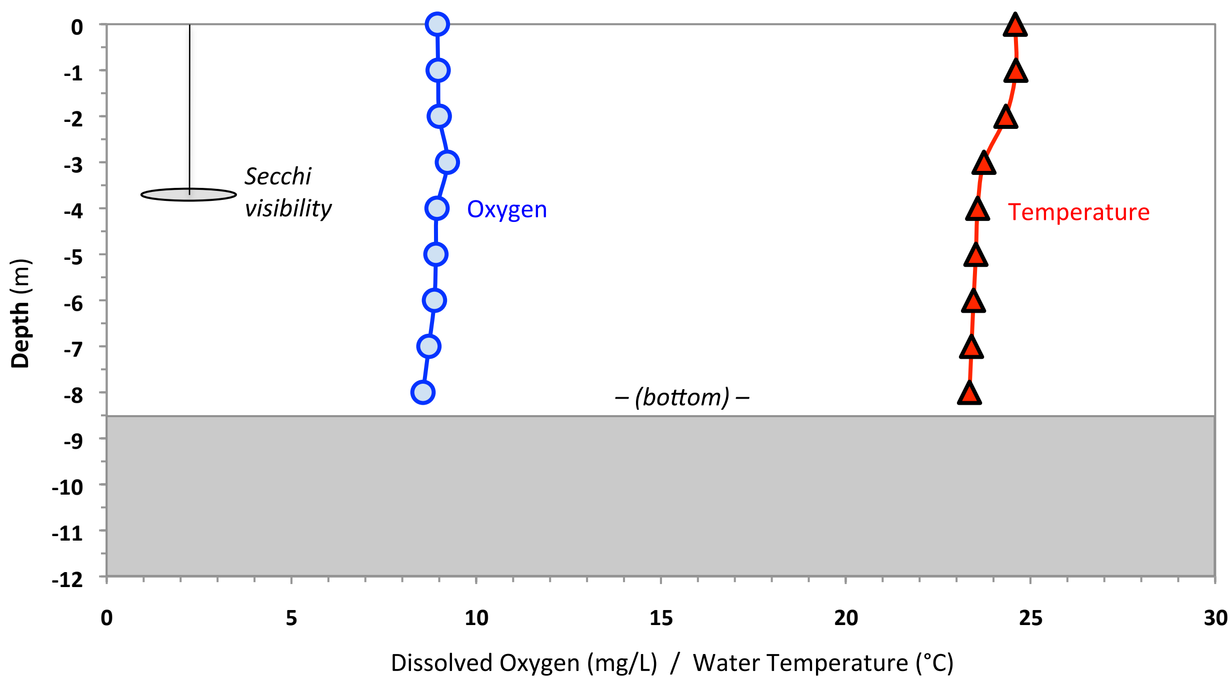


**Figure 4(b). JUN 18, 2020 – B1 Pond framework parameters**

**Table 4(b).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**JUN 18:** max. depth 8.5 m (28 ft); Secchi disk water clarity: 3.7 m (12.1 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** | 24.6 | 8.95 | 108% | 1.13 | 1.67 | 0.46 | 0.12 |
| **1** | 24.6 | 8.97 | 108% | 1.17 | 1.49 | 0.45 | 0.09 |
| **2** | 24.3 | 9.00 | 108% | 1.24 | 1.44 | 0.47 | 0.12 |
| **3** | 23.7 | 9.22 | 109% | 1.38 | 1.73 | 0.47 | 0.13 |
| **4** | 23.6 | 8.94 | 106% | 1.04 | 1.69 | 0.41 | 0.11 |
| **5** | 23.5 | 8.91 | 105% | 1.09 | 1.95 | 0.43 | 0.13 |
| **6** | 23.5 | 8.87 | 105% | 1.41 | 1.89 | 0.40 | 0.16 |
| **7** | 23.4 | 8.72 | 103% | 2.06 | 2.01 | 0.43 | 0.16 |
| **8** | 23.4 | 8.56 | 101% | 2.75 | 1.98 | 0.44 | 0.17 |

**Table 4(c). Syar – B1 Pond: 2020 Water Column Profiling Data**
**AUG 4:** max. depth 8.2 m (27 ft); Secchi disk water clarity: 3.4 m (11.2 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** | 28.6 | 8.73 | 113% | 642 | 0.31 | 417 | 9.03 | 39 |
| **1** | 28.6 | 8.75 | 113% | 643 | 0.31 | 418 | 9.03 | 42 |
| **2** | 28.2 | 8.74 | 112% | 643 | 0.31 | 418 | 9.04 | 44 |
| **3** | 28.0 | 8.51 | 109% | 643 | 0.31 | 418 | 9.04 | 46 |
| **4** | 27.9 | 8.46 | 108% | 642 | 0.31 | 418 | 9.04 | 47 |
| **5** | 27.8 | 8.32 | 106% | 642 | 0.31 | 418 | 9.02 | 49 |
| **6** | 27.7 | 8.04 | 102% | 642 | 0.31 | 418 | 9.00 | 51 |
| **7** | 27.6 | 6.91 | 88% | 643 | 0.31 | 418 | 8.91 | 55 |
| **8** | 27.2 | 5.62 | 71% | 643 | 0.31 | 418 | 8.82 | 58 |

*(additional parameters next page)*

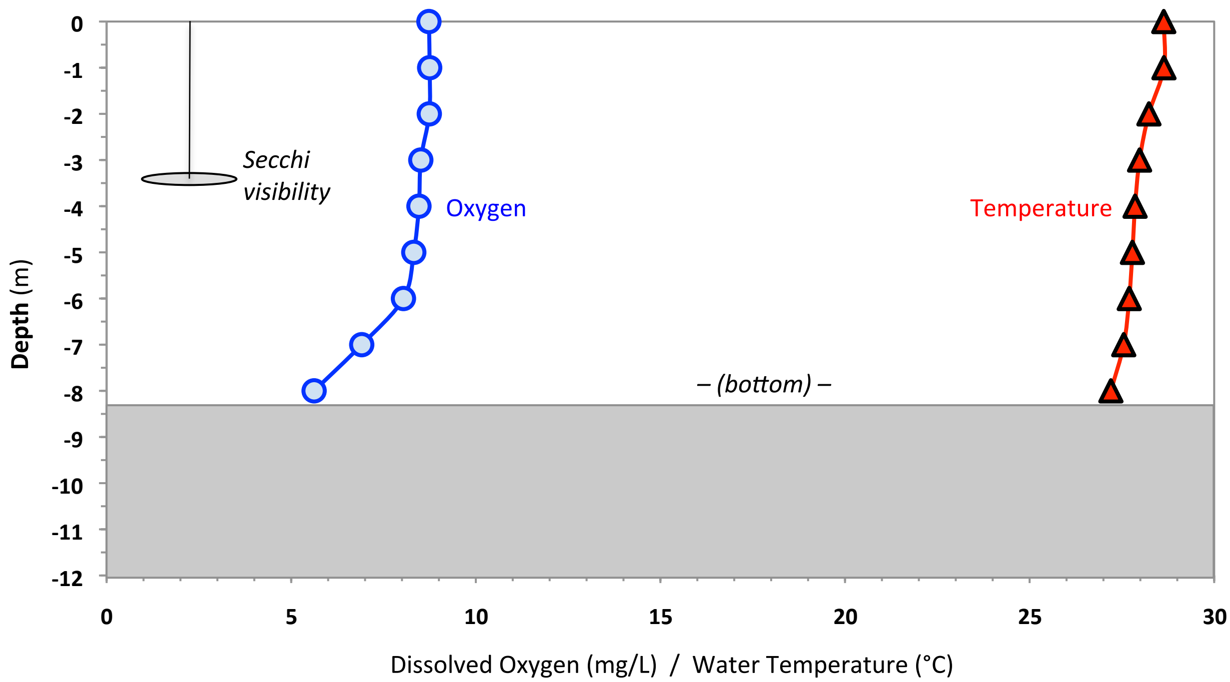


**Figure 4(c). AUG 4, 2020 – B1 Pond framework parameters**

**Table 4(c).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**AUG 4:** max. depth 8.2 m (27 ft); Secchi disk water clarity: 3.4 m (11.2 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** | 28.6 | 8.73 | 113% | 1.25 | 0.87 | 0.42 | 0.05 |
| **1** | 28.6 | 8.75 | 113% | 1.16 | 0.90 | 0.42 | 0.06 |
| **2** | 28.2 | 8.74 | 112% | 1.27 | 1.03 | 0.41 | 0.07 |
| **3** | 28.0 | 8.51 | 109% | 1.21 | 0.97 | 0.41 | 0.08 |
| **4** | 27.9 | 8.46 | 108% | 1.21 | 1.16 | 0.42 | 0.10 |
| **5** | 27.8 | 8.32 | 106% | 1.25 | 1.19 | 0.53 | 0.14 |
| **6** | 27.7 | 8.04 | 102% | 1.52 | 1.33 | 0.65 | 0.17 |
| **7** | 27.6 | 6.91 | 88% | 4.50 | 1.83 | 1.17 | 0.28 |
| **8** | 27.2 | 5.62 | 71% | 8.12 | 2.07 | 1.37 | 0.40 |

**Table 4(d). Syar – B1 Pond: 2020 Water Column Profiling Data**

**SEP 20**: max. depth 8.2 m (27 ft); Secchi disk water clarity: 3.1 m (10.2 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** | 24.2 | 8.71 | 104% | 647 | 0.31 | 421 | 8.92 | 13 |
| **1** | 24.2 | 8.71 | 104% | 647 | 0.31 | 421 | 8.92 | 13 |
| **2** | 24.2 | 8.69 | 104% | 647 | 0.31 | 420 | 8.91 | 14 |
| **3** | 23.9 | 8.61 | 102% | 647 | 0.31 | 420 | 8.91 | 15 |
| **4** | 23.7 | 8.43 | 100% | 646 | 0.31 | 420 | 8.92 | 16 |
| **5** | 23.6 | 8.26 | 98% | 646 | 0.31 | 420 | 8.90 | 17 |
| **6** | 23.6 | 7.61 | 90% | 647 | 0.31 | 421 | 8.85 | 19 |
| **7** | 23.5 | 7.01 | 83% | 647 | 0.31 | 420 | 8.81 | 21 |
| **8** | 23.4 | 6.35 | 75% | 648 | 0.31 | 421 | 8.75 | 23 |

*(additional parameters next page)*

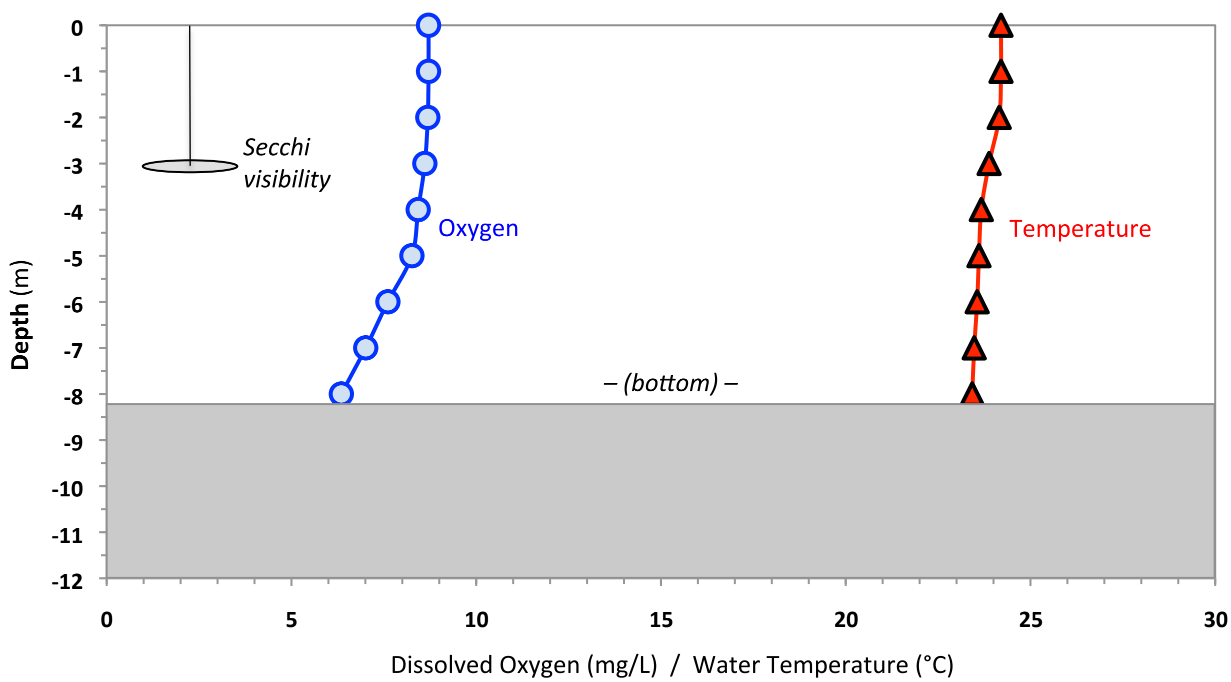


**Figure 4(d). SEP 20, 2020 – B1 Pond framework parameters**

**Table 4(d).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**SEP 20**: max. depth 8.2 m (27 ft); Secchi disk water clarity: 3.1 m (10.2 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** | 24.2 | 8.71 | 104% | 0.97 | 1.69 | 0.88 | 0.25 |
| **1** | 24.2 | 8.71 | 104% | 0.99 | 1.65 | 0.88 | 0.26 |
| **2** | 24.2 | 8.69 | 104% | 0.93 | 1.76 | 0.90 | 0.25 |
| **3** | 23.9 | 8.61 | 102% | 1.00 | 1.94 | 0.93 | 0.27 |
| **4** | 23.7 | 8.43 | 100% | 1.05 | 1.92 | 1.43 | 0.33 |
| **5** | 23.6 | 8.26 | 98% | 1.33 | 1.93 | 1.95 | 0.36 |
| **6** | 23.6 | 7.61 | 90% | 1.54 | 2.02 | 2.17 | 0.48 |
| **7** | 23.5 | 7.01 | 83% | 2.77 | 2.24 | 1.51 | 0.42 |
| **8** | 23.4 | 6.35 | 75% | 5.36 | 2.13 | 1.58 | 0.41 |

**Table 4(e). Syar – B1 Pond: 2020 Water Column Profiling Data**

**OCT 26**: max. depth 7.9 m (26 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** | 17.4 | 9.64 | 101% | 649 | 0.32 | 422 | 8.31 | 36 |
| **1** | 17.4 | 9.65 | 101% | 649 | 0.32 | 422 | 8.30 | 35 |
| **2** | 17.4 | 9.66 | 101% | 649 | 0.32 | 422 | 8.30 | 35 |
| **3** | 17.4 | 9.66 | 101% | 649 | 0.32 | 422 | 8.29 | 35 |
| **4** | 17.4 | 9.66 | 101% | 649 | 0.32 | 422 | 8.29 | 35 |
| **5** | 17.4 | 9.63 | 101% | 649 | 0.32 | 422 | 8.28 | 35 |
| **6** | 17.4 | 9.62 | 101% | 649 | 0.32 | 422 | 8.28 | 35 |
| **7** | 17.4 | 9.58 | 100% | 649 | 0.32 | 422 | 8.28 | 35 |
| **7.5** | 17.3 | 9.39 | 98% | 649 | 0.32 | 422 | 8.26 | 36 |

*(additional parameters next page)*

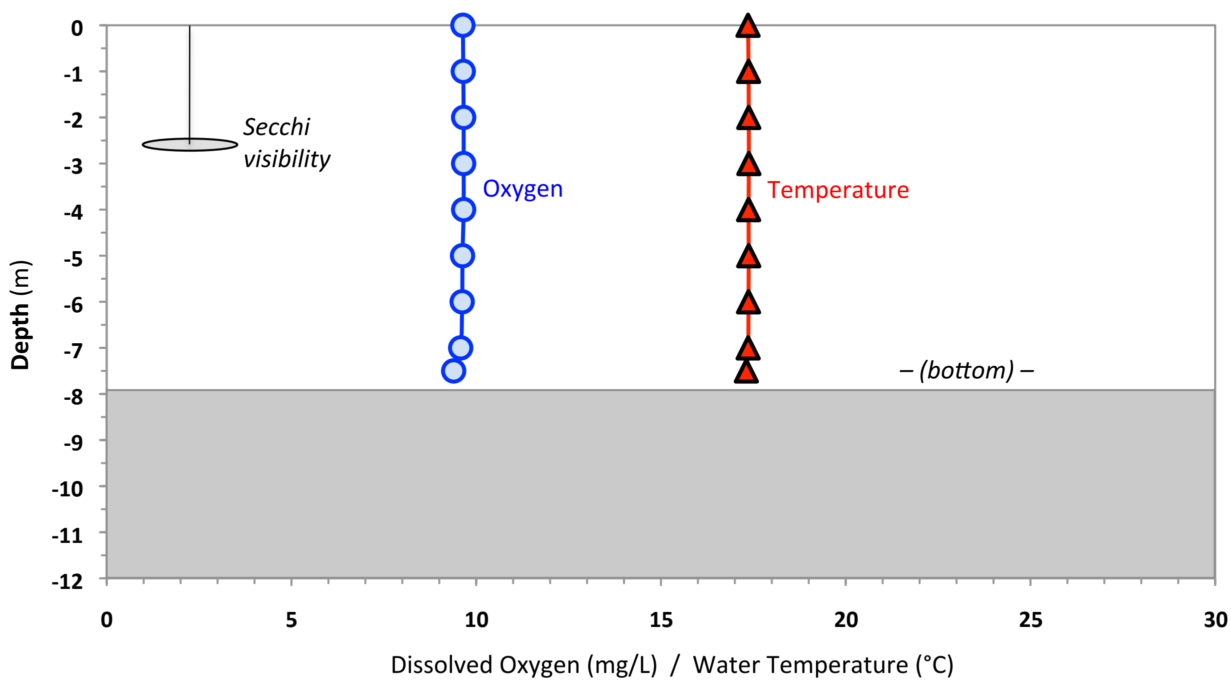


**Figure 4(e). OCT 26, 2020 – B1 Pond framework parameters**

**Table 4(e).** ***(continued)*** **– OPTICAL PARAMETERS (with framework data for reference)**
**OCT 26**: max. depth 7.9 m (26 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** | 17.4 | 9.64 | 101% | 3.07 | 2.13 | 2.28 | 0.53 |
| **1** | 17.4 | 9.65 | 101% | 3.19 | 2.11 | 2.50 | 0.52 |
| **2** | 17.4 | 9.66 | 101% | 3.12 | 2.19 | 3.75 | 0.55 |
| **3** | 17.4 | 9.66 | 101% | 3.13 | 2.28 | 2.39 | 0.54 |
| **4** | 17.4 | 9.66 | 101% | 3.09 | 2.24 | 2.24 | 0.56 |
| **5** | 17.4 | 9.63 | 101% | 3.17 | 2.12 | 2.05 | 0.56 |
| **6** | 17.4 | 9.62 | 101% | 3.18 | 2.19 | 2.44 | 0.58 |
| **7** | 17.4 | 9.58 | 100% | 3.43 | 2.25 | 3.08 | 0.57 |
| **7.5** | 17.3 | 9.39 | 98% | 3.67 | 2.27 | 2.07 | 0.63 |

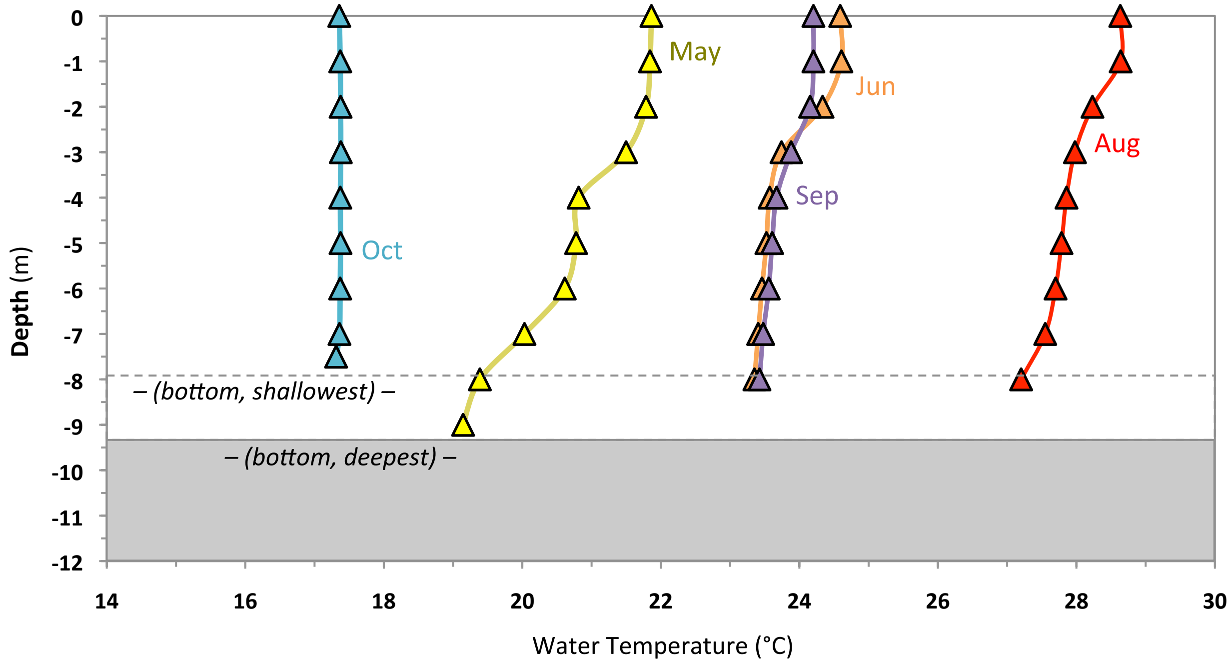


**Figure 4(f). Syar – B1 Pond: 2020 May-Oct TEMPERATURE**

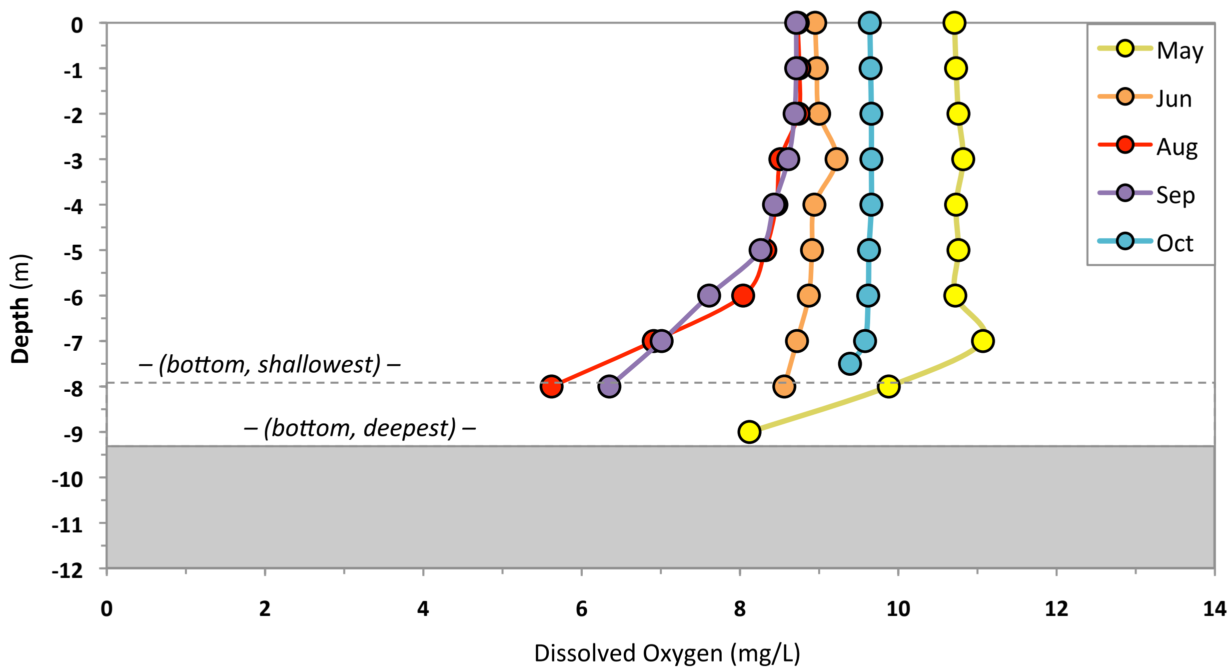


**Figure 4(g). Syar – B1 Pond: 2020 May-Oct OXYGEN**

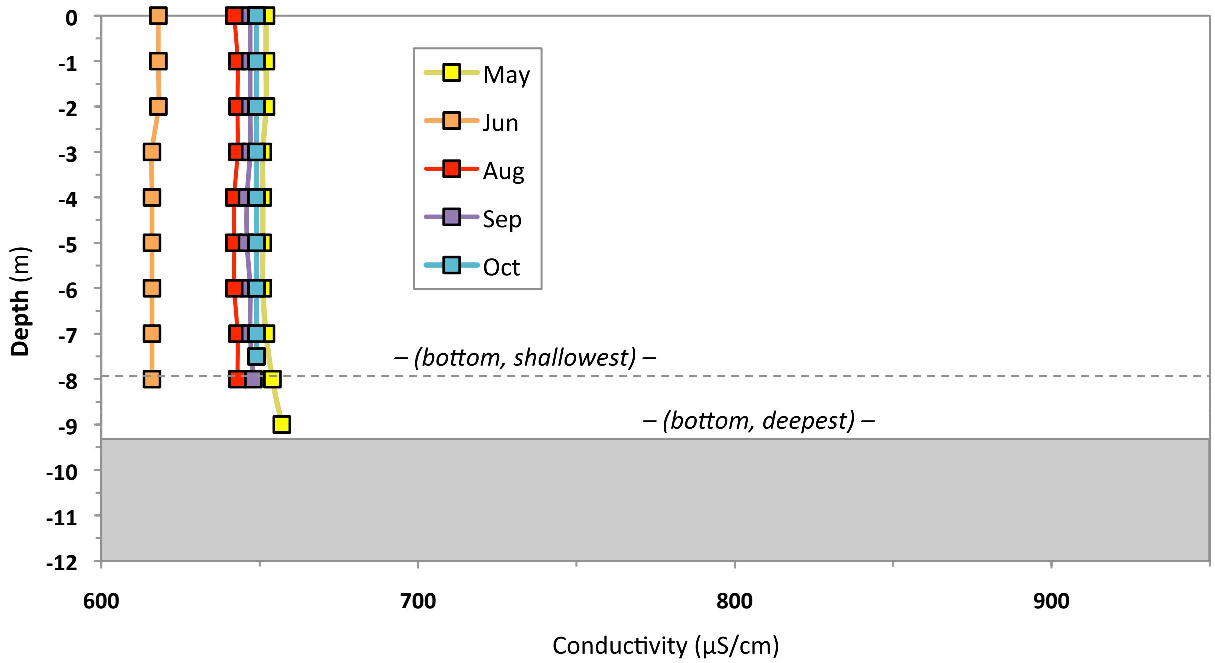


**Figure 4(h). Syar – B1 Pond: 2020 May-Oct CONDUCTIVITY**

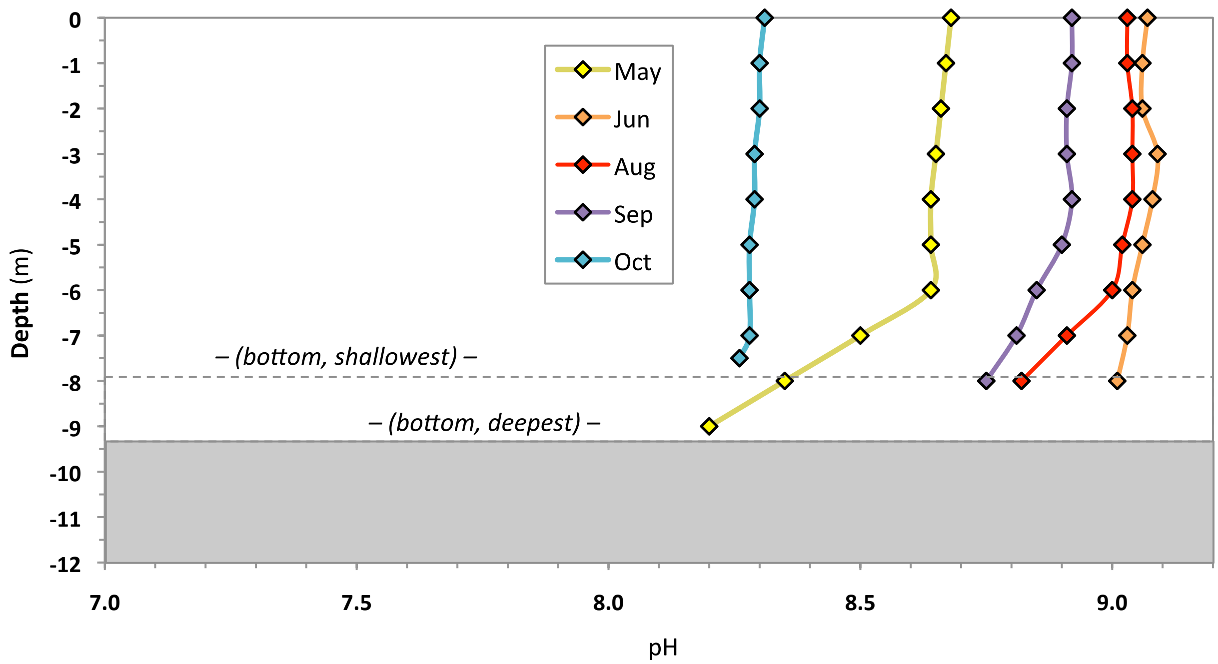


**Figure 4(i). Syar – B1 Pond: 2020 May-Oct pH**

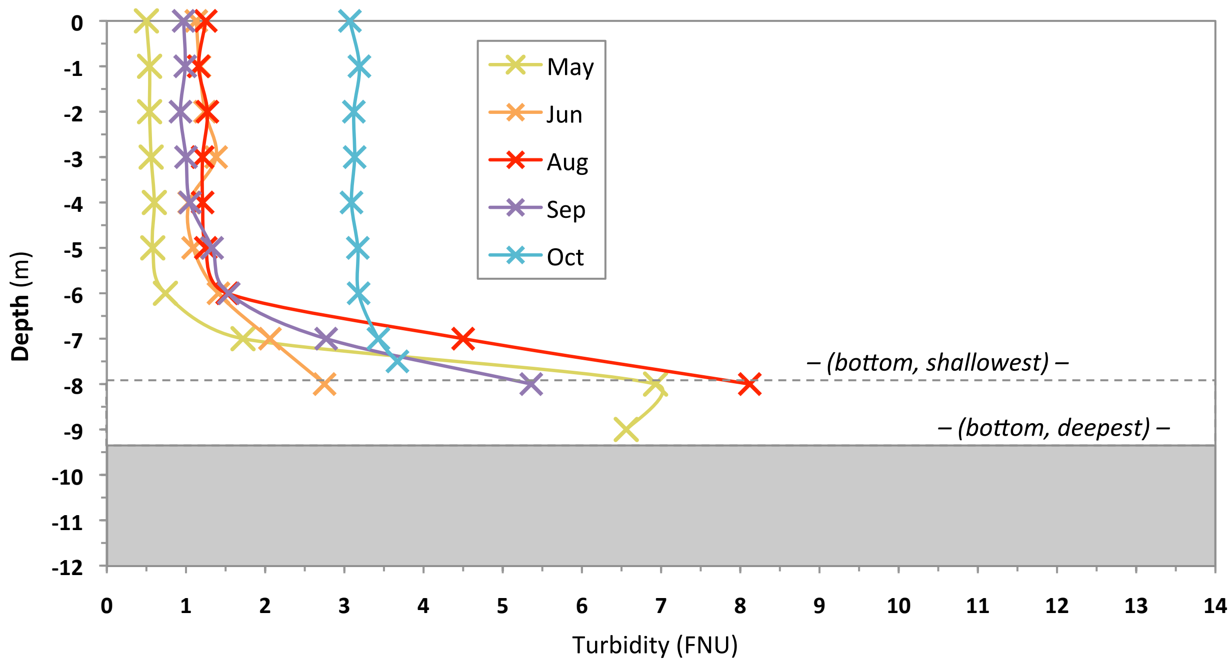


**Figure 4(j). Syar – B1 Pond: 2020 May-Oct TURBIDITY**

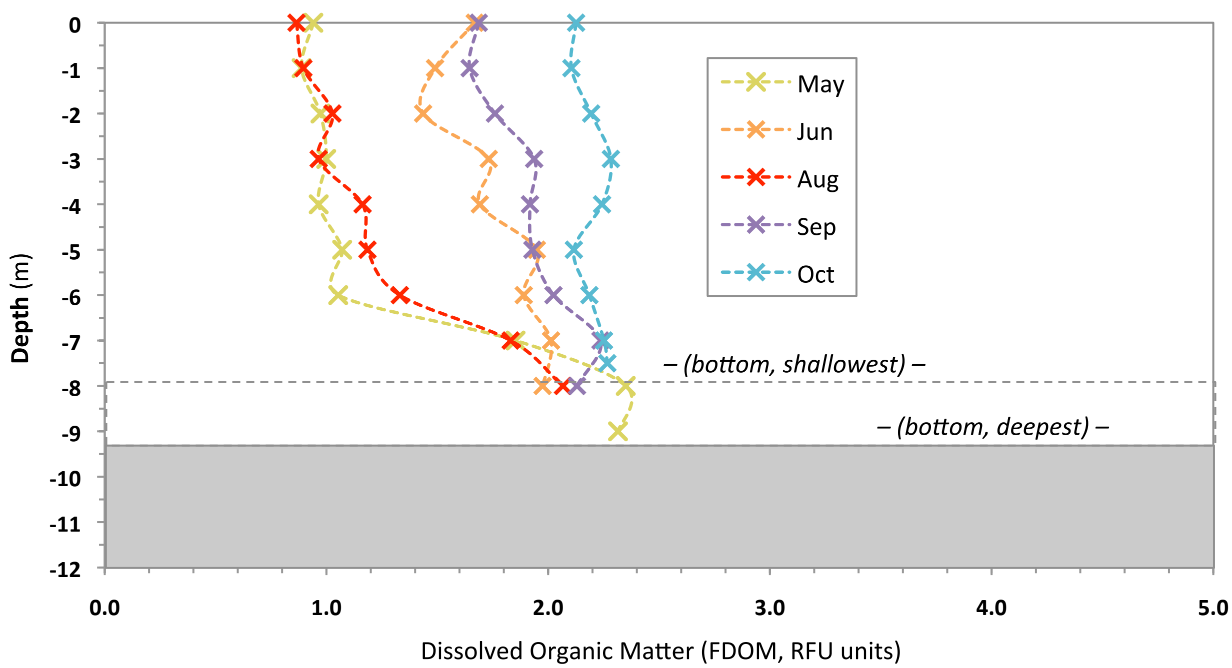


**Figure 4(k). Syar–B1 Pond: 2020 May-Oct DISSOLVED ORGANIC MATTER**

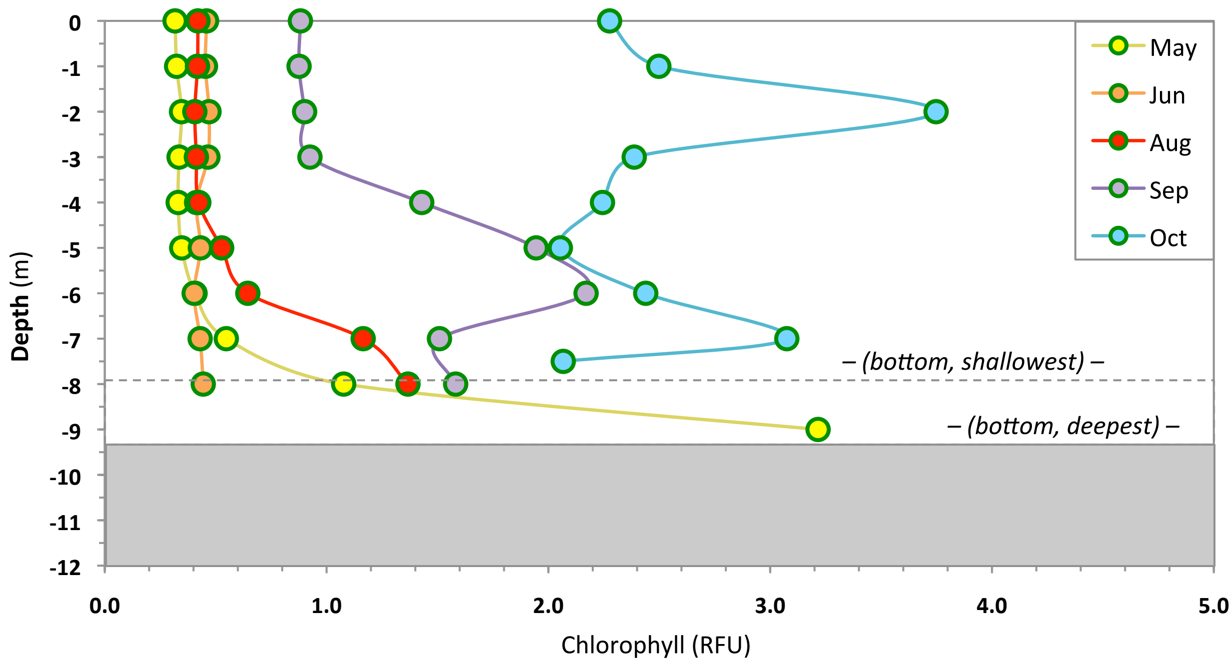


**Figure 4(l). Syar – B1 Pond: 2020 May-Oct CHLOROPHYLL**

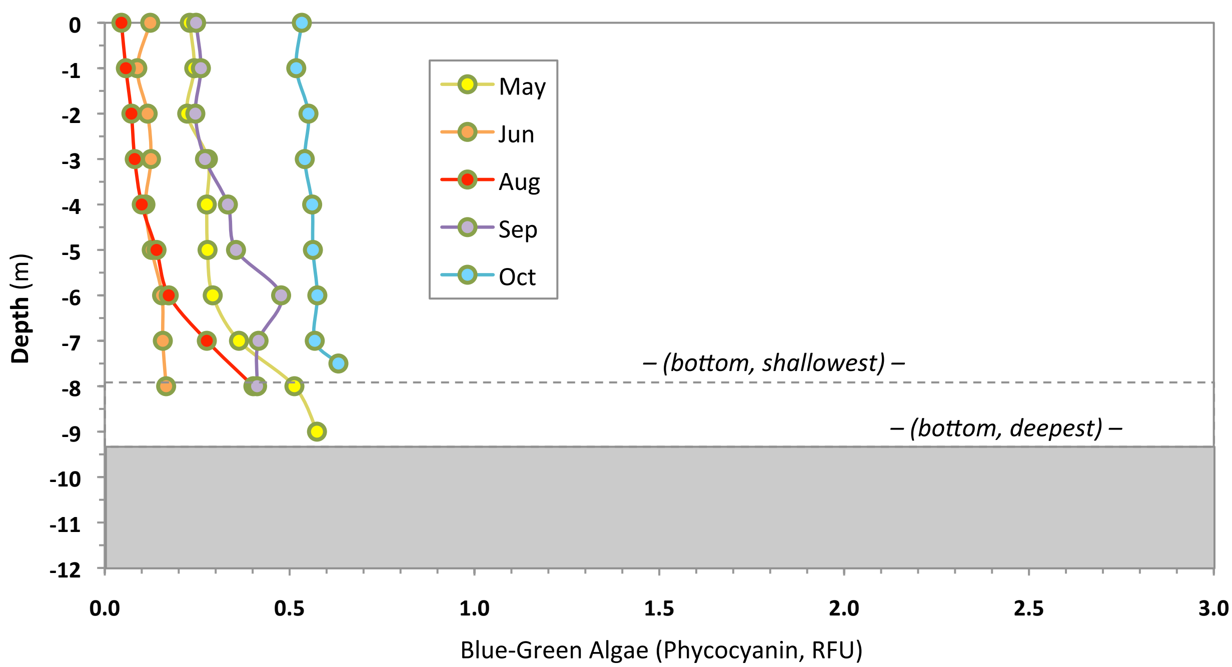


**Figure 4(m). Syar – B1 Pond: 2020 May-Oct BLUE-GREEN ALGAE**

# 5. SYAR–WEST POND


*(Google Earth 10/21/2020)*

## 5. Syar–West Pond

**In summary,** the Syar–West Pond was initially in the 'inconclusive' category for fish mercury but shifted into 'elevated' status this year. It has been monitored since 2019 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. This was found to be the case. 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 October. This 'classic warm season thermal stratification' pattern at Syar–West makes it a straightforward candidate pond for a possible 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 2020 water profiling surveys are presented in Tables 5(a) (May) through 5(e) (October). For each survey date, some of the key, driving parameters are also shown in figure form, Figures 5(a-e).

After the individual survey information, each water quality parameter is plotted across the year of sampling, in Figures 5(f) (Temperature) through 5(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.

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Water Depth (Tables and Figs. 5(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 was 17.4 m (57 ft). Warm season evaporation gradually lowered the depth to 16.3 m (53 ft).

Secchi Water Clarity (Tables and Figs. 5(a-e): was always very clear, ranging from 5.1 m (17 ft) to as deep as 10.3 m (34 ft) in June. 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. 5(a-e), Fig. 5(f)): As in past years, this deep, relatively wind-sheltered pond developed a full, classic seasonal thermal stratification, with a large volume of 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 23-28 °C (73-83 °F). But, while the other ponds had their bottom waters ultimately rise to over 25 °C (77 °F), the much deeper Syar–West bottom zone remained cool at 13-16 °C (56-61 °F). More important, for keeping the water layers separated, was the *difference* between the high and low temperatures, creating different-density layers that don't easily mix. At Syar–West between May and September, this difference was 8-13 °C (14-24 °F), a much larger spread than at any of the other ponds. And, it persisted throughout the season.

The zone of rapid temperature change, with over 1 °C change per m, called the *thermocline*, set up at around 7-10 m depth, creating a 'density barrier' and isolating the bottom levels of the water column from above. The thermocline slowly descended 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 late October 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. 5(a-e), <u>Fig. 5(g)</u>): Bottom water oxygen depletion again occurred here, as in 2019. From May through September, when the thermocline was strong, oxygen became depleted in the bottom several meters to below 2 mg/L (ppm) and as little as 2% of saturation levels. 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 14 m (46 ft). Interestingly, the very highest oxygen production was right around the thermocline in May through August, as often occurs due to a 'pile-up' of phytoplankton. Below this, though, oxygen levels dropped rapidly, presumably increasing methylmercury production and incorporation into the water.

<u>Conductivity</u> (Tables 5(a-e), <u>Fig. 5(h)</u>): ranged between 608 and 680 µS/cm overall, similar to previous years, with highest levels toward the bottom under stratified conditions from June to September and uniform, lowest levels top to bottom by late October with water column mixing.

<u>Salinity</u> (Tables 5(a-e): was fairly uniform, at 0.29-0.33 ppt (parts per thousand, g/L) across all dates and water depths, similar to previous years. Typical freshwaters range below 0.50 ppt; seawater averages 35 ppt.

<u>Total Dissolved Solids (TDS)</u> (Tables 5(a-e): fell within the narrow range of 395-442 mg/L (ppm) across all dates and water depths, similar to previous years. Highest levels occurred toward the bottom under stratified conditions in August and September. Lowest levels were seen top to bottom in late October (395 mg/L), following fall mixing.

pH (Tables 5(a-e), Fig. 5(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 5 m (16 ft) ranged between 8.4 and 9.4. 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 7.2-7.8; pH essentially tracked oxygen levels. Following the onset of fall mixing, pH throughout the water column was approximately 8.0.

Oxidation/Reduction Potential (ORP) (Tables 5(a-e): Across the whole period with temperature stratification (May-Sep), ORP increased gradually with depth, peaked 1-2 m above the bottom, and then dropped approaching the bottom. ORP throughout this time ranged between 18 and 140 mV in the top 15 m (49 ft). The drop in ORP near the bottom became more pronounced through the season, reaching negative readings – under -100 mV – in August and September. Following the onset of fall mixing, ORP throughout the water column hovered narrowly between 32 and 39 mV.

Turbidity (Tables 5(a-e), Fig. 5(j)): The Syar–West pond remains 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. Turbidities were well under 1.0 FNU throughout the top 10 m or more, across the seasons. In June through September, as in other years, a 'murky layer' developed in the bottom several meters, with turbidity levels of 2-12 FNU.

Dissolved Organic Matter (FDOM) (Tables 5(a-e), Fig. 5(k)): Similar to the other ponds, same-date levels were consistent throughout the depths above the thermocline (= top 5 m in May to top 11 m by September), and similar top to bottom in late October after the pond had thoroughly mixed. All of these levels were in the range of 0.5-2.0 RFU. Also, as in most of the other ponds, a buildup of dissolved organic matter (2.3-6.1 RFU) occurred in deeper water layers when the lake was strongly stratified. This was the case on all dates before late October. The profiles through 9-10 m depth (the depth extent of the other ponds) were similar to the surface layers of the other ponds, with general increases lower down under stratification. With 7+ m (23+ ft) of additional depth in the Syar–West pond, as compared to the other ponds, it is interesting to see that these higher levels continued throughout the deep layers.

Green Algae (Chlorophyll) (Tables 5(a-e), Fig. 5(l)): As above for Dissolved Organic Matter, the deep water showed large accumulations relative to the surface layers. The top 10 m had readings all below 0.80 RFU between early May and August. Below the thermocline though, chlorophyll rose as high as 9.69 RFU, a function of both live and dead cells accumulating. In September, there was also the signature of an upper water green algae bloom, into the 2 RFU range. With fall turnover and mixing of the water column, chlorophyll levels in late October were all low (0.2 RFU).

Blue-Green Algae (Phycocyanin) (Tables 5(a-e), Fig. 5(m)): similarly, showed May-September accumulations in the deep water relative to the surface 8-10 m. Surface layer levels were at or well below 0.50 RFU on all dates; increasing to as high as 5.38 in the deep water. The September bloom of green algae in the upper waters was not seen for the blue-green algae. In late October, with fall water column mixing, Phycocyanin levels were about 0.3 RFU top to bottom.

## Table 5(a). Syar – West Pond: 2020 Water Column Profiling Data

**MAY 5:** max. depth 17.4 m (57 ft); Secchi disk water clarity: 9.1 m (30 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** | 22.3 | 10.93 | 126% | 660 | 0.32 | 429 | 8.44 | 104 |
| **1** | 22.2 | 11.00 | 127% | 660 | 0.32 | 429 | 8.44 | 107 |
| **2** | 21.6 | 11.25 | 128% | 659 | 0.32 | 428 | 8.45 | 109 |
| **3** | 21.3 | 11.16 | 126% | 659 | 0.32 | 428 | 8.45 | 110 |
| **4** | 21.2 | 10.92 | 123% | 660 | 0.32 | 429 | 8.42 | 112 |
| **5** | 21.0 | 11.03 | 124% | 659 | 0.32 | 428 | 8.43 | 113 |
| **6** | 20.5 | 10.64 | 118% | 673 | 0.33 | 438 | 8.27 | 118 |
| **7** | 17.9 | 13.75 | 145% | 649 | 0.32 | 422 | 8.50 | 118 |
| **8** | 16.7 | 13.59 | 140% | 648 | 0.32 | 421 | 8.48 | 120 |
| **9** | 16.0 | 13.04 | 133% | 649 | 0.32 | 422 | 8.43 | 122 |
| **10** | 15.5 | 12.46 | 125% | 649 | 0.32 | 422 | 8.35 | 124 |
| **11** | 14.7 | 11.71 | 116% | 649 | 0.32 | 422 | 8.23 | 126 |
| **12** | 14.0 | 10.34 | 101% | 650 | 0.32 | 422 | 8.07 | 129 |
| **13** | 13.6 | 8.55 | 82% | 652 | 0.32 | 424 | 7.89 | 131 |
| **14** | 13.3 | 6.33 | 61% | 654 | 0.32 | 425 | 7.66 | 134 |
| **15** | 13.0 | 1.53 | 15% | 659 | 0.32 | 429 | 7.33 | 140 |
| **16** | 13.0 | 1.17 | 11% | 659 | 0.32 | 428 | 7.30 | 141 |
| **17** | 13.0 | 0.83 | 8% | 659 | 0.32 | 429 | 7.28 | 132 |

**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** | 22.3 | 10.93 | 126% | 0.24 | 0.98 | 0.22 | 0.22 |
| **1** | 22.2 | 11.00 | 127% | 0.28 | 1.05 | 0.24 | 0.20 |
| **2** | 21.6 | 11.25 | 128% | 0.29 | 0.95 | 0.21 | 0.21 |
| **3** | 21.3 | 11.16 | 126% | 0.28 | 1.06 | 0.19 | 0.25 |
| **4** | 21.2 | 10.92 | 123% | 0.30 | 1.16 | 0.16 | 0.22 |
| **5** | 21.0 | 11.03 | 124% | 0.31 | 1.00 | 0.18 | 0.29 |
| **6** | 20.5 | 10.64 | 118% | 0.38 | 1.50 | 0.18 | 0.31 |
| **7** | 17.9 | 13.75 | 145% | 0.41 | 1.90 | 0.28 | 0.34 |
| **8** | 16.7 | 13.59 | 140% | 0.39 | 1.89 | 0.40 | 0.48 |
| **9** | 16.0 | 13.04 | 133% | 0.42 | 1.84 | 0.45 | 0.54 |
| **10** | 15.5 | 12.46 | 125% | 0.48 | 1.90 | 0.53 | 0.61 |
| **11** | 14.7 | 11.71 | 116% | 0.47 | 2.30 | 0.62 | 0.69 |
| **12** | 14.0 | 10.34 | 101% | 0.54 | 2.45 | 1.04 | 0.81 |
| **13** | 13.6 | 8.55 | 82% | 0.57 | 2.54 | 1.41 | 0.87 |
| **14** | 13.3 | 6.33 | 61% | 0.64 | 2.58 | 1.56 | 0.92 |
| **15** | 13.0 | 1.53 | 15% | 0.72 | 2.78 | 1.36 | 0.94 |
| **16** | 13.0 | 1.17 | 11% | 0.71 | 2.83 | 0.88 | 0.91 |
| **17** | 13.0 | 0.83 | 8% | 0.85 | 2.84 | 1.37 | 0.99 |

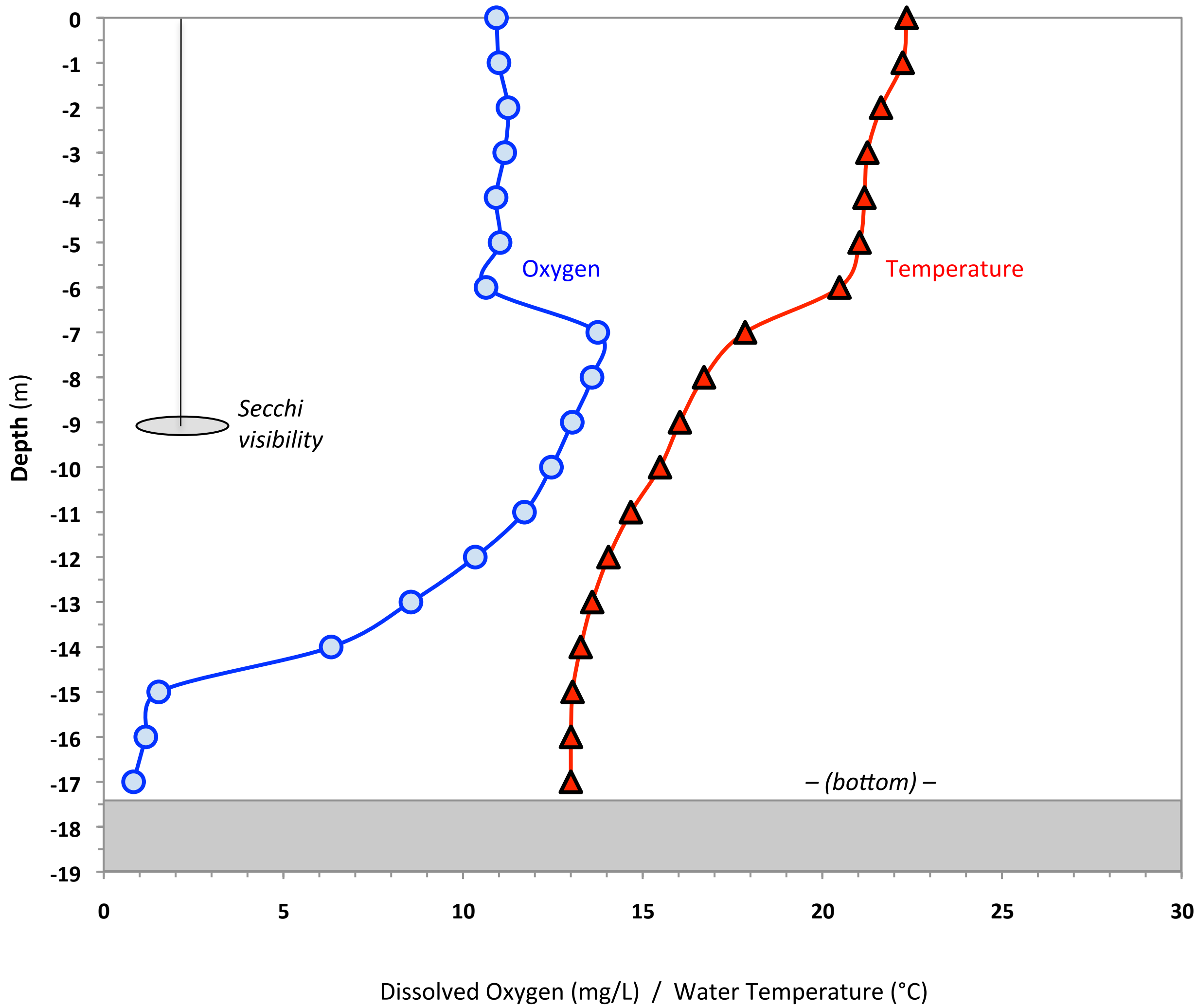


**Figure 5(a). MAY 5, 2020 – West Pond framework parameters**

**Table 5(b). Syar – West Pond: 2020 Water Column Profiling Data**
**JUN 18:** max. depth 17.1 m (56 ft); Secchi disk water clarity: 10.3 m (34 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** | 24.0 | 10.24 | 122% | 622 | 0.30 | 404 | 8.89 | 71 |
| **1** | 24.0 | 10.26 | 122% | 622 | 0.30 | 404 | 8.88 | 73 |
| **2** | 23.9 | 10.35 | 123% | 621 | 0.30 | 404 | 8.87 | 75 |
| **3** | 23.5 | 10.80 | 127% | 620 | 0.30 | 403 | 8.88 | 79 |
| **4** | 23.4 | 10.30 | 121% | 621 | 0.30 | 403 | 8.86 | 81 |
| **5** | 23.3 | 10.29 | 121% | 621 | 0.30 | 404 | 8.86 | 82 |
| **6** | 23.2 | 10.25 | 120% | 621 | 0.30 | 404 | 8.85 | 83 |
| **7** | 23.1 | 10.31 | 121% | 621 | 0.30 | 403 | 8.84 | 84 |
| **8** | 22.9 | 10.26 | 120% | 621 | 0.30 | 404 | 8.82 | 86 |
| **9** | 22.6 | 10.27 | 119% | 622 | 0.30 | 404 | 8.81 | 87 |
| **10** | 19.4 | 12.78 | 139% | 620 | 0.30 | 403 | 8.86 | 90 |
| **11** | 17.4 | 12.08 | 126% | 619 | 0.30 | 402 | 8.88 | 94 |
| **12** | 16.5 | 11.33 | 116% | 620 | 0.30 | 403 | 8.77 | 96 |
| **13** | 15.8 | 10.33 | 104% | 620 | 0.30 | 403 | 8.66 | 99 |
| **14** | 14.9 | 7.82 | 78% | 624 | 0.30 | 406 | 8.38 | 103 |
| **15** | 14.4 | 0.73 | 7% | 630 | 0.31 | 409 | 7.79 | 111 |
| **16** | 14.2 | 0.22 | 2% | 632 | 0.31 | 411 | 7.69 | 75 |
| **16.5** | 14.2 | 0.17 | 2% | 634 | 0.31 | 412 | 7.67 | 34 |

**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** | 24.0 | 10.24 | 122% | 0.65 | 1.39 | 0.35 | 0.11 |
| **1** | 24.0 | 10.26 | 122% | 0.32 | 1.55 | 0.36 | 0.13 |
| **2** | 23.9 | 10.35 | 123% | 0.19 | 1.39 | 0.35 | 0.18 |
| **3** | 23.5 | 10.80 | 127% | 0.21 | 1.57 | 0.38 | 0.15 |
| **4** | 23.4 | 10.30 | 121% | 0.18 | 1.58 | 0.29 | 0.14 |
| **5** | 23.3 | 10.29 | 121% | 0.21 | 1.50 | 0.32 | 0.12 |
| **6** | 23.2 | 10.25 | 120% | 0.23 | 1.73 | 0.34 | 0.19 |
| **7** | 23.1 | 10.31 | 121% | 0.26 | 1.63 | 0.38 | 0.17 |
| **8** | 22.9 | 10.26 | 120% | 0.29 | 1.82 | 0.39 | 0.15 |
| **9** | 22.6 | 10.27 | 119% | 0.31 | 2.04 | 0.37 | 0.19 |
| **10** | 19.4 | 12.78 | 139% | 0.37 | 3.74 | 0.39 | 0.23 |
| **11** | 17.4 | 12.08 | 126% | 0.41 | 4.35 | 0.53 | 0.40 |
| **12** | 16.5 | 11.33 | 116% | 0.42 | 4.53 | 0.81 | 0.51 |
| **13** | 15.8 | 10.33 | 104% | 0.67 | 4.84 | 0.86 | 0.73 |
| **14** | 14.9 | 7.82 | 78% | 1.27 | 5.11 | 3.85 | 0.91 |
| **15** | 14.4 | 0.73 | 7% | 0.66 | 5.75 | 0.90 | 0.82 |
| **16** | 14.2 | 0.22 | 2% | 1.74 | 5.92 | 1.34 | 1.03 |
| **16.5** | 14.2 | 0.17 | 2% | 3.20 | 6.15 | 0.60 | 0.87 |

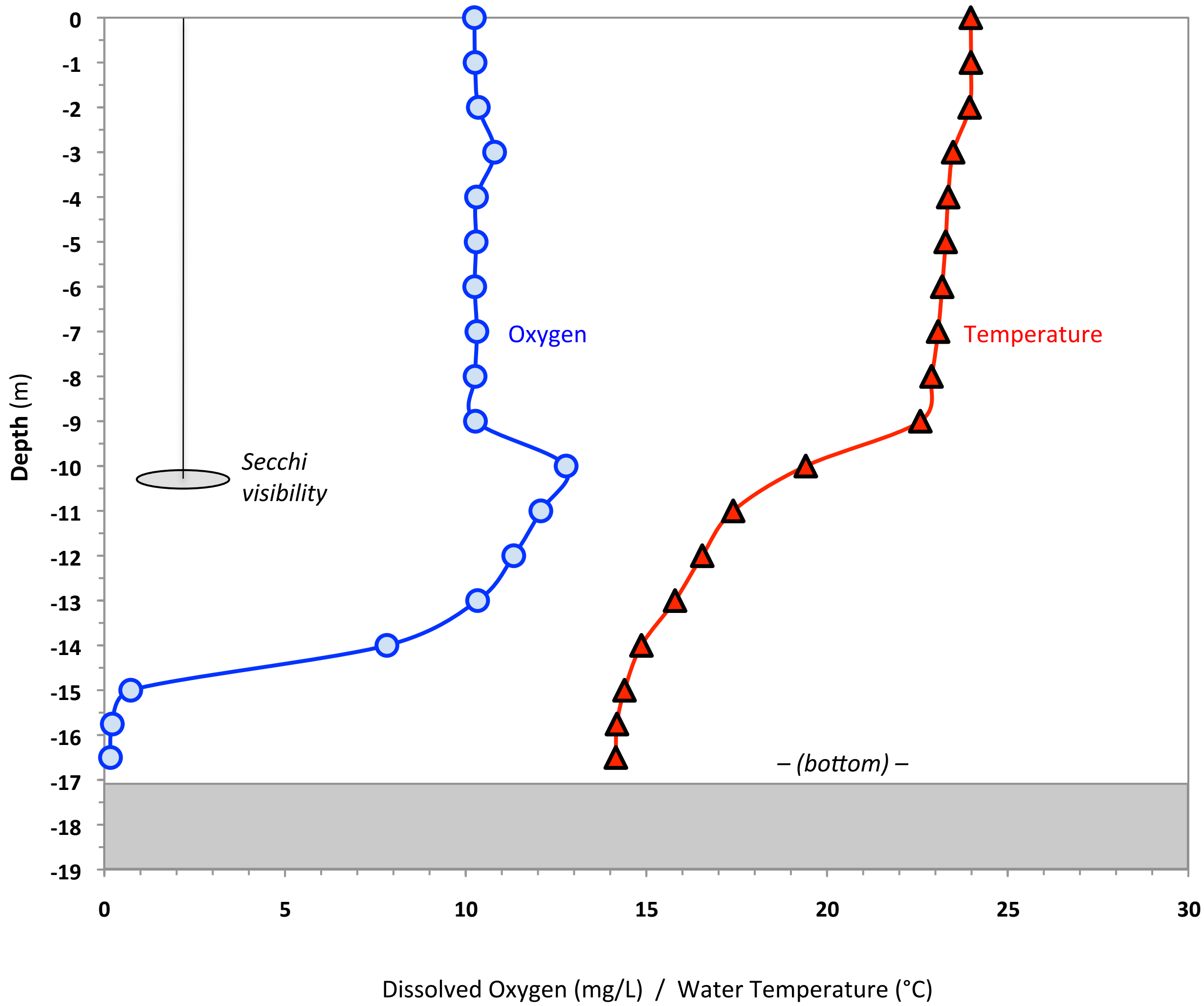


**Figure 5(b). JUN 18, 2020 – West Pond framework parameters**

## Table 5(c). Syar – West Pond: 2020 Water Column Profiling Data

**AUG 4:** max. depth 16.8 m (55 ft); Secchi disk water clarity: 7.6 m (25 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 | 9.81 | 126% | 631 | 0.30 | 410 | 8.84 | 53 |
| 1 | 28.2 | 9.97 | 128% | 634 | 0.31 | 412 | 8.86 | 57 |
| 2 | 27.9 | 10.67 | 136% | 632 | 0.30 | 411 | 8.89 | 58 |
| 3 | 27.6 | 10.50 | 133% | 633 | 0.31 | 412 | 8.89 | 60 |
| 4 | 27.4 | 10.54 | 134% | 633 | 0.30 | 411 | 8.90 | 62 |
| 5 | 27.3 | 10.29 | 130% | 633 | 0.31 | 411 | 8.88 | 63 |
| 6 | 27.2 | 10.21 | 129% | 633 | 0.31 | 412 | 8.84 | 66 |
| 7 | 26.9 | 10.26 | 129% | 635 | 0.31 | 413 | 8.82 | 68 |
| 8 | 26.7 | 10.21 | 128% | 635 | 0.31 | 413 | 8.80 | 68 |
| 9 | 26.3 | 10.51 | 130% | 635 | 0.31 | 413 | 8.78 | 71 |
| 10 | 24.5 | 13.67 | 164% | 637 | 0.31 | 414 | 8.86 | 74 |
| 11 | 21.6 | 15.36 | 175% | 641 | 0.31 | 417 | 9.01 | 77 |
| 12 | 19.1 | 14.17 | 153% | 642 | 0.31 | 417 | 9.04 | 81 |
| 13 | 17.8 | 13.25 | 140% | 642 | 0.31 | 417 | 8.81 | 84 |
| 14 | 16.6 | 2.70 | 28% | 652 | 0.32 | 424 | 7.92 | 95 |
| 15 | 16.0 | 0.34 | 4% | 655 | 0.32 | 425 | 7.65 | 99 |
| 16 | 15.1 | 0.19 | 2% | 679 | 0.33 | 441 | 7.46 | -145 |

**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 | 9.81 | 126% | 0.49 | 0.67 | 0.49 | 0.09 |
| 1 | 28.2 | 9.97 | 128% | 0.39 | 0.55 | 0.48 | 0.07 |
| 2 | 27.9 | 10.67 | 136% | 0.41 | 0.67 | 0.40 | 0.06 |
| 3 | 27.6 | 10.50 | 133% | 0.43 | 0.56 | 0.46 | 0.08 |
| 4 | 27.4 | 10.54 | 134% | 0.44 | 0.62 | 0.54 | 0.11 |
| 5 | 27.3 | 10.29 | 130% | 0.43 | 0.82 | 0.47 | 0.12 |
| 6 | 27.2 | 10.21 | 129% | 0.50 | 0.77 | 0.48 | 0.14 |
| 7 | 26.9 | 10.26 | 129% | 0.56 | 0.91 | 0.56 | 0.16 |
| 8 | 26.7 | 10.21 | 128% | 0.50 | 0.90 | 0.56 | 0.18 |
| 9 | 26.3 | 10.51 | 130% | 0.58 | 1.26 | 0.48 | 0.16 |
| 10 | 24.5 | 13.67 | 164% | 0.58 | 2.25 | 0.58 | 0.31 |
| 11 | 21.6 | 15.36 | 175% | 0.62 | 2.90 | 0.62 | 0.42 |
| 12 | 19.1 | 14.17 | 153% | 0.90 | 3.55 | 0.76 | 0.61 |
| 13 | 17.8 | 13.25 | 140% | 0.99 | 3.57 | 0.83 | 0.80 |
| 14 | 16.6 | 2.70 | 28% | 1.72 | 3.92 | 1.74 | 0.92 |
| 15 | 16.0 | 0.34 | 4% | 6.48 | 3.56 | 2.92 | 1.68 |
| 16 | 15.1 | 0.19 | 2% | 7.62 | 4.58 | 4.69 | 3.00 |

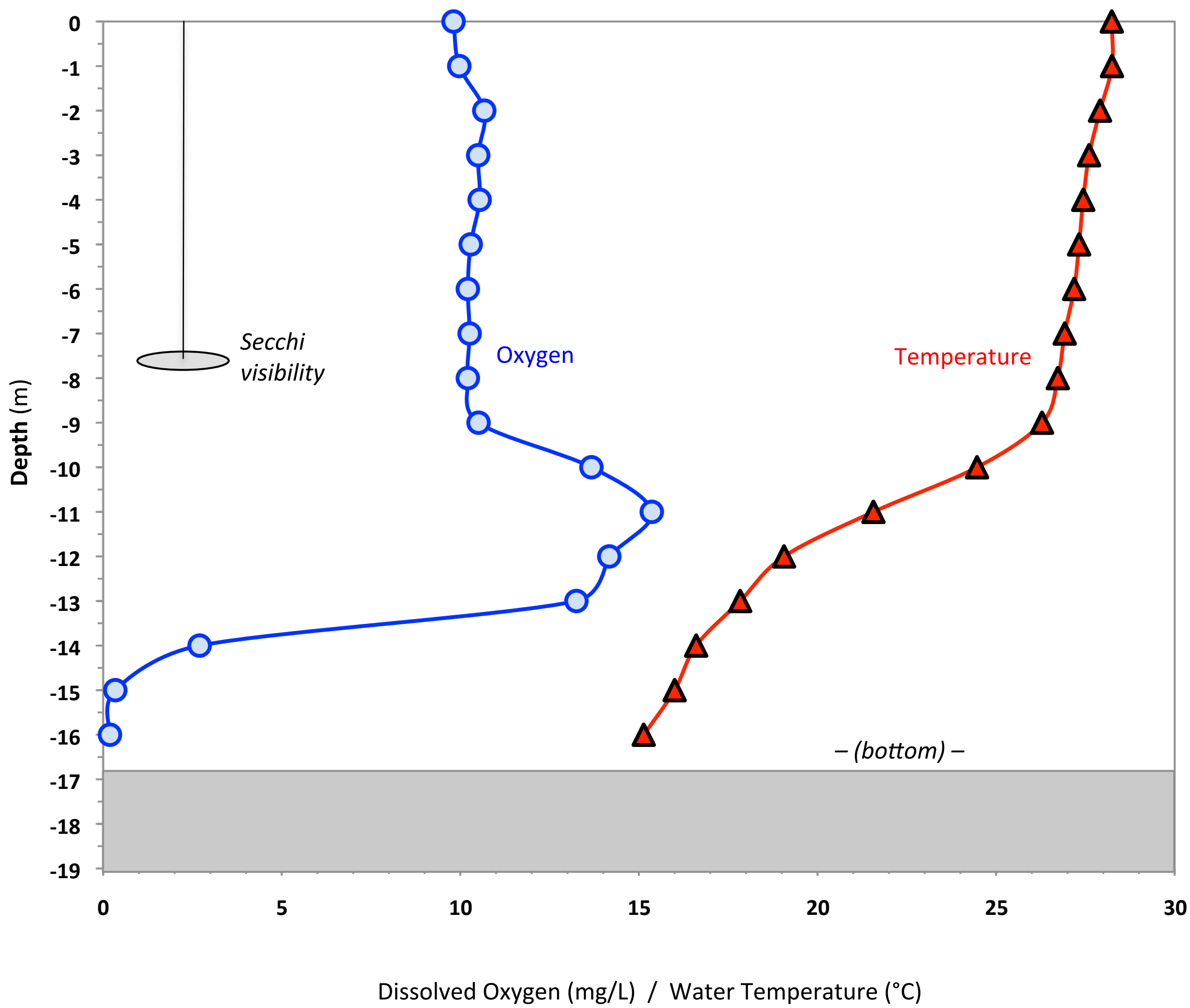


**Figure 5(c). AUG 4, 2020 – West Pond framework parameters**

## Table 5(d). Syar – West Pond: 2020 Water Column Profiling Data

**SEP 20**: max. depth 16.5 m (54 ft); Secchi disk water clarity: 5.1 m (16.7 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** | 24.5 | 10.98 | 132% | 612 | 0.30 | 398 | 9.35 | 18 |
| **1** | 24.3 | 10.94 | 131% | 612 | 0.30 | 398 | 9.26 | 19 |
| **2** | 24.0 | 12.10 | 144% | 609 | 0.29 | 396 | 9.22 | 20 |
| **3** | 23.8 | 11.29 | 134% | 611 | 0.30 | 397 | 9.03 | 24 |
| **4** | 23.7 | 11.06 | 131% | 611 | 0.30 | 397 | 8.98 | 26 |
| **5** | 23.7 | 10.86 | 129% | 612 | 0.30 | 397 | 8.95 | 27 |
| **6** | 23.7 | 10.63 | 126% | 612 | 0.30 | 398 | 8.92 | 28 |
| **7** | 23.6 | 10.45 | 123% | 612 | 0.30 | 398 | 8.90 | 29 |
| **8** | 23.6 | 10.06 | 119% | 612 | 0.30 | 398 | 8.85 | 31 |
| **9** | 23.5 | 9.88 | 117% | 612 | 0.30 | 398 | 8.83 | 32 |
| **10** | 23.2 | 8.76 | 103% | 612 | 0.30 | 398 | 8.70 | 35 |
| **11** | 23.1 | 8.91 | 104% | 611 | 0.30 | 397 | 8.71 | 36 |
| **12** | 22.3 | 8.04 | 93% | 623 | 0.30 | 405 | 8.59 | 41 |
| **13** | 19.3 | 6.27 | 68% | 641 | 0.31 | 417 | 8.44 | 49 |
| **14** | 18.1 | 1.66 | 18% | 643 | 0.31 | 418 | 8.08 | 54 |
| **15** | 17.1 | 0.24 | 3% | 647 | 0.32 | 421 | 7.84 | 57 |
| **16** | 16.3 | 0.18 | 2% | 680 | 0.33 | 442 | 7.54 | -122 |

### 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** | 24.5 | 10.98 | 132% | 0.13 | 1.12 | 2.14 | 0.29 |
| **1** | 24.3 | 10.94 | 131% | 0.06 | 1.30 | 2.03 | 0.28 |
| **2** | 24.0 | 12.10 | 144% | 0.09 | 1.25 | 1.92 | 0.29 |
| **3** | 23.8 | 11.29 | 134% | 0.07 | 1.33 | 1.94 | 0.35 |
| **4** | 23.7 | 11.06 | 131% | 0.09 | 1.30 | 1.91 | 0.37 |
| **5** | 23.7 | 10.86 | 129% | 0.04 | 1.45 | 1.89 | 0.32 |
| **6** | 23.7 | 10.63 | 126% | 0.09 | 1.39 | 1.90 | 0.34 |
| **7** | 23.6 | 10.45 | 123% | 0.05 | 1.48 | 1.92 | 0.37 |
| **8** | 23.6 | 10.06 | 119% | 0.04 | 1.61 | 1.77 | 0.38 |
| **9** | 23.5 | 9.88 | 117% | 0.07 | 1.66 | 1.84 | 0.37 |
| **10** | 23.2 | 8.76 | 103% | 0.20 | 1.70 | 1.31 | 0.33 |
| **11** | 23.1 | 8.91 | 104% | 0.17 | 1.79 | 1.42 | 0.33 |
| **12** | 22.3 | 8.04 | 93% | 0.26 | 2.72 | 1.00 | 0.30 |
| **13** | 19.3 | 6.27 | 68% | 0.30 | 4.18 | 0.63 | 0.35 |
| **14** | 18.1 | 1.66 | 18% | 0.44 | 4.32 | 0.44 | 0.44 |
| **15** | 17.1 | 0.24 | 3% | 4.32 | 4.12 | 9.69 | 5.38 |
| **16** | 16.3 | 0.18 | 2% | 11.36 | 4.80 | 0.83 | 1.16 |

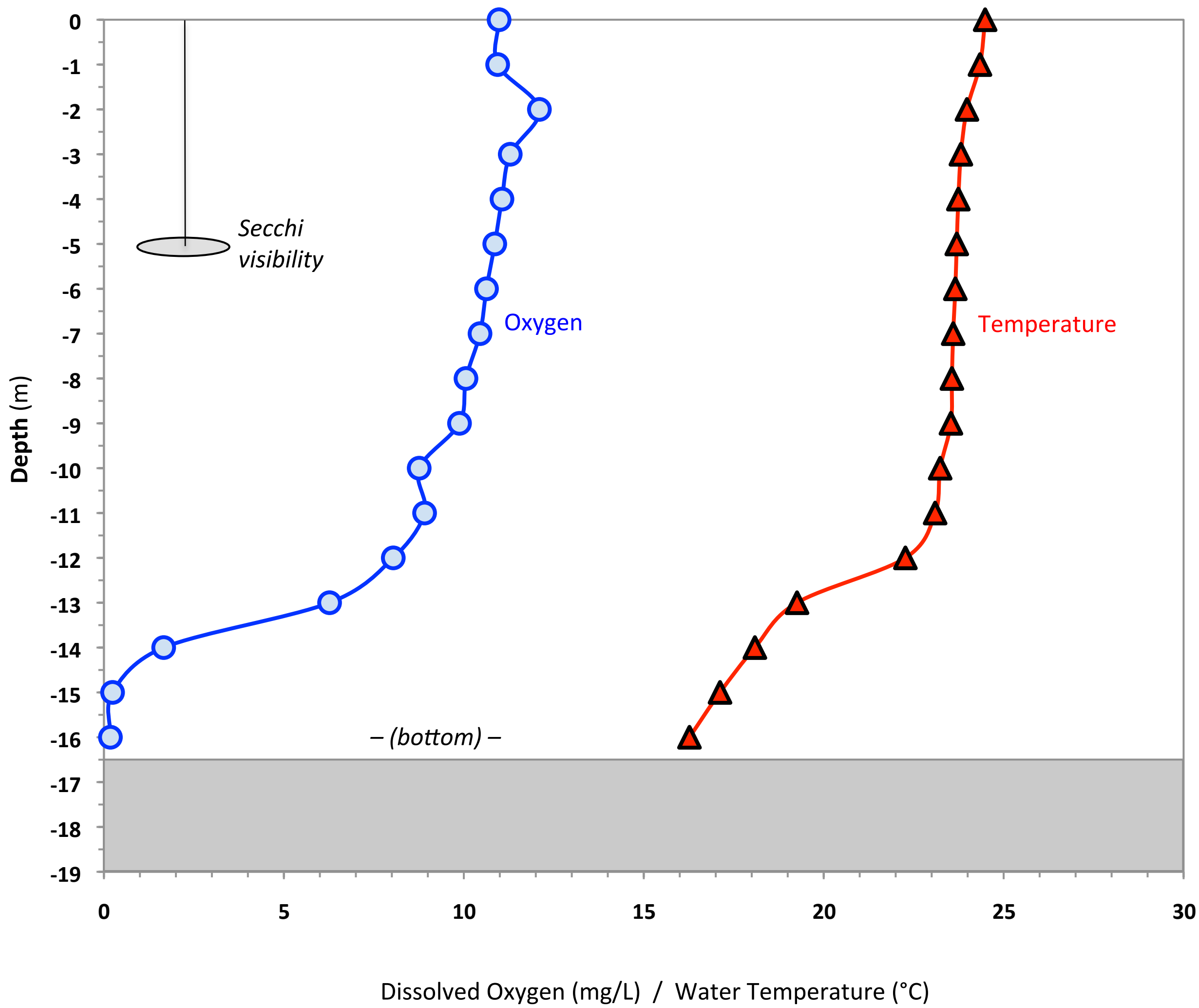


**Figure 5(d). SEP 20, 2020 – West Pond framework parameters**

**Table 5(e). Syar – West Pond: 2020 Water Column Profiling Data**

**OCT 26**: max. depth 16.3 m (53.5 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** | 18.4 | 8.02 | 86% | 607 | 0.30 | 395 | 8.01 | 32 |
| **1** | 18.4 | 8.01 | 85% | 607 | 0.30 | 395 | 8.01 | 32 |
| **2** | 18.4 | 7.99 | 85% | 607 | 0.30 | 395 | 8.00 | 33 |
| **3** | 18.4 | 7.96 | 85% | 607 | 0.30 | 395 | 8.00 | 33 |
| **4** | 18.4 | 7.96 | 85% | 607 | 0.30 | 395 | 8.00 | 33 |
| **5** | 18.4 | 8.00 | 85% | 607 | 0.30 | 395 | 8.00 | 33 |
| **6** | 18.4 | 8.01 | 85% | 608 | 0.30 | 395 | 8.00 | 34 |
| **7** | 18.4 | 8.00 | 85% | 607 | 0.30 | 395 | 8.00 | 34 |
| **8** | 18.4 | 7.98 | 85% | 608 | 0.30 | 395 | 8.00 | 34 |
| **9** | 18.4 | 7.98 | 85% | 608 | 0.30 | 395 | 8.00 | 34 |
| **10** | 18.4 | 7.95 | 85% | 608 | 0.30 | 395 | 8.00 | 35 |
| **11** | 18.4 | 7.95 | 85% | 608 | 0.30 | 395 | 7.99 | 35 |
| **12** | 18.4 | 7.97 | 85% | 608 | 0.30 | 395 | 8.00 | 35 |
| **13** | 18.4 | 7.98 | 85% | 608 | 0.30 | 395 | 8.00 | 36 |
| **14** | 18.4 | 7.92 | 85% | 608 | 0.30 | 395 | 7.99 | 38 |
| **15** | 18.4 | 7.91 | 84% | 608 | 0.30 | 395 | 7.99 | 38 |
| **16** | 18.4 | 7.89 | 84% | 608 | 0.30 | 395 | 7.99 | 39 |

**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** | 18.4 | 8.02 | 86% | 0.46 | 1.80 | 0.20 | 0.28 |
| **1** | 18.4 | 8.01 | 85% | 0.47 | 1.76 | 0.24 | 0.30 |
| **2** | 18.4 | 7.99 | 85% | 0.48 | 1.83 | 0.22 | 0.29 |
| **3** | 18.4 | 7.96 | 85% | 0.45 | 1.93 | 0.21 | 0.30 |
| **4** | 18.4 | 7.96 | 85% | 0.48 | 1.96 | 0.24 | 0.29 |
| **5** | 18.4 | 8.00 | 85% | 0.48 | 1.94 | 0.23 | 0.28 |
| **6** | 18.4 | 8.01 | 85% | 0.50 | 1.82 | 0.23 | 0.29 |
| **7** | 18.4 | 8.00 | 85% | 0.48 | 1.76 | 0.20 | 0.31 |
| **8** | 18.4 | 7.98 | 85% | 0.51 | 1.80 | 0.25 | 0.26 |
| **9** | 18.4 | 7.98 | 85% | 0.51 | 1.87 | 0.21 | 0.28 |
| **10** | 18.4 | 7.95 | 85% | 0.47 | 1.97 | 0.20 | 0.32 |
| **11** | 18.4 | 7.95 | 85% | 0.47 | 1.93 | 0.24 | 0.30 |
| **12** | 18.4 | 7.97 | 85% | 0.46 | 1.80 | 0.28 | 0.26 |
| **13** | 18.4 | 7.98 | 85% | 0.44 | 1.77 | 0.26 | 0.27 |
| **14** | 18.4 | 7.92 | 85% | 0.52 | 1.78 | 0.22 | 0.27 |
| **15** | 18.4 | 7.91 | 84% | 0.50 | 1.77 | 0.20 | 0.27 |
| **16** | 18.4 | 7.89 | 84% | 0.53 | 1.79 | 0.19 | 0.27 |

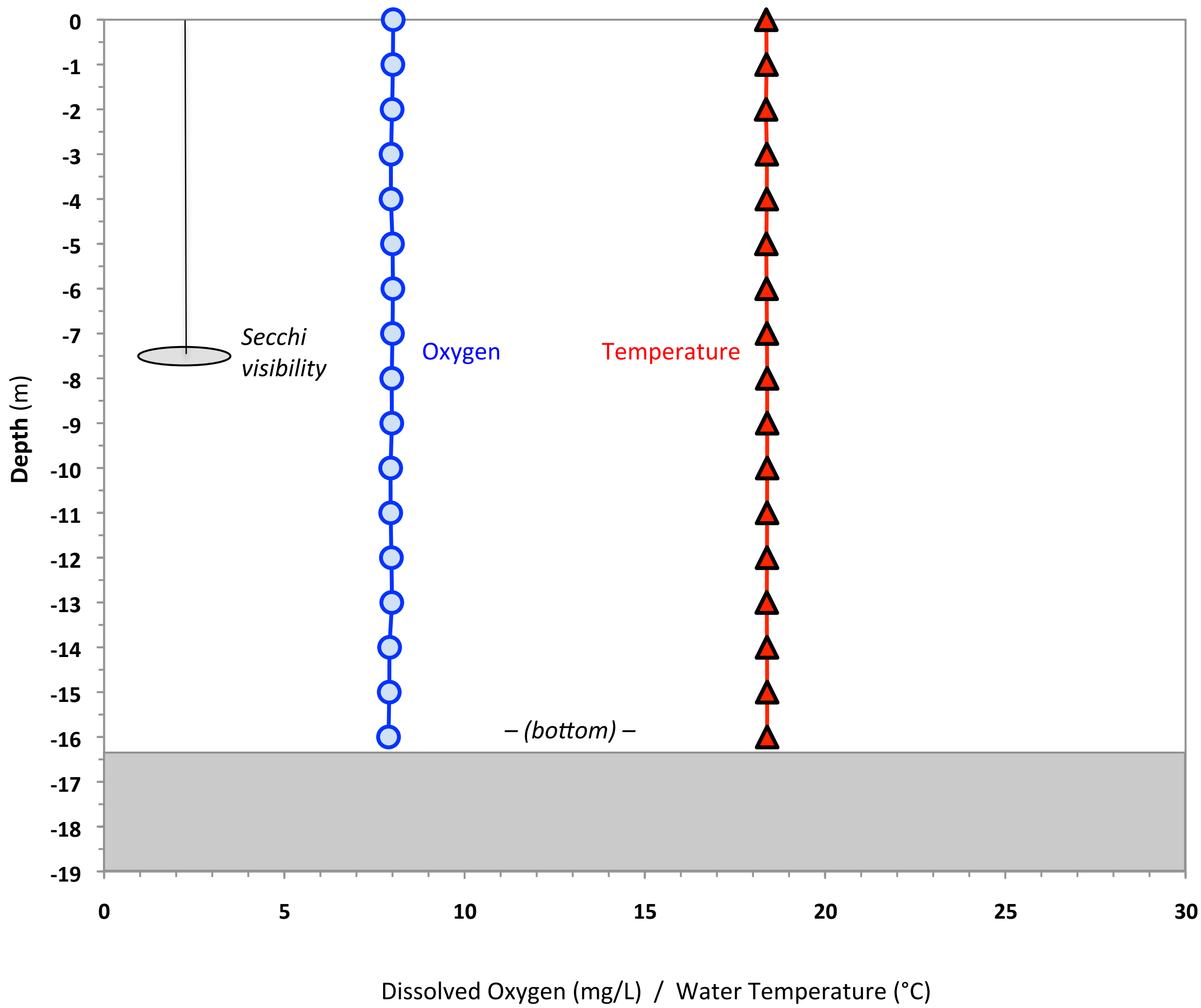


**Figure 5(e). OCT 26, 2020 – West Pond framework parameters**

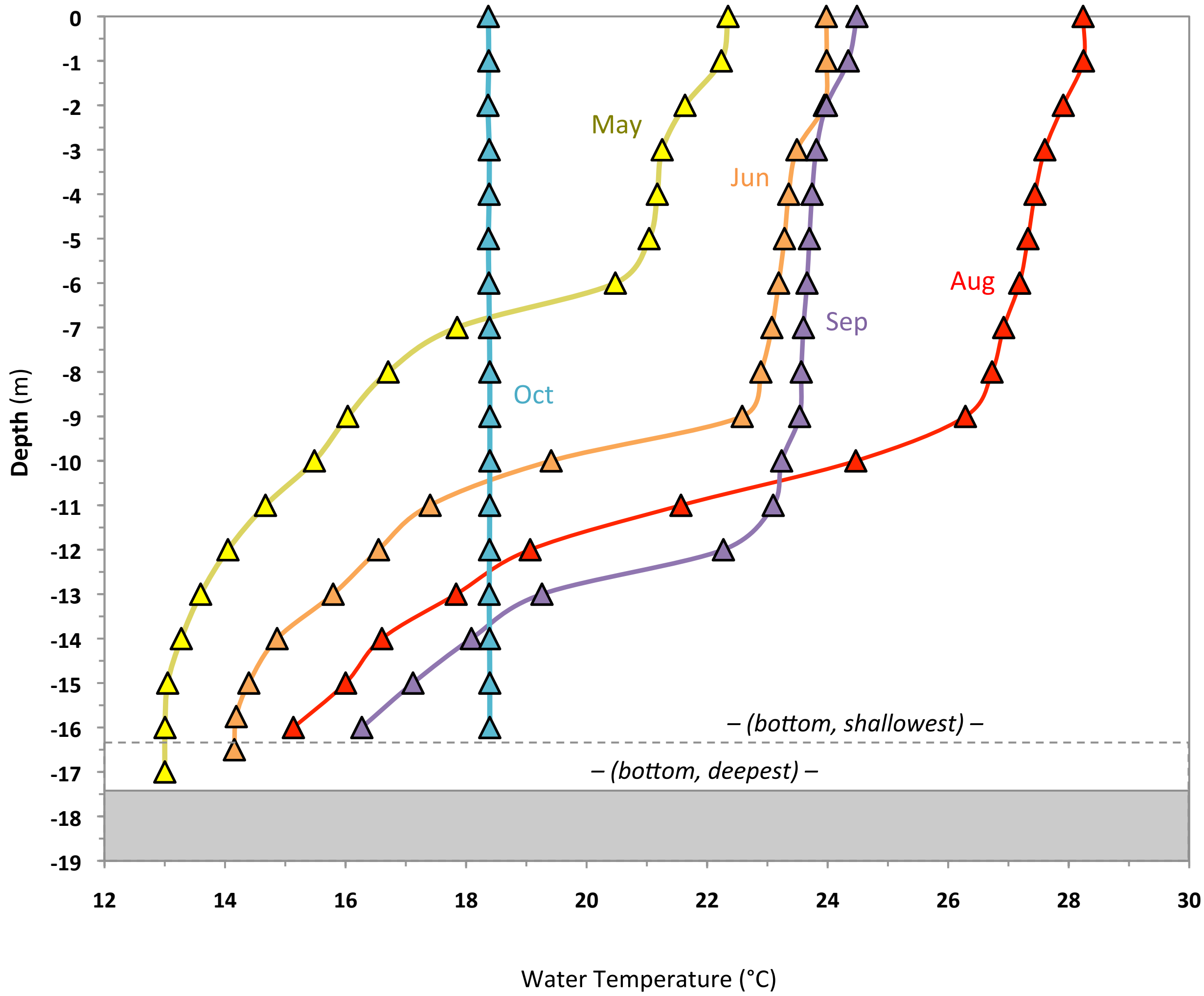


**Figure 4(f). Syar – West Pond: 2020 May-Oct TEMPERATURE**

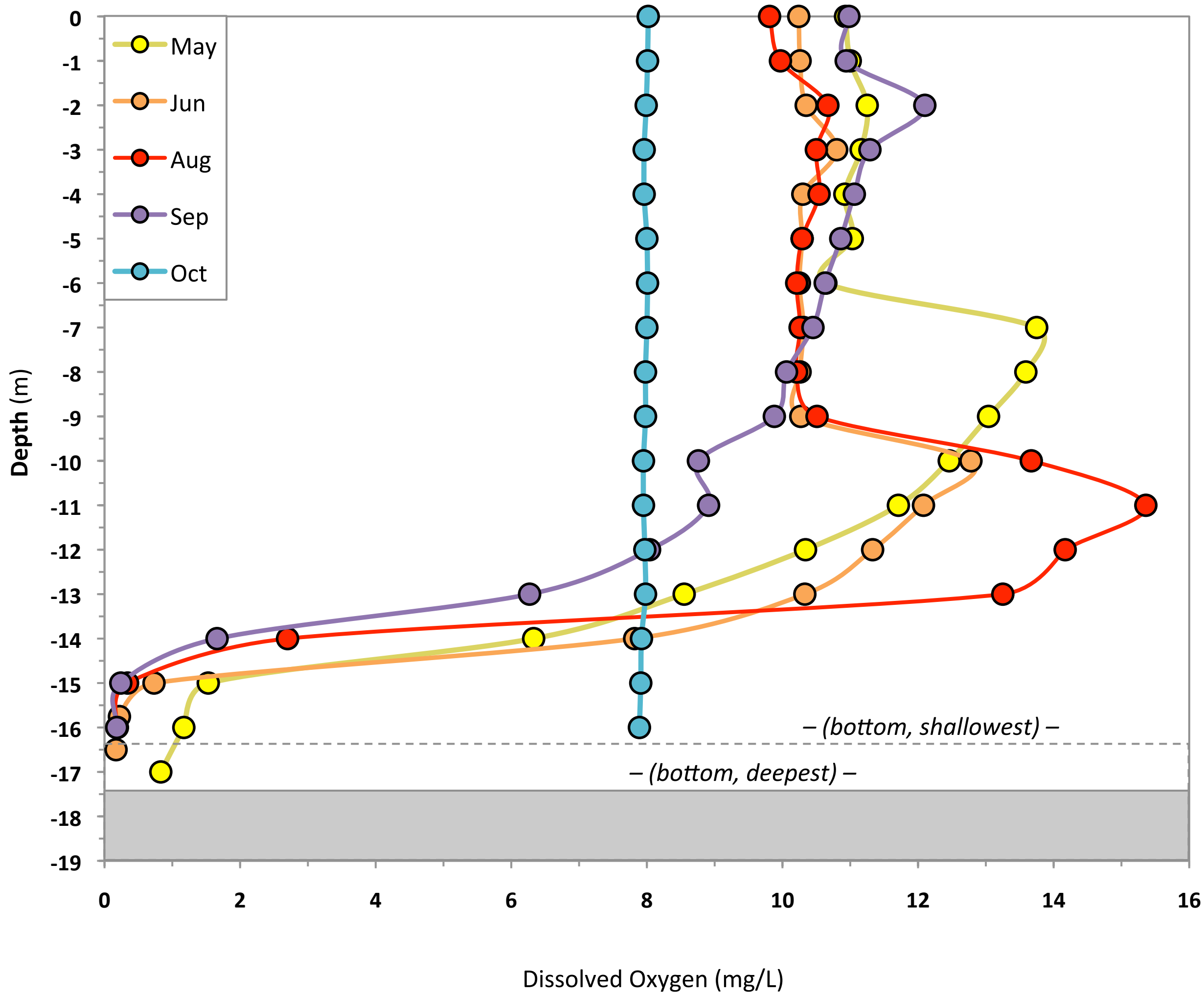


**Figure 4(g). Syar – West Pond: 2020 May-Oct OXYGEN**

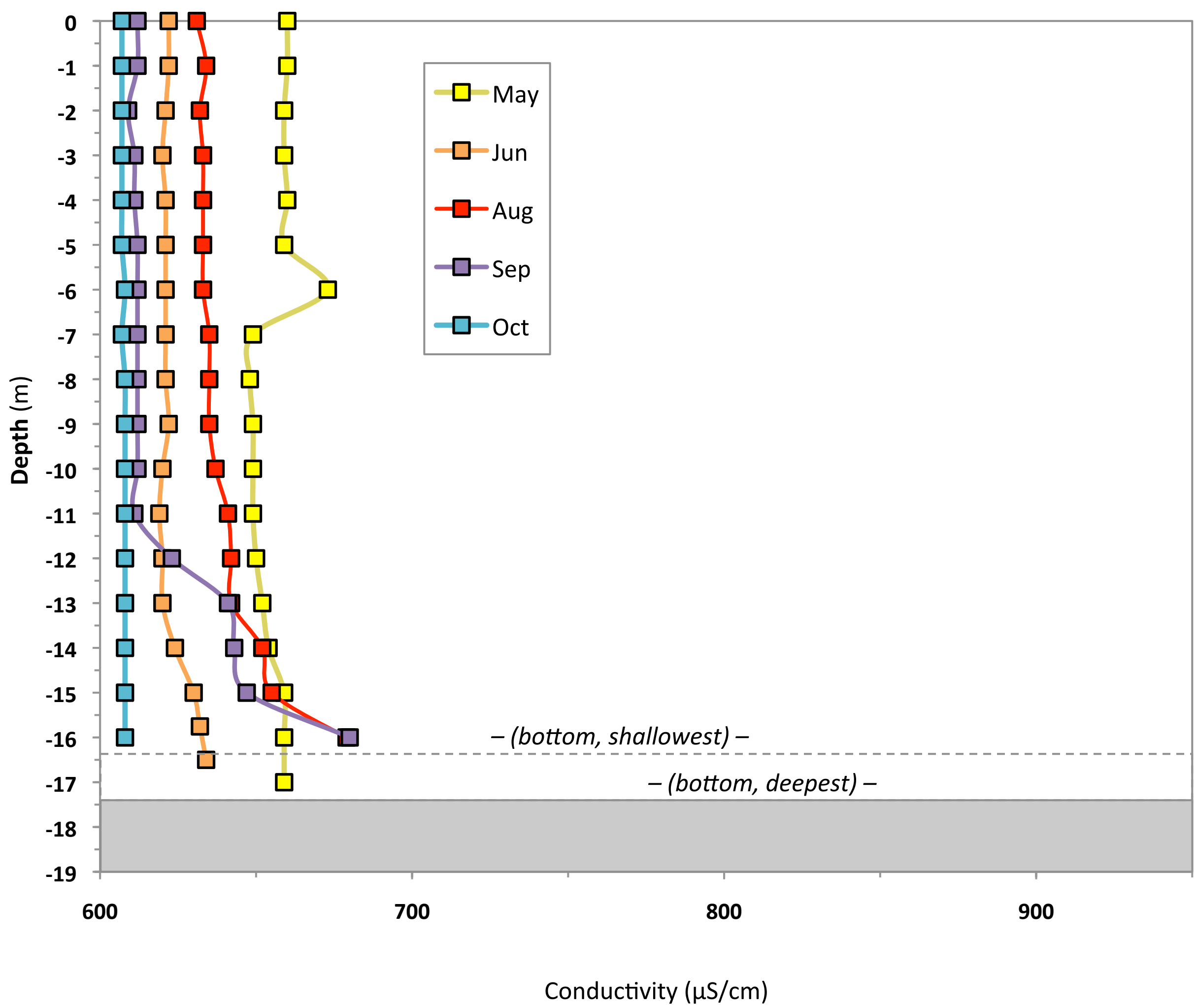


**Figure 4(h). Syar – West Pond: 2020 May-Oct CONDUCTIVITY**

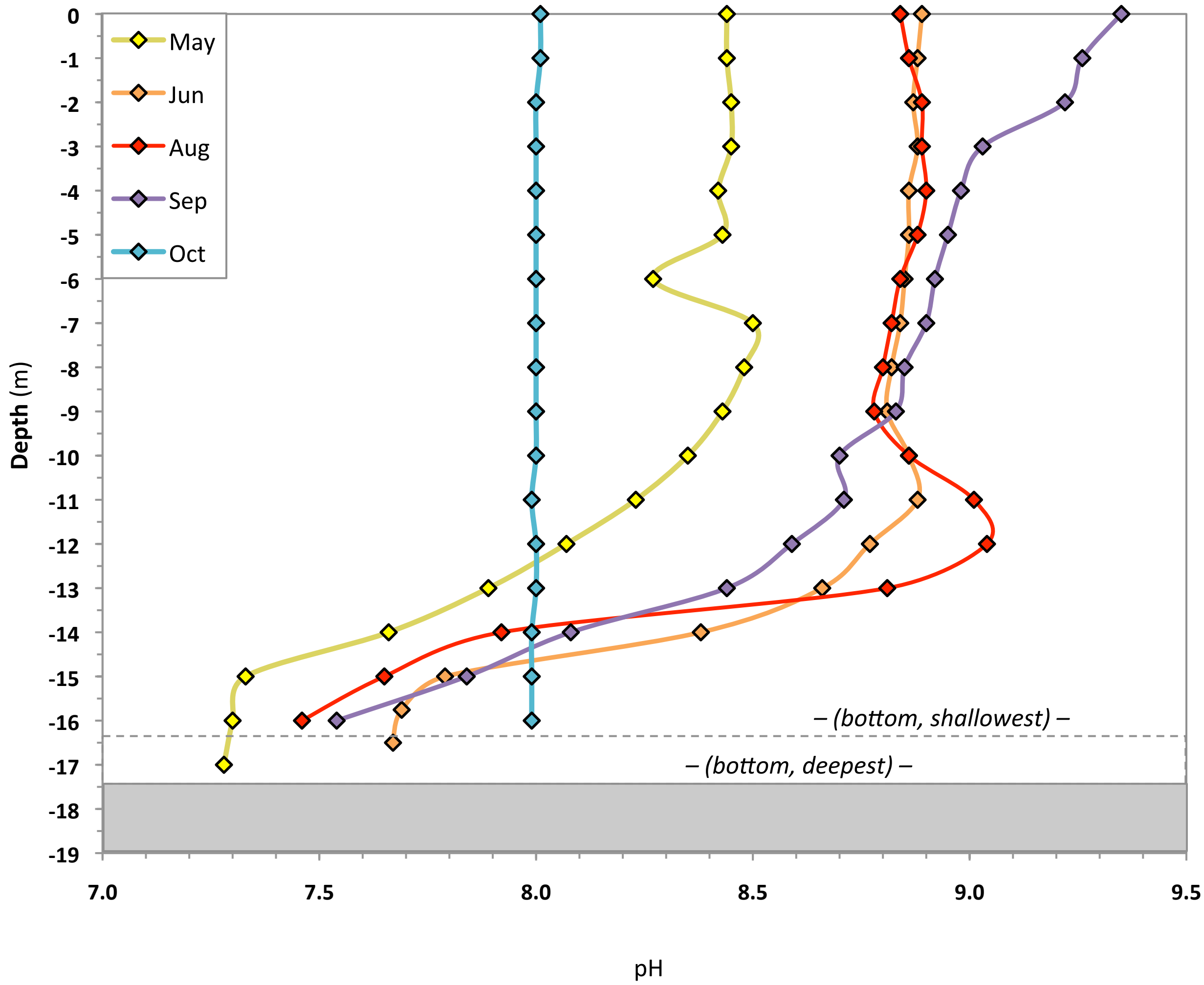


**Figure 4(i). Syar – West Pond: 2020 May-Oct pH**

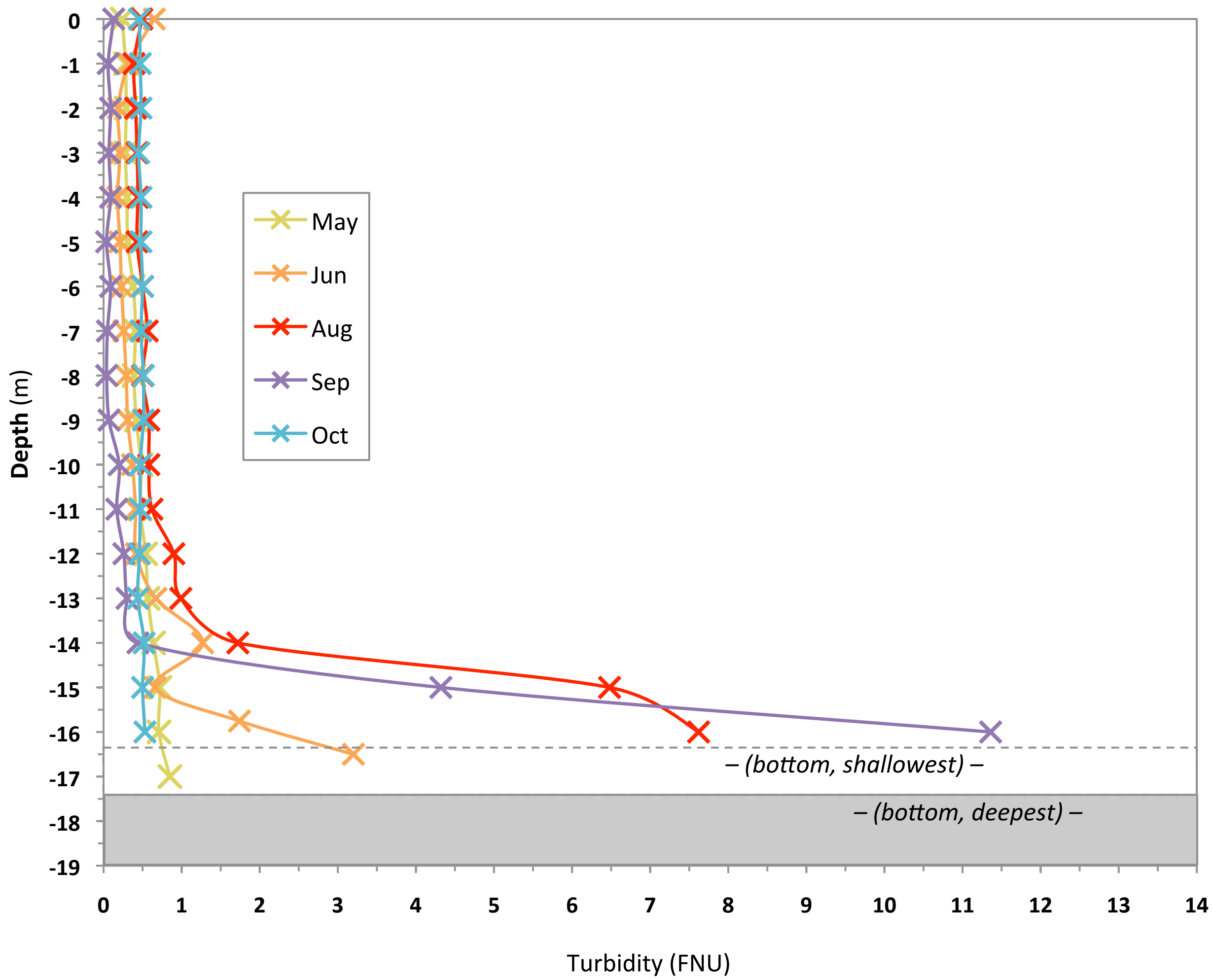


**Figure 4(j). Syar – West Pond: 2020 May-Oct TURBIDITY**

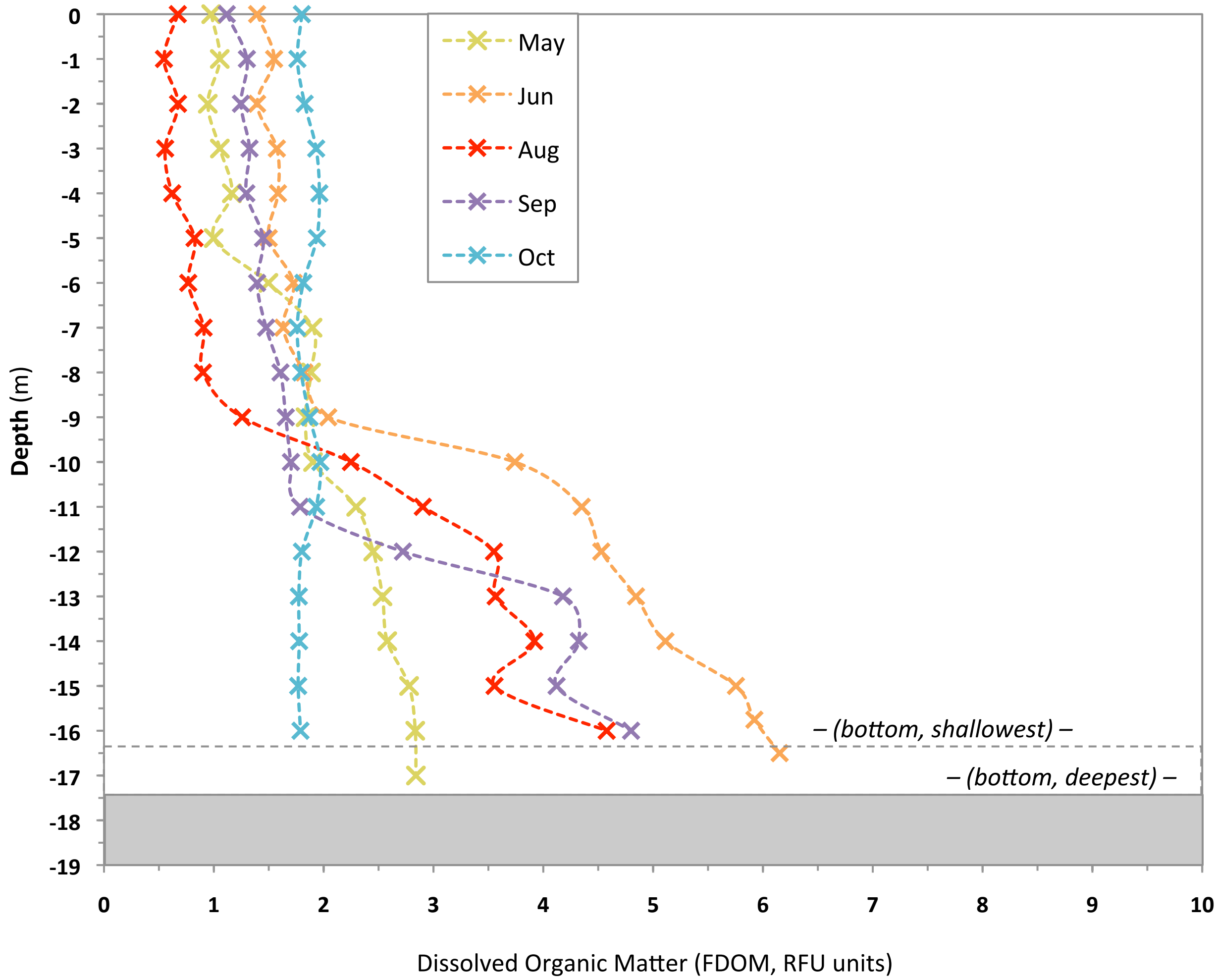


**Figure 4(k). Syar – West Pond: 2020 May-Oct DISSOLVED ORGANIC MATTER**

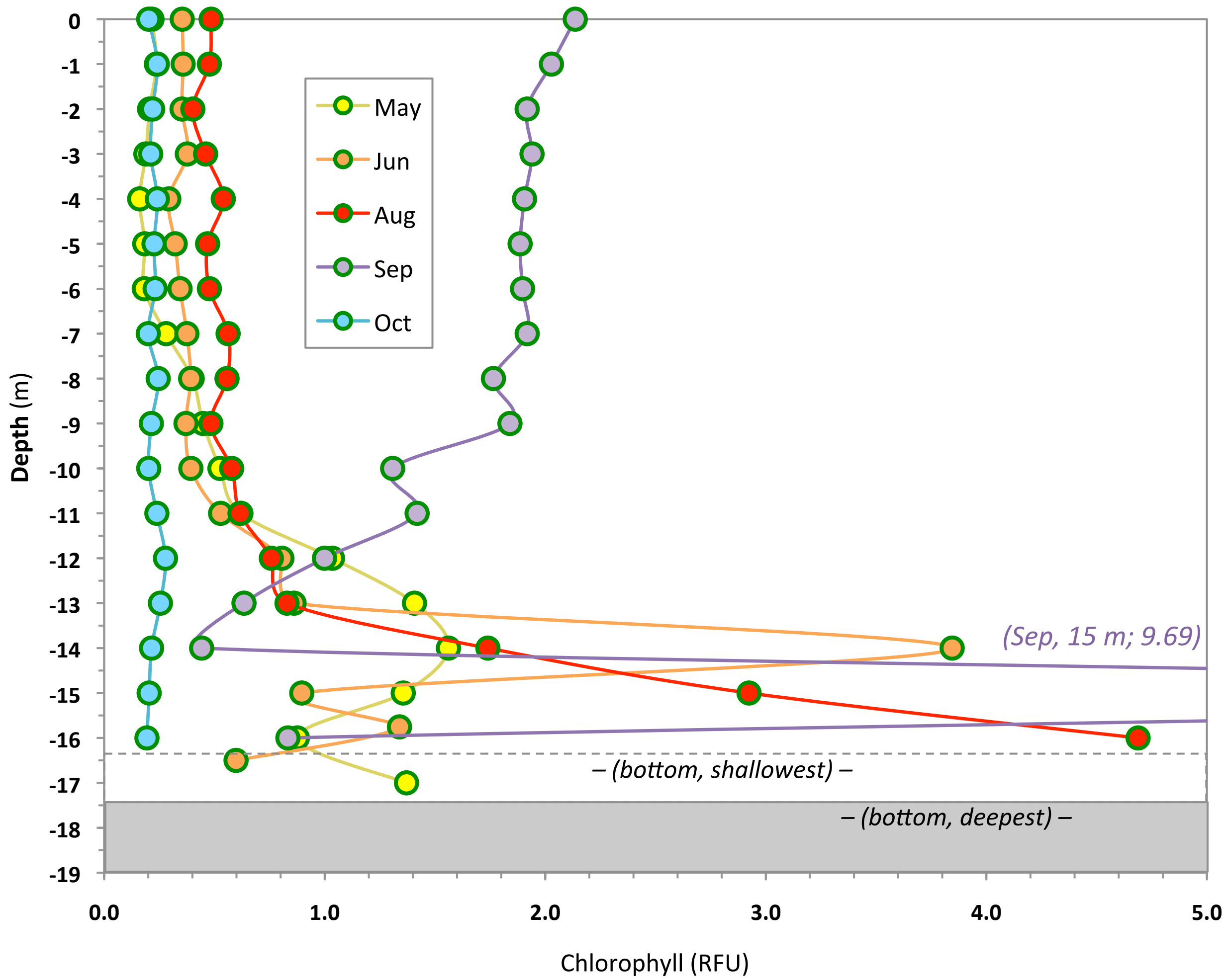


**Figure 4(l). Syar – West Pond: 2020 May-Oct CHLOROPHYLL**

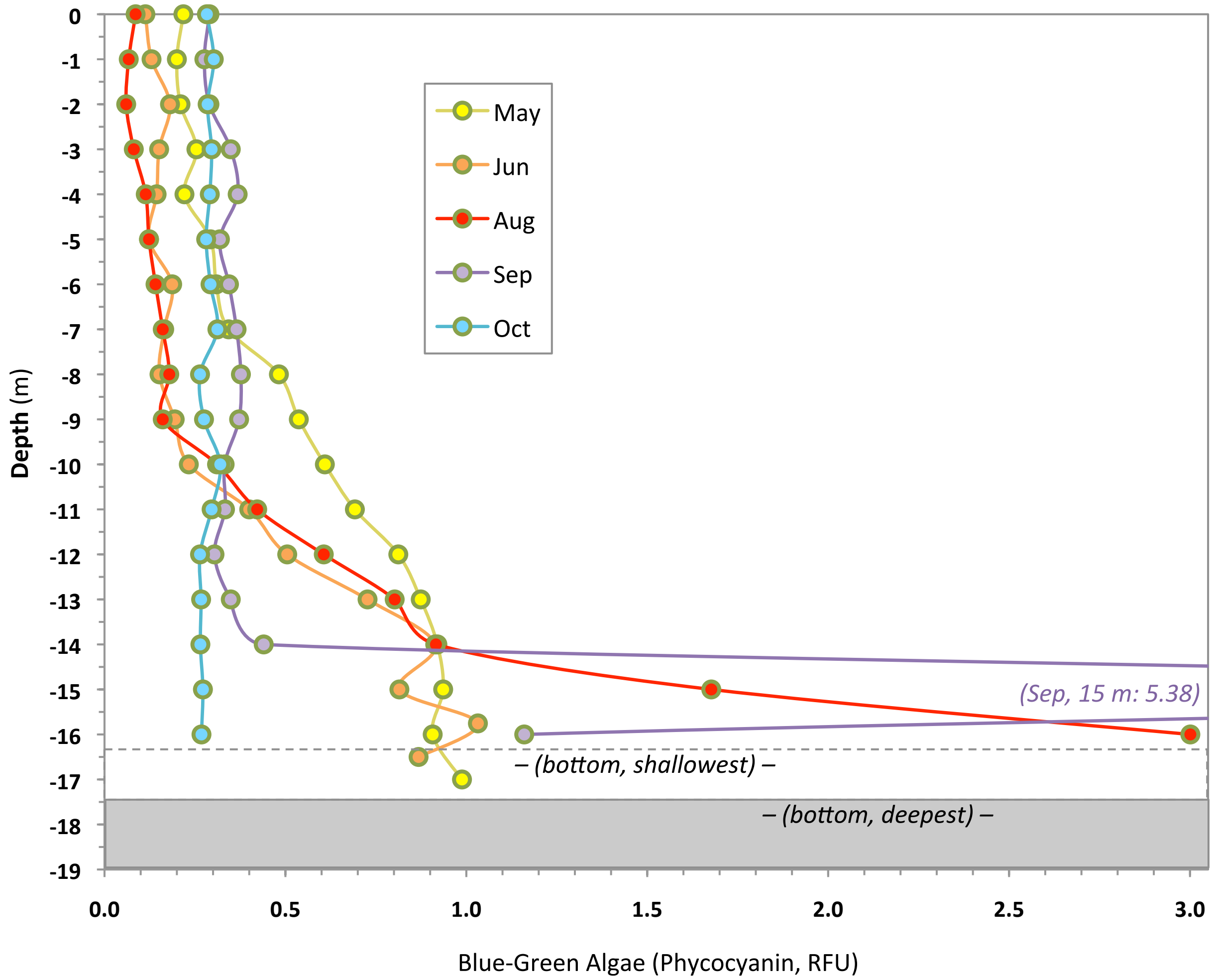


**Figure 4(m). Syar – West Pond: 2020 BLUE-GREEN ALGAE**

## CONCLUSIONS

Table C below summarizes the 2020 water profiling data from all of the tested ponds. Many of the parameters fell within similar overall ranges, including conductivity, salinity, dissolved solids, pH, and oxidation/reduction potential. 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 four ponds identified as elevated in fish mercury – Syar-B1, Teichert-Esparto, and Cemex-Phase 3-4, and Syar-West – there was not a single, consistent trend. The two most elevated ponds, Syar-B1 and Teichert-Esparto, have consistently shown evidence of seasonal water column anoxia (loss of oxygen). The deep Syar–West pond was again found to be a site of strong seasonal water stratification and bottom water anoxia. But that was not the case for the other elevated site, Cemex-Phase 3-4. However, the data provide some clues. In particular, there was notably higher salinity, dissolved solids, and conductivity (linked parameters) in the Cemex-Phase 3-4 pond.

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 2020 Profiling Data From Each of the Tested Ponds**
*(ponds arranged left to right in general order of ascending fish mercury levels)*

| | Cem-Phase 1 | Cem-Phase 3-4 | Syar-West | Syar-B1 | Teich.-Esparto |
|---|---|---|---|---|---|
| ***Fish Mercury*** | **Not Elevated** | Elevated | Elevated | **Elevated** | **Elevated** |
| ***Active Mining?*** | **–** | **Yes** | **–** | **–** | **–** |
| ***Plant Slurry Inflows?*** | **Yes** | **–** | **–** | **–** | **?** |
| **Pond Depth** (average) | 6.0 m (20 ft) | 10.3 m (34 ft) | 16.8 m (55 ft) | 8.7 m (28 ft) | 10.7 m (35 ft) |
| **Water Clarity** (avg visibility) | 2.1 m (7 ft) | 3.7 m (12ft) | 7.9 m (26 ft) | 6.4 m (21 ft) | 1.2 m (4 ft) |
| **Temperature Gradient** (max btw surface and bottom) | 1.7 °C (3.0 °F) | 5.3 °C (9.5 °F) *(May only)* | 13.1 °C (24 °F) | 2.8 °C (5.0 °F) | 4.5 °C (8.1 °F) |
| **Bottom Anoxia?** | **NO** | **NO** | **YES** | Yes | **YES** |
| **Conductivity** (µS/cm) | 654-717 | 849-920 | 607-680 | 616-657 | 628-682 |
| **Salinity** (ppt) | 0.32-0.35 | 0.42-0.45 | 0.30-0.33 | 0.30-0.32 | 0.30-0.33 |
| **Total Dissolved Solids** (mg/L) | 425-466 | 552-598 | 395-442 | 400-427 | 408-443 |
| **pH** | 8.1-8.9 | 8.1-9.3 | 7.3-9.3 | 8.2-9.1 | 8.0-9.3 |
| **Oxid.-Reduct. Potential** (mV) | 48-124 | 31-128 | -145-141 | 13-120 | 26-113 |
| **Turbidity** (FNU) | 0.78-23.1 | 0.56-5.36 | 0.04-11.36 | 0.50-8.12 | 1.61-21.4 |
| **Diss. Org. Matter** (RFU) | 0.37-1.96 | 0.31-1.55 | 0.55-6.15 | 0.87-2.35 | 0.61-1.91 |
| **Chlorophyll** (RFU) | 0.06-0.26 | 0.18-0.59 | 0.19-9.69 | 0.32-3.75 | 0.30-2.92 |
| **Blue-Green Algae** (RFU) | 0.07-0.44 | 0.05-0.50 | 0.06-5.38 | 0.05-0.63 | 0.05-0.63 |

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 app. 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 this 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 3-4 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.

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