# AVISTA CORPORATION

## LAKE SPOKANE DISSOLVED OXYGEN WATER QUALITY ATTAINMENT PLAN 2020 ANNUAL SUMMARY REPORT

WASHINGTON 401 CERTIFICATION
FERC LICENSE APPENDIX B, SECTION 5.6

SPOKANE RIVER HYDROELECTRIC PROJECT
FERC PROJECT NO. 2545

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*March 31, 2021*

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# 1.0 INTRODUCTION

Avista Corporation (Avista) received a new, 50-year license from the Federal Energy Regulatory Commission (FERC) on June 18, 2009 (FERC 2009) for the Spokane River Hydroelectric Project (Project). The project consists of five dams on the Spokane River, including Long Lake Hydroelectric Development (HED), which creates Lake Spokane. The license incorporates a water quality certification (Certification) issued by the Washington Department of Ecology (Ecology) under Section 401 of the Clean Water Act (Ecology 2009).

Ecology determined that the dissolved oxygen (DO) levels in certain portions of the Spokane River and Lake Spokane do not meet Washington's water quality standards. Consequently, those portions of the river and lake are listed as impaired under Section 303d of the Clean Water Act. To address this, Ecology developed the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load Water Quality Improvement Report (issued February 12, 2010).

Avista does not discharge nutrients into either the Spokane River or Lake Spokane, however, the impoundment creating Lake Spokane increases the residence time for water flowing down the Spokane River, and thereby influences nutrients and how they affect DO levels. Reduced DO levels are largely due to the discharge of nutrients into the Spokane River and Lake Spokane. Nutrients are discharged into the Spokane River and Lake Spokane by point sources, such as waste water treatment facilities and industrial facilities, and from non-point sources, such as tributaries, groundwater, and stormwater runoff, relating largely to land-use practices. In an effort to address low DO levels and to comply with Section 5.6.C of the Certification, Avista submitted an Ecology-approved Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP) to FERC on October 8, 2012. Avista began implementing the DO WQAP upon receiving FERC's December 19, 2012 approval.

### DO WQAP

The DO WQAP addresses Avista's proportional level of responsibility, as determined in the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL). It identified nine potentially reasonable and feasible measures to improve DO conditions in Lake Spokane by reducing non-point source phosphorus loading into the lake. It also incorporated an implementation schedule to analyze, evaluate, and implement such measures. In addition, it contains benchmarks and reporting sufficient for Ecology to track Avista's progress toward implementing the plan within the ten-year compliance period identified in the DO WQAP (Figure 1).

The DO WQAP included a prioritization of the nine reasonable and feasible mitigation measures based upon several criteria including, but not limited to, quantification of the phosphorus load reduction, DO response time, likelihood of success, practicality of implementation, longevity of load reduction, and assurance of obtaining credit. From highest to lowest priority, the following summarizes the results of the measure prioritization: reducing carp populations; managing aquatic weeds; acquiring, restoring, and enhancing wetlands; reducing phosphorus from Hangman Creek sediment loads; educating the public on improved septic system operations; reducing lawn area; providing native vegetation buffers; and converting grazing land to conservation or recreation use. One measure, which involved modifying the intake of an agricultural irrigation system, was removed from the list, as it was determined infeasible given it would create adverse effects on crop production.

Based on preliminary evaluations, Avista proposed to focus its initial efforts on two measures: reducing carp populations and aquatic weed management, which were expected to have the greatest potential for phosphorus reduction.

**Investigation Studies**

In order to evaluate harvesting aquatic plants as a viable method of reducing phosphorus in the lake, Avista contracted Tetra Tech to complete a Phase I Analysis, the results of which were included in the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2013 Annual Summary Report. Based upon the results, Avista concluded that harvesting aquatic plants in Lake Spokane at senescence, would not be a reasonable and feasible mitigation measure to reduce total phosphorus in Lake Spokane. However, Avista will continue, as appropriate, to implement winter drawdowns, herbicide applications at public and community lake access sites, and bottom barrier placement to control invasive/noxious aquatic weeds within Lake Spokane. Avista may also, through adaptive management, reassess opportunities to harvest macrophytes to control phosphorus in the future.

In order to investigate whether removing carp would improve water quality in Lake Spokane, a Lake Spokane Carp Population Abundance and Distribution Study consisting of a Phase I and Phase II component, was initiated during 2013 and 2014. Results of the Phase I and Phase II Analyses indicate that carp removal from Lake Spokane may provide meaningful reductions in TP directly through removal of TP in carp biomass (5g of TP/kg of carp) and indirectly through the reduction of re-suspended TP from sediments that carp disturb (bioturbation). Results from Phase 1 and Phase II, as well as pilot testing, also indicated where the most carp may be removed and the best method of removal.

Avista included a recommendation in its 2014 Annual Report, to implement a pilot study utilizing a combination of mechanical methods (including spring electrofishing, passive netting, and winter seining), to identify the most effective method to remove carp from Lake Spokane. Ecology approved the 2014 Annual Report and the recommendation to move forward with the carp removal pilot study. Avista has been working with Ecology and Washington Department of Fish and Wildlife (WDFW) to plan and implement the carp removal efforts, a summary of which is provided in Section 3.1.

As required by the DO WQAP, this report provides a summary of monitoring efforts, implementation activities, effectiveness of the implementation activities, and proposed actions for 2021.

# 2.0 MONITORING

Longitudinally, the lake can be classified as having three distinct zones, which consist of a riverine, transition and lacustrine zone. Six water quality monitoring stations, LL5 through LL0, exist within these three zones (Figure 2). Station LL5 is the most upstream station and is located within a riverine zone, Stations LL3 and LL4 are located in the transition zone, and Stations LL0 through LL2 are located in the lacustrine zone. The vertical structure of Lake Spokane is set up by thermal stratification, largely determined by its inflow rates, atmospheric and water temperature, and location of the powerhouse intake. Within Lake Spokane's lacustrine zone, thermal stratification creates three layers (the epilimnion, metalimnion, and hypolimnion) that are generally present between late spring and early fall. The epilimnion is the uppermost layer, and the warmest due to solar radiation. The metalimnion is the transition layer between the epilimnion and the hypolimnion that contains the thermocline and is influenced by both surface and interflow inflows. The hypolimnion is the deepest layer and is present throughout the lacustrine zone.

Beginning in 2010, baseline monitoring (nutrient sampling and in-situ monitoring) was conducted in Lake Spokane at the six established stations (LL5 through LL0), May through October. The baseline monitoring was conducted by Ecology and Avista in 2010 and 2011, and then solely by Avista from 2012 through 2017. Avista contracted with TetraTech since 2010 to complete the baseline monitoring. During this timeframe, Avista collected baseline nutrient monitoring over the full spectrum of flows that were likely to exist in the Spokane River under current license conditions (Figure 2). Results of the monitoring are summarized in Avista's 2013 through 2017 Annual Summary Reports and the data uploaded into Ecology's Environmental Information Management (EIM) database.

In 2018, monitoring was modified to only include in-situ dissolved oxygen (DO), temperature, conductivity and pH at the six established stations along with four supplemental monitoring locations, May through October (Figure 3). Additionally, zooplankton samples were collected at all ten monitoring locations. The narrow scope of the 2018 monitoring allowed Avista to focus on a more detailed analyses of the 2010 through 2018 water quality monitoring data to explore the relationship between rainbow trout habitat utilization in Lake Spokane and the multitude of water quality attribute information available. Results of this monitoring are summarized in Avista's 2018 Annual Summary Report and the data is uploaded into Ecology's EIM database.

## 2.1 2020 Results

In 2019, Avista worked with Ecology to develop a plan for monthly 24-hour temperature and DO monitoring. This new technique used automated recorders affixed to buoys at three different locations in the epilimnion of Lake Spokane during the summer of 2020. Avista prepared an addendum to the Lake Spokane Nutrient Monitoring QAPP (approved

May 2020) which detailed the 24-hour continuous monitoring locations, depths, and data quality control procedures. The three continuous monitoring locations (Figure 3) were chosen based on bathymetry, water current, flow, access and security. Temperature and DO measurements were recorded every 15 minutes, at varying depths from June through September. The purpose of this monitoring is to provide a better understanding of the diurnal fluctuations that may be present during the summer and how primary productivity influences water quality conditions.

Results of the monitoring are summarized in Appendix A, Lake Spokane Annual Summary, 2020 Water Quality Monitoring Results (Tetra Tech 2021). Appendix A includes the water quality conditions in Lake Spokane as well as inflows and outflows, tables of water quality data collected for the DO WQAP, and a description of the general hydrologic and climatic conditions during 2020. Data from this collection effort has been uploaded to Ecology's EIM database. A general summary of the results, taken from the Tetra Tech Report, is provided below.

- Weather conditions during 2020 differed from the 30-year norm reported at the Spokane International Airport, with warmer than normal temperatures in January, February, May, July, August, September, November and December. Temperatures were cooler than normal in March and June. A notable windstorm occurred in September 7th with winds up to 44 mph measured at the Spokane Airport.
- Precipitation was above normal during January, May, and October, around normal in December. It was well below normal in February through April, June through September, and in November. Drought conditions began in June and continued through September.
- Peak flow in the Spokane River occurred in late May, reaching 19,600 cfs (recorded at the USGS 12422500 Spokane River at Spokane Gage). The May peak flow was preceded by a smaller peak in February. Lake Spokane's annual mean daily flow in 2020 was 6,062 cfs.
- Whole lake water residence time during 2020 (June through October) in Lake Spokane averaged 32 days. Average whole reservoir residence time was 34 days for the past 11 years (2010 through 2020). Using the DO TMDL season timeframe of July through September, the whole lake residence time was calculated at 54 days, which is less than in 2015 (85 days) but higher than the 2010 – 2014 average (41 days).
- Cyanobacteria occurrence in Lake Spokane was very limited in 2020 and there were only a few minor blooms in small areas that disappeared within 24 hours, as reported by Mr. Galen Buterbaugh, retired US Fish and Wildlife Service Fishery Biologist who serves as the Lake Spokane Association Technical Advisor.

- Continuous monitoring of DO in the epilimnion from June through September at three depths and three near-shore sites (Figure 3) indicated DO was usually above 8 mg/L and near 100% saturation at all three depths measured. Maximum diurnal fluctuations of DO occurred in June at the downstream continuous monitoring site (3.7 mg/L at Daily A), and in July and August at the up-reservoir sites respectively (3.5 mg/L at Daily C and 4.9 mg/L at Daily B). Daily mean DO fluctuations were between 0.6 and 2.1 mg/L depending on site and depth.
- Continuous monitoring of temperature at the three stations indicated maximum temperature occurred in July and August reaching around 26 ºC with the highest temperatures recorded at the surface. Daily mean temperature fluctuations were around 1-2 ºC and maximum fluctuations around 2-4 ºC, diminishing through the summer.

## 2.2 Monitoring Recommendations

Avista has collected baseline nutrient monitoring over the full spectrum of flows that are likely to exist in the Spokane River under current License conditions. Avista has also conducted 24-hour diel monitoring of DO and temperature in the epilimnion in support of Ecology's DO TMDL 10-Year Assessment. As Ecology's DO TMDL 10-Year Assessment Monitoring in Lake Spokane is anticipated to begin in 2021, Avista does not propose monitoring activities for 2021.

# 3.0 IMPLEMENTATION CONTROL ACTIONS

The DO WQAP states that Avista will work towards meeting its proportional level of responsibility, outlined in the DO TMDL, by implementing Ecology-approved reasonable and feasible water quality improvement measures, with the goal of improving water quality in Lake Spokane. Along with carp reduction and aquatic plant removal, Avista has pursued implementation of other reasonable and feasible measures to reduce phosphorus loading listed in the DO WQAP. All implemented actions have been summarized in past annual reports and are briefly described below along with actions undertaken in 2020 and proposed actions for 2021.

## 3.1 Reducing Carp Populations

Based on the results of the Lake Spokane Carp Population Abundance and Distribution Study and pilot testing in 2016, Avista has worked with WDFW to remove carp from Lake Spokane from 2017 through 2020.

### *3.1.1 2020 Activities*

During 2020, Avista implemented the fourth year of its common carp (*Cyprinus carpio*) removal program on Lake Spokane. The removal effort was done in cooperation with WDFW and completed under a Scientific Collection Permit issued by WDFW. During the 2020 carp removal activites, WDFW expanded this effort to include the removal of Northern pike, a non-native and highly invasive predator considered a serious threat to native and other preferred fish species. The removal efforts benefit the fishery by removing invasive species that compete with warm-water trophy fish.

The removal effort occurred during a five week-long sampling events from May 18 through June 18 and focused on sampling carp during their spring spawning behavior. Removal efforts were focused in the upper portion of Lake Spokane between McLellan Slough and the Nine Mile Recreation Area (Figure 4). Multifilament gillnets (60 m long by 3 m high) were deployed at the same four study areas as have been surveyed in previous years: McLellan Slough, Felton Slough, Sportsman's Paradise, and Nine Mile Flats (**Error! Reference source not found.**4). Nets were also set in areas that met depth and habitat requirements to hold carp that were outside the four study areas, including Willow Bay and Sunset Bay. In total, 1,227 carp were collected along with 2,801 other fish considered by-catch (Table 1).

**Table 1**. Species, total number caught, and total number removed (per species) during the spring 2020 carp removal effort.

| Species | Total Caught | Total Removed |
|---|---|---|
| Common carp | 1229 | 1227 |
| Black crappie | 193 | 51 |
| Bridgelip sucker | 1 | 1 |
| Brown bullhead | 283 | 11 |
| Largemouth bass | 105 | 24 |
| Largescale sucker | 710 | 267 |
| Longnose sucker | 5 | 1 |
| Mountain whitefish | 1 | 1 |
| Northern pike | 324 | 324 |
| Northern pikeminnow | 121 | 70 |
| Rainbow trout (hatchery) | 78 | 46 |
| Rainbow trout (wild) | 24 | 17 |
| Smallmouth bass | 82 | 31 |
| Tench | 317 | 89 |
| Walleye | 404 | 290 |
| Yellow bullhead | 6 | 1 |
| Yellow perch | 145 | 64 |
| **Total** | **4,028** | **2,515** |

All carp were weighed, measured, and checked for sex and maturity. Carp ranged in length from 18.7 to 34.1 inches and averaged 26.8 inches. The average carp weight was 11.1 pounds (lbs) with the range of weights being 3.6 to 24.1 lbs. All removed carp were placed into a refuse bin and transported to the Greater Wenatchee Regional Landfill for disposal.

### *3.1.2 Total Phosphorus Removal*

The 1,227 carp collected in 2020 totaled approximately 13,580 lbs of biomass being completely removed from the watershed. Using the average total phosphorus percent from 2014 to 2018 laboratory analysis, removal was calculated to be 74 lbs of total phosphorus in 2020 (Table 2). Combining the 2017, 2018, 2019, and 2020 carp removal sampling, a total of 188 lbs of total phosphorous has been removed from Lake Spokane by Avista's carp reduction program. That number does not quantify the amount of phosphorous that will no longer be re-activated in the water column by excretion or bioturbation (during the feeding and spawning behavior of these carp).

**Table 2**. Total number and weight of carp, along with the resulting total phosphorus, removed from Lake Spokane in 2017, 2018, 2019, and 2020.

| | **2017** | **2018** | **2019** | **2020** |
|---|---|---|---|---|
| Total carp collected | 1219 | 557 | 577 | 1227 |
| Carp weight removed (lbs) | 10,310 | 5,183 | 5,432 | 13,580 |
| Average TS (% wet wt)[1] | 32% | 32% | 32% | 32% |
| Average TP (% dry wt)[1] | 1.7% | 1.7% | 1.7% | 1.7% |
| TP removed (lbs) | 56 | 28 | 30 | 74 |

[1] Average 2014 to 2018 laboratory measurements

### *3.1.3 Future actions*

Avista will continue the carp population reduction program in 2021. Similar to the 2020 efforts, Avista will partner with WDFW, targeting an approximate five-week sampling event during spring spawning. After taking measurements, all removed carp will be placed in a refuse bin and transported to a landfill. Additionally, in 2021, the carp population reduction program will be evaluated for continuance or modification. Evaluation may include whether the goals of phosphorus reduction and WDFW's goals for fisheries management are being achieved. WDFW will continue their Northern Pike removal program in Lake Spokane and will explore ways to determine whole-body total phosphorus of Northern Pike in order to quantify its removal from Lake Spokane.

## 3.2 Acquiring, Restoring and/or Enhancing Wetlands

Wetland acquisition, restoration and enhancement was identified in the DO WQAP as a reasonable and feasible measure. Wetlands can increase the deposition of sediments and their attached phosphorus along with increasing the uptake and retention of phosphorus by emergent wetland species. In 2012, Avista pursued acquisition or permanent protection of a 43-acre wetland area downstream of Nine Mile HED, in the vicinity of the Spokane River and the Little Spokane River confluence. Due to landowner complications Avista was unable to acquire this property but since 2012, Avista has purchased and enhanced over 500 acres of wetlands within the Spokane River drainage.

### *3.2.1 2020 Activities*

Sacheen Springs Wetlands

In 2013, Avista acquired the 109-acre Sacheen Springs property, located on the west branch of the Little Spokane River. This property contains over one-half mile of frontage wetlands and 58 acres of mature upland forest. Avista completed a site-specific wetland management plan and implemented it upon Ecology and FERC's approval in 2014. The property was protected in perpetuity when it was put into a conservation easement with the Inland Northwest Land Conservancy in 2018.

Management actions conducted in 2020 include: (a) understory thinning of approximately 0.5 acres of the mature upland forest to remove ladder fuels and promote forest health, (b) development of a primitive trail along the interface of the wetland and mature upland forest, and (c) herbicide application to control terrestrial invasive weeds on 0.5 miles of 2-track access road.

Hangman Creek Wetlands

Avista and the Coeur d'Alene Tribe (Tribe) have acquired approximately 1,022 acres on upper Hangman Creek since 2011, within the southern portion of the Coeur d'Alene Tribe Reservation in Idaho, approximately 10 miles east of the Washington-Idaho Stateline. The Hangman Creek wetland complex contains over 15,000 linear feet of Hangman Creek, flowing north and west through the complex then continuing along its northwest course for approximately 63 miles until it meets with the Spokane River just west of the city of Spokane.

Prior to the Tribe's acquisition of the Hangman Creek wetland complex, portions of the land were in agricultural use, and streams had been straightened to maximize farming yields. Avista and the Coeur d'Alene Tribe implement the Coeur d'Alene Reservation Hangman Creek Site Management Plan (Avista and the Coeur d'Alene Tribe, 2020) which focuses on establishing long-term, self-sustaining native emergent, scrub-shrub and/or forested wetlands, riparian habitat and associated uplands, through preservation, restoration and enhancement activities.

In 2020, a total of 1,768 seedlings were planted. Since 2013, approximately 18,978 native tree and shrub species have been planted on this wetland complex. Other wetland management activities included noxious weed herbicide treatments, construction of fence enclosures to protect seedlings, and monitoring survival of the seedlings planted as well as wetland functionality.

### *3.2.2 Total Phosphorus Removal*

Phosphorus load reduction from wetland acquisition, restoration and/or enhancement is described in the DO WQAP. Given Hangman Creek and the Little Spokane River are significant contributors of sediment and phosphorus loading to the Spokane River, Avista anticipates a significant total phosphorus load reduction from the wetland mitigation work. In 2019 and 2020 Avista worked with Ecology to quantify phosphorus removal from its wetland acquisition and implementation activities to date. In 2021, Avista will continue conversations with Ecology to determine the appropriate phosphorus load reduction quantification.

### 3.2.3 Future Actions

Activities that Avista will implement during 2021 at the Sacheen Springs wetland complex include constructing a primitive trail around the forested island, thinning the forest understory to promote forest health and reduce the potential of a catastrophic wildfire, and to control terrestrial weeds along the access road.

Avista and the Coeur d'Alene Tribe will continue to implement the Hangman Creek Site Management Plan which includes annual plantings, monitoring survival of existing plantings and wetland functionality, construction of fence enclosures to protect seedlings and noxious weed herbicide treatments. Additional wetland property acquisitions will be considered as they become available.

## 3.3 Grazing Land Conversion

As early as 2009, Avista identified 215 acres of Lake Spokane property that Washington State Department of Natural Resources (DNR) leased for cattle grazing. Avista and the Washington State Parks Recreation Commission (State Parks) pursued a lease for the 215 acres of land from DNR with the intent of changing the land use. Following a robust, multi-year negotiation, DNR leased the property to State Parks starting in 2017 for public recreation, eliminating livestock grazing on this Lake Spokane shoreline property.

### 3.3.1 Total Phosphorus Removal

Phosphorus load reduction estimates for converting grazing land use to conservation are identified in the DO WQAP. In 2019 and 2020 Avista worked with Ecology to quantify phosphorus removal from its grazing land conversion activities. In 2021, Avista will continue conversations with Ecology on the appropriate phosphorus load reduction quantification.

## 3.4 Vegetative Shoreline Buffer on Avista Lake Spokane Property

Avista owns approximately 350 acres of land located within 200 feet of the Lake Spokane shoreline in Spokane, Stevens, and Lincoln counties at the downstream end of the reservoir. This includes approximately 14-miles of Avista-owned shoreline that is managed in accordance with Avista's, FERC approved, Spokane River Project Land Use Management Plan (Avista 2016). For the most part this land is contiguous along the north and south shorelines and is managed primarily as Conservation Land. Avista has maintained a 200-foot buffer along the lake's shoreline on these properties, creating a sediment-filtering effect.

To enhance the vegetative buffer, reduce erosion and provide shade, Avista began a tree planting program in 2013, planting trees and shrubs along Avista-owned shoreline on a two-year cycle.

### *3.4.1 2020 Activities*

In 2020, Avista conducted vegetation monitoring of trees planted during past planting events along the shoreline of Lake Spokane. Vegetation survival assessments consisted of monitoring the condition and location of living trees with a handheld GPS device. The data was then used to evaluate what areas needed replanting. Avista planted 250 seedlings of redosier dogwood, willow and cottonwoods at four of Avista's Lake Spokane recreation sites. The seedlings were fenced to protect them from browsing. Once mature, the trees will form canopy cover along the lake and provide shade, reduce water temperature, encourage fish habitat, and help stabilize the shoreline.

### *3.4.2 Total Phosphorus Removal*

The potential phosphorus loads that have been avoided by maintaining a 200-foot vegetative buffer along the shoreline have not been identified. In 2021, Avista will continue conversations with Ecology on the appropriate phosphorus load reduction quantification.

### *3.4.3 Future Activities*

As the tree planting effort is a parallel improvement, identified in the Long Lake Dam Reservoir and Tailrace Temperature WQAP, this program will continue in 2021 with vegetation monitoring of trees planted in 2020 and previous years. Maintenance activities include repairing or removing tree cages that are damaged or no longer needed, removing flagging set during planting, and watering where necessary and feasible.

## 3.5 Lawn Area Reduction and Native Vegetation Buffers

Lawn area reduction, reduced fertilizer use, bulkhead removal, and installation of natural vegetative buffers along residential properties are intended to help reduce non-point source phosphorus loading into Lake Spokane. Since 2012 Avista has partnered with local and state agencies and homeowners to identify, encourage and implement projects to convert bulkheads or lawns to more naturalized shorelines. Additionally, Avista participated with others to support passage of a Washington law, effective January 2013, limiting the use of phosphorus (except for certain circumstances) in residential lawn fertilizers, which includes those adjacent to Lake Spokane in Spokane, Stevens, and Lincoln counties. Although the new law legally restricts use of fertilizer containing phosphorus, homeowner education has been an important tool in reducing phosphorus loads to the lake (see Section 3.6).

The Staggs Project was completed in 2012, replacing a 90-foot bulkhead with a natural shoreline. Avista and Stevens County Conservation District worked from 2013 – 2017 to secure permits and plans for a native shoreline installation project on Avista owned property on Lake Spokane, which was not able to be completed. The Wright Project was completed in 2019, replacing a 90-foot bulkhead with a bioengineered vegetative wall and buffer. Avista has worked with multiple landowners interested in these projects but ultimately, with the associated costs and permitting, many choose other, cheaper ways of improving their waterfront property.

### *3.5.1 2020 Activities*

2020 was the first year of vegetation monitoring at the Wright Project, under the Army Corp of Engineer (Army Corp) permits for the project. Avista conducted two monitoring events in the summer of 2020 and worked with the landowner to complete the annual report. Additionally, Avista presented at the Northern Idaho/Eastern Washington Regional Lakes Conference, using the Wright Project to demonstrate the benefits of replacing bulkheads or lawns with naturalized shorelines, including native vegetation buffers. Education is an important tool in reducing phosphorus loads to the lake.

### *3.5.2 Future Activities*

In 2021 Avista will continue vegetation monitoring at the Wright Bulkhead Removal Project and continue to work with the landowner to complete the annual reporting requirements. Avista is also planning to implement up to four shoreline enhancement projects utilizing bioengineering techniques at heavily used Lake Spokane recreation sites. The anticipated schedule includes design and permitting in 2021 with construction occurring during the 2021/2022 winter drawdown.

Avista will also continue to evaluate the lawn area reduction and native vegetation buffer program for continuance or modification. Factors that will be taken into consideration for this evaluation include the cost to implement bulkhead removal projects, the permitting difficulties involved, and the level of interest from landowners compared with the long term benefits to water quality, both through phosphorus reduction on site as well as education of other landowners through demonstration.

## 3.6 Education and Outreach

The success of improving dissolved oxygen levels in Lake Spokane is dependent on the effectiveness of reducing nutrient loads from point and non-point sources throughout the Spokane River Basin. With that in mind, Avista has targeted education and outreach to raise awareness of non-point sources entering the lake and how shoreline best management practices can have a positive impact on water quality.

In 2017, Avista partnered with the Stevens County Conservation District (SCCD) and Spokane Community College (SCC) to install a floating wetland in the downstream portion of Lake Spokane, adjacent to Avista owned shoreline. The floating wetlands serve as a real-time educational lab to better understand the potential for TP uptake from plant roots, wave attenuation from a log boom, and to provide water quality education for both SCC students and boaters on plant species growth and fish habitat. The floating wetlands were installed on Avista property at the downstream end of Lake Spokane, near the Lake Spokane Campground. While no measurable phosphorus removal occurred at the deeper lacustrine location, the floating wetland provided a real-time educational opportunity. The floating wetland structures were launched, monitored, and removed in coordination with SCCD and SCC during the summers of 2018, 2019, and 2020.

### *3.6.1 2020 Activities*

In 2020, Avista sponsored and presented at the Northern Idaho/Eastern Washington Regional Lakes Conference, highlighting the bulkhead removal project at the Wright property and the carp removal efforts on Lake Spokane to reduce phosphorus and improve oxygen.

Avista produced a Lake Spokane water quality article discussing the water quality monitoring efforts on Lake Spokane as well as the relationship between dissolved oxygen and fish habitat. This article was published in the Spokane Indian Baseball team newsletter, social media, and myavista.com website (see Appendix C), link below. https://www.myavista.com/connect/articles/2020/09/protecting-the-health-of-our-waterways

Avista also worked with WDFW and Ecology in 2019 to produce two educational videos focused on natural shorelines and how to properly install a bottom barrier to control nuisance aquatic weeds. The two videos are available for viewing at https://myavista.com/about-us/celebrate-our-rivers/shoreline-health. In 2020, these videos were played at the Northern Idaho/Eastern Washington Regional Lakes Conference.

Additionally, Avista actively participates with the Lake Spokane Association and periodically features articles regarding best management practices for shoreline homeowners in its annual Spokane River Newsletter which is distributed electronically to the Lake Spokane shoreline homeowners.

Floating Wetlands

In June 2020, Avista and the SCCD installed 17 floating wetland structures on Lake Spokane. Each structure contained approximately 40 plants of mixed beaked sedge and common rush. Avista monitored temperature, dissolved oxygen, pH and conductivity at depths of 0.5m, 1m and 2m beneath the wetland structure platforms and at a reference site approximately 25 feet southwest of the log boom. Samples were also collected at 1m depth for total phosphorus, nitrate plus nitrite, total nitrogen and chlorophyll a analysis. Monitoring was conducted twice per month during July, August and September, and once during June and October. Avista has provided the preliminary results to Ecology and looks forward to discussing any measurable observations in the water quality data. A summary is provided in Appendix B.

Due to the COVID-19 pandemic restrictions, Avista switched its educational focus from tours to a floating wetland educational video that could be shared with the public. This video can be found at https://myavista.com/connect/articles/2021/01/lake-spokane-floating-wetland. During removal of the wetlands in October 2020, Avista and SCCD were able to accommodate a group of students from Habitat for Humanity who assisted with the removal of the floating wetland plant structures and plant relocation to the Lake Spokane shoreline. This was a great opportunity to learn learning about plant species, survival, rootmass, and shoreline planting along with water quality.

### *3.6.2 Future Activities*

As the COVID-19 pandemic restrictions continue, Avista will look for opportunities to provide educational materials to the public or participate in virtual conferences, meetings, homeowner events, or other public forums. The Ecology grant for the floating wetland project, held by SCCD, sunset in 2020. Avista will explore other uses for the floating wetland structures outside of Lake Spokane during 2021.

## 3.7 Effectiveness of Implemented Control Actions

Avista has pursued implementation of the reasonable and feasible measures identified in the DO WQAP, prioritizing measures that capture the highest proportion of phosphorus removal. Phosphorus removal values were estimated in the DO WQAP, using established methods, to provide a means of prioritizing and quantifying phosphorus removal. Following Ecology and FERC approval of the DO WQAP (2012), Avista continued to evaluate the reasonableness and feasibility of measures through detailed studies and reporting in its Annual Summary Reports. For the control actions that have been implemented, Avista has pursued quantification of phosphorus credit toward its proportional level of responsibility, identified as a target phosphorus load of 511 – 1,896 kg TP/year in the DO WQAP. Avista will continue to summarize phosphorus removal and work with Ecology to determine the credits acquired through implementing the above reasonable and feasible measures and compare to the target phosphorus load.

# 4.0 2021 PROPOSED NEW MITIGATION MEASURES

Avista is not proposing to begin new mitigation or control measures in 2021. Many of the implemented control measures (Section 3.0) will continue in 2021 and be evaluated for their efficacy and goal attainment. As 2021 is the final year of implementation according to the DO WQAP compliance schedule, Avista will work with Ecology to assess each program for continuance, discontinuance, or modification. Decisions will take into account the phosphorus load reduction from each control measure.

# 5.0 LAKE MANAGEMENT

According to the 2019 updated Washington State Water Quality Standards, WAC 173-201A-200, "fresh water designated uses and criteria are designed for protection in fresh surface waters of the state". The designated uses for Lake Spokane (downstream of Nine Mile Bridge to Long Lake Dam) include aquatic life uses, recreation uses, water supply uses and miscellaneous uses. The aquatic life use designated for Lake Spokane is for core summer salmonid habitat. The key identifying characteristics of core summer salmonid habitat are the following, as defined by WAC 173-201A-200:

- Summer (June 15 – September 15) salmonid spawning or emergence, or adult holding;
- Use as important summer rearing habitat by one or more salmonids; or
- Foraging by adult or sub-adult native char.

Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing and migration by salmonids (WAC 173-201A-200). In addition, WAC 173- 201A-200(1)(a)(vi) requires "protection of waters where the dominant species under natural conditions would be temperature tolerant indigenous non-salmonid species.

The WDFW manages Lake Spokane as a mixed species fishery. In addition, WDFW is directed by the Washington Wild Salmonid Policy to protect, restore and enhance the productivity, production, and diversity of native salmonids.

## 5.1 Lake Improvements

Aquatic life (including water quality and the fishery) and the many forms of recreation (primary and secondary contact, boating, swimming, aesthetics, etc.) are all important measures to assess improvements in the overall health of Lake Spokane.

With regard to water quality, Avista has monitored nutrients and in situ water quality parameters at the baseline stations from 2010 – 2018. As described in Avista's past Annual Summary Reports, Lake Spokane's dissolved oxygen concentrations have dramatically improved with upgraded wastewater treatment plants and other efforts to reduce nutrient inputs to the lake (Figure 5).

We also see improvements reflected in the trophic status, recreational fishery, recreational use of the lake and in the aesthetics of the lake.

During the last eight years of nutrient monitoring (2010 – 2017), Lake Spokane was at or near borderline oligotrophy-mesotrophy on average in all zones, except for the transition and riverine zones with slightly greater TP than 10 µg/L, which is the oligotrophic-mesotrophic boundary. This is a substantial improvement from the eutrophic state documented in the 1970s (Figure 6). However, management goals for Lake Spokane, as noted in Section 5.0, may not call for oligotrophic conditions.

According to EPA's 2009 National Lakes Assessment, "there is no ideal trophic state for lakes as a whole since lakes naturally fall in all of these categories. Additionally, the determination of "ideal" trophic state depends on how the lake is used or managed. Eutrophic lakes can be biologically diverse with abundant fish, plants, and wildlife" (EPA 2009). Avista works with both Ecology and WDFW to meet the management goals for Lake Spokane.

With regard to aquatic life, Avista conducted a Rainbow Trout Habitat Assessment during 2017 and 2018 to gain a better understanding of rainbow trout habitat utilization throughout Lake Spokane. Results of the assessment indicated rainbow trout were frequently found in the epilimnion during the summer of 2017 and 2018, and often in water temperatures that were higher than anticipated (up to 23.6 °C). This is contrary to common limnology literature suggesting rainbow trout would be utilizing deeper depths in the lake due to high temperature and/or low dissolved oxygen conditions. Avista will continue to process the results of the habitat assessment and work with Ecology and WDFW with the goal of obtaining a better understanding of Lake Spokane's core summer salmonid habitat.

Additionally, Avista began implementing a 10-year Lake Spokane rainbow trout stocking program in 2014, per WDFW's recommendation in the Spokane River License. As part of the program, Avista annually stocks 155,000 triploid rainbow trout (approximately six inches in length) in the lake every spring. The hatchery rainbow trout, along with the warmwater fish species and native rainbow trout, provides for a mixed species fishery. To evaluate how the fish stocking program is affecting the lake's recreational fishery, Avista conducts biennial creel surveys during the fishing season (March – November) in accordance with its Revised Lake Spokane Fishery Enhancement and Creel Survey Plan

(2013). Data from past three creel surveys (2016, 2018, and 2020) suggest that anglers expect to catch fish in Lake Spokane, with many anglers now targeting both Bass and Rainbow Trout. Cursory observations from routine visits to Lake Spokane from Avista's Spokane River License implementation team indicates Lake Spokane has become a very popular destination for anglers.

With regard to recreation, Avista monitors recreation activities and visitor use at Lake Spokane to help guide management decisions and assess visitor experiences. In 2014, visitors were asked to rate their satisfaction with the number of sites and recreation facilities, and experiences at Lake Spokane. Overall 83% of visitors were "satisfied" or "very satisfied "with their outdoor experience. The most popular recreation activity on Lake Spokane is swimming, followed by boating, fishing, water-skiing, tubing or wake boarding, and canoeing and kayaking (Avista 2015). In 2020 visitor use at Lake Spokane increased dramatically with some sites experiencing over 40% increases in recreation visits (Pinnacle 2021).

Algae bloom occurrences and intensity has greatly decreased since the late 1970s, following the reduction of nutrient inputs to Lake Spokane. Recently, an example of this is the decrease of samples from Lake Spokane sent to Ecology's Freshwater Algae Program. Algae blooms are still observed in Lake Spokane, typically during August and September. However, we expect blooms to remain improved, with intensity and occurrence being a function of annual residence time and climatic conditions.

# 6.0 DISCUSSION

At the time the DO TMDL was being developed there were limited, if any, examples of similar situation where a Licensee was assigned a proportional level of responsibility in a TMDL, through their 401 Water Quality Certification. This is an unprecedented regulatory scenario in Washington and Avista is unaware of similar situations currently. Avista's proportional level of responsibility is defined in the DO TMDL using water quality modeling results (based on 2001 data) that have an implied level of accuracy and precision. In other words, the model can calculate very small expected changes in water quality in thousands of different portions of the lake. However, it is impossible to match this level of implied accuracy with actual monitoring data. There was a gap in expectations between the model results and actual results based on monitoring data. Due to this, Avista and Ecology agreed that Avista would focus efforts on nutrient reductions with the goal of meeting the target total phosphorus removal load of 511 – 1,896 kg TP/year, in lieu of Table 7 of the DO TMDL, and demonstrate ongoing compliance by documentation actions outlined in the DO WQAP; calculating phosphorous reductions resulting from those actions, monitoring efforts related to phosphorus reduction; and monitoring and modeling of water quality and aquatic habitat (since the goal of DO standards is to support designated uses including habitat). Avista looks forward to working with Ecology to finalize the phosphorus quantification during 2021.

## 7.0 SCHEDULE

Avista's implementation schedule incorporates several benchmarks and decision points important to implementing the DO WQAP. As part of the 2015 Annual Summary Report and based on Ecology's recommendation, Avista revised the DO WQAP Implementation Schedule (Figure 1) to better sync with the compliance schedule of the DO TMDL, including point- and non-point source wasteload and load reductions. The revision consisted of changing the initial implementation dates that Avista would run the CE-QUAL-W2 model (2016/2017, 2019/2020, and 2021/2022). It is Avista's understanding that Ecology will be determining whether it will complete any CE-QUAL-W2 modeling as part of its DO TMDL 10-Year Assessment. As such, Avista does not anticipate completing any model runs in 2021. Benchmarks and important milestones completed to date, and extending into 2021, are summarized in Table 3.

**Table 3.** Benchmarks and milestones completed to date and proposed through 2021.

| Year | Year of Schedule | Benchmark or Milestone |
|---|---|---|
| **2012** | **-** | • Prepared the DO WQAP. Approval of the DO WQAP was obtained from Ecology on September 27, 2012 and from FERC on December 19, 2012. |
| **2013** | **1** | • Conducted the baseline nutrient monitoring in Lake Spokane (May through October).<br>• Conducted the Aquatic Weed Management Phase I Analysis and Nutrient Reduction Evaluation.<br>• Initiated the Lake Spokane Carp Population Abundance and Distribution Study.<br>• Planted 300 trees on Lake Spokane.<br>• Assisted with a bulkhead removal on the Staggs parcel and began designing the bulkhead removal for the second property on Lake Spokane.<br>• Protected approximately 14-miles of Avista-owned shoreline from future development.<br>• Acquired 109-acres of wetland property in the Little Spokane Watershed and 656-acres in the upper Hangman Creek Watershed.<br>• Continued education activities targeted at Lake Spokane shoreline homeowners. |
| **2014** | **2** | • Completed and submitted the 2013 DO WQAP Annual Summary Report to Ecology and FERC.<br>• Conducted baseline nutrient monitoring in Lake Spokane (May through October).<br>• Completed the Lake Spokane Carp Population Abundance and Distribution Study.<br>• Planned and began permitting a bulkhead removal on an Avista Lake Spokane parcel.<br>• Protected approximately 14-miles of Avista-owned shoreline from future development.<br>• Implemented site-specific wetland plans on the Sacheen Springs and Hangman Creek properties.<br>• Continued education activities targeted at Lake Spokane shoreline homeowners. |
| **2015** | **3** | • Completed and submitted the 2014 DO WQAP Annual Summary Report to Ecology and FERC.<br>• Conducted baseline nutrient monitoring in Lake Spokane (May through October).<br>• Worked with WDFW and Ecology in planning a carp reduction effort for 2016.<br>• Continued planning and permitting the bulkhead removal on an Avista Lake Spokane parcel.<br>• Protected approximately 14-miles of Avista-owned shoreline from future development.<br>• Implemented site specific wetland plans on the Sacheen Springs and Hangman Creek properties.<br>• Stocked 155,000 triploid rainbow trout in Lake Spokane.<br>• Continued education activities targeted at Lake Spokane shoreline homeowners. |

| Year | Year of Schedule | Benchmark or Milestone |
|---|---|---|
| **2016** | **4** | • Completed and submitted the 2015 DO WQAP Annual Summary Report to Ecology and FERC.<br>• Conducted the baseline nutrient monitoring in Lake Spokane (May through October). Following monitoring, evaluated the results and success of monitoring baseline nutrient conditions in Lake Spokane and worked with Ecology to define future monitoring goals for the lake.<br>• Initiated carp removal activities during spring spawning. Activities were rescheduled due to timing of the hydrograph and early aquatic weed growth.<br>• Continued to implement site specific wetland plans on the Sacheen Springs and Hangman Creek properties.<br>• Protected approximately 14-miles of Avista-owned shoreline from future development.<br>• Planted 13,625 trees along Lake Spokane shoreline. |
| **2017** | **5** | • Submitted the DO WQAP Five Year Report to Ecology and FERC on February 1 and April 1, respectively.<br>• Removed carp during winter aggregation and spring spawning.<br>• Continued baseline nutrient monitoring in Lake Spokane.<br>• Initiated the Rainbow Trout Habitat Assessment.<br>• Completed other mitigation measures as proposed in the DO WQAP Five Year Report.<br>• Avista continued to work with Ecology in regard to developing a plan to run the CE-QUAL-W2 model. |
| **2018** | **6** | • Submitted the 2017 DO WQAP Annual Summary Report to Ecology and FERC by February 1 and April 1, respectively.<br>• Continued carp removal efforts.<br>• Continued the Rainbow Trout Habitat Assessment.<br>• Collected *in-situ* and zooplankton data at all 6, plus 4 additional, water quality monitoring stations.<br>• Completed other mitigation measures as proposed in previous years' Annual Summary Report.<br>• Continued discussions of timing, objectives, and data input of potential future CE-QUAL-W2 model runs with Ecology. |
| **2019** | **7** | • Submitted the 2018 DO WQAP Annual Summary Report to Ecology and FERC by February 1 and April 1, respectively. |

| Year | Year of Schedule | Benchmark or Milestone |
|---|---|---|
| | | • Completed analysis of the Rainbow Trout Habitat Assessment, relating identified occupancy information to lake-wide habitat and water quality parameters to quantify available habitat.<br>• Evaluated water quality monitoring needs in coordination with Ecology's proposed DO TMDL 10-year assessment monitoring.<br>• Continued carp removal efforts.<br>• Assisted with a bulkhead removal on the Wrights parcel and began the planning process for the Franks parcel, both on Lake Spokane.<br>• Completed other mitigation measures as proposed in previous years' Annual Summary Report.<br>• Continued discussions of timing, objectives, and data input of potential future CE-QUAL-W2 model runs with Ecology. |
| **2020** | **8** | • Submitted the DO WQAP Eight-Year Annual Summary Report to Ecology and FERC by February 1 and April 1, respectively.<br>• Evaluated water quality monitoring needs in coordination with Ecology's proposed DO TMDL 10-year assessment monitoring.<br>• Continued carp removal program with extended removal timeframe.<br>• Completed monthly 24-hour DO monitoring from June to September in Lake Spokane.<br>• Continue working with shoreline homeowners interested in bulkhead removal projects.<br>• Completed other mitigation measures as proposed in previous years Annual Summary Report.<br>• Continued discussions of timing, objectives, and data input of potential future CE-QUAL-W2 model runs with Ecology. |
| **2021** | **9** | • Submit the 2020 DO WQAP Annual Summary Report to Ecology and FERC by February 1 and April 1, respectively.<br>• No monitoring is proposed; will continue discussions with Ecology on the DO TMDL 10-Year Assessment monitoring timeline.<br>• Continue carp removal program with extended removal timeframe and evaluate carp removal program.<br>• Continue bulkhead removals discussions and design and evaluate benefits of bulkhead removal program.<br>• Continue discussions with Ecology and WDFW to identify and define usable rainbow trout habitat in the lake.<br>• Will complete other mitigation measures as proposed in previous years Annual Summary Report. |

| Year | Year of Schedule | Benchmark or Milestone |
|---|---|---|
| | | • Will discuss timing, objectives, and data input of potential future CE-QUAL-W2 model runs with Ecology. |

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# FIGURES

| | Activity | Implementation Year[1] 2012 | | | | Year 1 2013 | | | | Year 2 2014 | | | | Year 3 2015 | | | | Year 4 2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall |
| DO WQAP Submittal | Submit DO WQAP to Ecology | | x | | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Receive approval from Ecology* | | | x | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Submit DO WQAP to FERC* | | | x | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Receive approval from FERC* | | | | x | | | | | | | | | | | | | | | | |
| Carp | Phase I Analysis: Identify location and population of carp | | | | | | | x | x | x | x | x | | | | | | | | | |
| Carp | Summarize Phase I findings [2]* | | | | | | | | | x | | | | x | | | | | | | |
| Carp | Phase II Analysis: Evaluate harvest technology | | | | | | | | | x | x | x | x | | | | | | | | |
| Carp | Select carp removal method(s) | | | | | | | | | | | | x | | | | | | | | |
| Carp | Summarize Phase II findings[2], consult and discuss with Ecology | | | | | | | | | | | | | x | | | | | | | |
| Carp | Determine with Ecology whether carp population reduction is reasonable and feasible to implement in Lake Spokane* | | | | | | | | | | | | | | x | | | | | | |
| Carp | If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule* | | | | | | | | | | | | | | | x | x | x | x | x | x |
| Carp | If implemented, monitor for nutrient reductions | | | | | | | | | | | | | | | x | x | | | x | x |
| Aquatic Weed Management | Phase I Analysis: Evaluate feasibility of mechanical harvesting | | | | | | x | x | x | | | | | | | | | | | | |
| Aquatic Weed Management | Nutrient reduction evaluation | | | | | | | x | x | | | | | | | | | | | | |
| Aquatic Weed Management | Summarize findings[2], consult and discuss with Ecology* | | | | | | | | | x | | | | | | | | | | | |
| Aquatic Weed Management | Determine with Ecology whether aquatic weed harvesting is reasonable and feasible to implement in Lake Spokane* | | | | | | | | | | x | | | | | | | | | | |
| Aquatic Weed Management | If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule* | | | | | | | | | | | x | x | | | x | x | | | x | x |
| Aquatic Weed Management | If implemented, monitor for nutrient reductions | | | | | | | | | | | x | x | | | x | x | | | x | x |
| Aquatic Weed Management | Implement yearly aquatic weed controls through separate program[3] | | | | | | | | | | | x | x | | | x | x | | | x | x |
| Other Measures | Evaluate & implement additional measures, as appropriate | | | | | | | | | | | | | | | | | | | | |
| Monitoring & Modeling | Baseline Monitoring[4] | | x | x | x | | x | x | x | | x | x | x | | x | x | x | | x | x | x |
| Monitoring & Modeling | Ongoing Habitat Analysis[5] | | | | | | | | | | x | x | | | x | x | | | x | x | |
| Monitoring & Modeling | Site Specific Nutrient Reduction Analysis[6] | | | | | | | | | | | | | | | | | | | | |
| Monitoring & Modeling | CE-QUAL Modeling[7] | | | | | | | | | | | | | | | | | | | | |
| Compliance Reporting | DO WQAP Annual Summary Report* | | | | | | | | | x | | | | x | | | | x | | | |
| Compliance Reporting | Five, Eight, and Ten-Year Reports* | | | | | | | | | | | | | | | | | | | | |

| | Activity | Year 5 2017 | | | | Year 6 2018 | | | | Year 7 2019 | | | | Year 8 2020 | | | | Year 9 2021 | | | | Year 10 2022 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall | Winter | Spring | Summer | Fall |
| DO WQAP Submittal | Submit DO WQAP to Ecology | | | | | | | | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Receive approval from Ecology* | | | | | | | | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Submit DO WQAP to FERC* | | | | | | | | | | | | | | | | | | | | | | | | |
| DO WQAP Submittal | Receive approval from FERC* | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Phase I Analysis: Identify location and population of carp | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Summarize Phase I findings [2]* | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Phase II Analysis: Evaluate harvest technology | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Select carp removal method(s) | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Summarize Phase II findings[2], consult and discuss with Ecology | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | Determine with Ecology whether carp population reduction is reasonable and feasible to implement in Lake Spokane* | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule* | | | | | | | | | | | | | | | | | | | | | | | | |
| Carp | If implemented, monitor for nutrient reductions | | | x | x | | | x | x | | | x | x | | | x | x | | | x | x | | | | |
| Aquatic Weed Management | Phase I Analysis: Evaluate feasibility of mechanical harvesting | | | | | | | | | | | | | | | | | | | | | | | | |
| Aquatic Weed Management | Nutrient reduction evaluation | | | | | | | | | | | | | | | | | | | | | | | | |
| Aquatic Weed Management | Summarize findings[2], consult and discuss with Ecology* | | | | | | | | | | | | | | | | | | | | | | | | |
| Aquatic Weed Management | Determine with Ecology whether aquatic weed harvesting is reasonable and feasible to implement in Lake Spokane* | | | | | | | | | | | | | | | | | | | | | | | | |
| Aquatic Weed Management | If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule* | | | x | x | | | x | x | | | x | x | | | x | x | | | x | x | | | | |
| Aquatic Weed Management | If implemented, monitor for nutrient reductions | | | x | x | | | x | x | | | x | x | | | x | x | | | x | x | | | | |
| Aquatic Weed Management | Implement yearly aquatic weed controls through separate program[3] | | | x | x | | | x | x | | | x | x | | | x | x | | | x | x | | | | |
| Other Measures | Evaluate & implement additional measures, as appropriate | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | |
| Monitoring & Modeling | Baseline Monitoring[4] | | | | | | | | | | | | | | | | | | | | | | | | |
| Monitoring & Modeling | Ongoing Habitat Analysis[5] | | x | x | | | x | x | | | x | x | | | x | x | | | x | x | | | | | |
| Monitoring & Modeling | Site Specific Nutrient Reduction Analysis[6] | | | | | | | | | | | | | | | | | | | | | | | | |
| Monitoring & Modeling | CE-QUAL Modeling[7] | | | | | | | | | | | | | | | | | | | | | | | | |
| Compliance Reporting | DO WQAP Annual Summary Report* | | | | | x | | | | x | | | | | | | | x | | | | | | | |
| Compliance Reporting | Five, Eight, and Ten-Year Reports* | x | | | | | | | | | | | | x | | | | | | | | x | | | |

Notes:

* Benchmarks

(1) = Implementation Year dependent upon date of FERC approval.

(2) = Findings would be summarized in the DO WQAP Annual Summary/Report, which will be submitted to Ecology for review and approval.

(3) = Annual aquatic weed control activities implemented under the Lake Spokane and Nine Mile Reservoir Aquatic Weed Management Program.

(4) = Avista and Ecology will re-evaluate baseline nutrient monitoring program following the completeing of the 2016 season.

(5) = Ongoing in nature with periodic reporting to Ecology.

(6) = Dependent upon outcome of carp population reduction and aquatic weed management phased analyses.

(7) = Avista will continue to work with Ecology to determine the timing for future CE-QUAL model runs.

Revised Figure 3. DO WQAP Implementation Schedule (Source: Figure 3-3, DO WQAP) Revised: March 2016

**Figure 1**. Revised DO WQAP Implementation Schedule (Source, DO WQAP Figure 3-3)

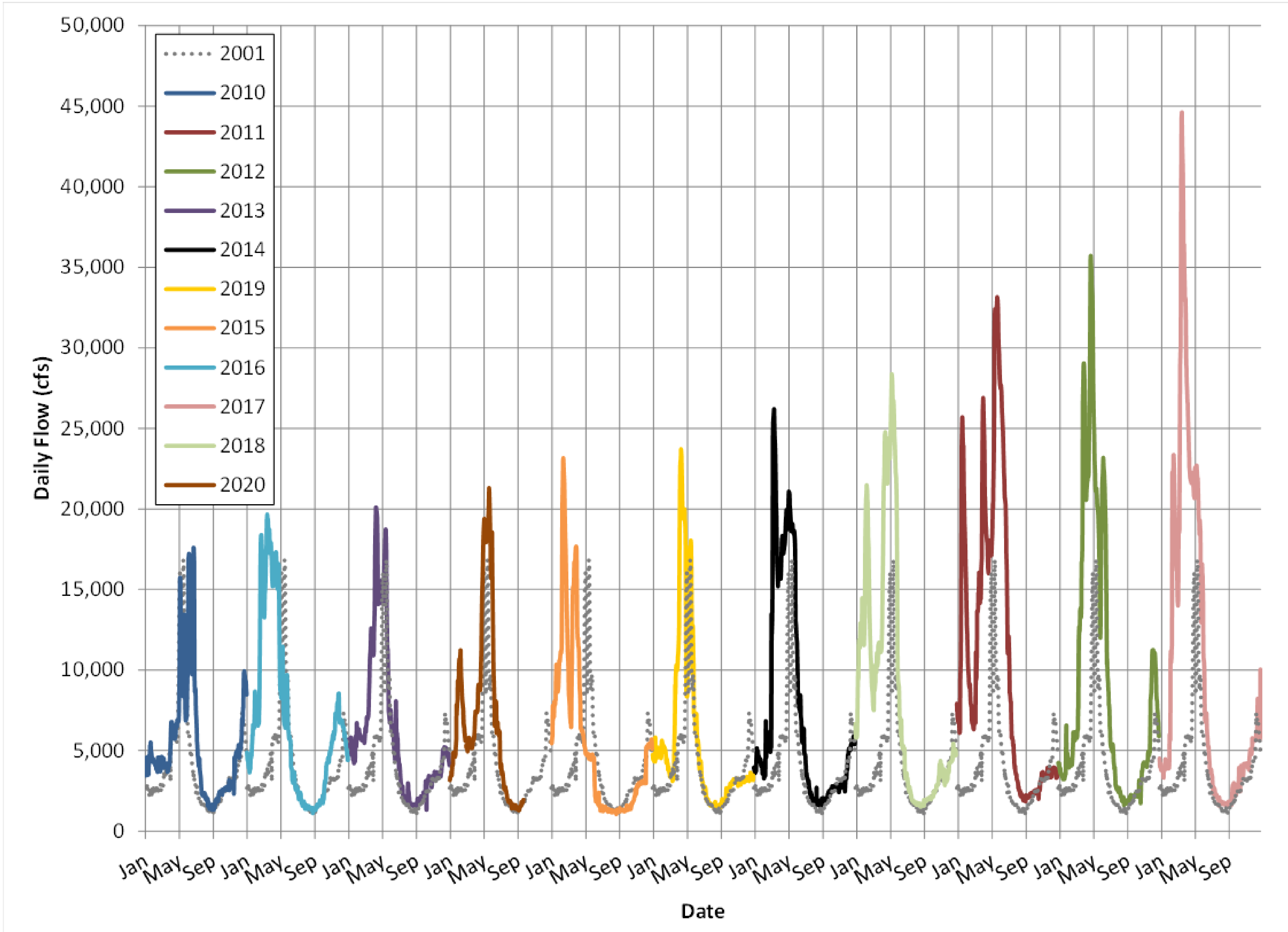


**Figure 2**. Total inflows into Lake Spokane 2001, 2010-2020, in order of magnitude. Inflows calculated based on midnight to midnight reservoir elevation and day average outflow at midnight, as recorded at Long Lake Dam.

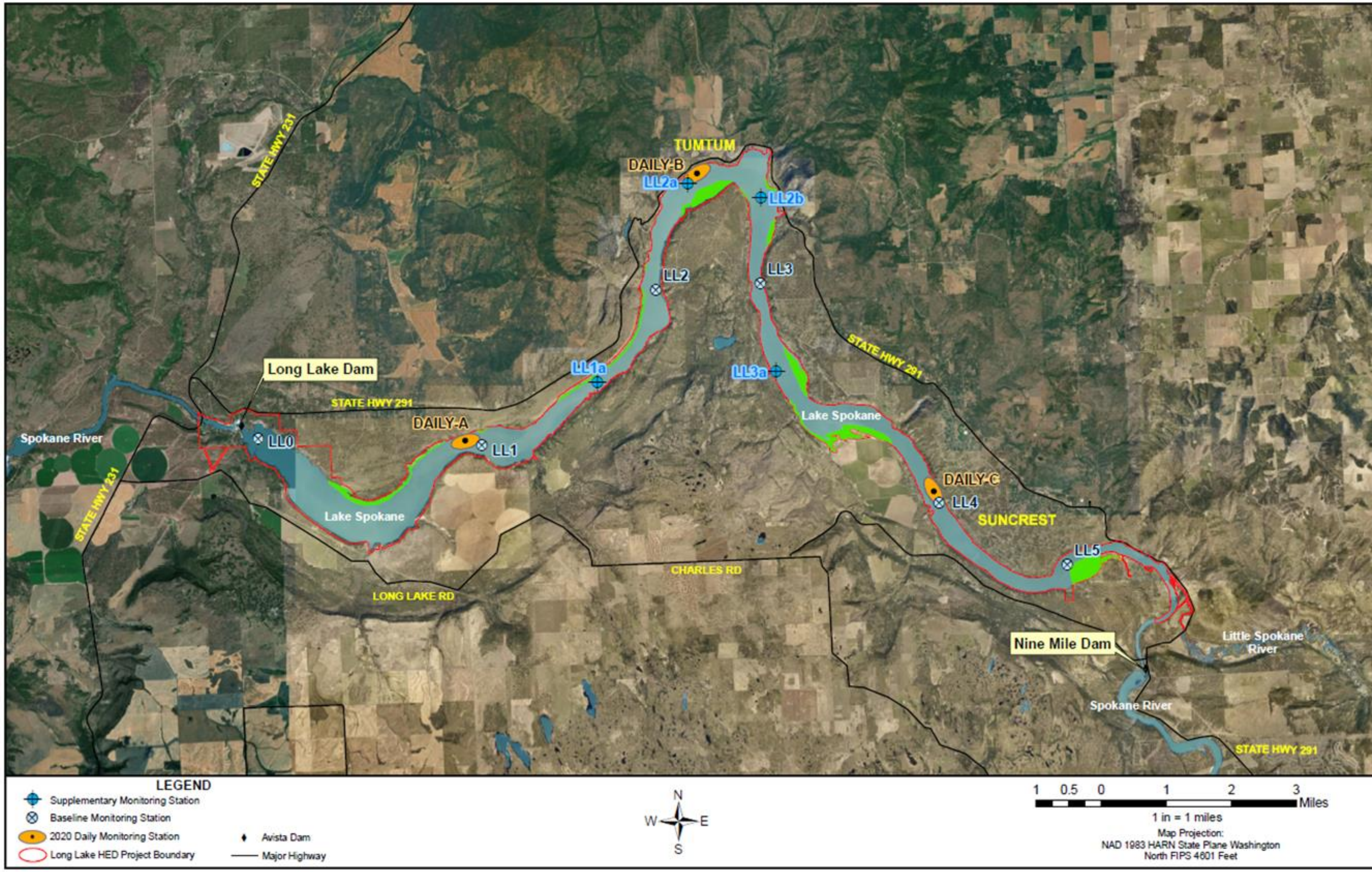


**Figure 3.** Location of Lake Spokane baseline monitoring stations, the four supplemental monitoring stations and the three 2020 continuous monitoring stations.

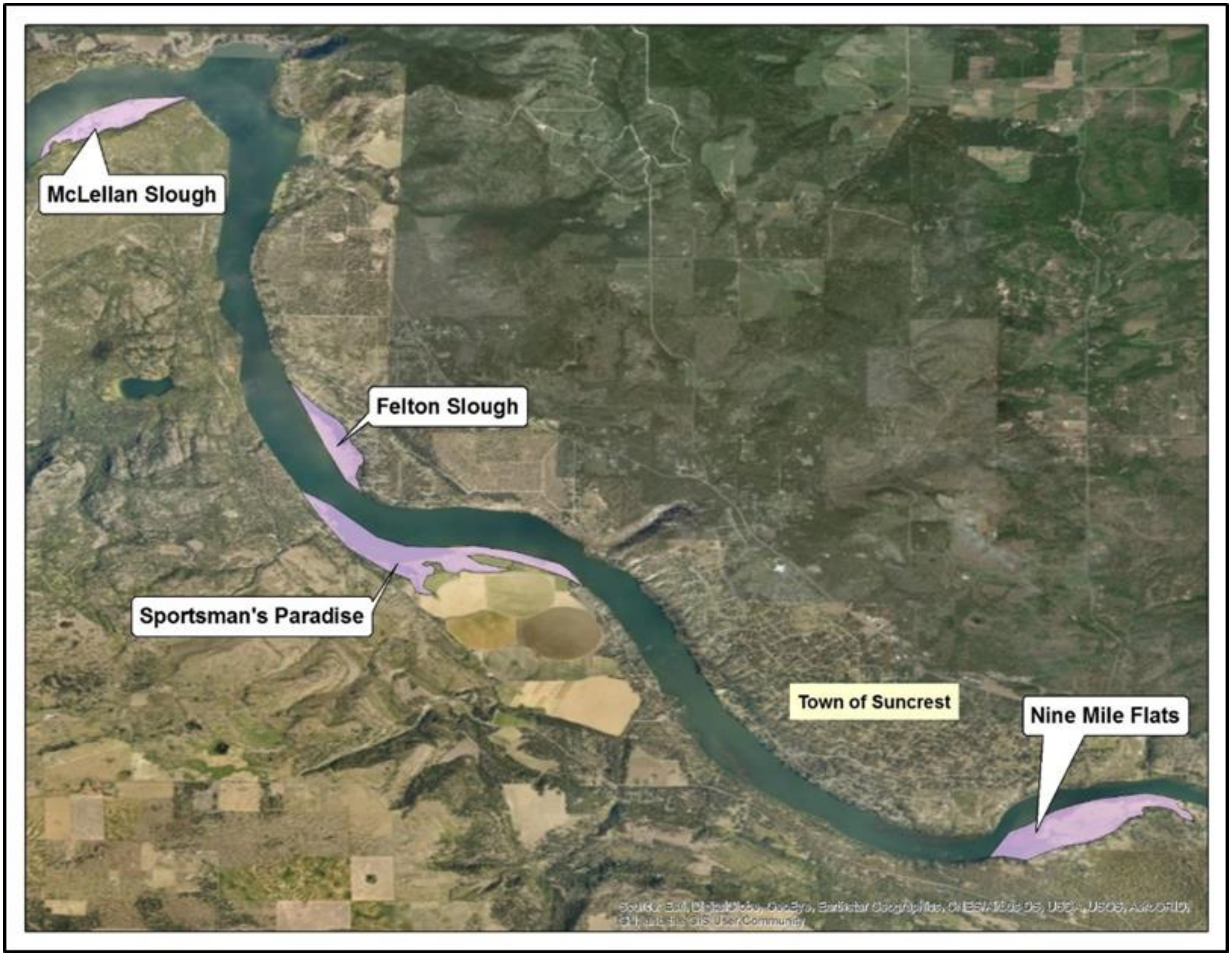


**Figure 4.** Lake Spokane carp removal locations (purple shaded area).

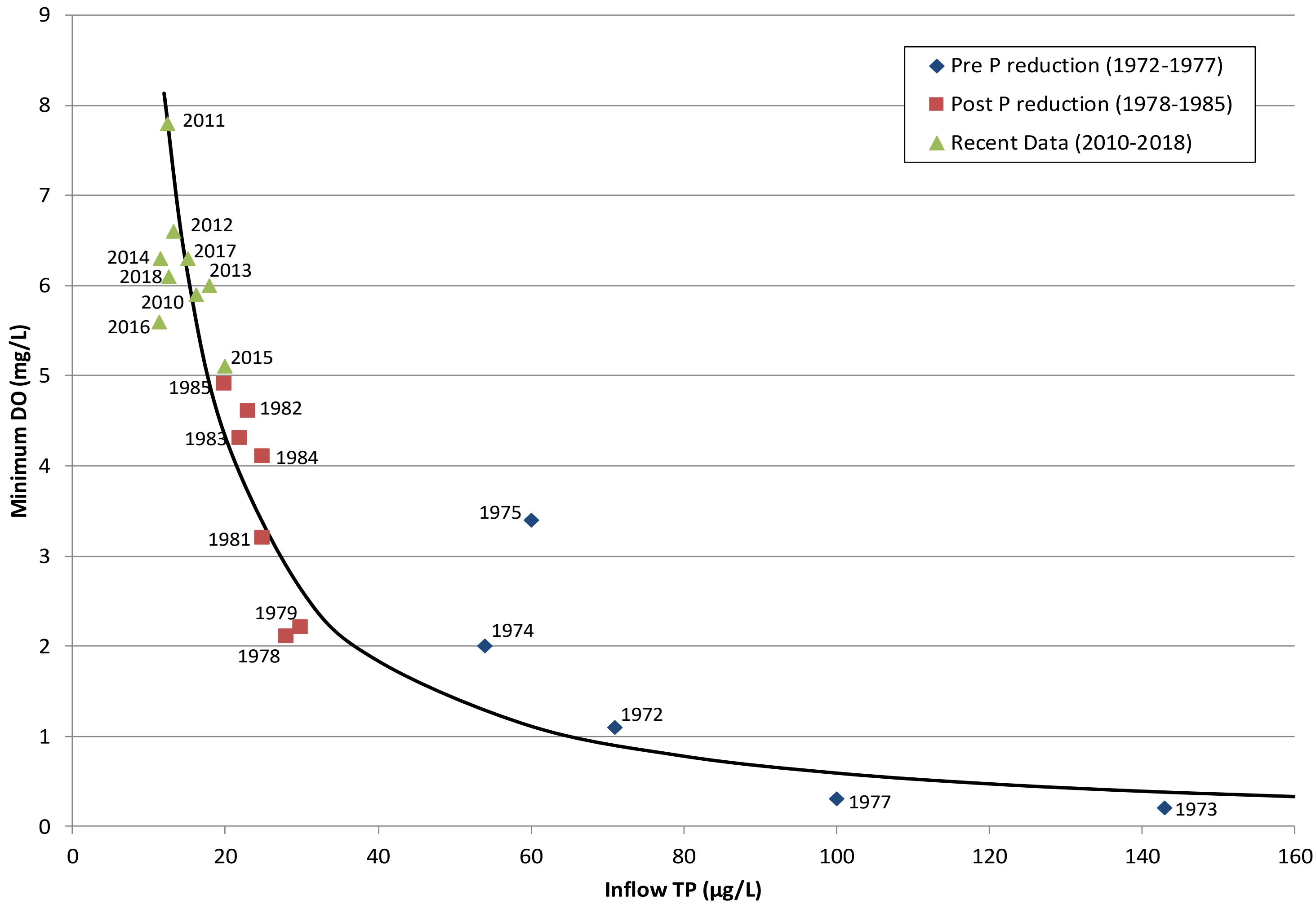


**Figure** 5. Volume-weighted mean inflow TP concentration related to minimum v-w hypolimnetic DO concentration during June-October before and after advanced wastewater treatment TP reduction in 1977. Concentrations from 1972 through 1985 were from observed loading at Nine Mile Dam (Patmont 1987). Mean inflow TP concentrations from 2010-2017 were taken as v-w mean TP concentrations at Station LL5, in lieu of loading data from Nine Mile Dam. Inflow TP in 2018 was calculated as the flow-weighted average from observations at Nine Mile and Little Spokane River. Equation for the line: $y = 175.4587x^{-1.2360}$, $r^2 = 0.84$.

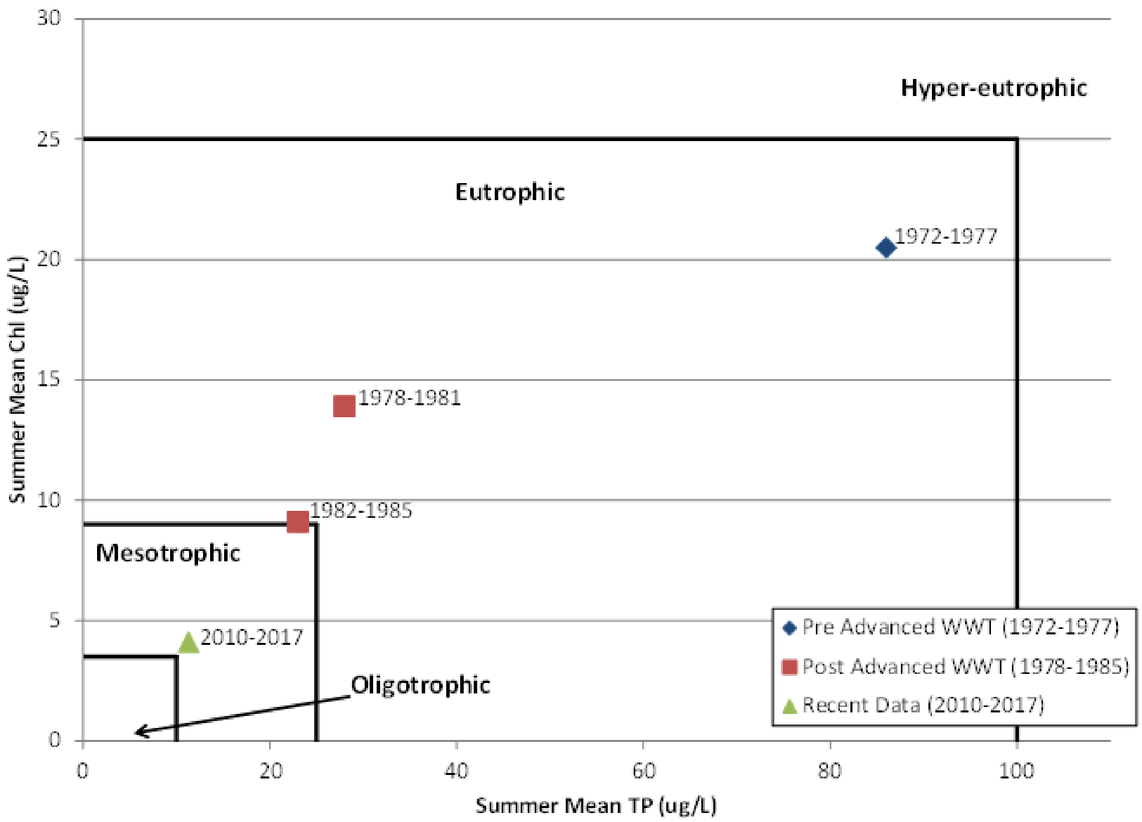


**Figure 6.** Transition of Lake Spokane from borderline hypereutrophy to meso-oligotrophy over a period of 45 years

# APPENDICES

# APPENDIX A

## Lake Spokane Annual Summary, 2020 Water Quality Monitoring Results (Tetra Tech, 2021)

# LAKE SPOKANE ANNUAL SUMMARY

## 2020 Water Quality Monitoring Results

## Prepared for

## AVISTA

**SPOKANE, WASHINGTON**

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*Spokane, WA 99201*

**January 2021**

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **Avista** | Avista Utilities |
| **DO** | dissolved oxygen |
| **Ecology** | Washington Department of Ecology |
| **HED** | Hydroelectric Development |
| **QAPP** | Quality Assurance Project Plan |
| **RM** | river mile |
| **TMDL** | total maximum daily load |

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# 1. INTRODUCTION

Avista owns and operates the Long Lake Hydroelectric Development (HED) on the Spokane River. Long Lake Dam created a reservoir, Lake Spokane, in a 23-mile (37 km) stretch of the Spokane River that was, at one-time, free flowing. Portions of the river, including Lake Spokane, experience seasonal patterns in DO concentrations, some of which do not meet Washington State's water quality standards.

Ecology has been working, along with several stakeholders, to address these water quality impairments through the development and implementation of a water quality improvement plan, or Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL) (Ecology 2010).

The DO TMDL relies on the CE-QUAL-W2 hydrodynamic and water quality model (CE-QUAL-W2 model) to assess the capacity of the Spokane River and Lake Spokane to assimilate oxygen-demanding pollutants (i.e., phosphorus, carbonaceous biological oxygen demand, and ammonia) under varying conditions (DO TMDL, page vi). Unlike point- and non-point source discharges, Avista does not discharge nutrients to either the Spokane River or Lake Spokane. Thus, it was not assigned a wasteload allocation or a load allocation. However, since the presence of the Long Lake HED increases the water residence time (average amount of time water resides in Lake Spokane) and a thermally stratified water column (which is common in deep reservoirs with an interflow zone; Cooke et al. 2005), the DO TMDL process assigned Avista a "proportional level of responsibility" for reduced DO levels in Lake Spokane through a water quality modeling scenario. This responsibility is reflected in Table 7 of the DO TMDL, which was subsequently corrected (Ecology 2010; Appendix B). Table 7 in the TMDL is based on a comparison of CE-QUAL-W2 model runs for the 2001 model year.

Ecology and Avista jointly conducted a 2-year baseline sampling effort that began in May 2010 and extended through October 2011 at six lake stations and two river stations. The main purpose was to gather more recent data to verify the baseline water quality conditions from 2001, which were used in the TMDL development process, and to account for any changes in water quality in the reservoir. Ecology and Avista collaborated on a monthly sampling routine extending from June through September in 2010 and 2011 to expand the frequency of observations at the six lake monitoring stations. To do that, Avista contracted with Tetra Tech to monitor water quality in the reservoir.

Beginning in 2012, Avista took over monitoring of the six lake stations in Lake Spokane and continued that effort through 2018, with additional lake stations added in 2018. Ecology continued to provide water quality data for the three river stations (54A090, 55B070, and 54A070). Following the 2018 monitoring season, Avista, with Tetra Tech's assistance, assessed the results and success of the baseline water quality monitoring program and DO conditions in Lake Spokane and, following that assessment, worked with Ecology and defined future monitoring goals for the reservoir.

In September 2019 Avista met with Ecology to discuss the timelines of the Avista DO Water Quality Attainment Plan (WQAP) Compliance Schedule and the DO TMDL 10-Year Assessment Study. It was determined that baseline monitoring would remain postponed until the City of Spokane's Riverside Park Water Reclamation Facility has come online. Avista will continue discussions with Ecology concerning the timeline for monitoring.

Monitoring activities conducted by Avista in 2020 included monthly 24-hour temperature and DO monitoring in the epilimnion of Lake Spokane during the summer months. This monitoring occurred at three locations in the reservoir, two in the deeper lacustrine zone and one in the shallower transition zone. This report summarizes the 24-hour temperature and DO data collected by Avista during 2020.

# 2. BASELINE MONITORING PROGRAM

Beginning in 2010, Avista contracted with Tetra Tech to complete baseline monitoring in Lake Spokane at six established stations during May through October. Longitudinally, the lake can be classified as having three distinct zones, which consist of a riverine, transition and lacustrine zone. Six water quality monitoring stations, LL5 through LL0, exist within these three zones (Figure 1). Station LL5 is the most upstream station and is located within a riverine zone, Stations LL3 and LL4 are located in the transition zone, and Stations LL0 through LL2 are located in the lacustrine zone. The vertical structure of Lake Spokane is set up by thermal stratification, largely determined by its inflow rates, atmospheric and water temperature, and location of the powerhouse intake. Within Lake Spokane's lacustrine zone, thermal stratification creates three layers (the epilimnion, metalimnion, and hypolimnion) that are generally present between late spring and early fall. The epilimnion is the uppermost layer, and the warmest due to solar radiation. The metalimnion is the transition layer between the epilimnion and the hypolimnion that contains the thermocline and is influenced by both surface and interflow inflows. The hypolimnion is the deepest layer and is present throughout the lacustrine zone.

Sampling events, both nutrient sampling and in-situ monitoring were completed at all six established stations from 2010 - 2017. In 2018, four supplemental monitoring locations, identified in the Quality Assurance Project Plan (QAPP) Addendum, Lake Spokane Baseline Nutrient Monitoring (approved 2018) were also sampled, May through October (Figure 1). Nutrient sampling (nitrogen and phosphorus) and phytoplankton sampling were not conducted in 2018 but in-situ dissolved oxygen (DO), temperature, conductivity and pH were measured, and zooplankton samples were collected at all ten monitoring locations.

Avista has collected baseline nutrient monitoring over the full spectrum of flows that were likely to exist in the Spokane River under current license conditions (see Section 2.2.1).

## 2.1 2020 Monitoring Activities

Avista worked with Ecology to develop a plan for monthly 24-hour temperature and DO monitoring in the epilimnion of Lake Spokane during the summer of 2020. Avista prepared an addendum to the Lake Spokane Nutrient Monitoring QAPP (approved May 2020) which detailed the 24-hour continuous monitoring locations, depths, and data quality control procedures. Per the request of Ecology, the purpose of monitoring temperature and DO in 15-minute increments over a period of 24 hours within the epilimnion was to provide a better understanding of the diurnal fluctuations that may be present during the summer and how primary productivity influences water quality conditions.
The three continuous monitoring locations (Figure 1) were chosen based on bathymetry, water current and flow, and security concerns. Table 1 provides a general description of the three continuous monitoring stations.

**Table 1. Three Continuous Monitoring Stations within Lake Spokane.**

| Site ID | Description | Logger Depths (m) | Longitude | Latitude |
|---|---|---|---|---|
| Daily A | Along the north shore of the reservoir, downstream of Station LL1. Water depth at the deployment location varied from 5 to 7 m (16.4 to 23 ft). | 0.6<br>2.4<br>4.0 | 117°45' 38.118" W | 47°49' 57.638" N |
| Daily B | Near north shore of TumTum Bay. Water depth at the deployment location varied from 5 to 6 m (16.4 to 19.7 ft). | 0.6<br>2.4<br>4.0 | 117°41' 6.417" W | 47° 53' 21.274" N |
| Daily C | Just outside the swim area at Suncrest Park along the northern shore of the reservoir. Water depth at the deployment location varied from 3 to 4 m (9.8 to 13.1 ft) | 0.6<br>1.5<br>2.4 | 117°36' 40.191" W | 47°48' 58.594" N |

Temperature and DO measurements were continuously measured during the summer months (June – September) using Onset HOBO data loggers (model No. U26-001). Data loggers were secured to a chain and buoy system at specified depths (Table 1). Each logger was attached to the chain using two methods; zip tie and bailing wire. The data loggers were deployed on June 11, 2020. Prior to deployment, each data logger was calibrated per the manufacturer instructions and programmed to measure temperature and DO at 15-minute intervals. The data loggers were retrieved, and data downloaded every two weeks to minimize the risk of data loss and drift. The loggers were removed from the reservoir on September 30, 2020.

Water column temperature, DO, pH, and conductivity were determined at 1-meter intervals with a Hydrolab multi-parameter water quality sonde at each of the three continuous monitoring locations as well as the nearby baseline monitoring stations, upon deployment of the continuous loggers as well as during data retrieval events. Secchi disk transparency was also measured at both the continuous monitoring stations and the baseline monitoring stations.

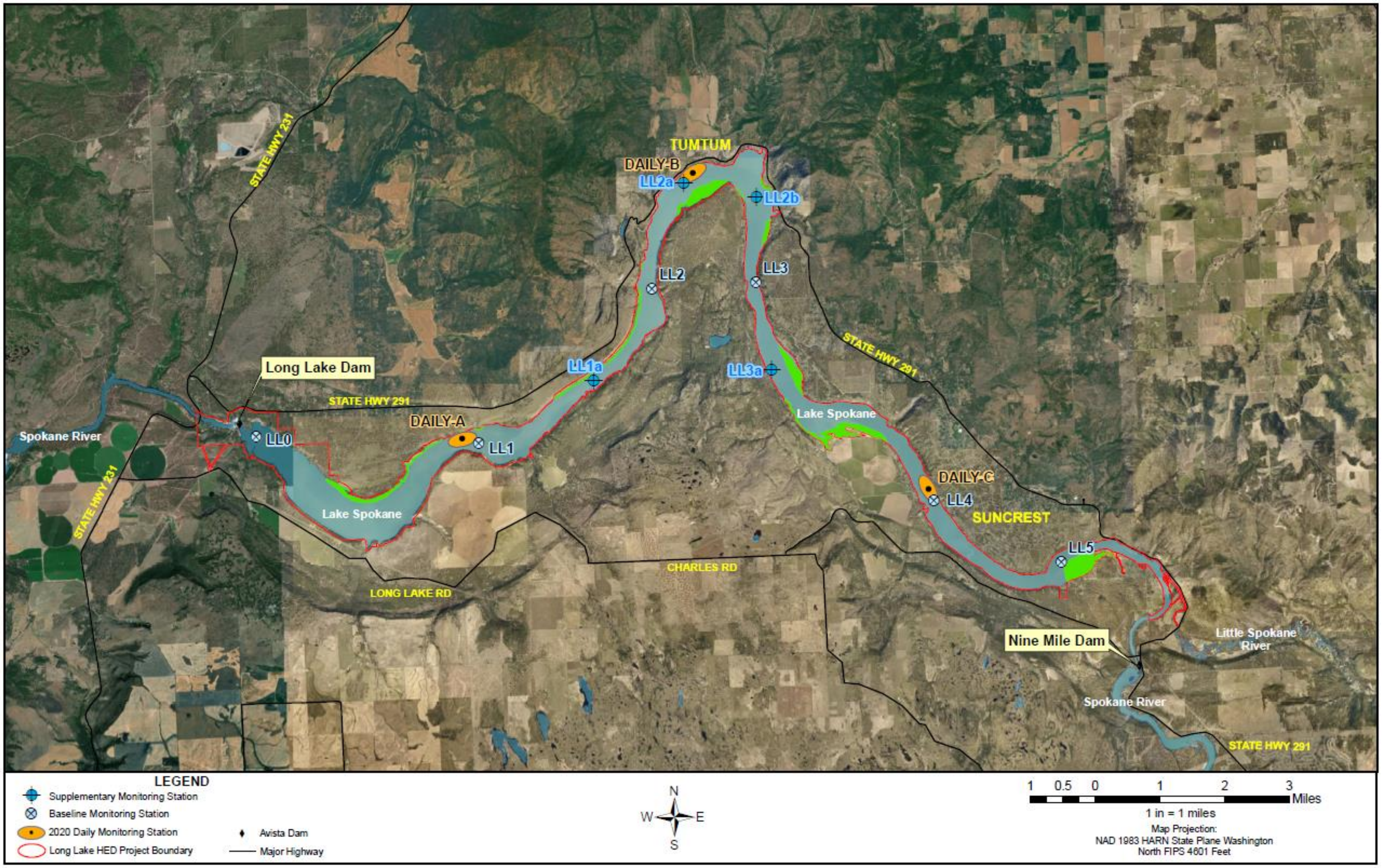


**Figure 1. Lake Spokane Baseline Monitoring Stations, Four Supplemental Monitoring Stations, and the Three 2020 Continuous Monitoring Locations**

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# 3. 2020 RESULTS

Monitoring was limited in 2020 and did not include the collection of samples for nutrient, chlorophyll, phytoplankton, or zooplankton analysis. The general hydrologic and climatic conditions as well as residence times were analyzed, and algae bloom occurrences were described for 2020 and are summarized below.

## 3.1 Climatic Conditions

Weather during 2020 differed from the 30-year norm reported at Spokane International Airport (Figure 2). The year started out warmer than normal with a mean temperature of 34.1 °F which was 4.6 °F warmer than normal. February was also warmer than normal with an average temperature of 35.1°F (1.7°C), 2.1°F (1.1°C) above normal, and a maximum temperature on the 28th of 60°F (15.6°C), which tied the record high for that date previously set in 1988. This is in contrast to February 2019 when Spokane recorded its 4th coldest February on record. March brought lower temperatures to the region with an average minimum temperature of 29.6°F (-1.3°C), which was 2.0°F (1.1°C) below normal and had an unseasonably cold period during the middle of the month (Figure 3). April started with below normal temperatures but finished with more normal conditions including a mean temperature of 47.6°F. May temperatures fluctuated between colder than normal and much warmer than normal but ended up just above normal with an average temperature of 55.7°F (13.2°C). On the 29th of May, temperatures reached 86°F (29.9°C). Temperature fluctuated throughout June and was overall slightly cooler than normal with an average temperature of 61.7°F (16.5°C). Most of July and August had normal to above normal air temperatures each with separate maximums of 102°F (38.9°C) and 101°F (38.3°C), respectively. Several temperature records were set during August. The average temperature in August was 71.6°F (22°C), which was 2.3°F (1.3°C) above normal. Warmer than normal air temperature continued into September, with an average temperature of 64.1°F (17.8°C), which was almost 4.0°F (2.2°C) higher than normal. Air temperatures in October fluctuated dramatically, with much warmer than normal temperatures in the beginning of the month and record low temperatures toward the end (Figure 3). The lowest temperature recorded in October was 13°F (-10.6°C) on the 25th. November was slightly warmer than normal with an average of 37.1°F (2.8°C), which was 1.4°F (0.7°C) greater than normal. December started with normal temperatures but for most of the month was warmer than normal, with an average temperature of 31.8°F (-0.11°C), which was 4.4°F (-2.4°C) greater than the normal average. Seasonal temperature ranged from a high of 102°F (38.9°C) on July 31st to a low of 13°F (-10.6°C) on October 25th (Figure 2). The annual cumulative rainfall total was 15.36 inches (39.0 cm), which was below normal (Figure 2).

Precipitation was above normal during January, May, and October, around normal in December, and was well below normal in February through April, June through September, and in November. The year began with slightly less than normal precipitation in early January which was followed by wetter than normal conditions in mid and late January. Spokane recorded 24 days of measurable precipitation during January, which was the second highest number of days on record for January. A new daily snowfall record occurred on January 10th with 7 inches of snow. Precipitation was

1.38 inches (3.5 cm) above normal in January. February was drier than normal with only 0.89 total inches (2.3 cm), which was 0.44 inches (1.1 cm) below normal. Dry conditions continued in March, with just 0.81 inches (2.1 cm) of precipitation. April precipitation was well below normal with a total of just 0.29 inches (0.74 cm). May was much wetter than normal with a total precipitation of 3.24 inches (8.2 cm), which is 1.62 inches (4.1 cm) above normal. Two daily rainfall records were set during May at the Spokane airport, including 1.40 inches (3.6 cm) on the 20th and 0.81 inches (2.1 cm) on the 31st.

Similar to 2019, drought conditions started in June with only 0.88 inches (2.2 cm) of precipitation; 0.37 inches (0.94 cm) below normal. That was more precipitation than in 2019 (0.44 inches (1.1 cm)). Precipitation during June 2020 was well above the extremely dry June in 2015 which had only 0.07 inches (0.2 cm). Average air temperature in June 2020 was 61.7°F (16.5°C).

Drier than normal conditions continued through July and August 2020 with only 0.05 inches (0.13 cm) for July and only 0.02 inches (0.05 cm) for August. That was much drier than July 2019, which had 0.52 inches (1.3 cm), but similar to July 2018 when only 0.06 inches (0.15 cm) of precipitation was recorded. July is typically a dry month, averaging only 0.64 inches (1.6 cm). August 2020 was the 15th driest on record dating back to 1881. Dry conditions continued into September, which recorded only 0.33 inches (0.84 cm) of precipitation during the month. That contrasts with the much wetter than normal September in 2019, with a total of 1.98 inches (5.0 cm) and was the snowiest September on record in Spokane. Normal average precipitation for September is 0.67 inches (1.7 cm). There was a strong cold front that moved into the region on Labor Day (September 7th) with very high winds. That storm resulted in downed trees and power lines, and occurred with very dry conditions, leading to at least 16 new wildfires and a dust storm across the Columbia Basin. Peak wind gusts during the storm event reached 44 mph at the Spokane Airport and 48 mph in Deer Park.

October 2020 started off dry and mild but finished with above normal precipitation. Precipitation in October was 1.66 inches (4.2 cm), 0.48 inches (1.2 cm) above normal. Snowfall in October was 7.5 inches (19.1 cm), which set a record for the snowiest October on record. On October 23rd there was a heavy snow event that started in the morning and persisted into the evening hours. There were numerous reports of snow accumulations ranging from 5 to 8 inches (12.7 to 20.3 cm) with local amounts up to 10 inches (25.4 cm). A total of 6.9 inches (17.5 cm) was officially recorded at the Spokane International Airport, setting a new daily record.

Precipitation in November was below normal with 1.65 inches (4.2 cm), which was 0.65 inches (1.7 cm) below normal. Snowfall in November however was well above normal with a total of 9.5 inches (24.1 cm). December had normal precipitation with a total of 2.37 inches (6.0 cm). Snowfall for the month of December was above normal with a total of 17.8 inches (45.2 cm) which was just over 3 inches (7.62 cm) above normal for the month.

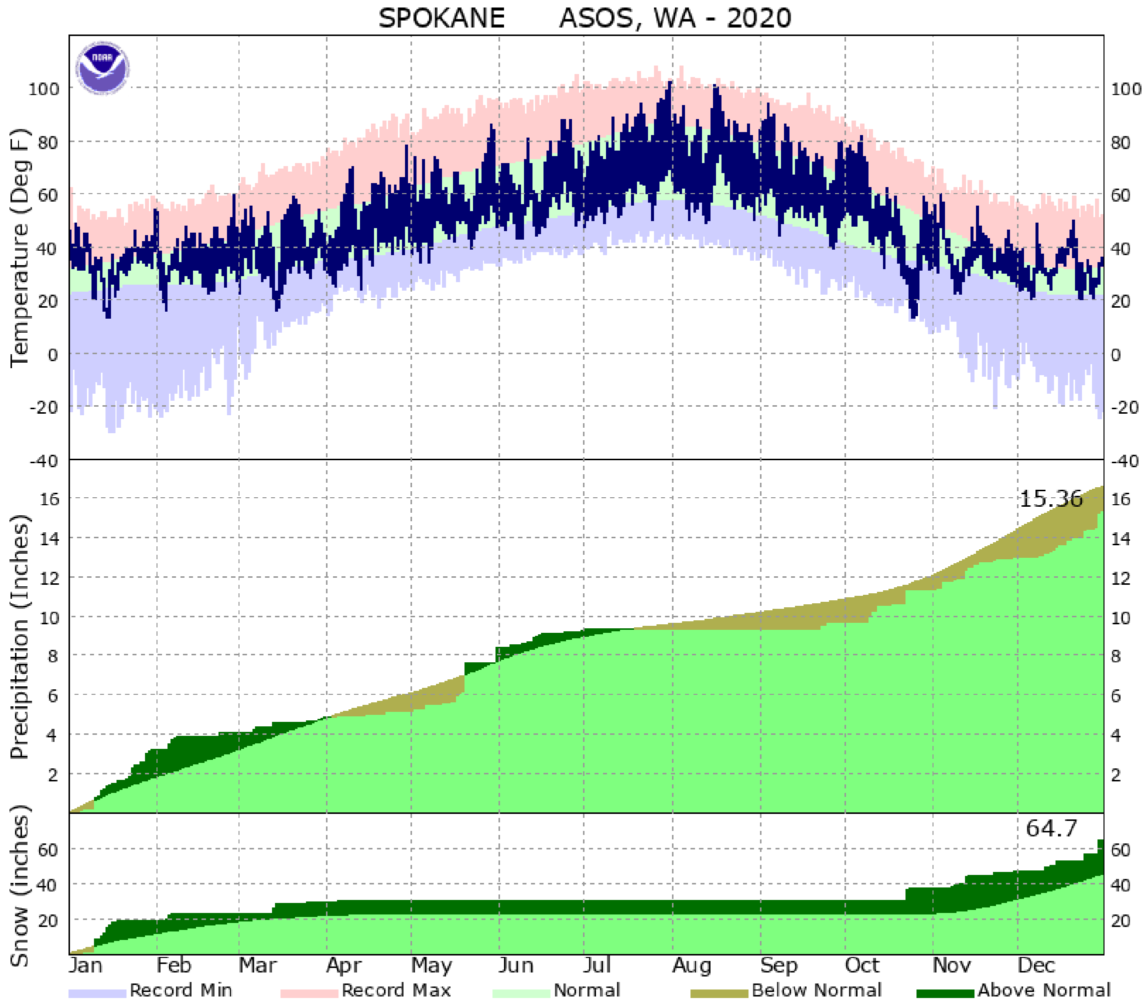


**Figure 2. Air Temperature and Precipitation at Spokane International Airport for 2020**

## 3.2 Hydrologic Conditions

Figures 3 and 4 show inflows and outflows, respectively, during 2020. Inflows include all incoming water as calculated by Avista using midnight to midnight reservoir elevation and daily average outflow as recorded at midnight at Long Lake Dam. Inflows and outflows to/from Lake Spokane are usually very similar, with only slight differences between inflow and outflow during annual drawdown in the early part of the year. Annual drawdown started in mid-January 2020, however, flows increased, and the reservoir was full again in the early part of February. Flows were low enough that a drawdown could be started again in late February. Temperatures and flow were low enough allowing Avista to hold the reservoir level down until early April.

Figures 4 and 5 show the difference between inflows and outflows in the early part of 2020. Maximum inflows typically occur during March, April, and May due to spring runoff. However, the magnitude and timing of peak inflows have varied greatly over the past ten years, compared to those in 2001, which was the 7Q10 for the DO TMDL (Figure 5). Peak flows in 2020 were less than 2019 and most similar to those in 2013 and 2015 (Figure 5). Peak flow in 2020 occurred in May, with another smaller peak occurring in early February, similar to the pattern in 2018 (Figure 5). In all, peak inflows have averaged 58% more than in 2001, the TMDL model year. Inflow volume determines reservoir water residence time, which to a large extent determines water quality.

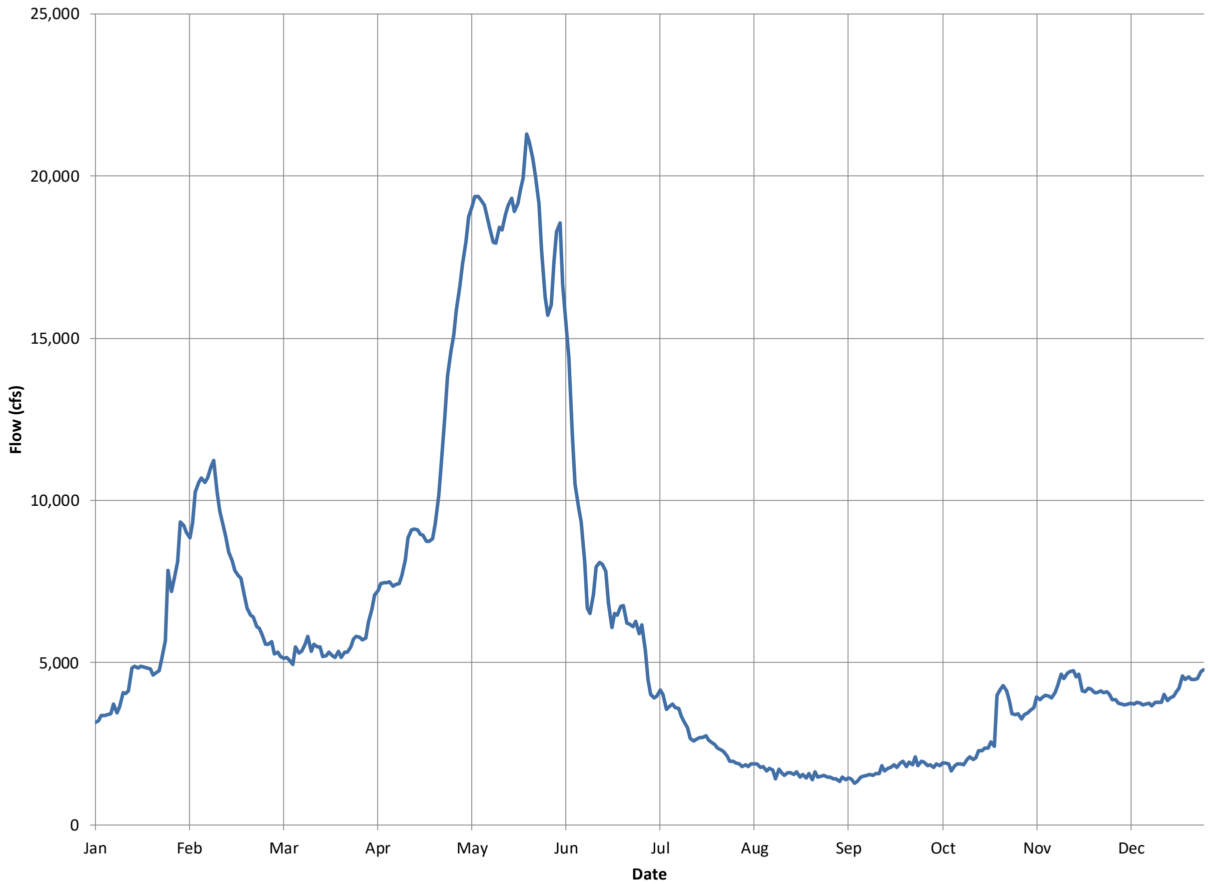


**Figure 3. Total Inflow into Lake Spokane, 2020**
**(Inflows calculated based on midnight to midnight reservoir elevation and day average outflow at midnight as recorded at Long Lake Dam)**

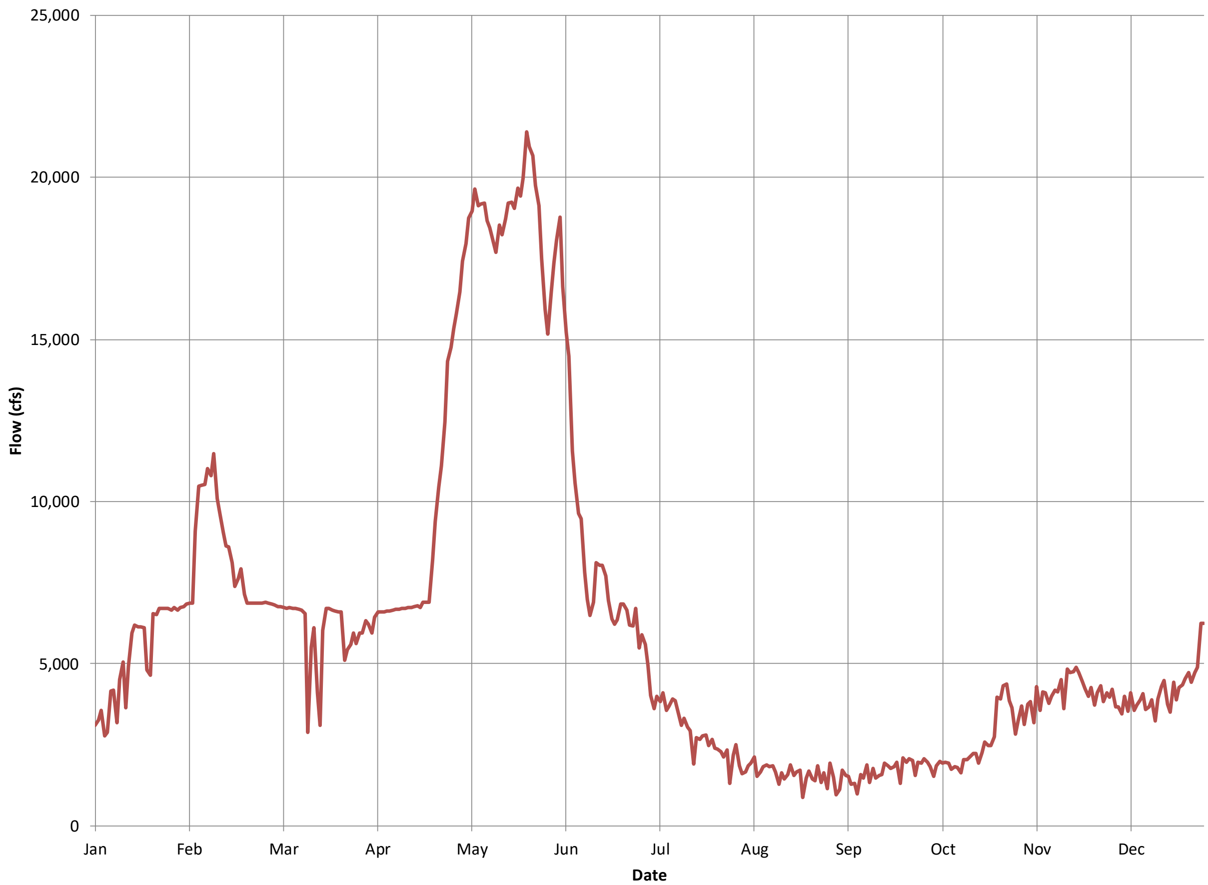


**Figure 4. Total Outflow from Lake Spokane, 2020**
**(Outflows as reported at Long Lake Dam at midnight daily)**

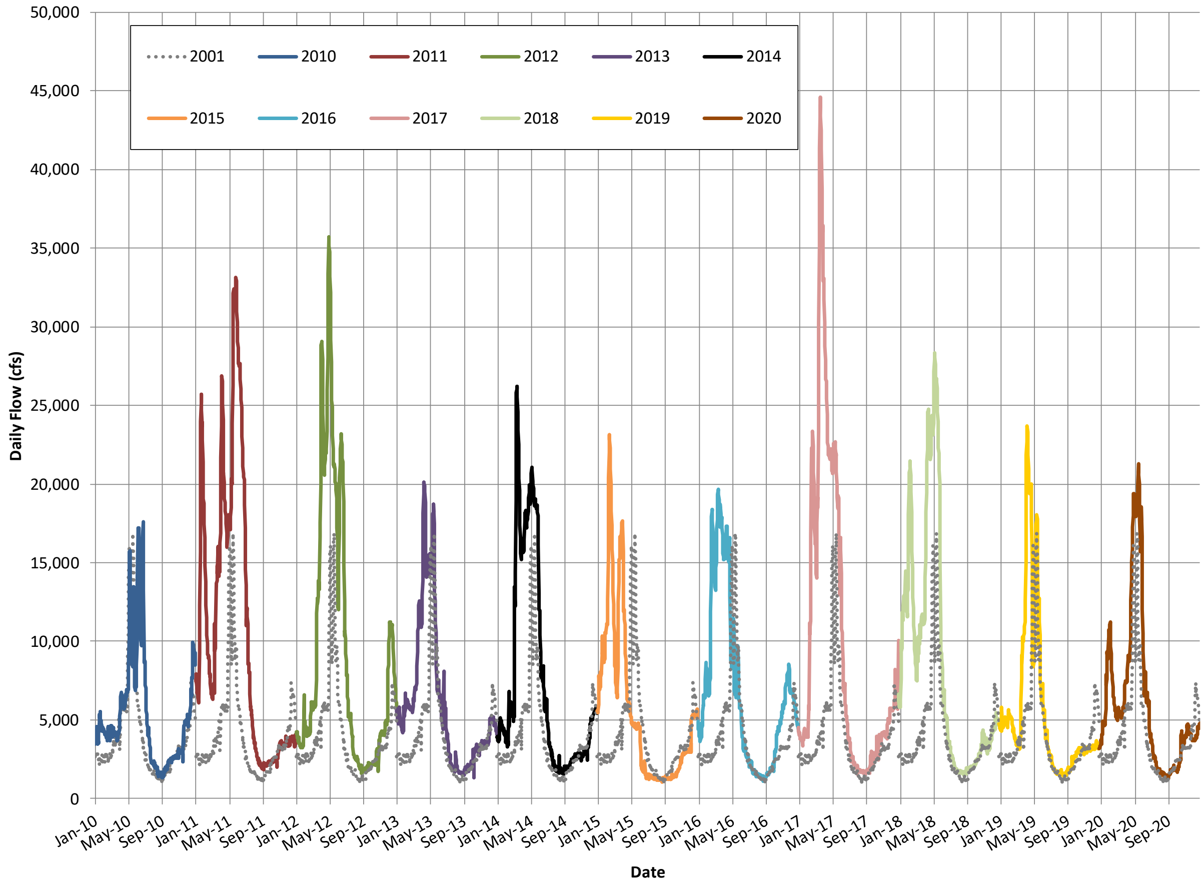


**Figure 5. Total Inflows into Lake Spokane 2010-2020**
**(Inflows calculated based on midnight to midnight reservoir elevation and day average outflow at midnight as recorded at Long Lake Dam)**

Flows in the Spokane River and the Little Spokane River ranged from near average to above average during January and February and decreased sharply in both rivers in mid-February to early March (Figures 6 and 7). Peak flow in the Spokane River occurred in late May, as is the case historically (Figure 6). Peak flow in the Spokane River was near the historical median but less than the 90th percentile peak, reaching 19,600 cfs in 2020 – slightly less than 21,100 cfs observed in 2019 and 27,800 cfs observed in 2018. The peak of 42,900 cfs in 2017 was the 4th largest since record keeping began in 1891.

Flows from May through September 2020 were slightly below the historical median (Figure 6). The peak flow in the Little Spokane River of 1,200 cfs in 2020 was slightly higher than the historical median and occurred much earlier (early February versus March and April) than normal (Figure 7). Flows in the Little Spokane River dropped below the historical median following the peak in early February through April. Flows increased in May and were above or near the historical median the remainder of the year. High flows in May approached the historical 90th percentile (Figure 7).

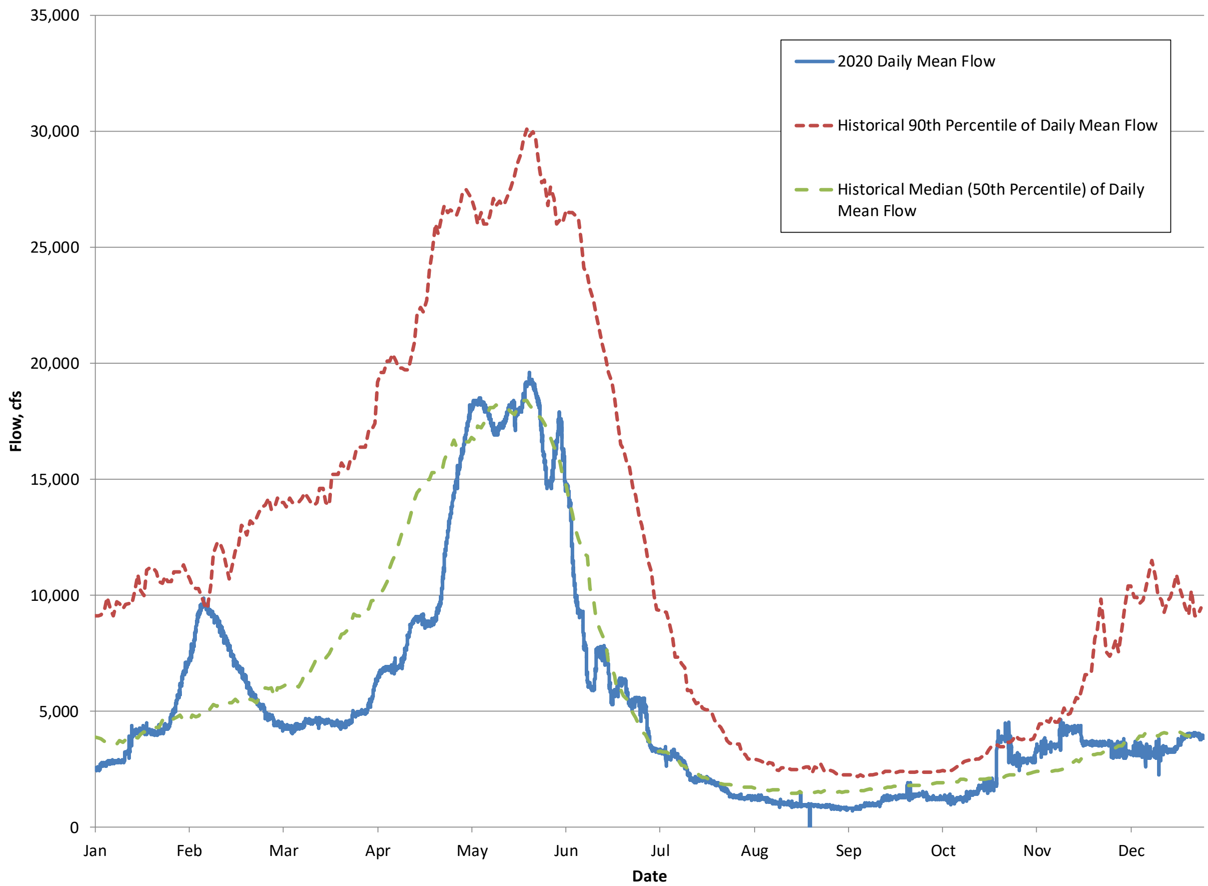


**Figure 6. Spokane River at Spokane (USGS Gage # 12422500) Daily mean flow, 2020 compared to Historical Daily Mean Flow**

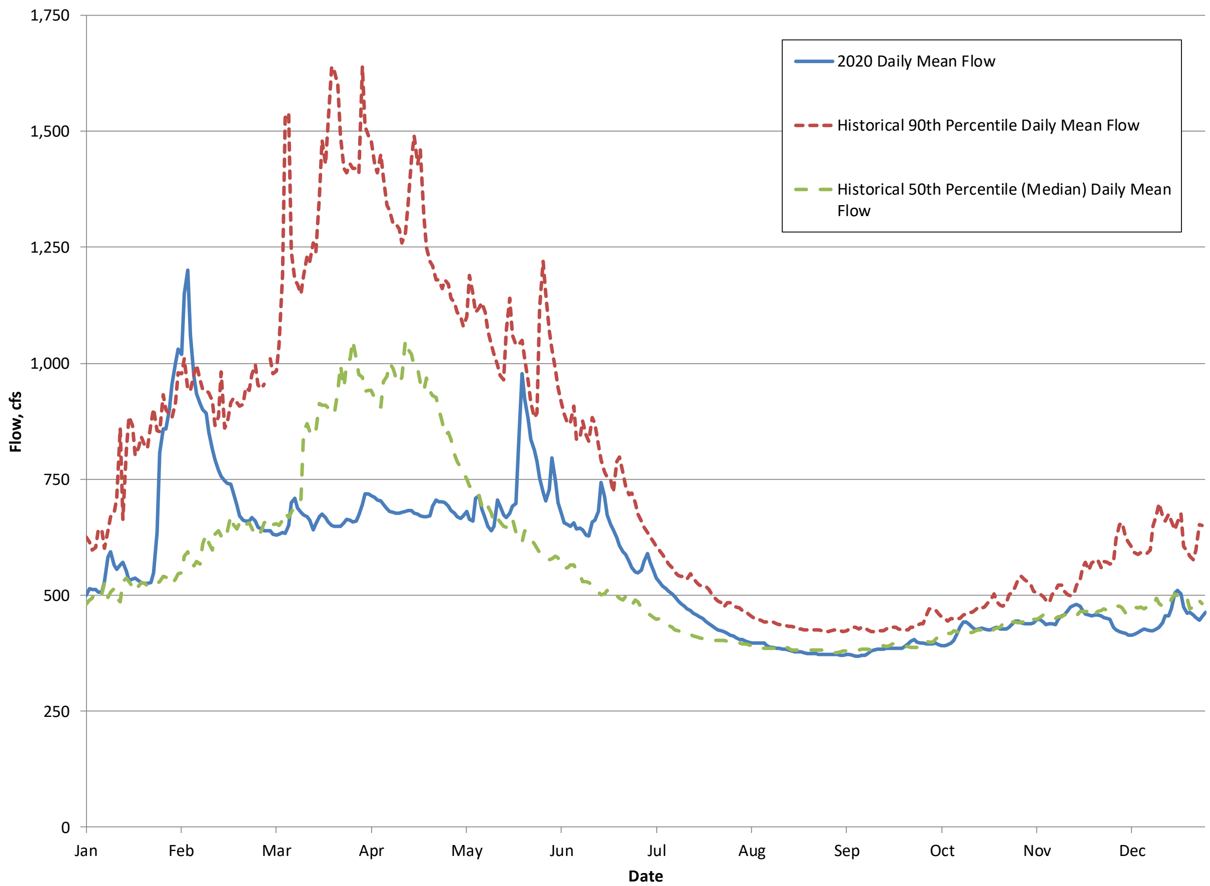


**Figure 7. Little Spokane River near Dartford (USGS Gage # 12431500) Daily mean flow, 2020 compared to Historical Daily Mean Flow**

Whole reservoir water residence time can markedly affect reservoir water quality. Long residence times tend to allow for more settling of particulate matter, including phosphorus in algae and particulate matter, producing greater transparency. Relatively short residence times, on the order of 10 days or less, may limit algal biomass accumulation.

Whole reservoir water residence time during June through October 2020, was about 32 days, similar to those observed in 2014 and 2017, but much lower than the above-normal residence times in 2015 (Table 2). Including the highest two years (2015 and 2016), whole reservoir residence time averaged 34.4 days for the past eleven years. Whole reservoir residence time was calculated based on reservoir volume and mean June through October discharge from Long Lake Dam. Outflow, rather than inflow, is normally used to calculate effective residence time after evaporation (Welch and Jacoby, 2004).

Residence times in the transition and riverine zones were calculated based on total volume of these two zones and the mean June through October discharge from Long Lake Dam, under the assumption that water is not retained in these zones due to their shallower depth. Residence times in the transition and riverine zones averaged 4.7 days in 2010 – 2014 but were much higher in

2015 at 13.2 days and 8.1 days in 2016 (Table 2). Residence time in the transition and riverine zones in 2020 was 6.0 days, lower than that in the past 4 of the previous 5 years and slightly lower than the eleven-year average (6.5 days).

Per Ecology's 2015 request[1], inflows and water residence times during 2010 - 2020, were separated into the seasonal timeframes consistent with the DO TMDL (Table 3). Each seasonal mean outflow was used to calculate respective residence times. The whole reservoir residence time was 53.5 days in 2020 during the DO TMDL seasonal timeframe of July through September. That was much less than in 2015 (84.8 days) but higher than 2010 – 2014 average (41.2 days).

[1] Ecology comment letter dated March 12, 2012, incorporated as Appendix F of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2014 Annual Summary Report (May 19, 2015)

**Table 2. Inflows and water residence times in Lake Spokane during 2001 and 2010-2020. Residence times are for June through October.**

| Year | Total Annual Flow Volume (cf x10^6) | Annual Mean Daily Flow (cfs) | Mean Daily Summer (June-October) Flow (cfs) | Residence Time[1] Whole Reservoir (days) | Residence Time[1] Transition/Riverine Zones (days) |
|---|---|---|---|---|---|
| 2001 | 125,782 | 3,989 | 2,413 | 46.3 | 8.7 |
| 2010 | 167,113 | 5,299 | 4,671 | 23.9 | 4.5 |
| 2011 | 337,576 | 10,704 | 7,828 | 14.4 | 2.7 |
| 2012 | 293,971 | 9,296 | 5,768 | 19.4 | 3.6 |
| 2013 | 189,846 | 6,020 | 3,035 | 36.8 | 6.9 |
| 2014 | 234,999 | 7,452 | 3,581 | 31.3 | 5.9 |
| 2015 | 171,137 | 5,427 | 1,595 | 70.1 | 13.2 |
| 2016 | 216,855 | 6,858 | 2,523 | 43.3 | 8.1 |
| 2017 | 317,811 | 10,078 | 3,697 | 30.2 | 5.7 |
| 2018 | 270,253 | 8,570 | 3,089 | 36.3 | 6.8 |
| 2019 | 173,136 | 5,490 | 2,762 | 40.4 | 7.6 |
| 2020 | 191,249 | 6,062 | 3,510 | 31.9 | 6.0 |

[1]residence time = reservoir volume/outflow

**Table 3. Daily flows and water residence times in Lake Spokane during 2001 and 2010-2018, using DO TDML seasonal timeframes.**

| Year | Mean Daily Summer Flow (cfs) | | | | Residence Time[1] Whole Reservoir (days) | | | | Residence Time[1] Transition/Riverine Zones (days) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | June | July – Sept. | Oct. | May | June | July – Sept. | Oct. | May | June | July– Sept. | Oct. |
| 2001 | 11,872 | 4,560 | 1,637 | 2,635 | 10.1 | 24.5 | 68.6 | 42.1 | 1.9 | 4.6 | 12.9 | 7.9 |
| 2010 | 10,036 | 13,297 | 2,550 | 2,620 | 11.2 | 8.4 | 43.8 | 42.7 | 2.1 | 1.6 | 8.2 | 8.0 |
| 2011 | 25,596 | 24,323 | 4,232 | 2,538 | 4.3 | 4.6 | 26.5 | 44.1 | 0.8 | 0.9 | 5.0 | 8.3 |
| 2012 | 23,667 | 17,333 | 3,092 | 2,520 | 4.8 | 6.5 | 36.1 | 44.4 | 0.9 | 1.2 | 6.8 | 8.3 |
| 2013 | 9,037 | 5,956 | 2,133 | 2,884 | 8.5 | 18.7 | 52.5 | 38.8 | 1.6 | 3.5 | 9.8 | 7.3 |
| 2014 | 19,127 | 8,243 | 2,373 | 2,657 | 5.9 | 13.6 | 47.2 | 41.9 | 1.1 | 2.6 | 8.9 | 7.9 |
| 2015 | 4,724 | 2,360 | 1,317 | 1,678 | 23.8 | 47.5 | 84.8 | 66.6 | 4.5 | 8.9 | 15.9 | 12.5 |
| 2016 | 8,101 | 3,865 | 1,677 | 3,735 | 13.8 | 28.8 | 66.8 | 27.7 | 2.6 | 5.4 | 12.5 | 5.2 |
| 2017 | 20,395 | 8,737 | 2,212 | 3,229 | 5.5 | 12.8 | 50.7 | 34.5 | 1.0 | 2.4 | 9.5 | 6.5 |
| 2018 | 24,568 | 6,711 | 2,056 | 2,647 | 4.6 | 16.8 | 54.3 | 42.2 | 0.9 | 3.1 | 10.2 | 7.9 |
| 2019 | 12,485 | 5,155 | 1,919 | 2,976 | 9.0 | 21.7 | 58.3 | 37.6 | 1.7 | 4.1 | 10.9 | 7.1 |
| 2020 | 18,693 | 8,896 | 2,093 | 2,494 | 6.0 | 12.6 | 53.5 | 44.9 | 1.1 | 2.4 | 10.0 | 8.4 |

[1]residence time = reservoir volume/outflow

### 3.3 Algal Bloom Occurrence

Cyanobacteria (blue-green algae) blooms were minimal in Lake Spokane during the summer of 2020. According to Mr. Galen Buterbaugh, retired US Fish and Wildlife Service Fishery Biologist who serves as the Lake Spokane Association Technical Advisor, cyanobacteria occurrence was very limited and there were only a few minor blooms in small areas. These minor blooms disappeared within 24 hours. Mr. Buterbaugh indicated cyanobacteria were observed in plankton net tows during the summer months but that a widespread bloom was never observed. A cyanobacteria bloom in the Suncrest Park area was reported on the Suncrest Park Association Facebook page on September 17 and 21. Caution signs were posted at the Suncrest boat launch and beach areas warning lake users that a cyanobacteria bloom could be present in the lake and to avoid contact with the water if a bloom is visible. According to the Washington State Toxic Algae website no samples were collected in Lake Spokane during the summer of 2020 for cyanotoxin analysis.

### 3.4 Continuous Temperature and Dissolved Oxygen Monitoring

***Temperature***

Water temperature was highest in July and August at all three sites with maximums around 26°C (Tables 4, 5, and 6). There was little difference with depth, for either maximum or minimum temperature indicating that the epilimnion, which usually extends to about 5 m in the deeper portions of the reservoir, was mostly well mixed except for short periods. Maximum daily fluctuations were greatest in June at both sites DAILY A and DAILY B and ranged from 3 to 4.6°C (Tables 8 and 10). Maximum daily fluctuations were greatest in July at site DAILY C and were around 3°C (Table 12). Mean daily fluctuations diminished through the summer at all sites (Tables 7, 9, and 11). Mean daily fluctuations were on the order of 1 - 2°C at all sites with maximums of 2 - 4°C (Tables 7, 9 and 11).

The highest temperature consistently occurred near the surface (0.6 m) causing temporary density stratification that would last for several days at sites DAILY A and DAILY B (Figures A1-A5 and A16-A20). Temporary stratification consistently occurred at a depth of 2.7 m at site DAILY C and occasionally between depths of 0.6 and 1.5 m (Figures A31-A35).

***Dissolved Oxygen***

Daily minimum DOs rarely dropped below 8 mg/L and were usually near or well over 100% saturated (Tables 4-6). Daily maximum DOs were usually supersaturated at all sites and depths, but rarely in excess of 150%. The highest DOs and percent saturations at site DAILY A were in June and possibly correlate to the previously identified spring diatom bloom (Table 4; Tetra Tech 2018). Maximum DO and percent saturation occurred later in the summer at site DAILY B, and later still at site DAILY C (Tables 5 and 6). The later higher maximum DOs and supersaturation at site DAILY C were probably due to slightly longer water residence times at that site exceeding 10 days in August and September which may have allowed for the accumulation of algal biomass. Depths of the continuous loggers were well within the photic zone at each site and even within the secchi depth, which averaged 4 – 5 m at sites DAILY A and DAILY B and 3.6 m at site DAILY

C, during June and July. Secchi depths typically represent 10-15% of surface light intensity and photic zone depths extend to 1% surface intensity (Welch and Jacoby, 2004). Transparencies also exceeded 4 m in September at all sites. Thus, differences in maximum DOs and percent saturations were likely not due to light limitations.

Diurnal fluctuation in DO varied in magnitude and timing among sites. Maximum and mean daily fluctuation occurred in June at site DAILY A and later in July and August at sites DAILY B and DAILY C (Tables 7-12). Average summer DOs were 9.4 and 9.6 mg/L at site DAILY A and 9.6 and 9.8 mg/L at site DAILY B at the same approximate depths (0.6 and 4 m) in 2020.

**Table 4. Monthly minimum and maximum temperature and DO at DAILY A, 2020.**

**Daily A Monthly Min and Max Temperature (deg C)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 15.4 | 22.8 | 14.8 | 22.4 | 14.8 | 21.8 |
| July | 19.0 | 25.8 | 18.6 | 25.3 | 18.6 | 25.3 |
| August | 21.1 | 26.4 | 21.1 | 24.7 | 20.7 | 24.7 |
| September | 17.1 | 23.0 | 17.0 | 21.9 | 17.1 | 21.8 |

**Daily A Monthly Min and Max Dissolved Oxygen (mg/L)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 9.2 | 12.9 | 8.3 | 13.3 | 8.3 | 13.8 |
| July | 8.1 | 10.3 | 7.8 | 10.9 | 7.9 | 11.4 |
| August | 8.6 | 10.6 | 8.7 | 10.9 | 8.9 | 11.8 |
| September | 7.6 | 9.9 | 7.4 | 10.2 | 7.5 | 10.4 |

**Daily A Monthly Min and Max Dissolved Oxygen (mg/L, %)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 9.2 (109%) | 12.9 (152%) | 8.3 (98.3%) | 13.3 (146%) | 8.3 (96.3%) | 13.8 (151%) |
| July | 8.1 (94.5%) | 10.3 (121%) | 7.8 (90.9%) | 10.9 (130%) | 7.9 (90.8%) | 11.4 (135%) |
| August | 8.6 (112%) | 10.6 (130%) | 8.7 (110%) | 10.9 (136%) | 8.9 (112%) | 11.8 (144%) |
| September | 7.6 (87.3%) | 9.9 (122%) | 7.4 (81.8%) | 10.2 (123%) | 7.5 (82.5%) | 10.4 (124%) |

**Table 5. Monthly minimum and maximum temperature and DO at DAILY B, 2020.**

**Daily B Monthly Min and Max Temperature (deg C)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 15.6 | 24.6 | 14.9 | 23.5 | 13.8 | 22.6 |
| July | 19.6 | 26.2 | 19.6 | 25.1 | 18.7 | 24.4 |
| August | 21.3 | 26.3 | 21.4 | 25.2 | 21.3 | 24.9 |
| September | 17.3 | 23.3 | 17.3 | 22.5 | 17.4 | 22.3 |

**Daily B Monthly Min and Max Dissolved Oxygen (mg/L)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 8.4 | 12.2 | 8.8 | 12.0 | 8.4 | 12.3 |
| July | 7.9 | 10.1 | 8.4 | 12.2 | 8.0 | 12.5 |
| August | 8.9 | 11.2 | 8.1 | 11.9 | 7.6 | 13.0 |
| September | 7.9 | 11.5 | 8.0 | 11.9 | 7.2 | 11.9 |

**Daily B Monthly Min and Max Dissolved Oxygen (mg/L, %)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 8.4 (99.9%) | 12.2 (131%) | 8.8 (106%) | 12.0 (136%) | 8.4 (96.3%) | 12.3 (131%) |
| July | 7.9 (93.8%) | 10.1 (124%) | 8.4 (100%) | 12.2 (150%) | 8.0(96.5%) | 12.5 (153%) |
| August | 8.9 (114%) | 11.2 (139%) | 8.1 (100%) | 11.9 (150%) | 7.6 (91.7%) | 13.0 (160%) |
| September | 7.9 (89.3%) | 11.5 (137%) | 8.0 (92.1%) | 11.9 (146%) | 7.2 (81.9%) | 11.9 (145%) |

**Table 6. Monthly minimum and maximum temperature and DO at DAILY C, 2020.**

**Daily C Monthly Min and Max Temperature (deg C)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 13.5 | 20.1 | 13.5 | 19.9 | 13.3 | 19.6 |
| July | 15.8 | 26.5 | 15.7 | 26.3 | 15.7 | 24.7 |
| August | 21.3 | 26.1 | 21.3 | 26.0 | 20.9 | 25.0 |
| September | 16.1 | 23.2 | 16.1 | 22.8 | 14.4 | 22.1 |

**Daily C Monthly Min and Max Dissolved Oxygen (mg/L)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 9.1 | 10.9 | 9.1 | 11.1 | 8.9 | 10.8 |
| July | 8.4 | 10.6 | 8.5 | 11.1 | 8.0 | 12.4 |
| August | 8.9 | 11.8 | 8.5 | 12.2 | 9.0 | 13.3 |
| September | 8.3 | 12.9 | 8.3 | 12.4 | 7.7 | 13.1 |

**Daily C Monthly Min and Max Dissolved Oxygen (mg/L, %)**

| Month | 0.6 m | | 2.4 m | | 4.0 m | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| June | 9.1 (102%) | 10.9 (117%) | 9.1 (101%) | 11.1 (119%) | 8.9 (99%) | 10.8 (110%) |
| July | 8.4 (104%) | 10.6 (119%) | 8.5 (104%) | 11.1 (128%) | 8.0 (97.1%) | 12.4 (140%) |
| August | 8.9 (115%) | 11.8 (145%) | 8.5 (105%) | 12.2 (150%) | 9.0 (110%) | 13.3 (165%) |
| September | 8.3 (93.4%) | 12.9 (159%) | 8.3 (93%) | 12.4 (152%) | 7.7 (86.4%) | 13.1 (153%) |

**Table 7. Mean daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY A, downstream of LL1.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 2.4 m | 4.0 m | 0.6 m | 2.4 m | 4.0 m |
| June | 1.4 | 1.9 | 2.0 | 1.3 | 1.5 | 1.6 |
| July | 1.3 | 1.2 | 1.2 | 0.7 | 1.1 | 1.1 |
| August | 1.0 | 0.8 | 1.0 | 0.6 | 0.6 | 0.8 |
| September | 0.8 | 0.5 | 0.4 | 0.6 | 0.6 | 0.6 |

**Table 8. Maximum daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY A, downstream of LL1.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 2.4 m | 4.0 m | 0.6 m | 2.4 m | 4.0 m |
| June | 3.1 | 4.6 | 3.5 | 3.7 | 3.5 | 3.0 |
| July | 2.5 | 2.3 | 2.5 | 1.5 | 2.5 | 2.4 |
| August | 2.7 | 1.7 | 2.3 | 1.1 | 1.4 | 2.0 |
| September | 1.8 | 1.7 | 1.7 | 1.6 | 1.6 | 1.9 |

**Table 9. Mean daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY B, in TumTum Bay, upstream from LL2.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 2.4 m | 4.0 m | 0.6 m | 2.4 m | 4.0 m |
| June | 1.8 | 1.8 | 1.6 | 0.9 | 1.3 | 1.3 |
| July | 1.4 | 0.9 | 1.1 | 0.8 | 1.1 | 1.5 |
| August | 1.1 | 0.6 | 0.9 | 0.7 | 1.5 | 2.1 |
| September | 1.0 | 0.5 | 0.4 | 1.0 | 1.1 | 1.6 |

**Table 10. Maximum daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY B, in TumTum Bay, upstream from LL2.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 2.4 m | 4.0 m | 0.6 m | 2.4 m | 4.0 m |
| June | 3.1 | 4.2 | 4.1 | 1.4 | 2.6 | 1.8 |
| July | 2.1 | 1.9 | 2.4 | 2.1 | 2.5 | 3.6 |
| August | 2.0 | 1.0 | 2.2 | 1.2 | 3.5 | 4.9 |
| September | 3.0 | 3.0 | 3.0 | 2.3 | 2.4 | 4.2 |

**Table 11. Mean daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY C, near Suncrest Park and LL4.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 1.5 m | 2.7 m | 0.6 m | 1.5 m | 2.7 m |
| June | 1.4 | 1.0 | 0.8 | 0.6 | 0.6 | 0.5 |
| July | 1.7 | 1.4 | 1.3 | 0.7 | 1.0 | 1.1 |
| August | 1.1 | 0.9 | 1.0 | 1.1 | 1.4 | 1.7 |
| September | 1.0 | 0.7 | 0.9 | 1.1 | 1.1 | 1.8 |

**Table 12. Maximum daily temperature and DO concentration fluctuations measured at continuous monitoring station DAILY C, near Suncrest Park and LL4.**

| Month | Temperature (deg C) | | | Dissolved Oxygen (mg/L) | | |
|---|---|---|---|---|---|---|
| | 0.6 m | 1.5 m | 2.7 m | 0.6 m | 1.5 m | 2.7 m |
| June | 2.5 | 1.7 | 1.4 | 0.8 | 1.0 | 0.8 |
| July | 3.3 | 3.0 | 2.9 | 1.5 | 2.1 | 3.1 |
| August | 1.9 | 1.6 | 1.9 | 2.4 | 3.0 | 2.9 |
| September | 1.8 | 1.5 | 2.7 | 2.3 | 2.4 | 3.5 |

## 3.5 Summary

Below is a summary of key findings from the 2020 continuous temperature and DO monitoring in lake Spokane:

- Continuous monitoring of DO and temperature at three depths and three sites showed daily fluctuations but DO was usually above 8 mg/L and near 100% saturation at all three depths.
- Continuous logger depths were well above the lighted zone and usually above the depth of measured transparency.
- Maximum temperature occurred in July and August at around 26 °C with little variation with depth, with the highest temperatures at the surface (0.6 m).
- Daily mean temperature fluctuations were about 1-2°C and maximum fluctuations around 2-4°C, diminishing through the summer.
- Maximum and mean DO fluctuations occurred in June at site DAILY A and later in the summer at the up-reservoir sites.
- Highest DOs and saturation (13 mg/L and 150%) occurred at deeper depths (2.4 and 4.0 m).
- Average summer DOs near the surface and at 4 m were between 9.4 and 9.8 mg/L in 2020 at sites DAILY A and DAILY B.

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# APPENDIX A – CONTINUOUS TEMPERATURE AND DISSOLVED OXYGEN FIGURES

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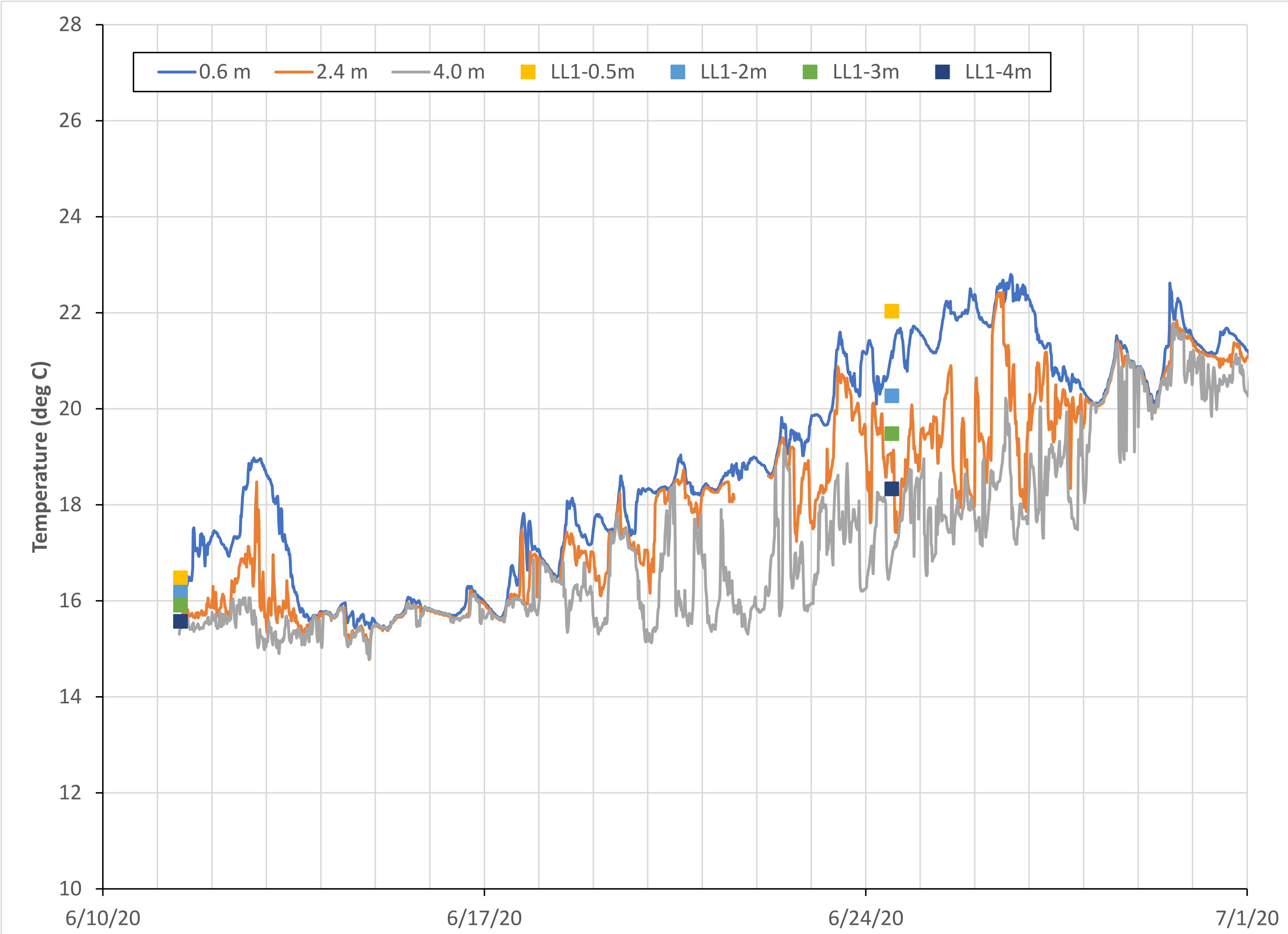


**Figure A1.** Continuous temperature (lines) at station DAILY A and regular profile sampling at LL1 (squares) during June 2020.

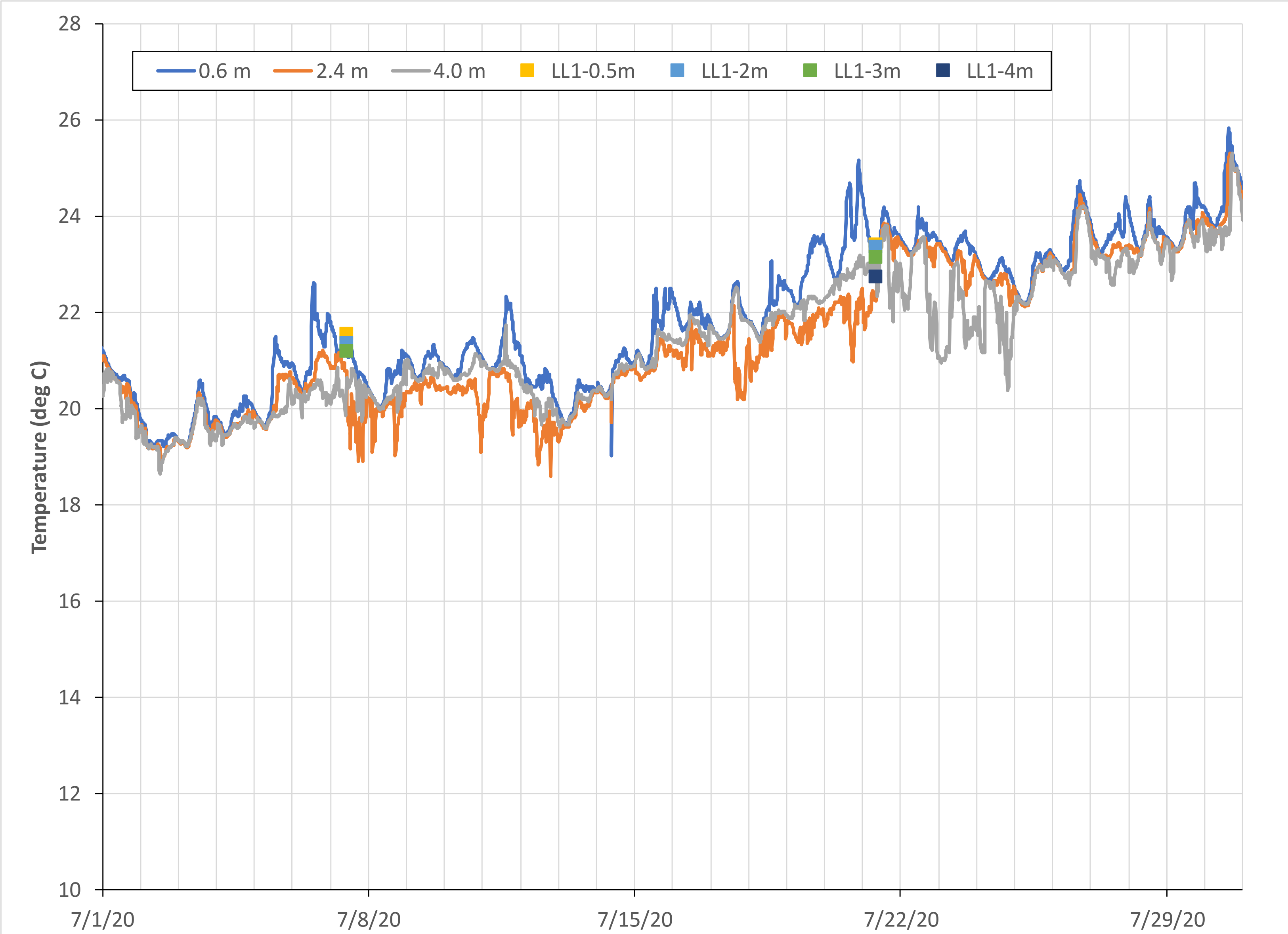


**Figure A2.** Continuous temperature (lines) at station DAILY A and regular profile sampling at LL1 (squares) during July 2020.

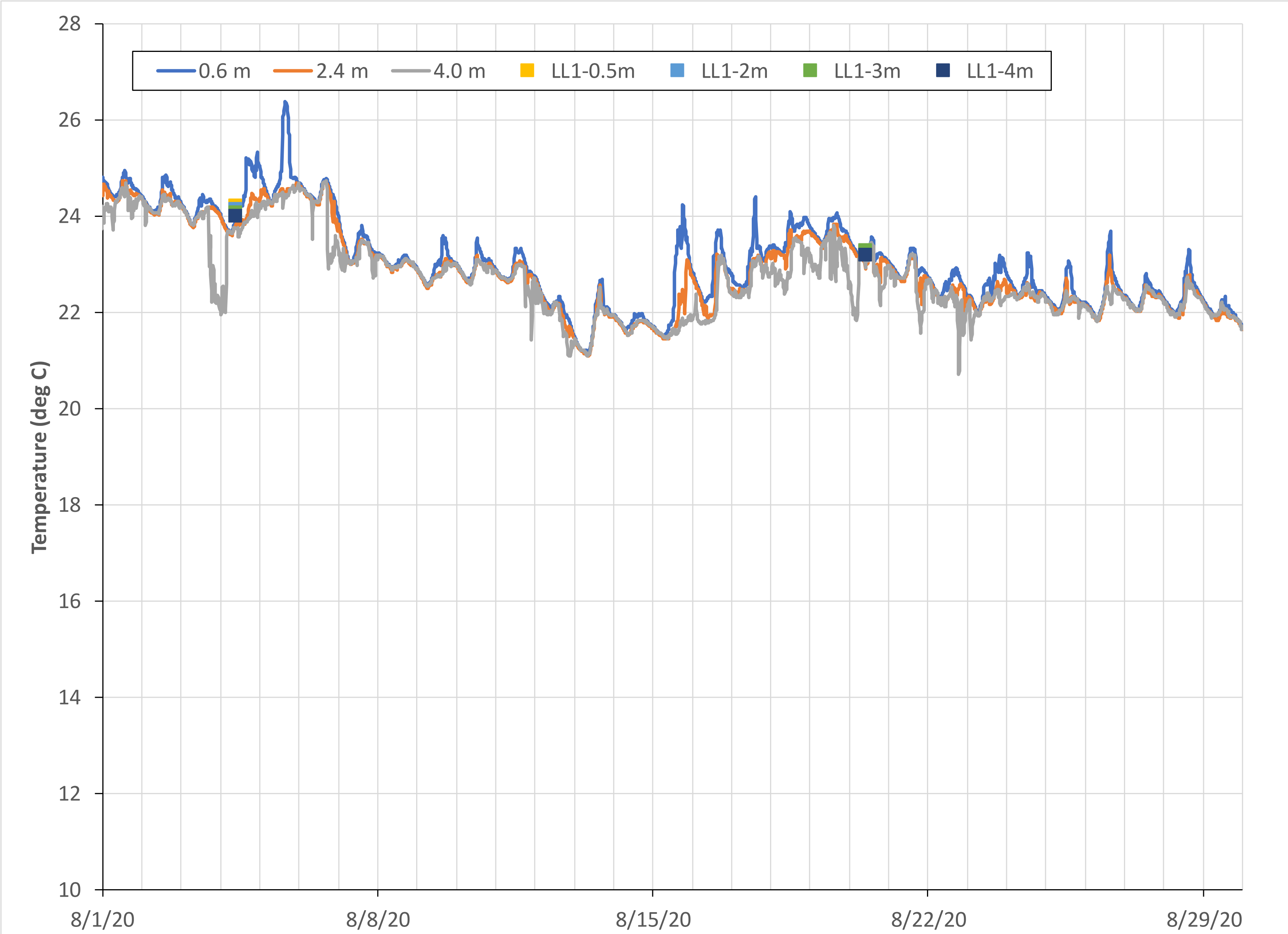


**Figure A3.** Continuous temperature (lines) at station DAILY A and regular profile sampling at LL1 (squares) during August 2020.

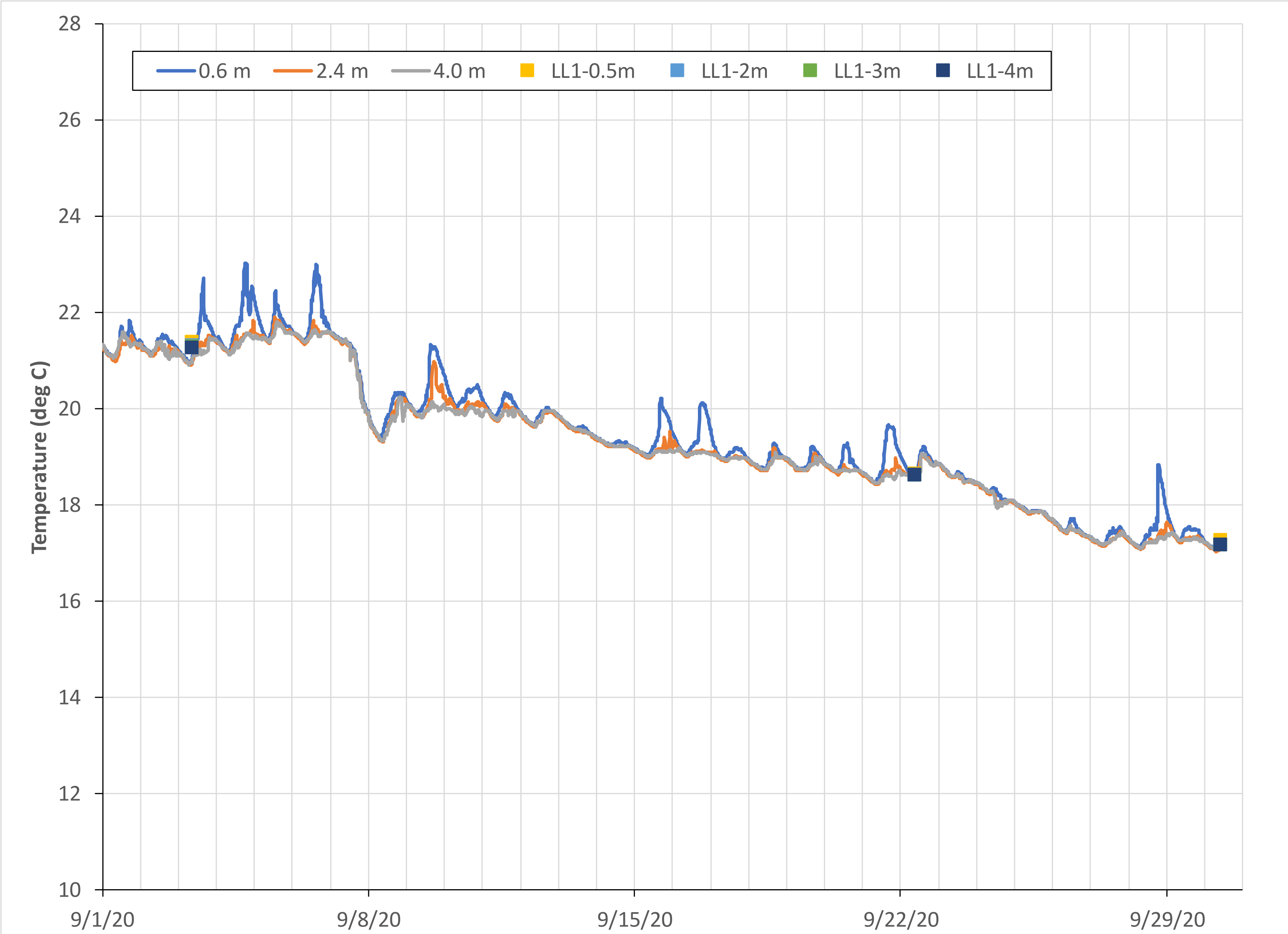


**Figure A4.** Continuous temperature (lines) at station DAILY A and regular profile sampling at LL1 (squares) during September 2020.

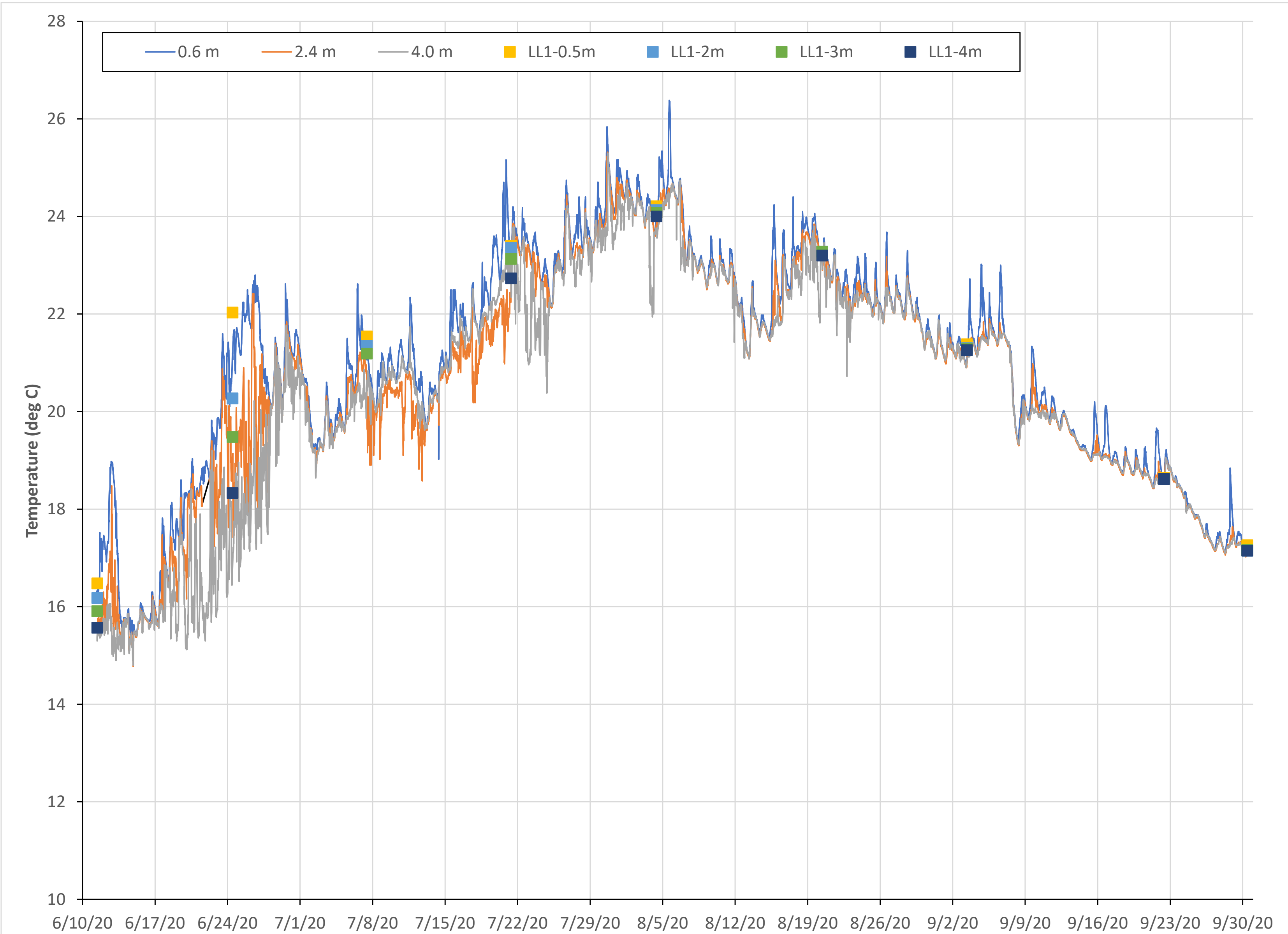


**Figure A5.** Continuous temperature (lines) at station DAILY A and regular profile sampling at LL1 (squares) during June – September 2020.

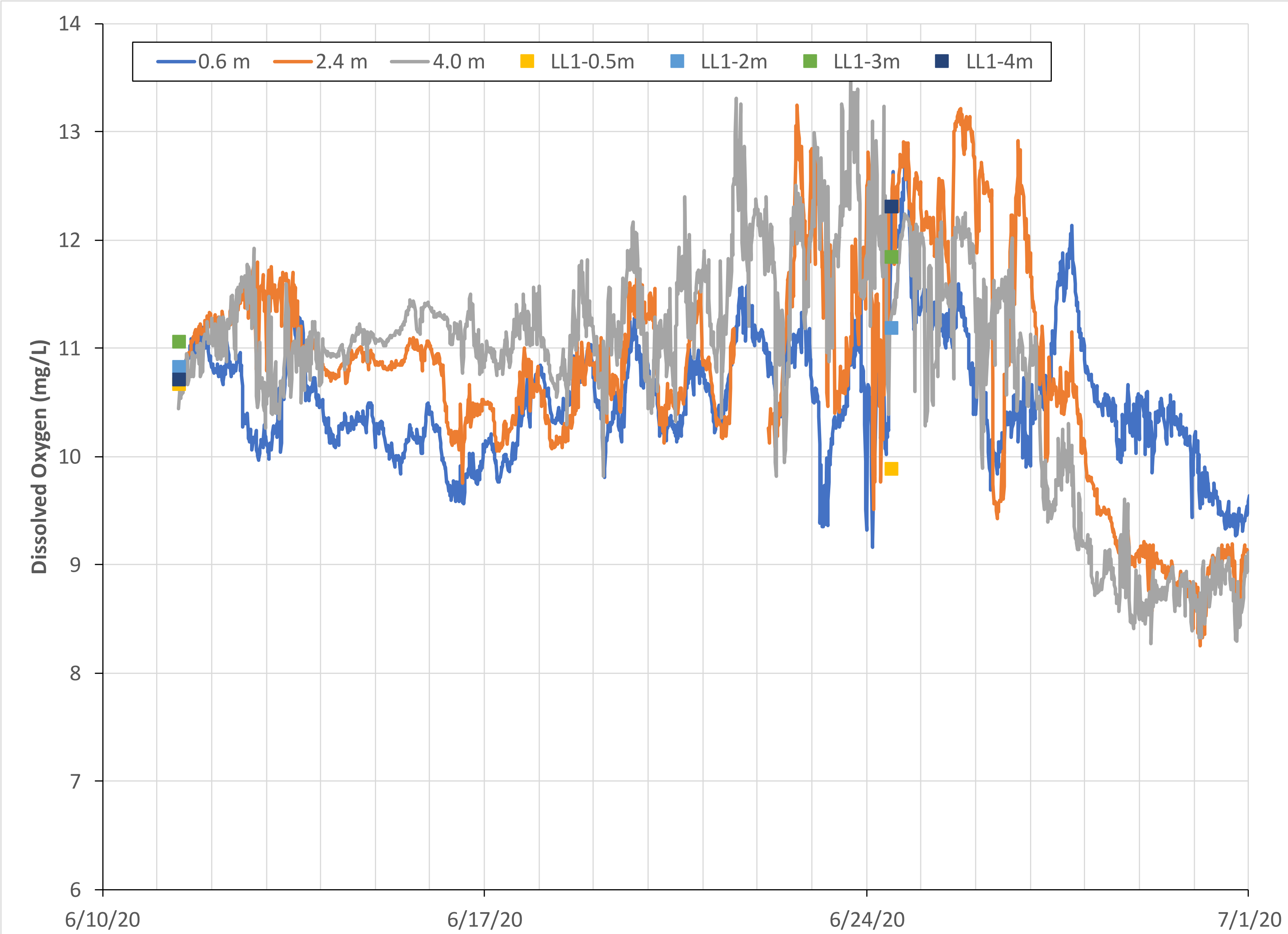


**Figure A6.** Continuous DO (lines) at station DAILY A and regular profile sampling at LL1 (squares) during June 2020.

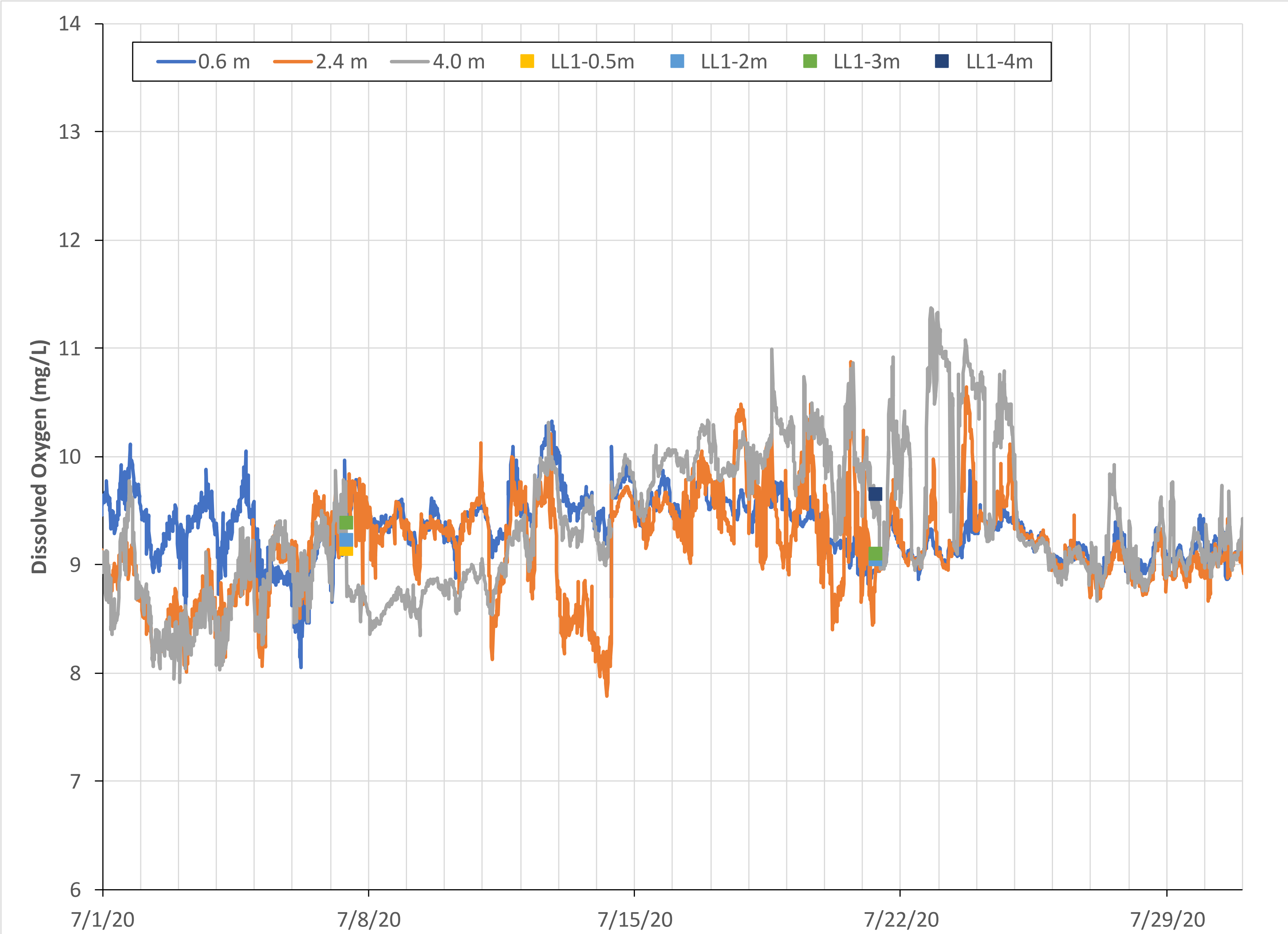


**Figure A7.** Continuous DO (lines) at station DAILY A and regular profile sampling at LL1 (squares) during July 2020.

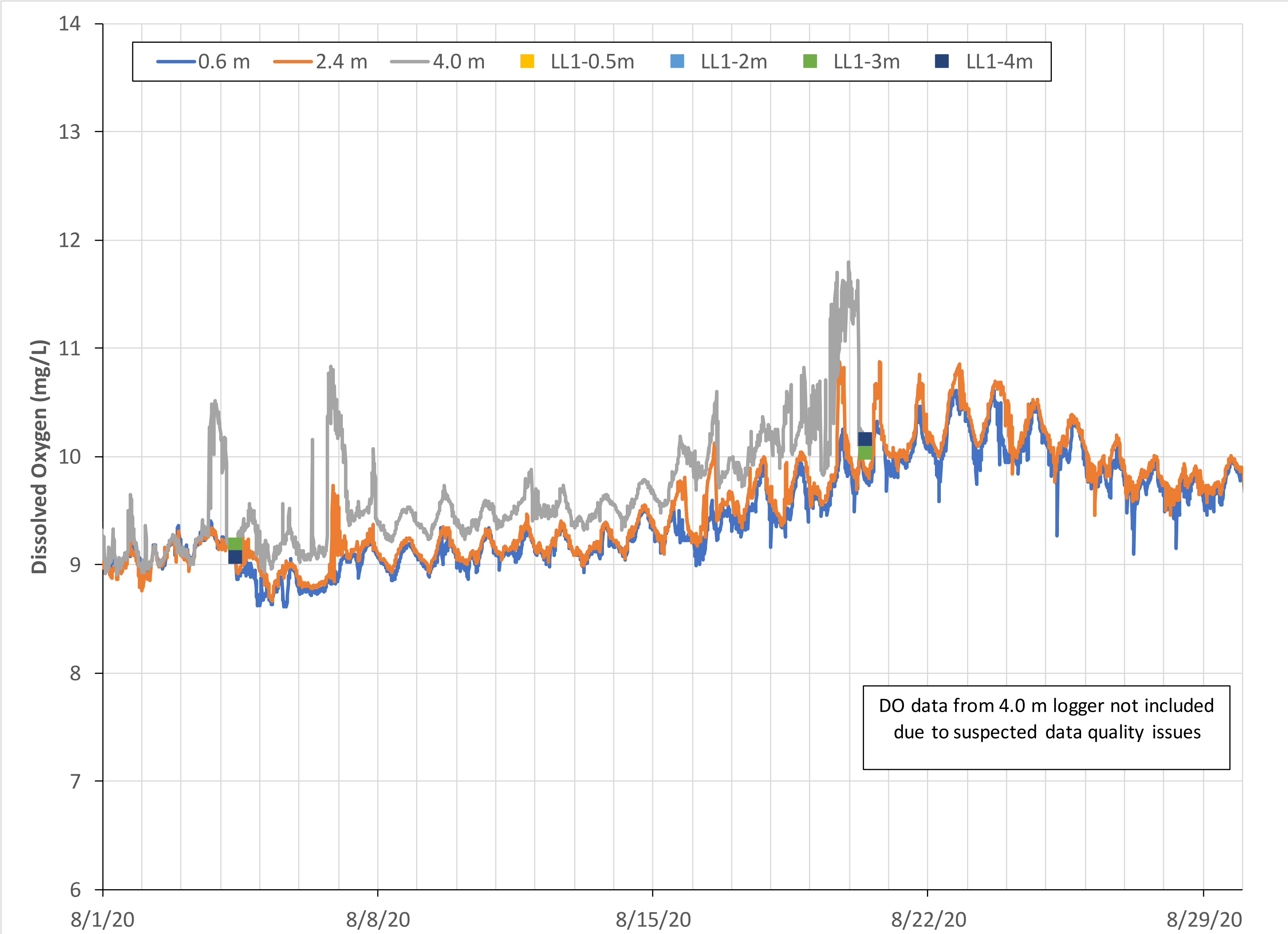


**Figure A8.** Continuous DO (lines) at station DAILY A and regular profile sampling at LL1 (squares) during August 2020.

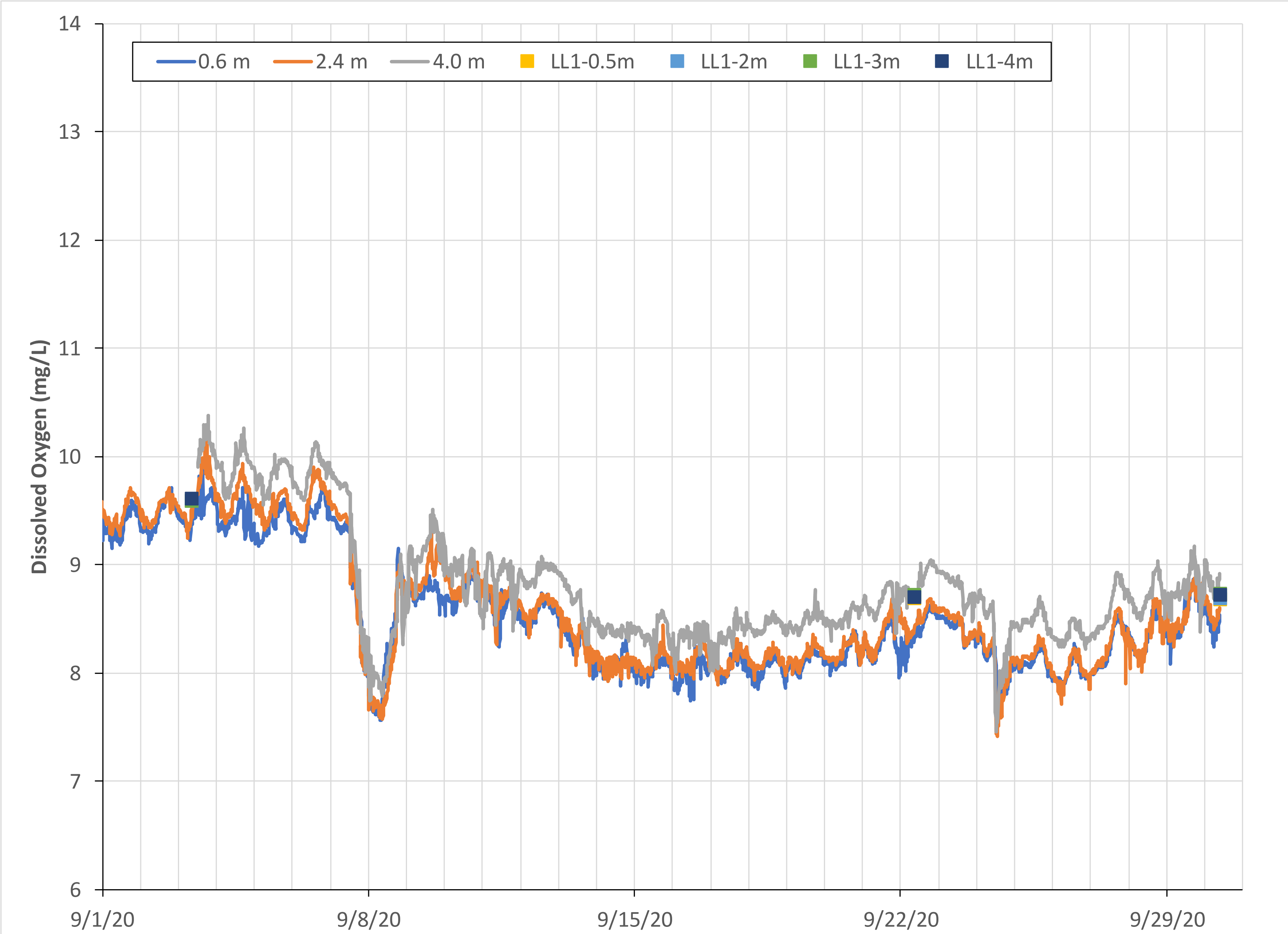


**Figure A9.** Continuous DO (lines) at station DAILY A and regular profile sampling at LL1 (squares) during September 2020.

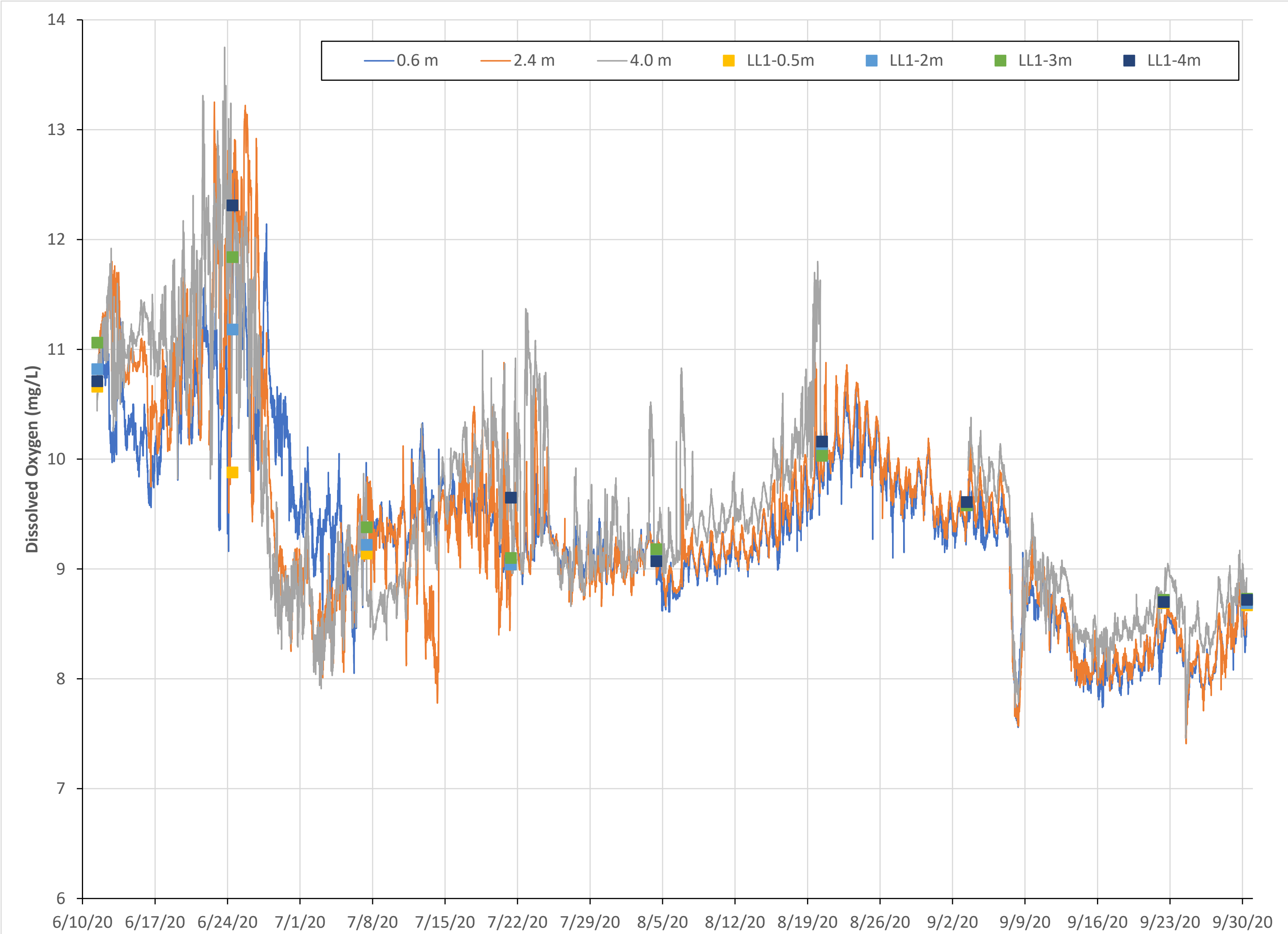


**Figure A10.** Continuous DO (lines) at station DAILY A and regular profile sampling at LL1 (squares) during June - September 2020.

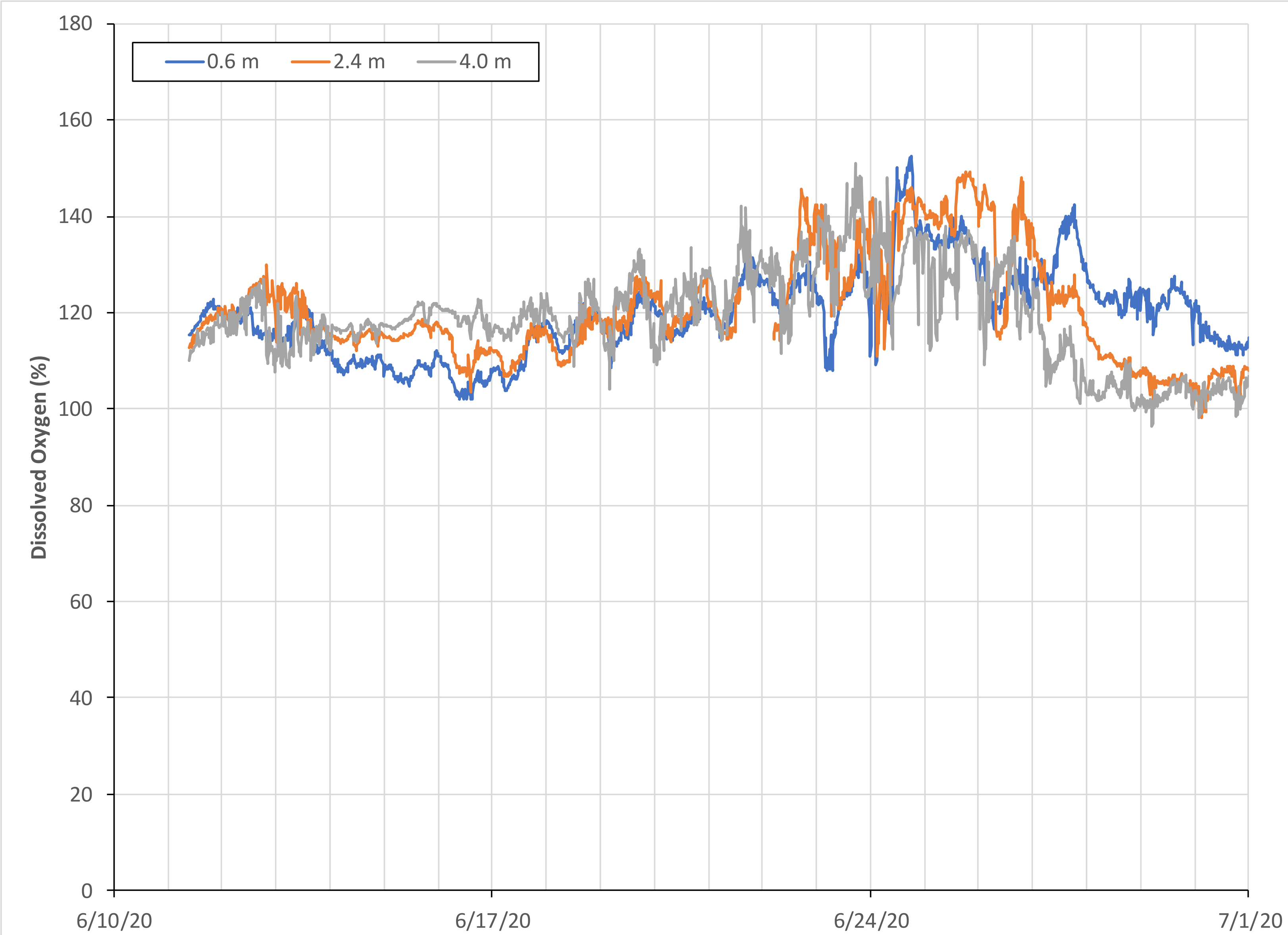

**Figure A11.** Continuous DO percent saturation at station DAILY A during June 2020.

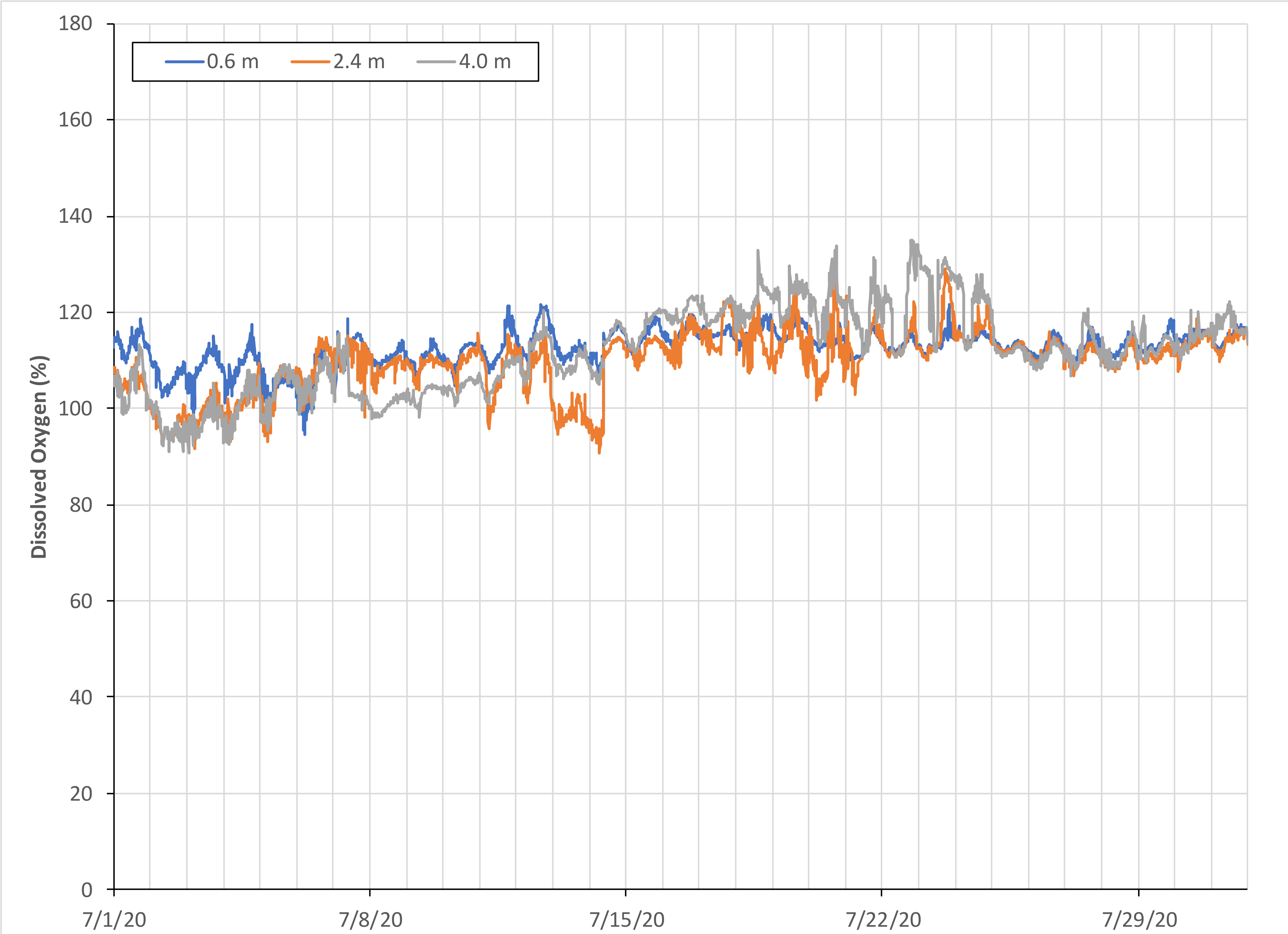


**Figure A12.** Continuous DO percent saturation at station DAILY A during July 2020.

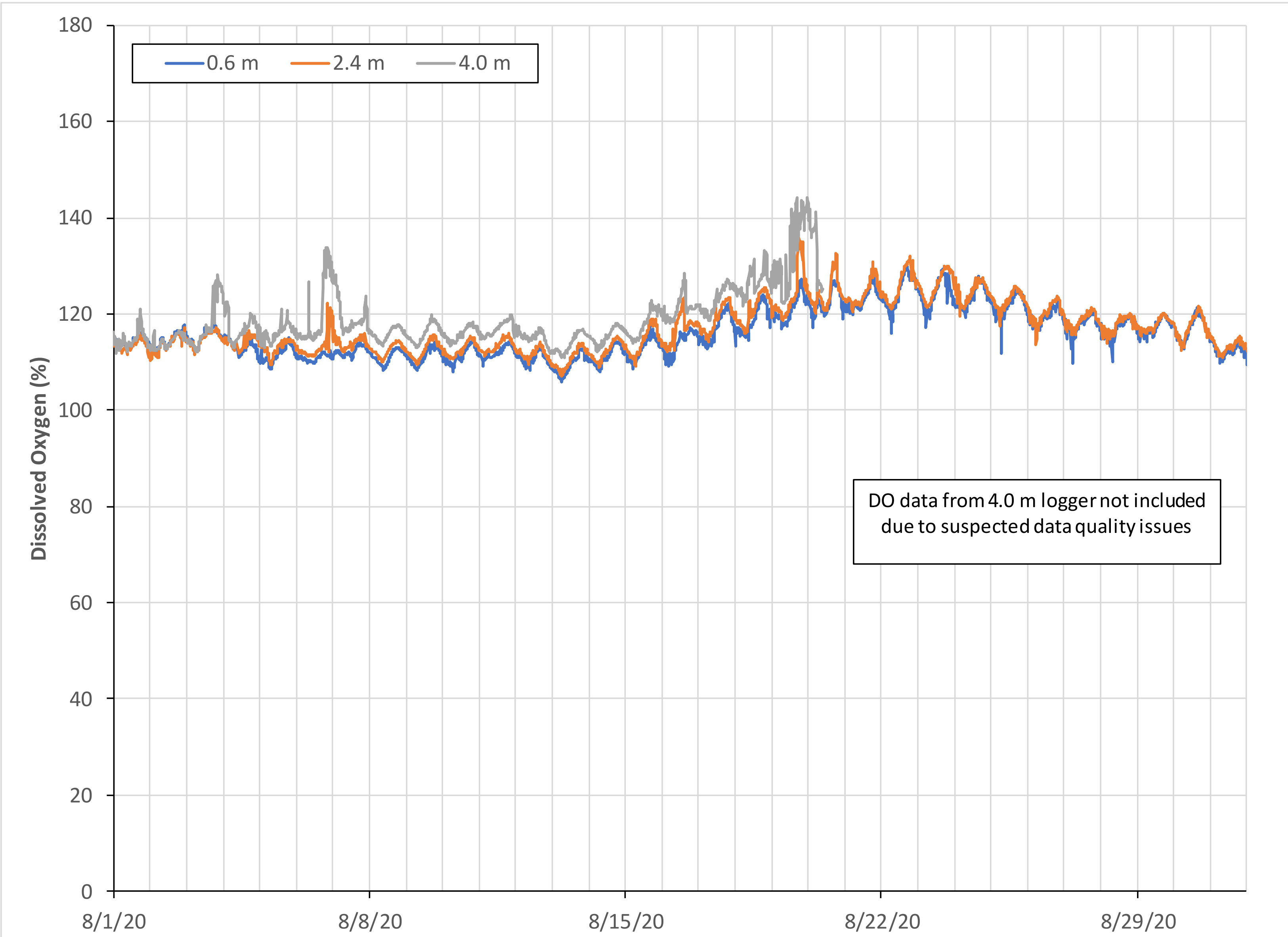


**Figure A13.** Continuous DO percent saturation at station DAILY A during August 2020.

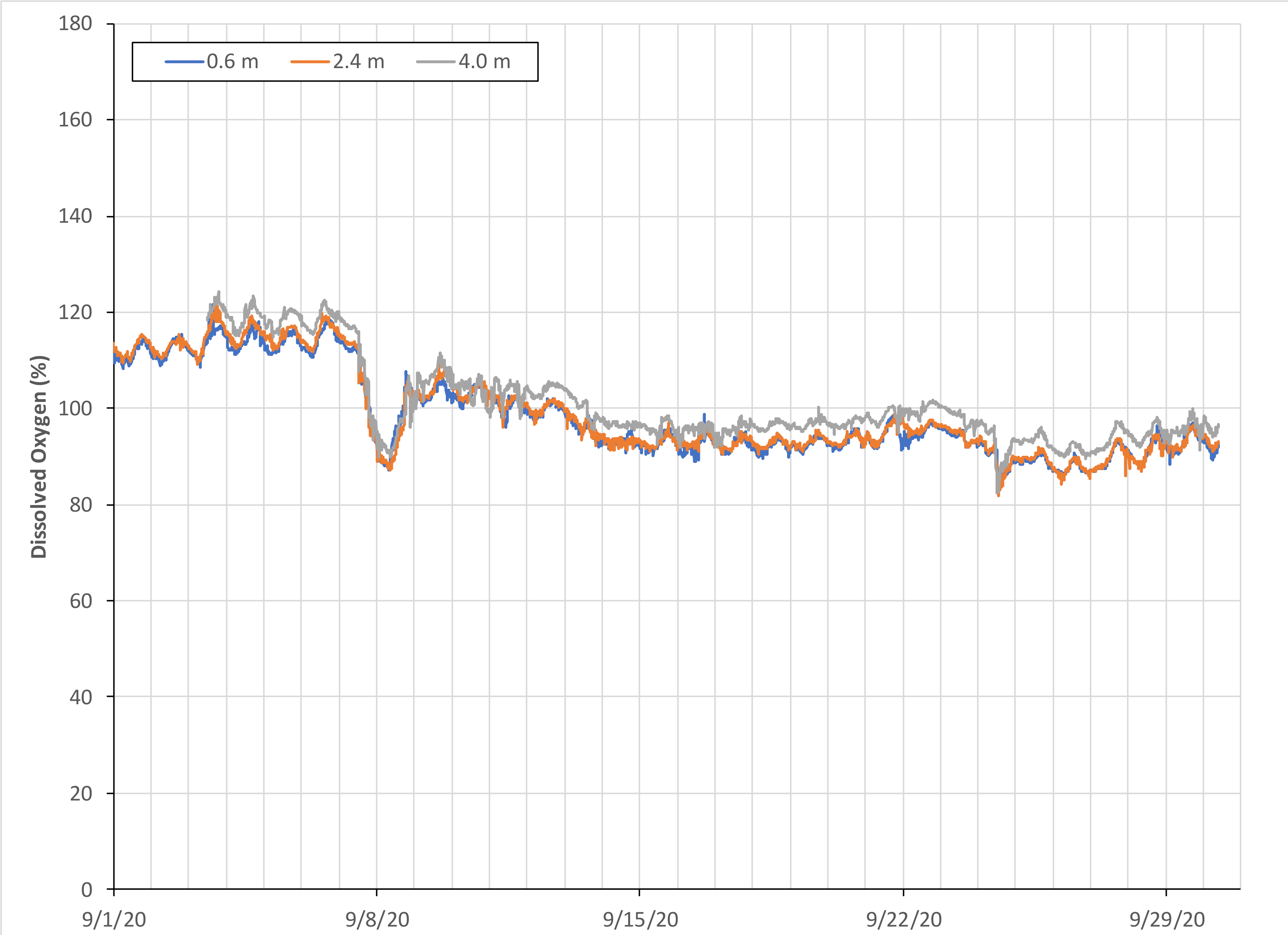


**Figure A14.** Continuous DO percent saturation at station DAILY A during September 2020.

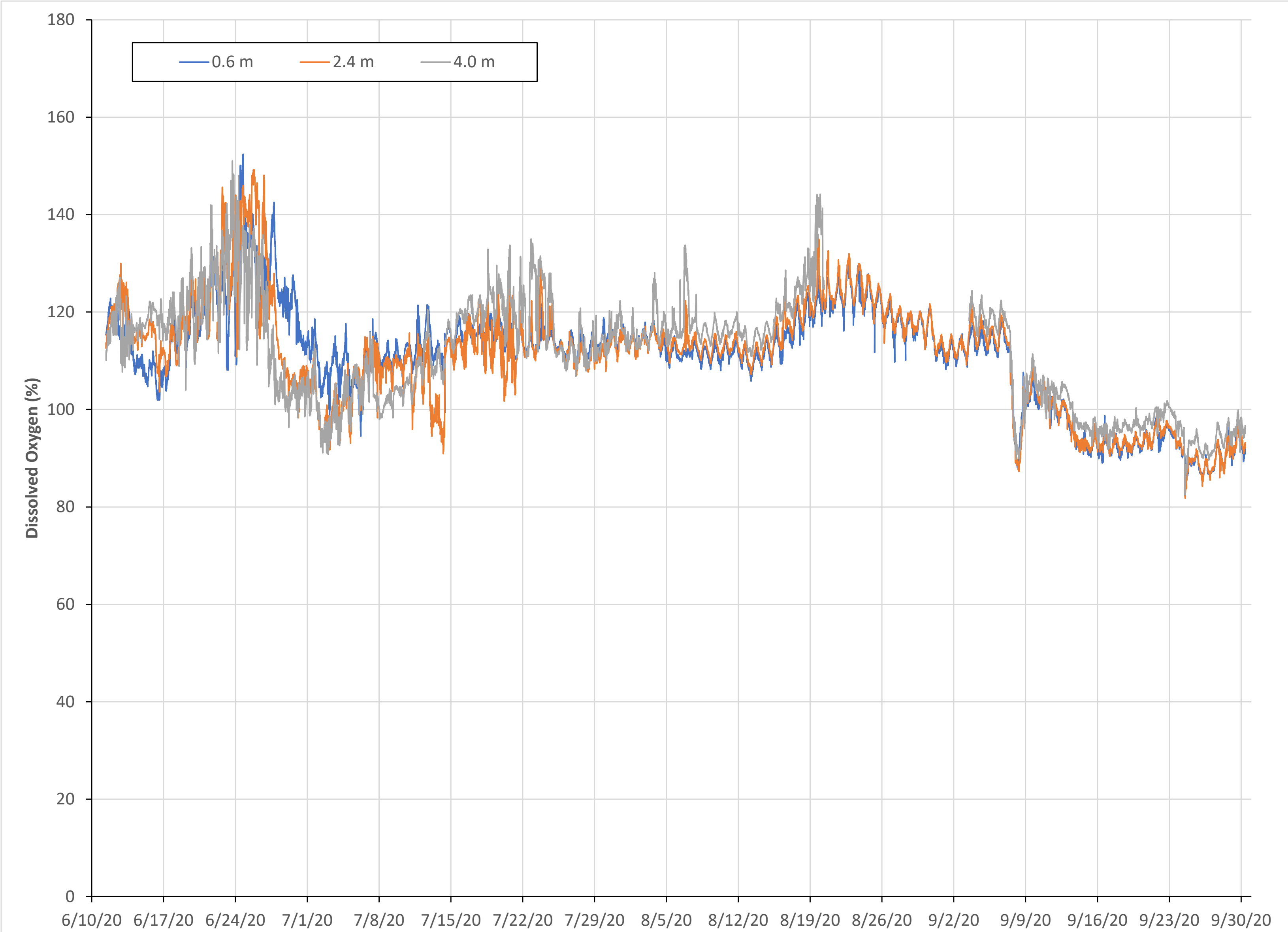


**Figure A15.** Continuous DO percent saturation at station DAILY A during June - September 2020.

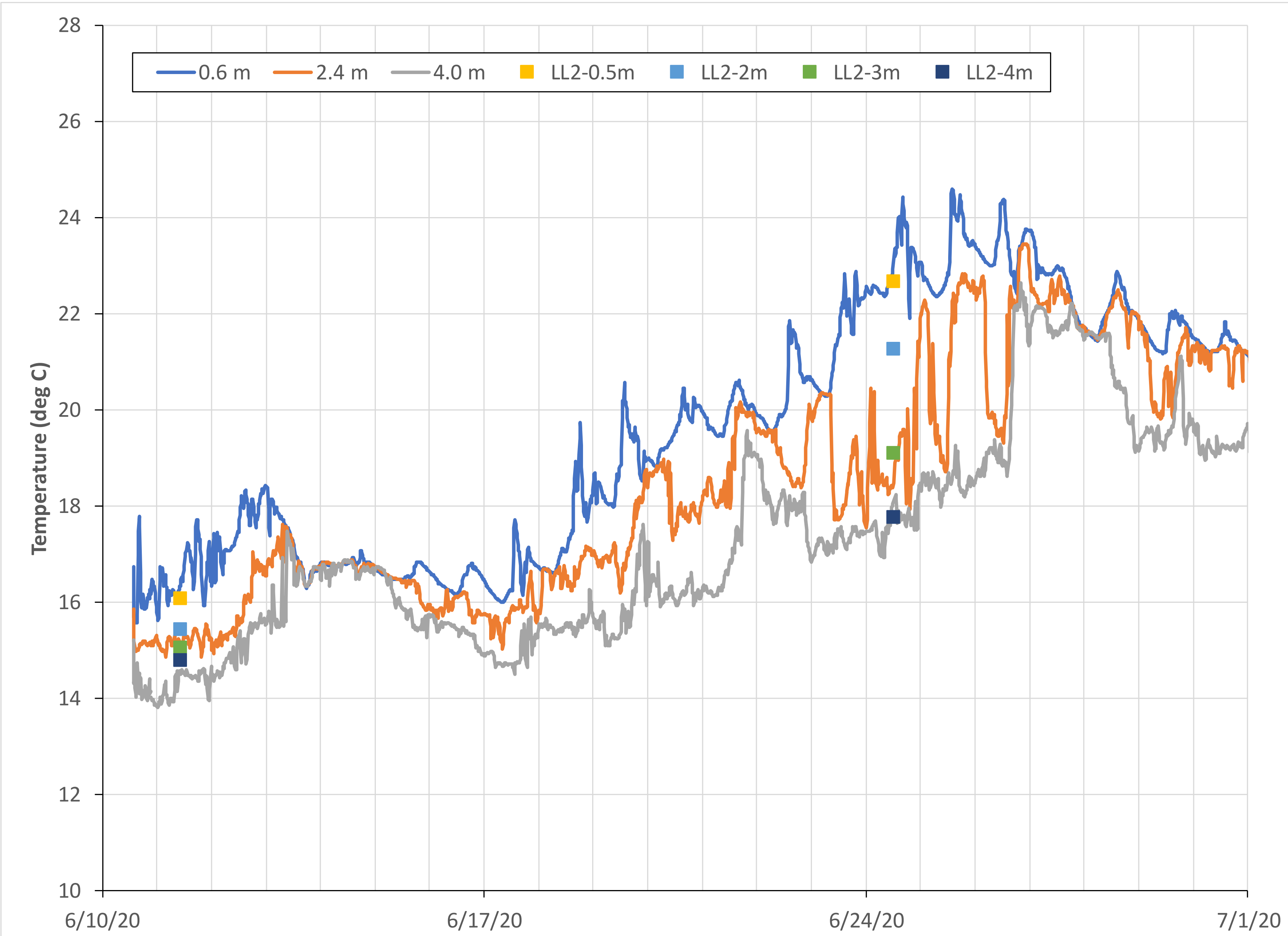


**Figure A16.** Continuous temperature (lines) at station DAILY B and regular profile sampling at LL2 (squares) during June 2020.

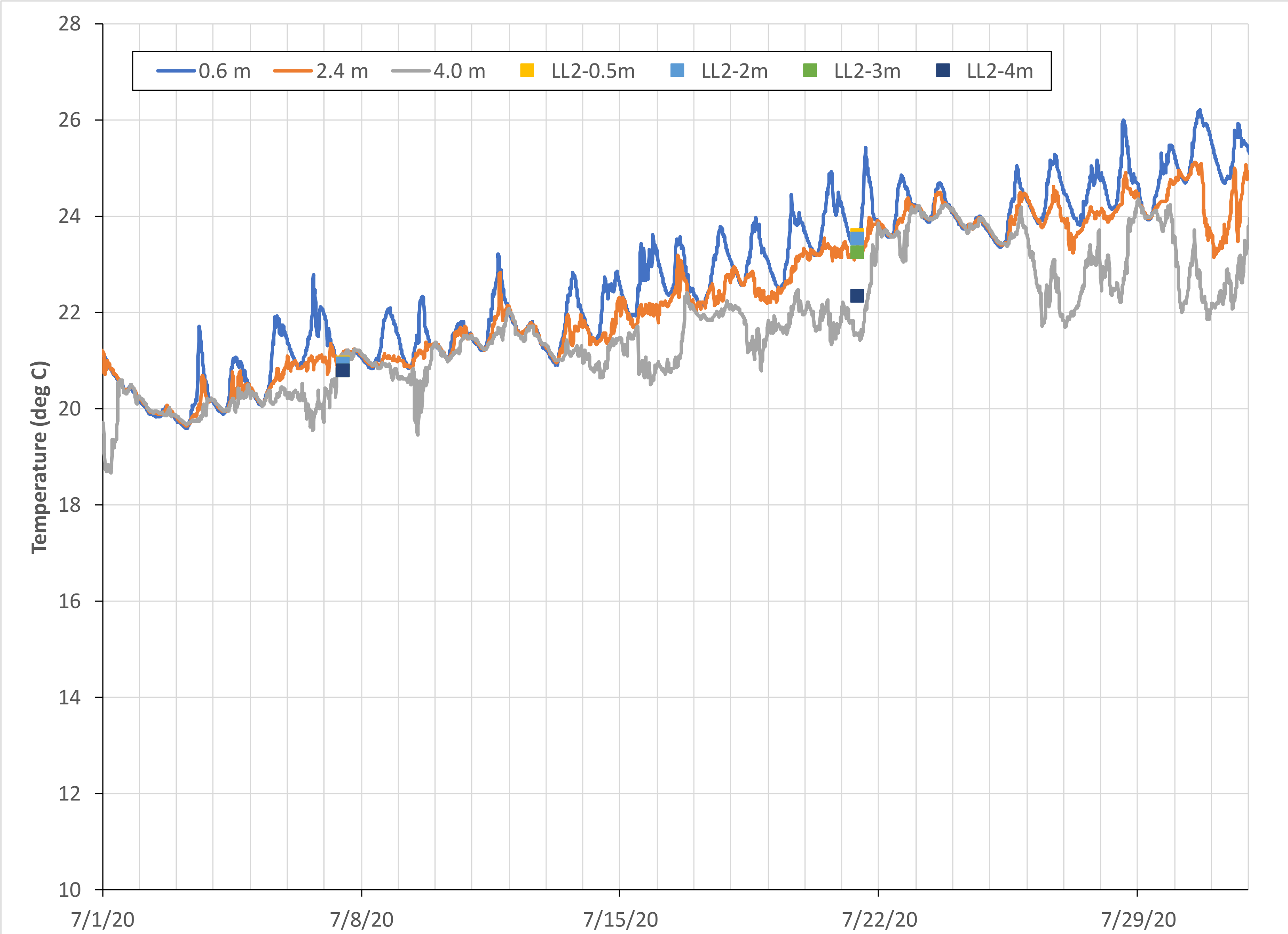


**Figure A17.** Continuous temperature (lines) at station DAILY B and regular profile sampling at LL2 (squares) during July 2020.

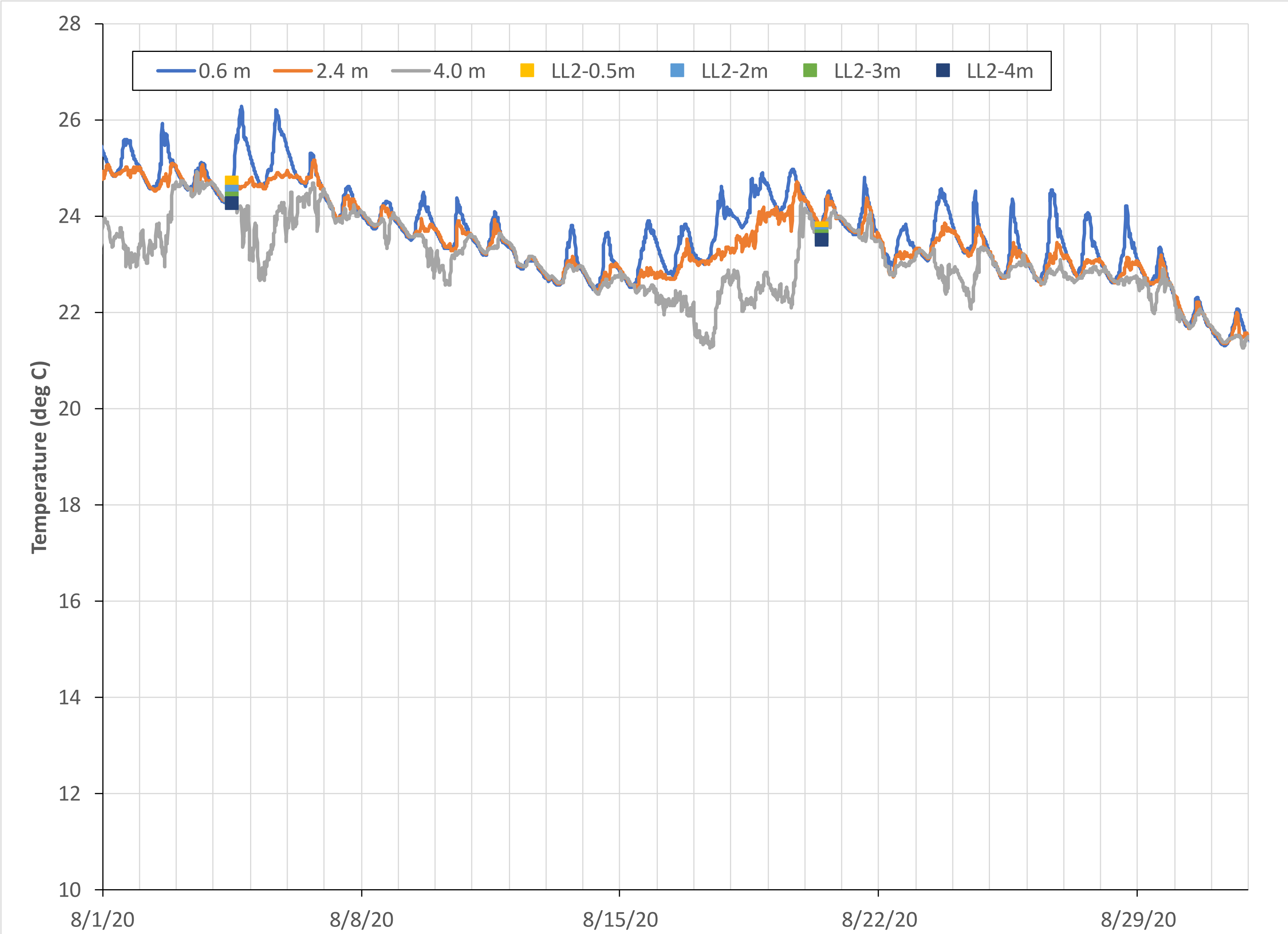


**Figure A18.** Continuous temperature (lines) at station DAILY B and regular profile sampling at LL2 (squares) during August 2020.

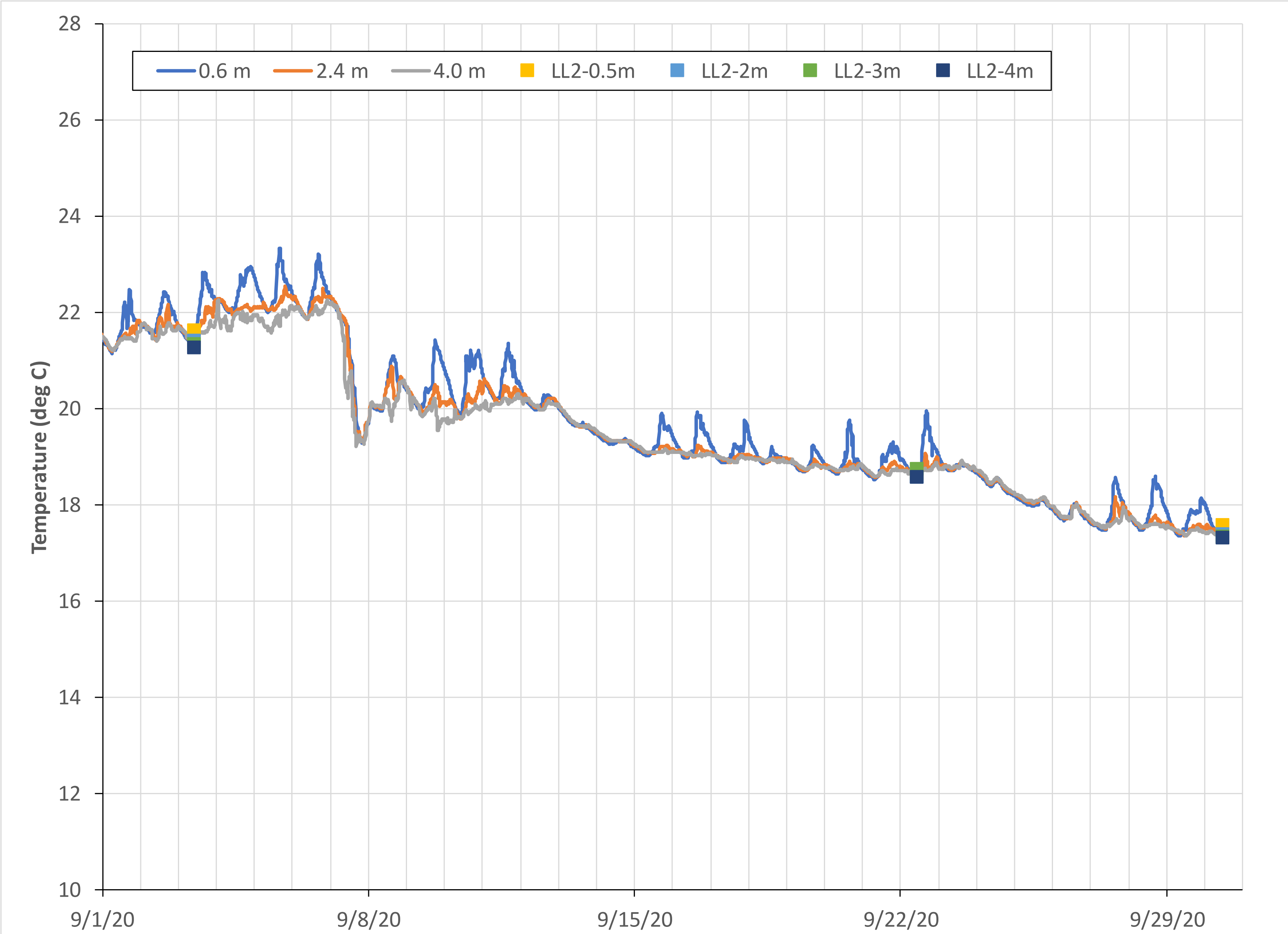


**Figure A19.** Continuous temperature (lines) at station DAILY B and regular profile sampling at LL2 (squares) during September 2020.

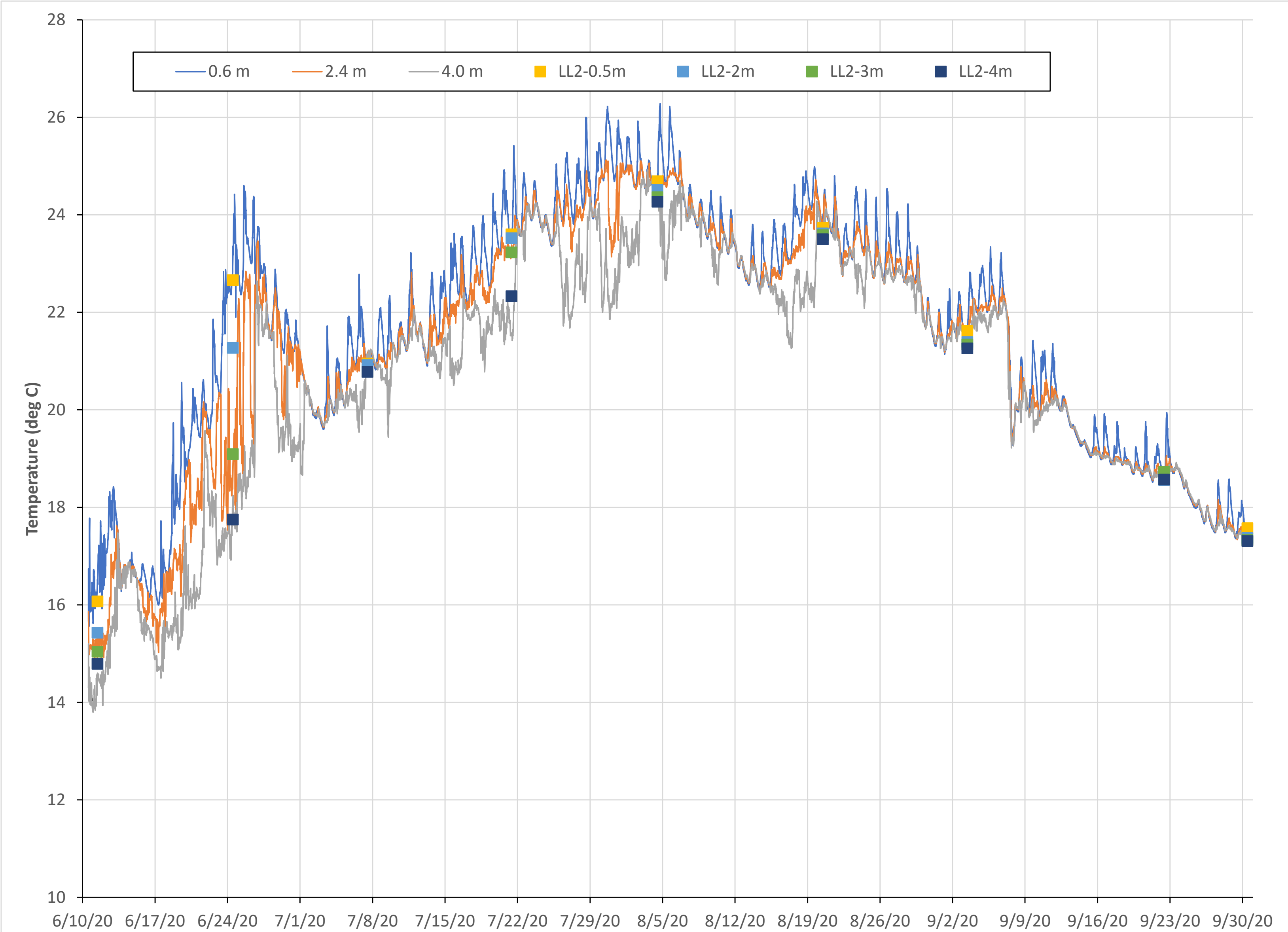


**Figure A20.** Continuous temperature (lines) at station DAILY B and regular profile sampling at LL2 (squares) during June - September 2020.

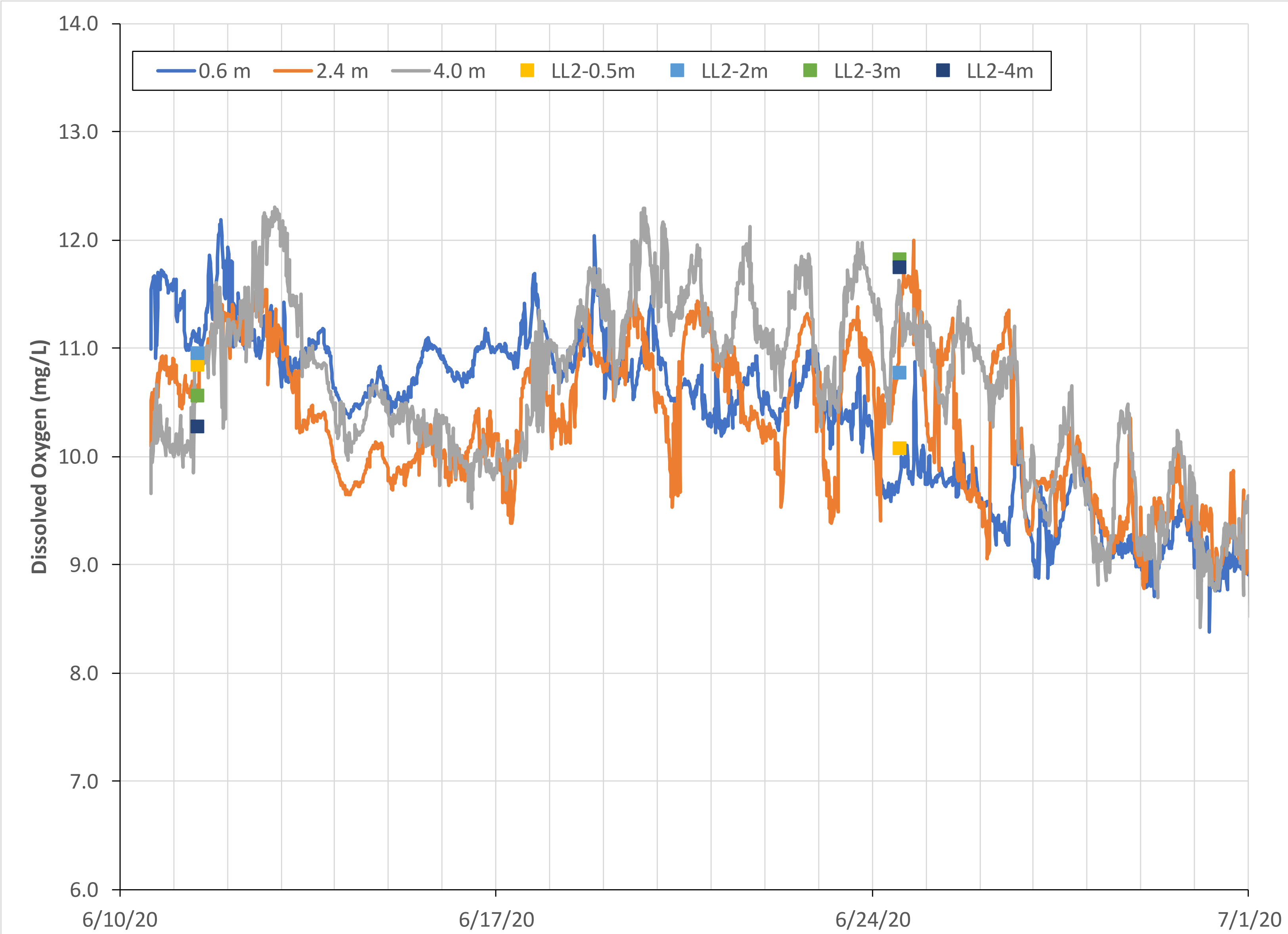


**Figure A21.** Continuous DO (lines) at station DAILY B and regular profile sampling at LL2 (squares) during June 2020.

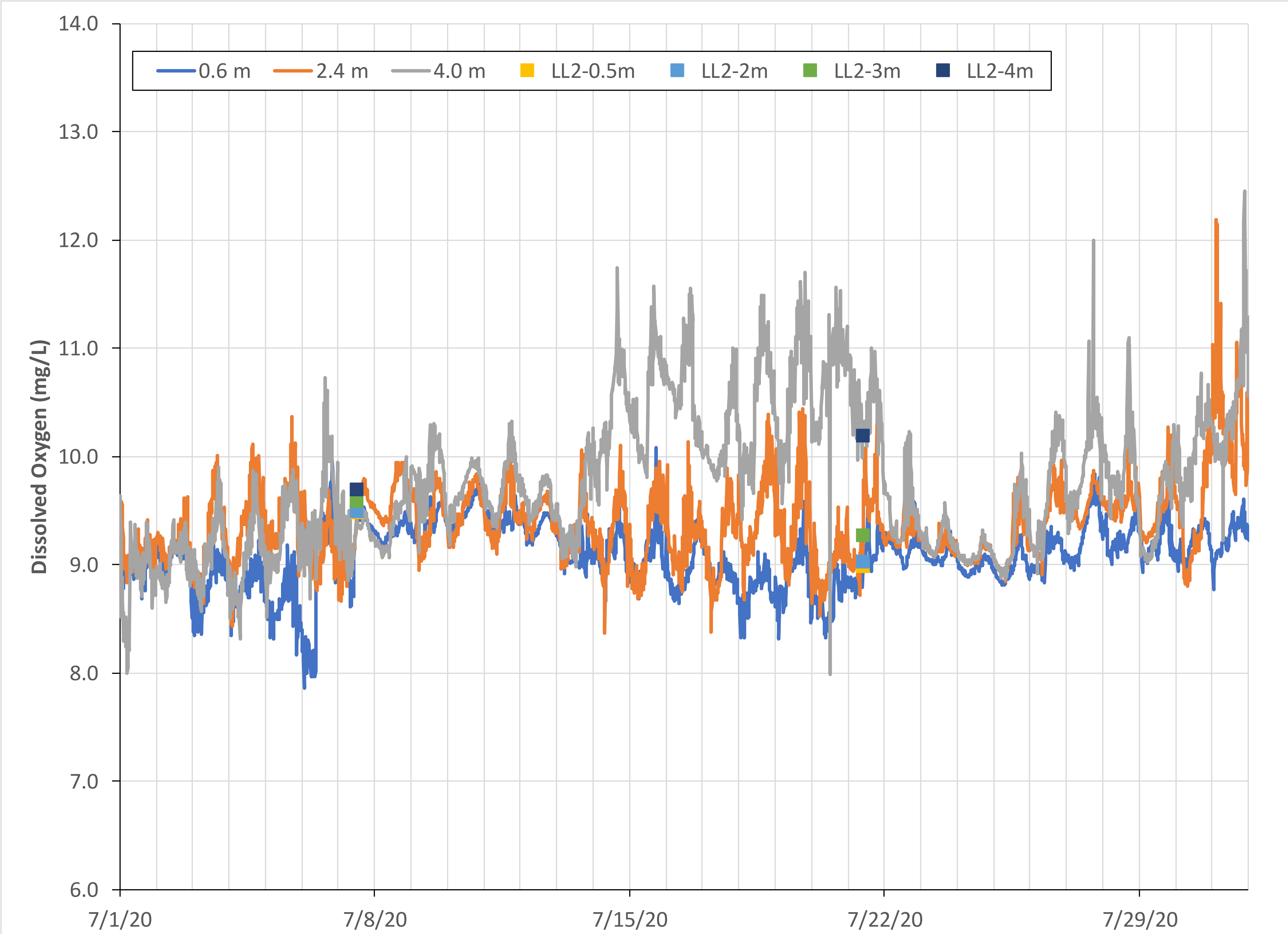


**Figure A22.** Continuous DO (lines) at station DAILY B and regular profile sampling at LL2 (squares) during July 2020.

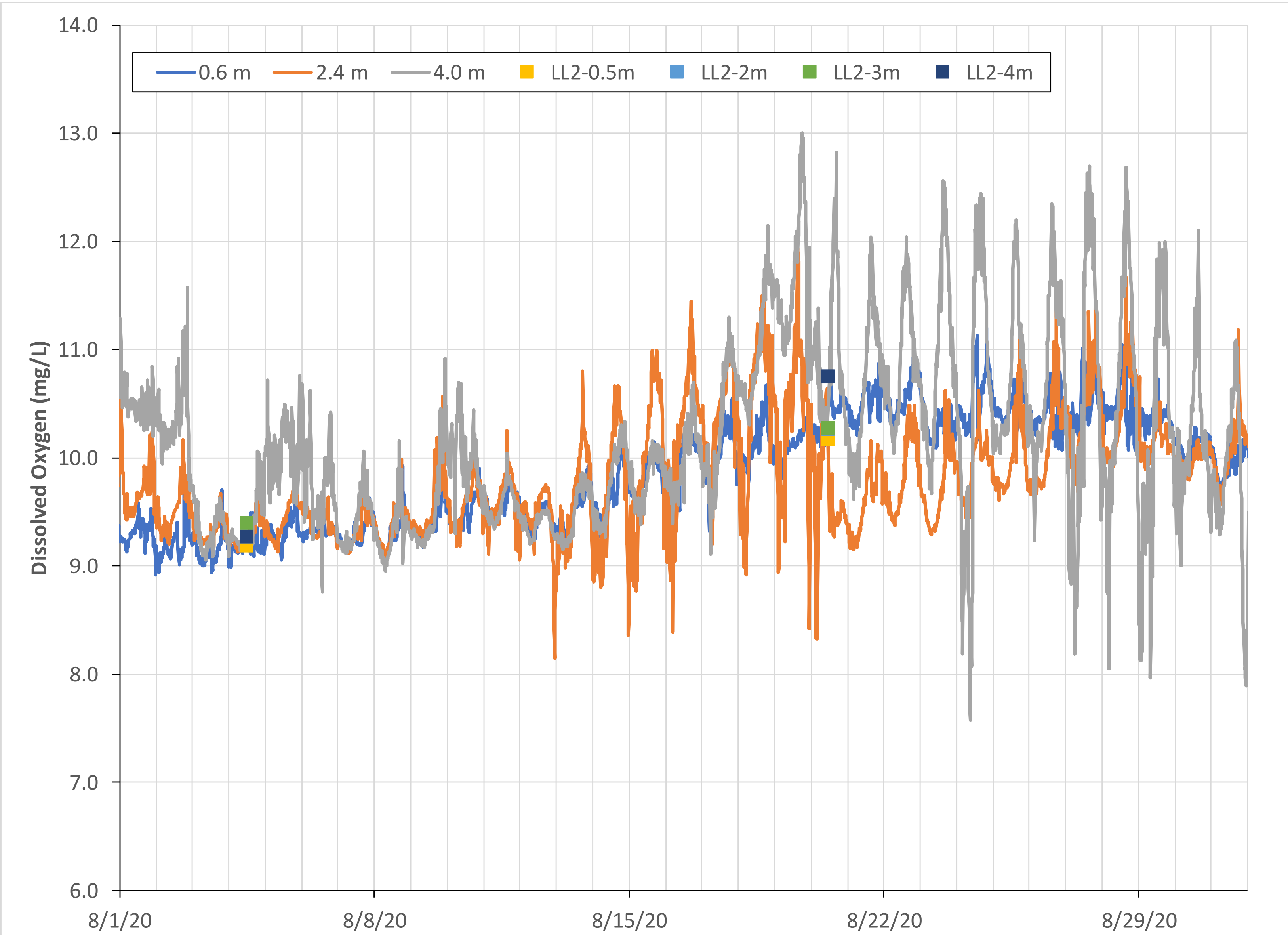


**Figure A23.** Continuous DO (lines) at station DAILY B and regular profile sampling at LL2 (squares) during August 2020.

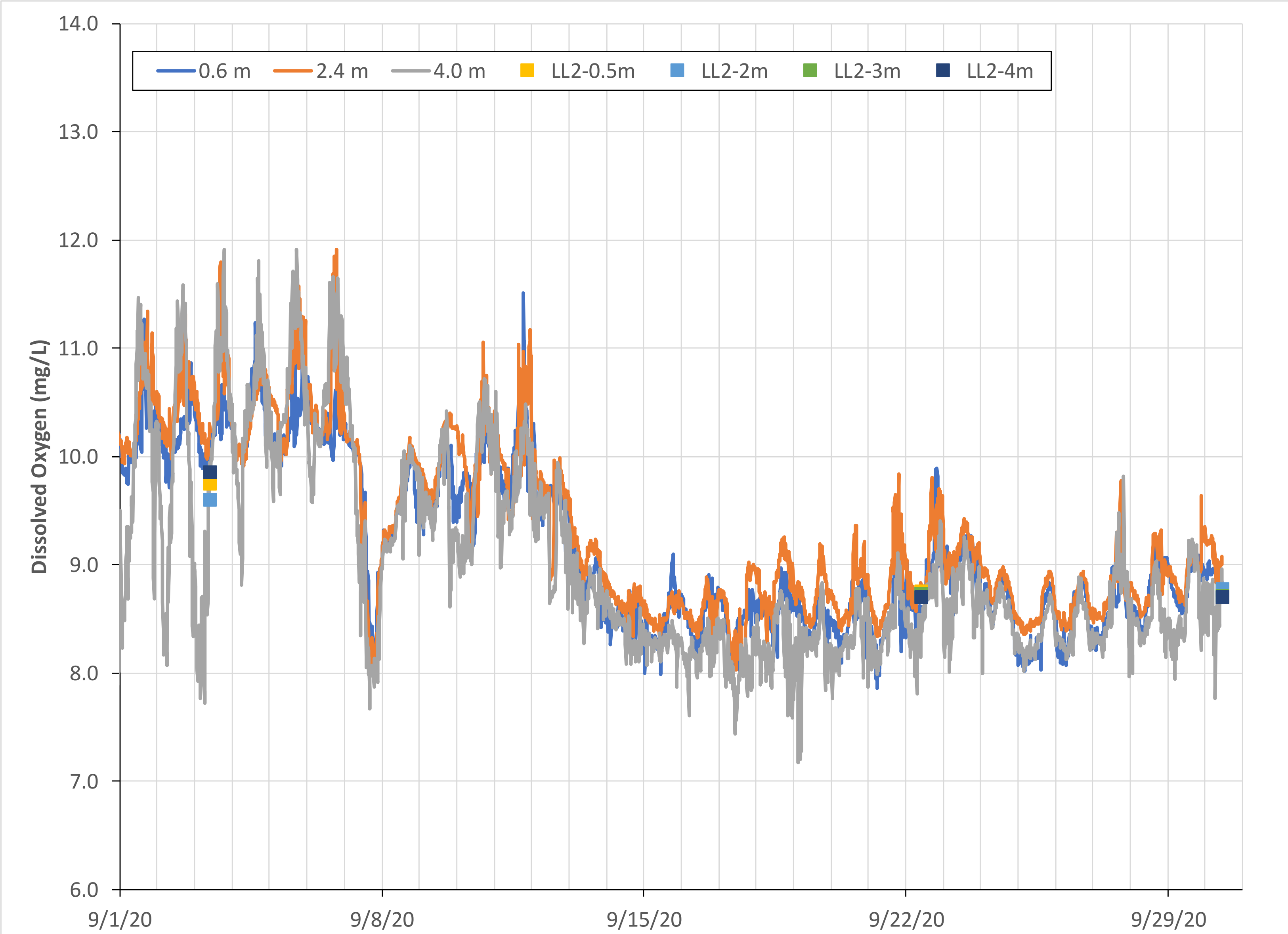


**Figure A24.** Continuous DO (lines) at station DAILY B and regular profile sampling at LL2 (squares) during September 2020.

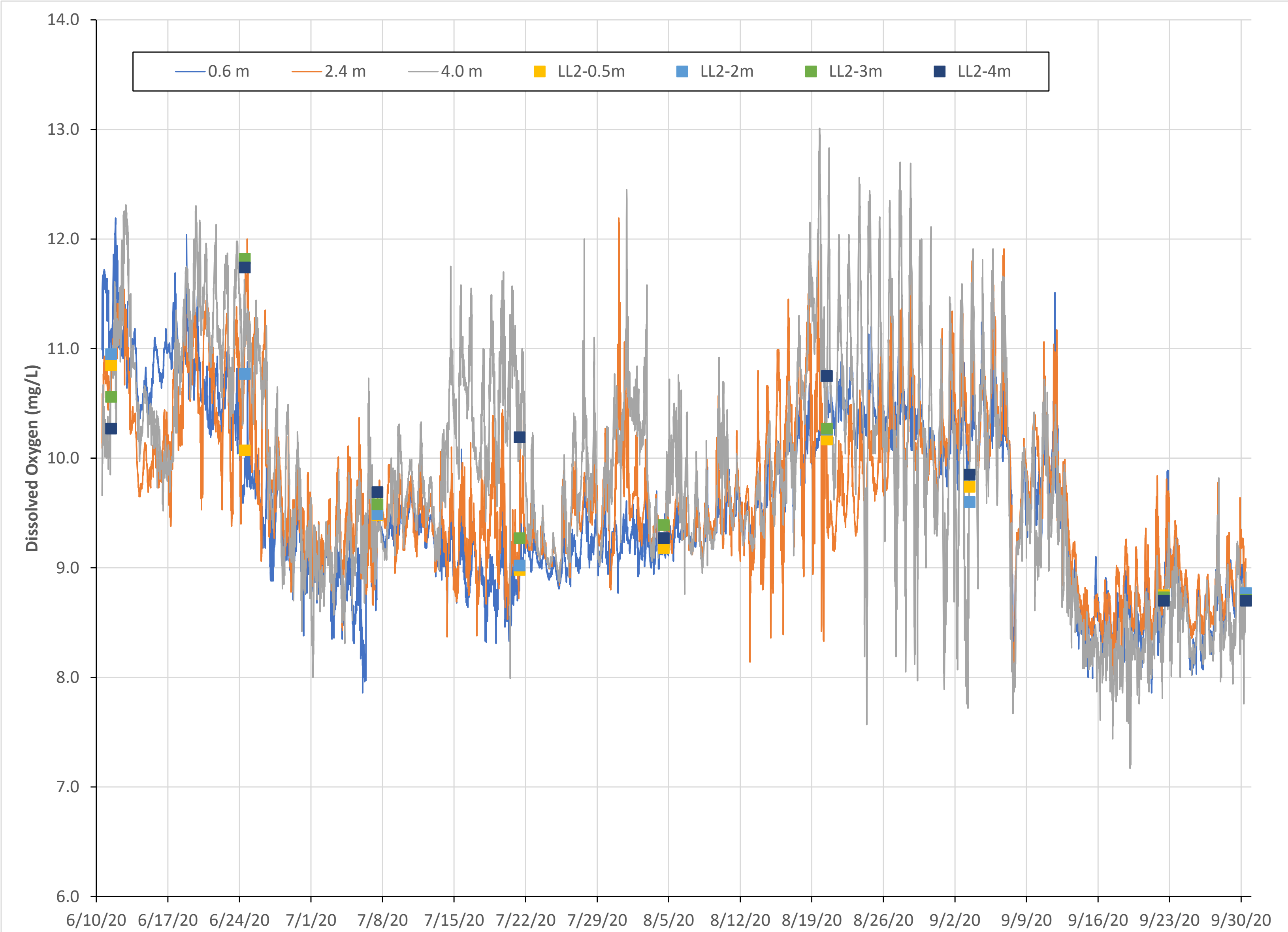


**Figure A25.** Continuous DO (lines) at station DAILY B and regular profile sampling at LL2 (squares) during June - September 2020.

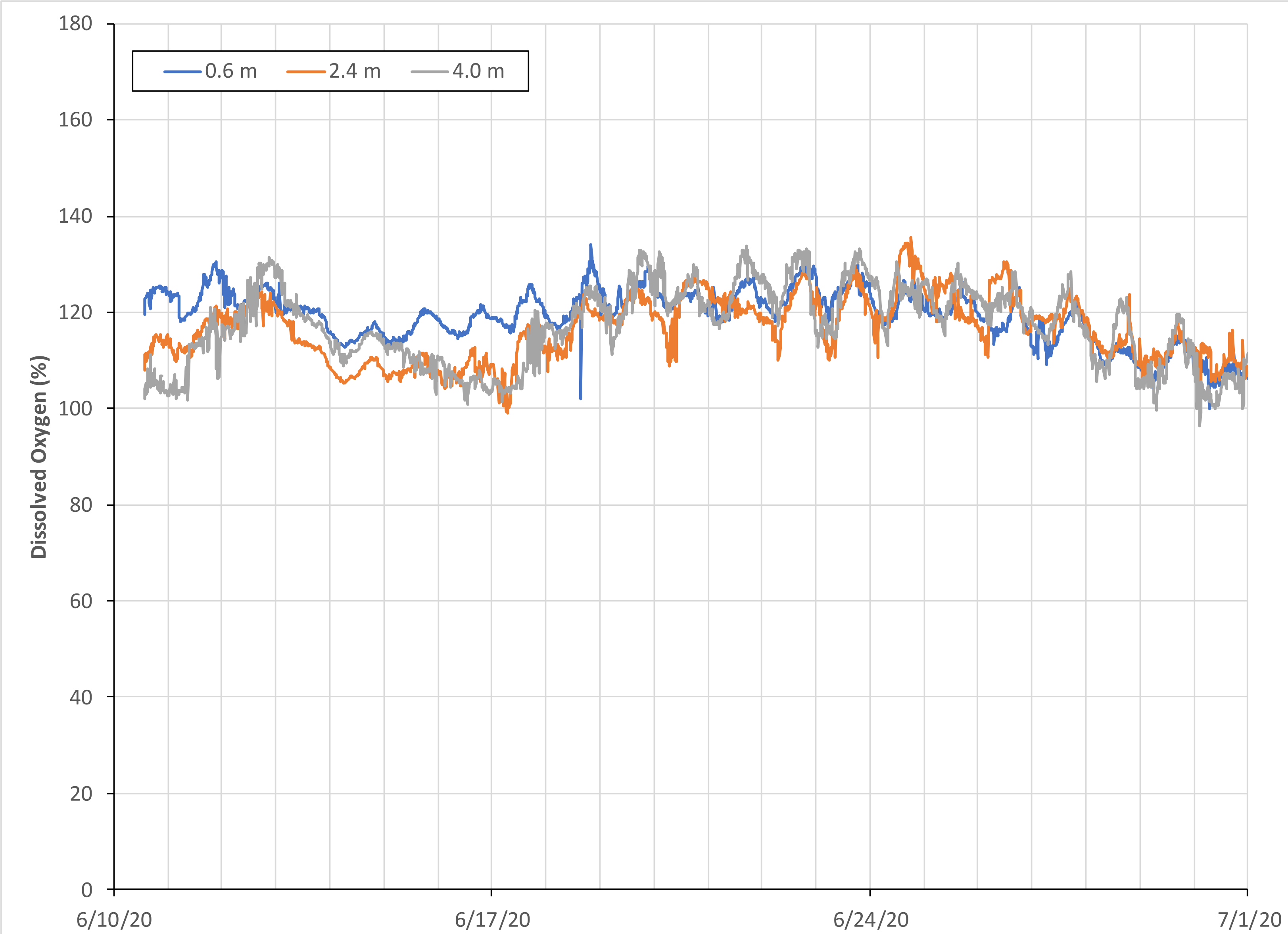


**Figure A26.** Continuous DO percent saturation at station DAILY B during June 2020.

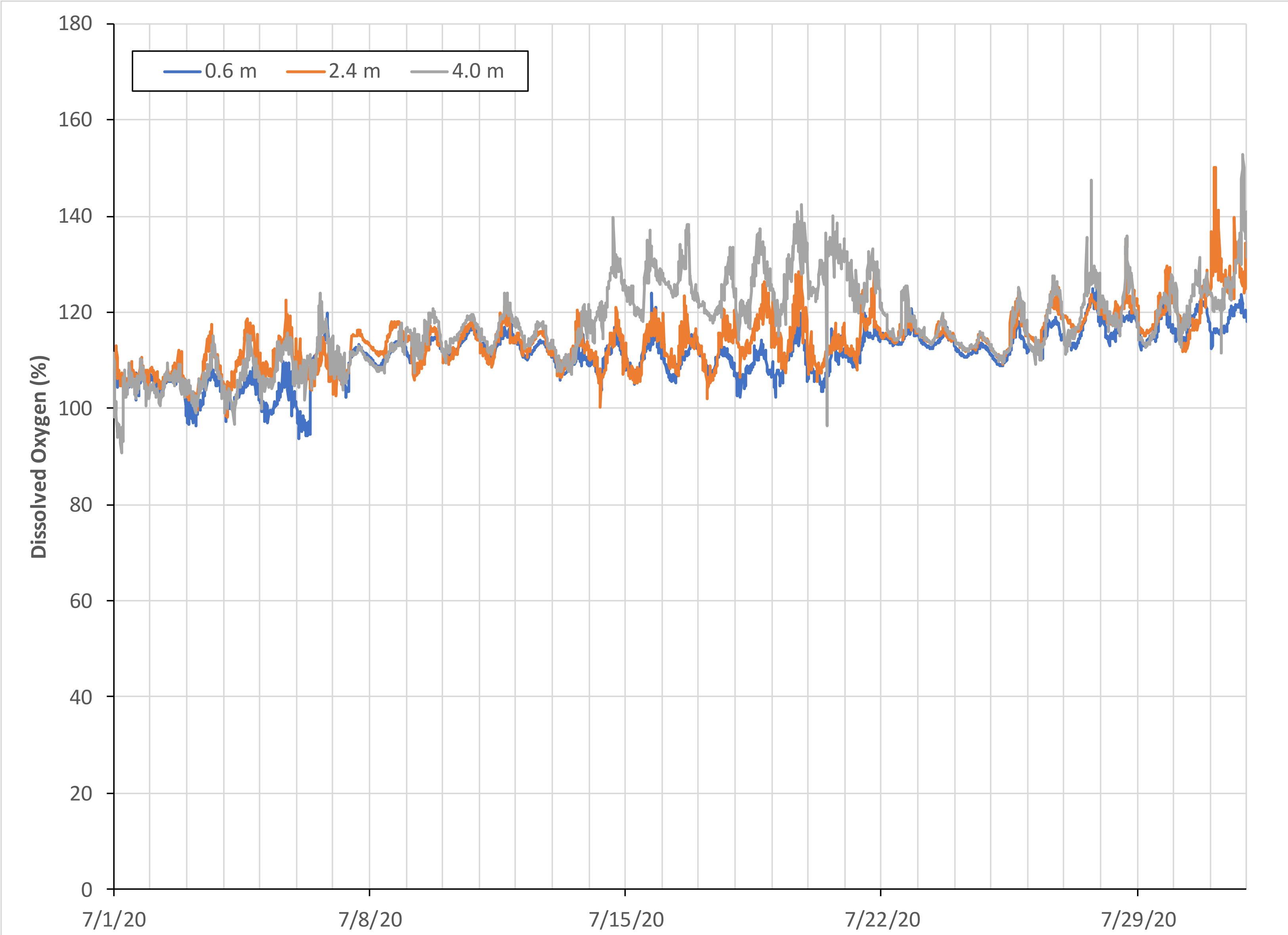


**Figure A27.** Continuous DO percent saturation at station DAILY B during July 2020.

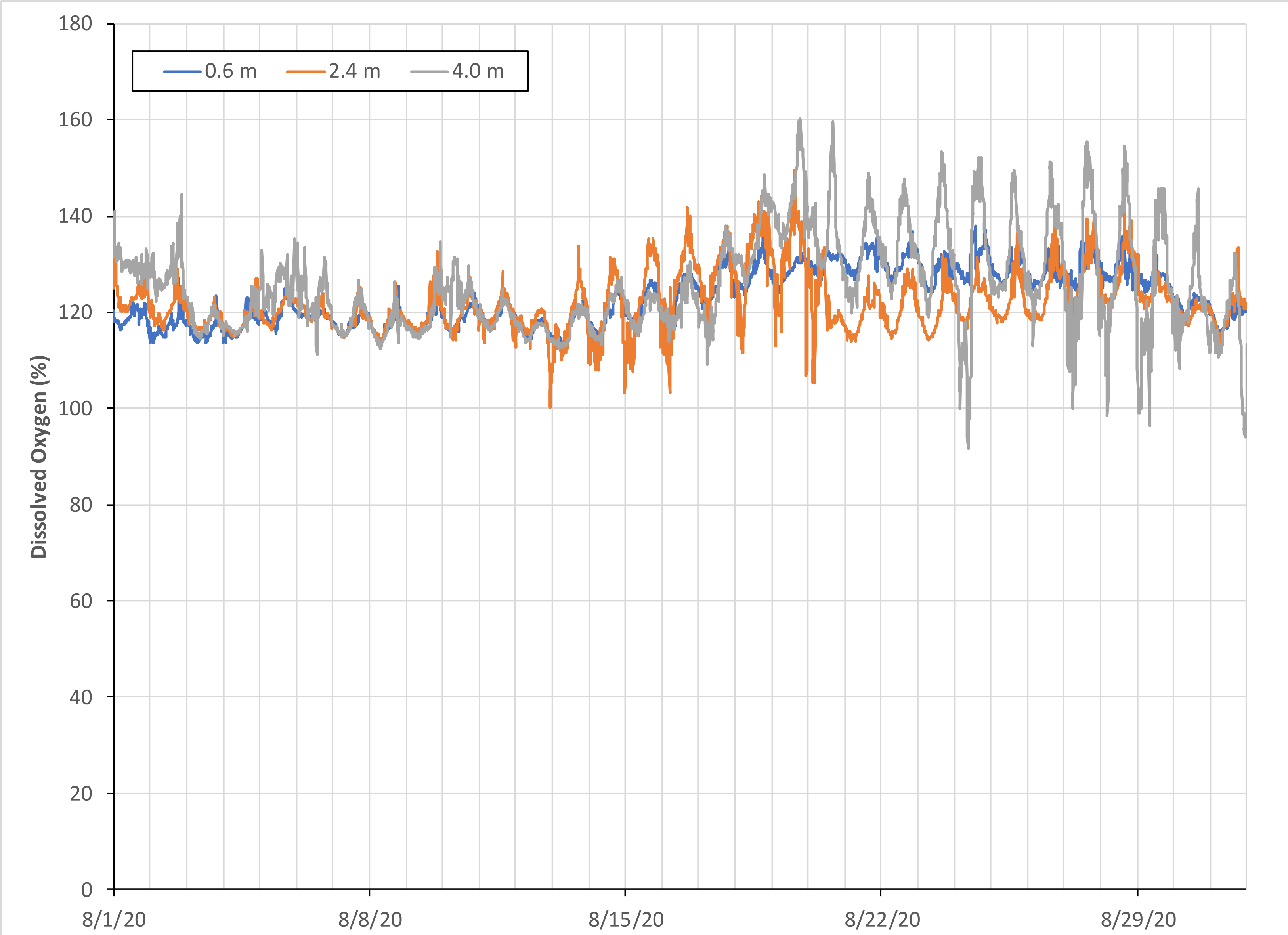


**Figure A28.** Continuous DO percent saturation at station DAILY B during August 2020.

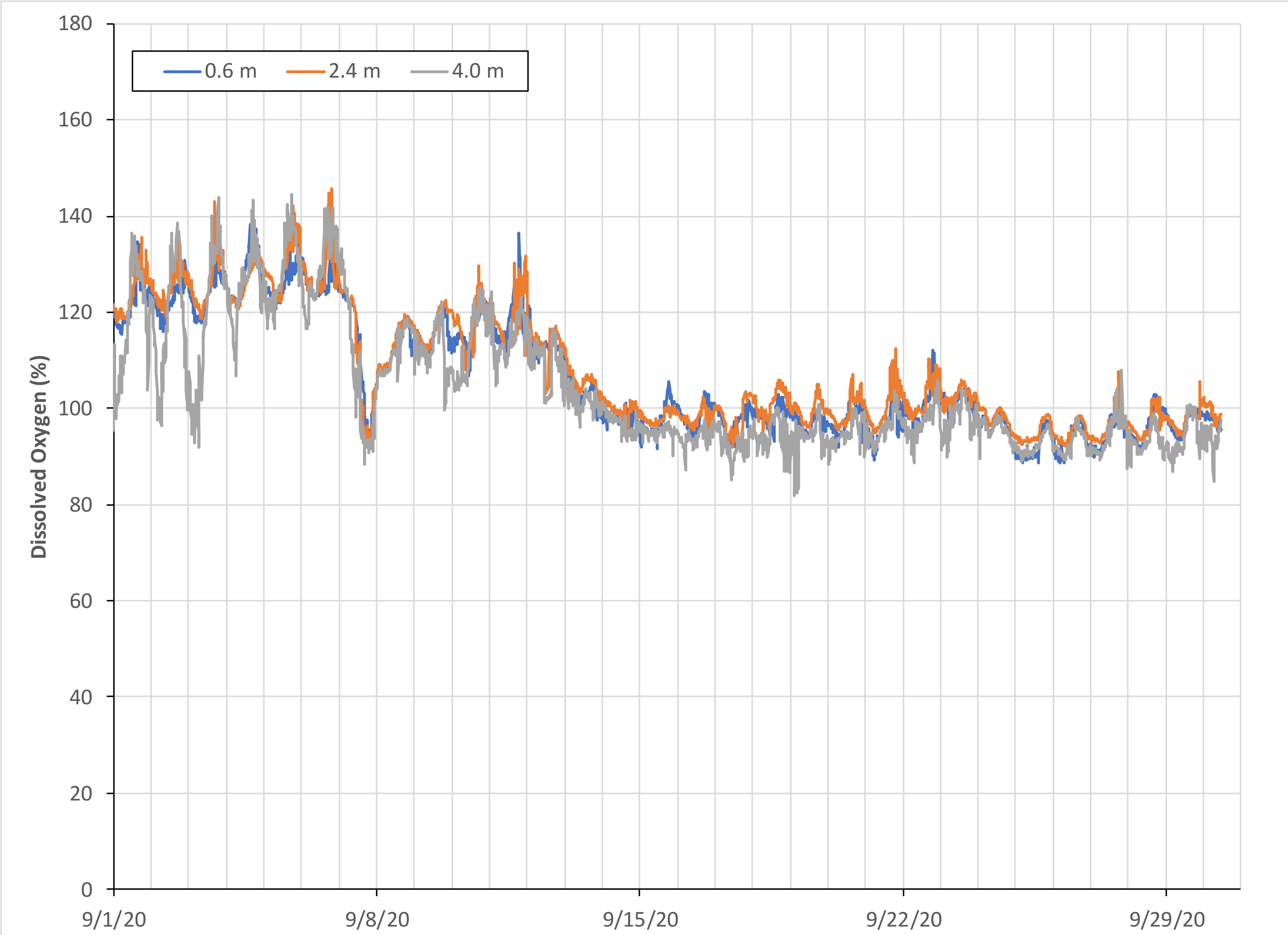


**Figure A29.** Continuous DO percent saturation at station DAILY B during September 2020.

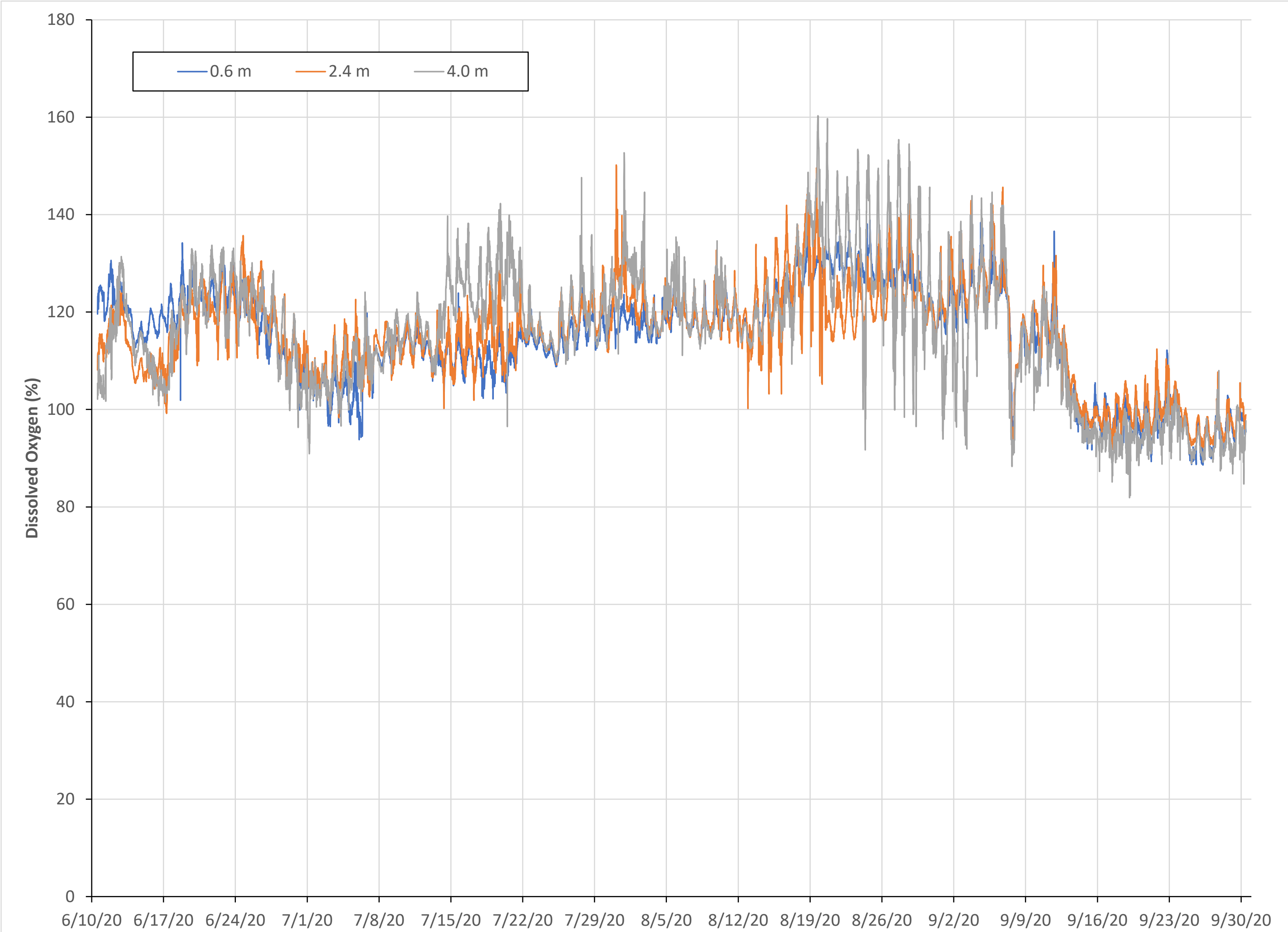


**Figure A30.** Continuous DO percent saturation at station DAILY B during June - September 2020.

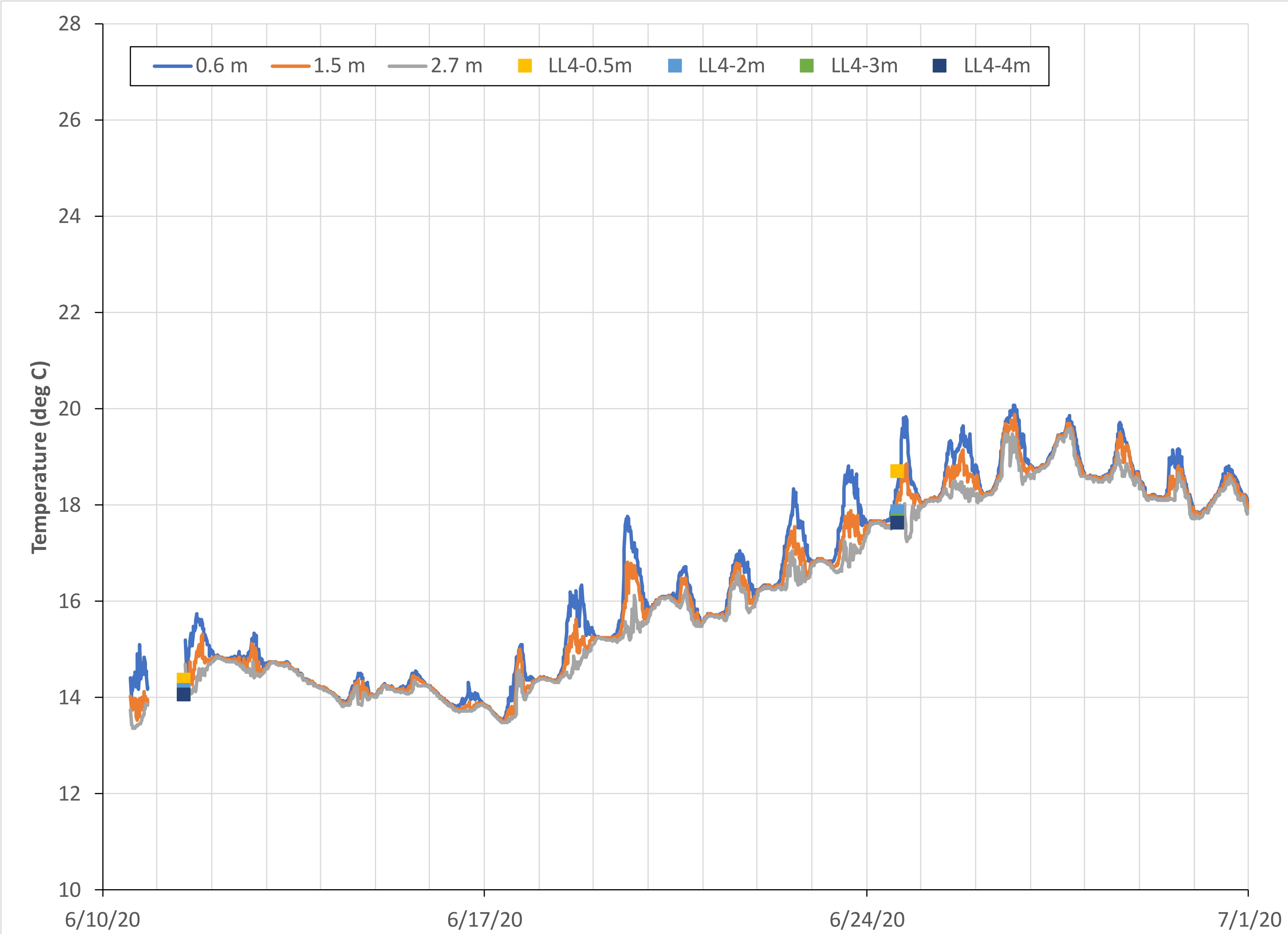


**Figure A31.** Continuous temperature (lines) at station DAILY C and regular profile sampling at LL4 (squares) during June 2020.

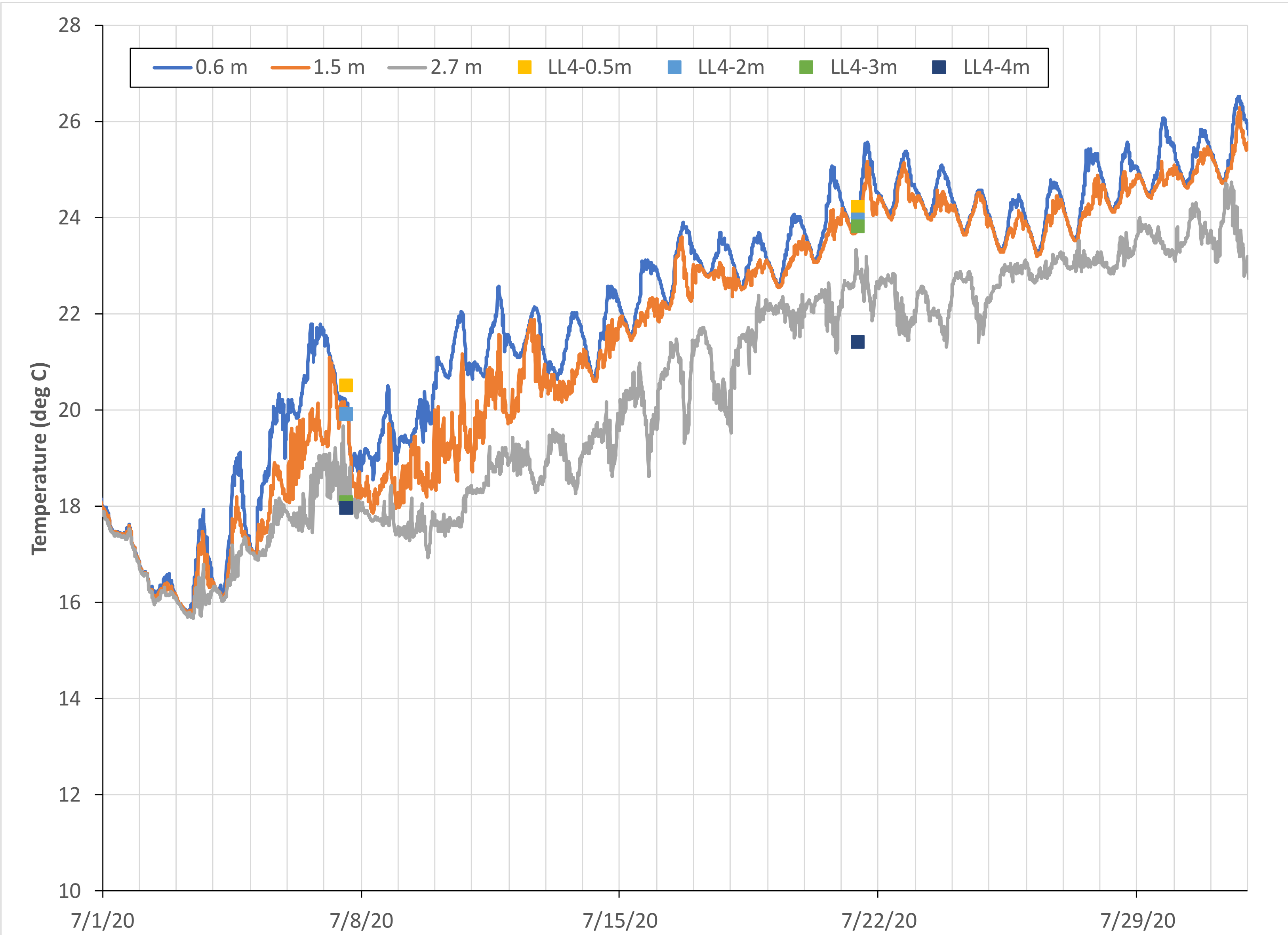


**Figure A32.** Continuous temperature (lines) at station DAILY C and regular profile sampling at LL4 (squares) during July 2020.

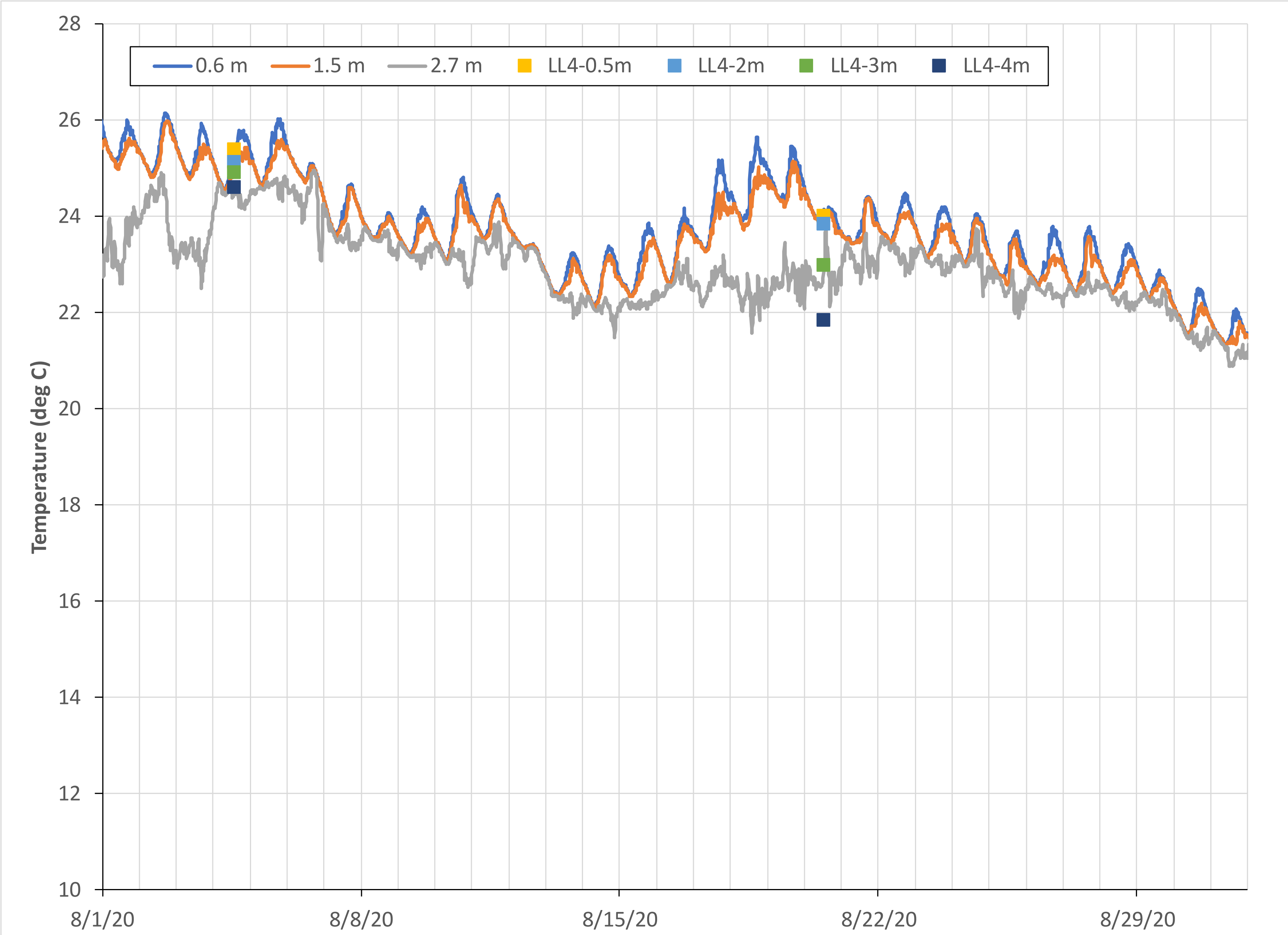


**Figure A33.** Continuous temperature (lines) at station DAILY C and regular profile sampling at LL4 (squares) during August 2020.

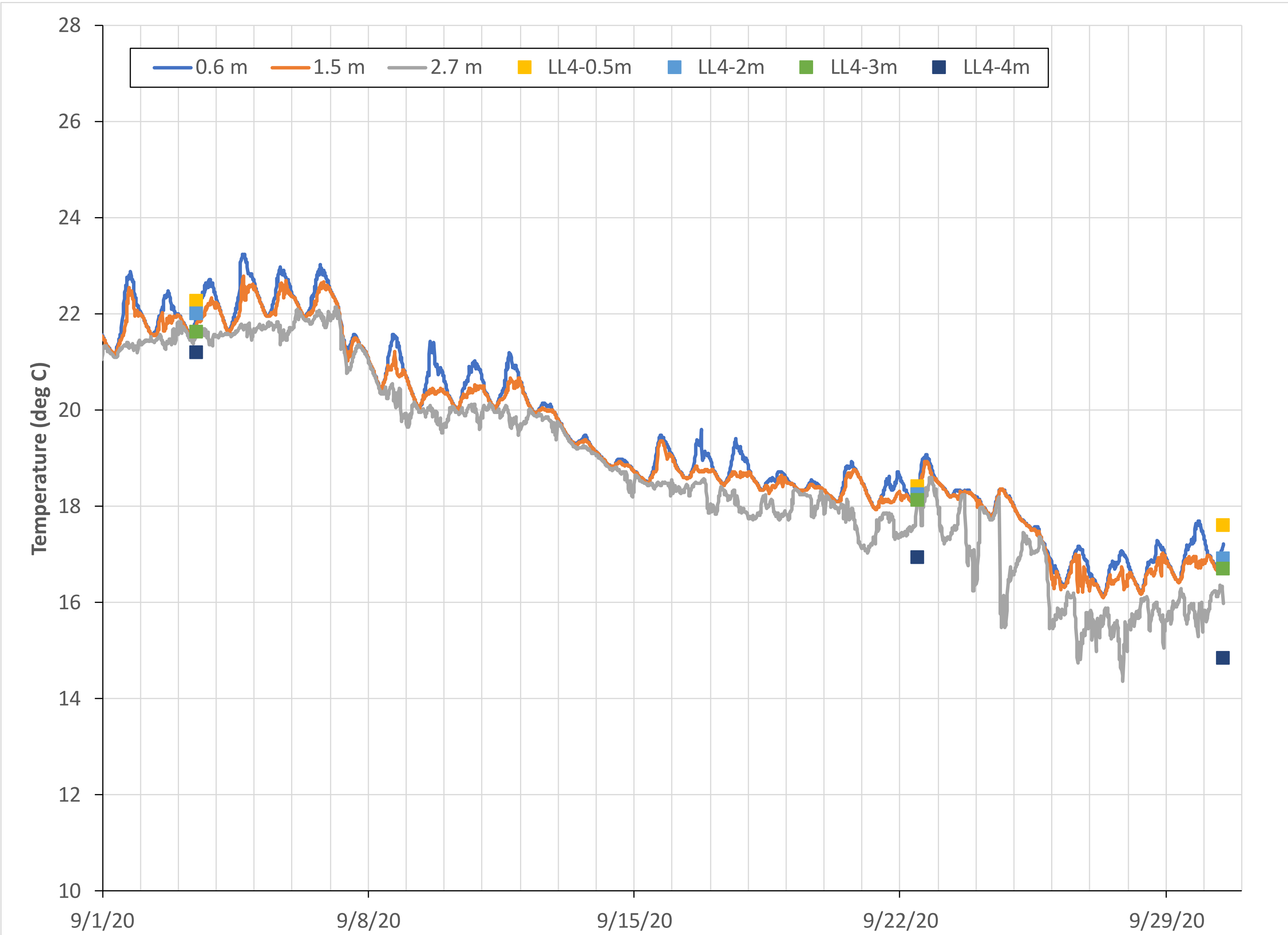


**Figure A34.** Continuous temperature (lines) at station DAILY C and regular profile sampling at LL4 (squares) during September 2020.

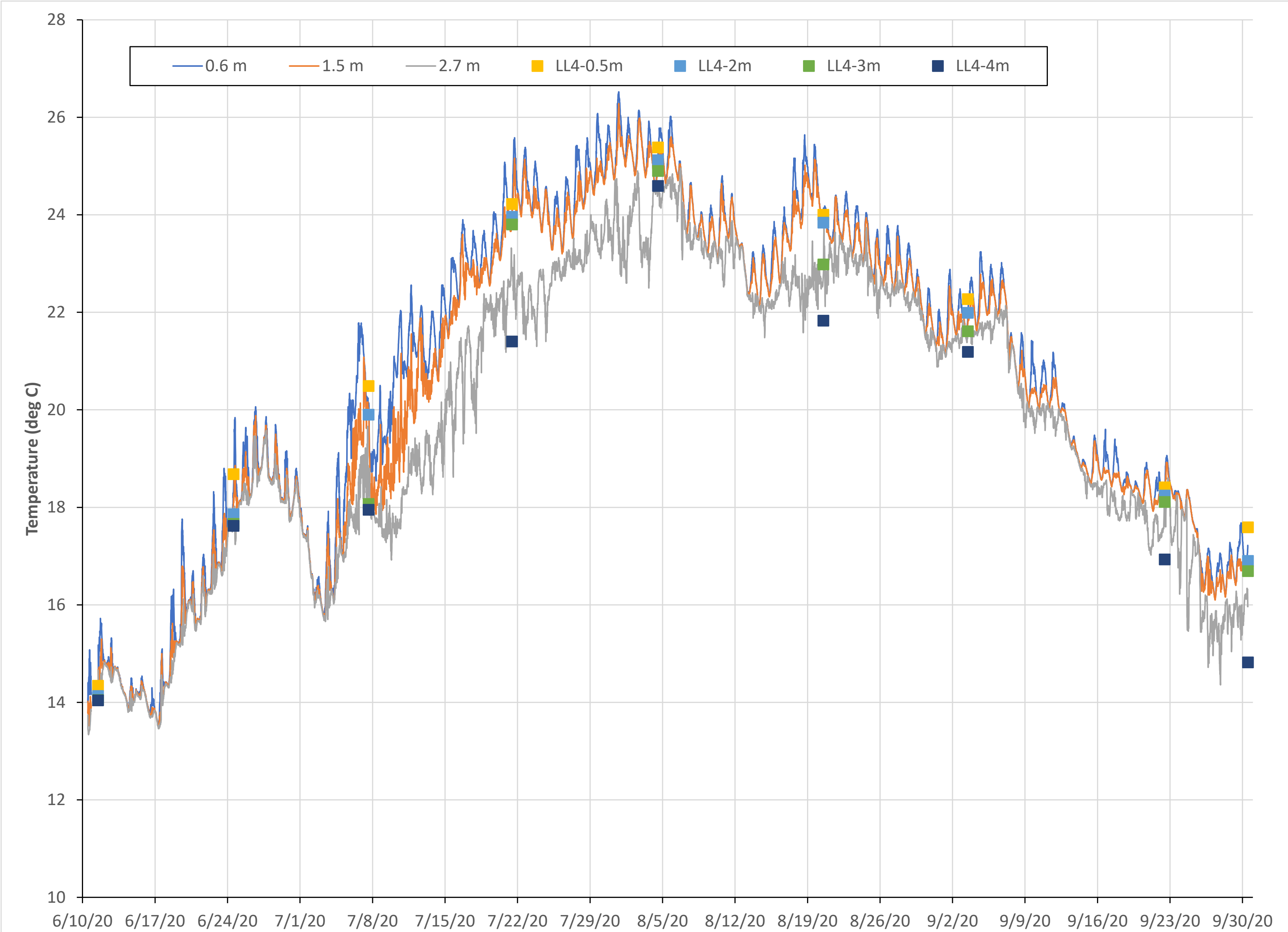


**Figure A35.** Continuous temperature (lines) at station DAILY C and regular profile sampling at LL4 (squares) during June - September 2020.

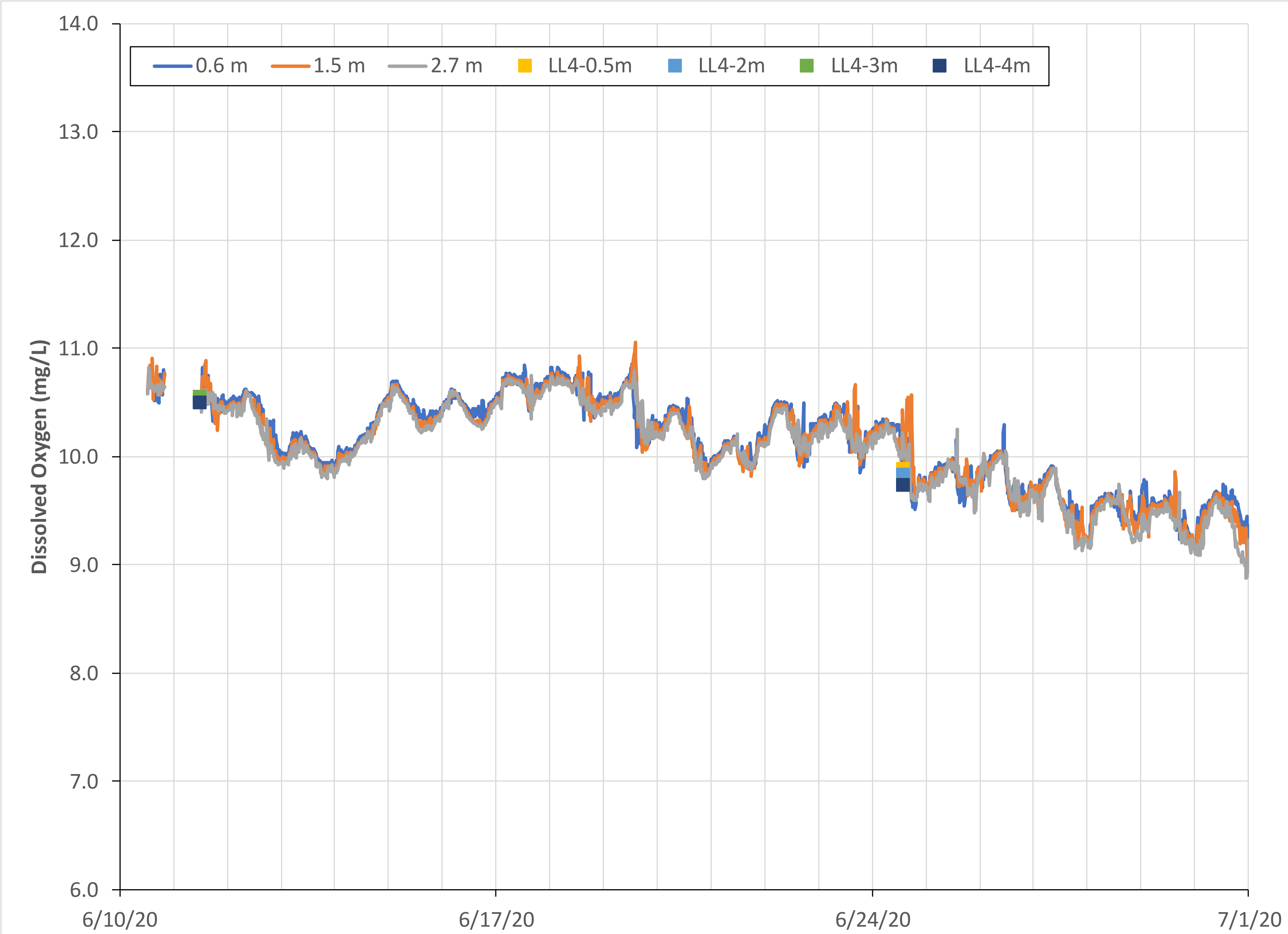


**Figure A36.** Continuous DO (lines) at station DAILY C and regular profile sampling at LL4 (squares) during June 2020.

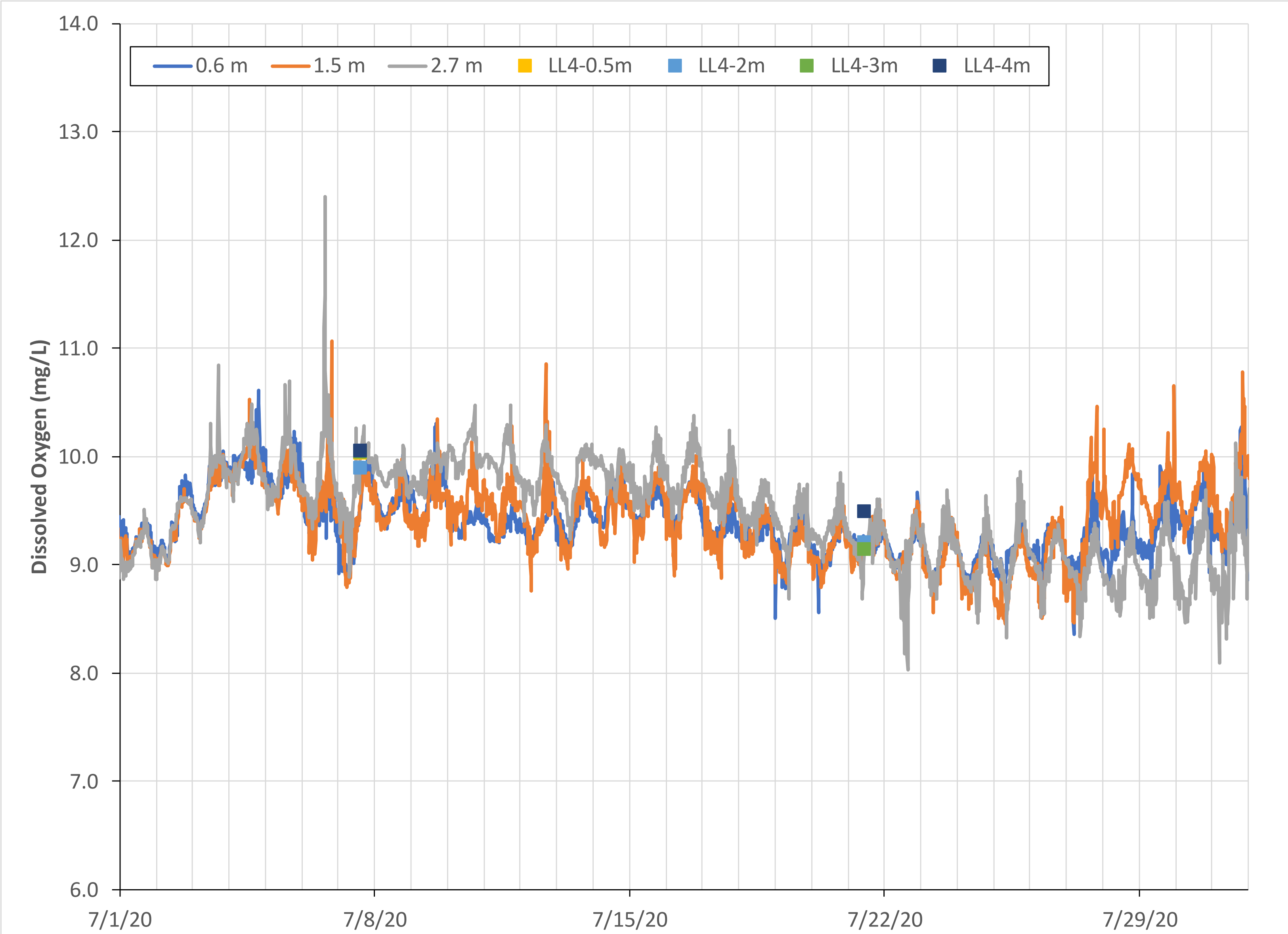


**Figure A37.** Continuous DO (lines) at station DAILY C and regular profile sampling at LL4 (squares) during July 2020.

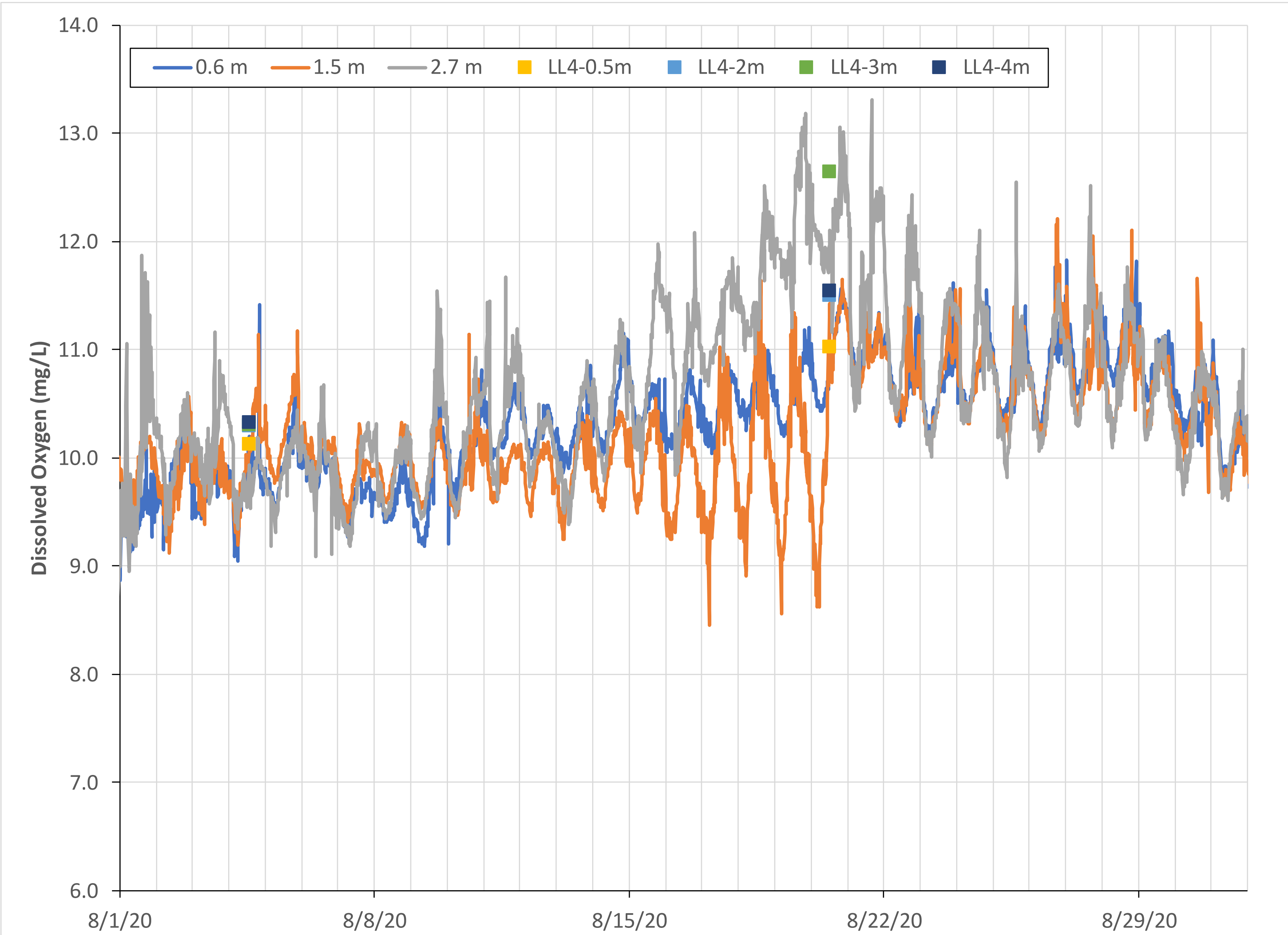


**Figure A38.** Continuous DO (lines) at station DAILY C and regular profile sampling at LL4 (squares) during August 2020.

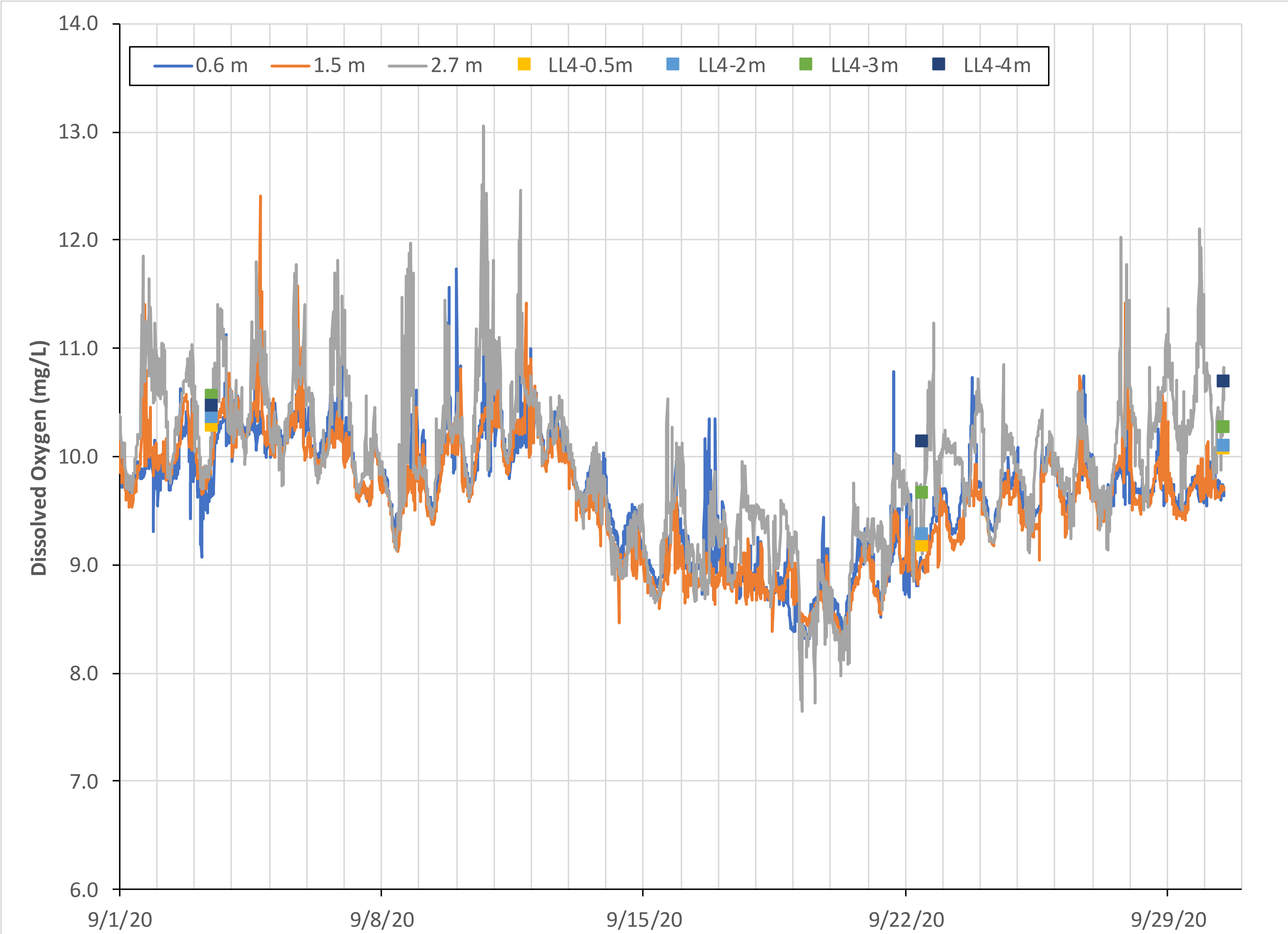


**Figure A39.** Continuous DO (lines) at station DAILY C and regular profile sampling at LL4 (squares) during September 2020.

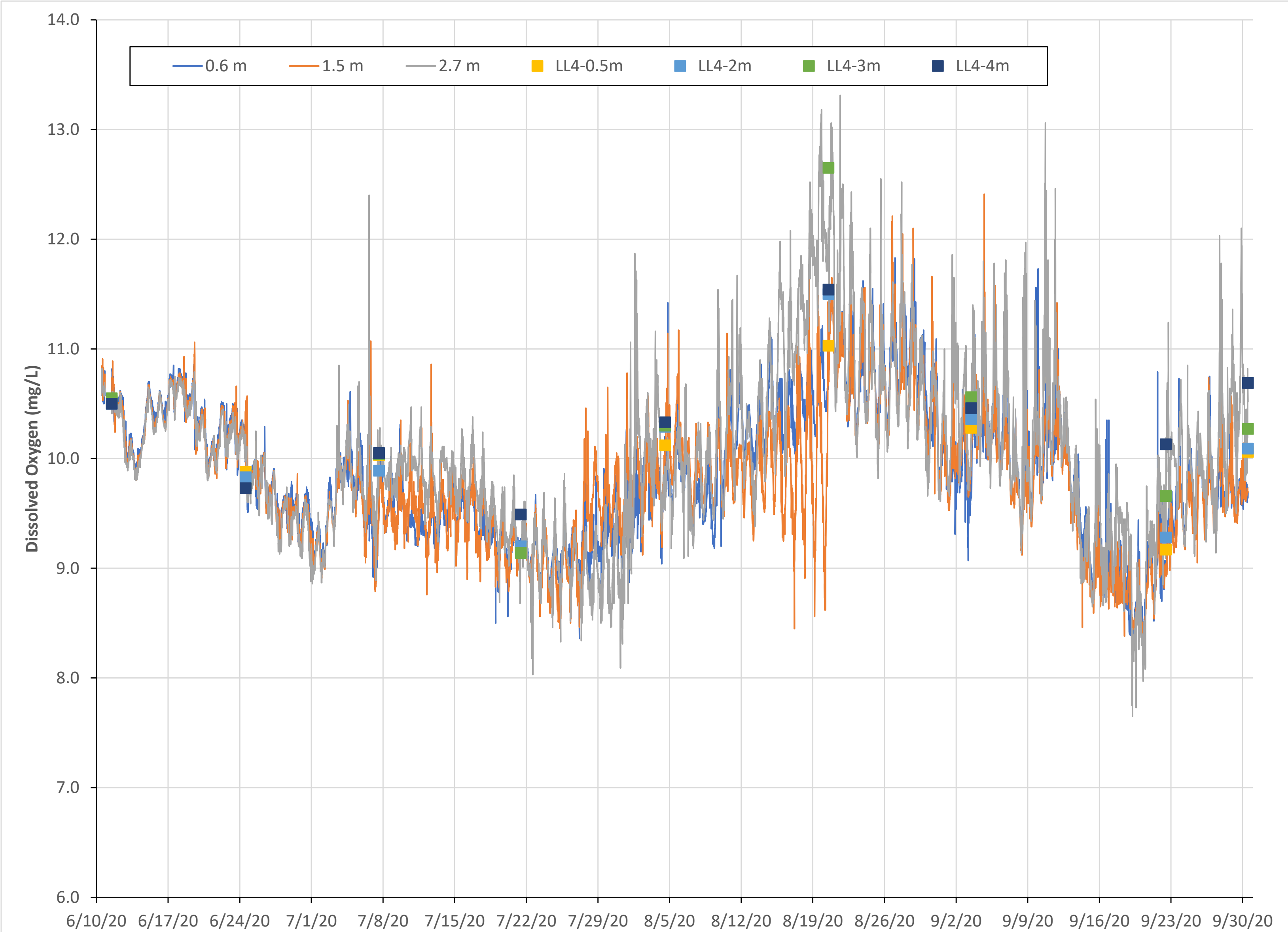


**Figure A40.** Continuous DO (lines) at station DAILY C and regular profile sampling at LL4 (squares) during June - September 2020.

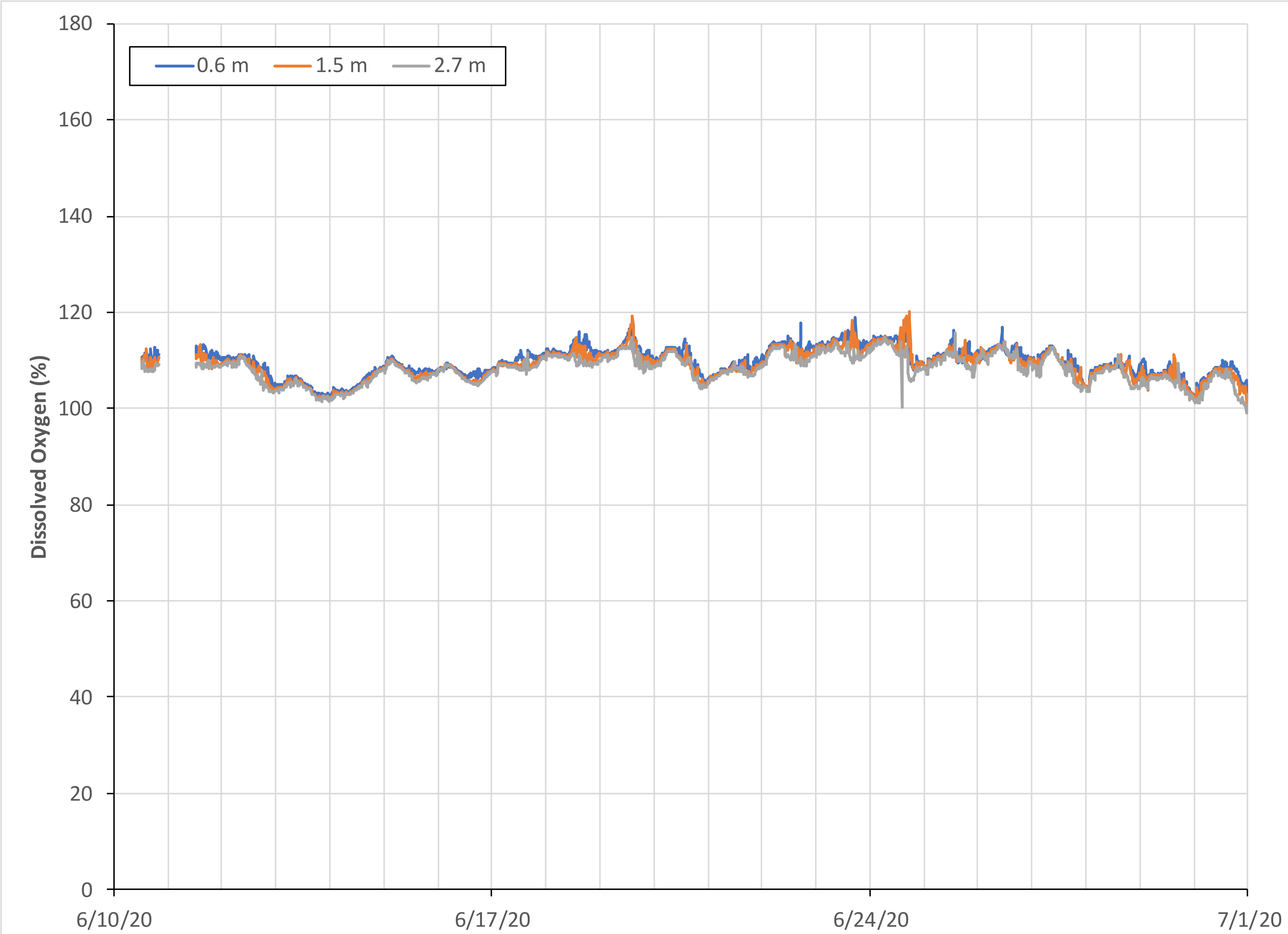


**Figure A41.** Continuous DO percent saturation at station DAILY C during June 2020.

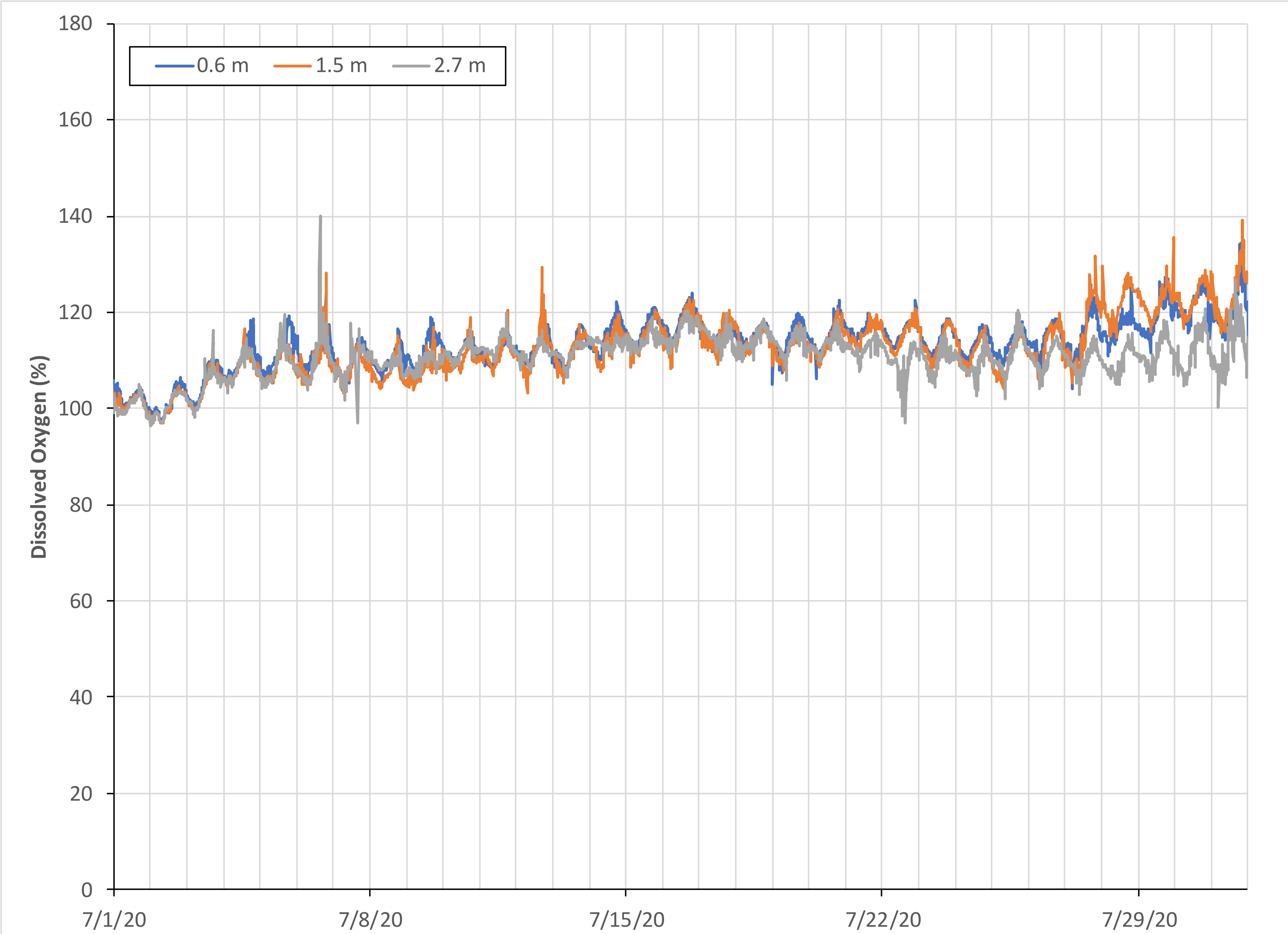


**Figure A42.** Continuous DO percent saturation at station DAILY C during July 2020.

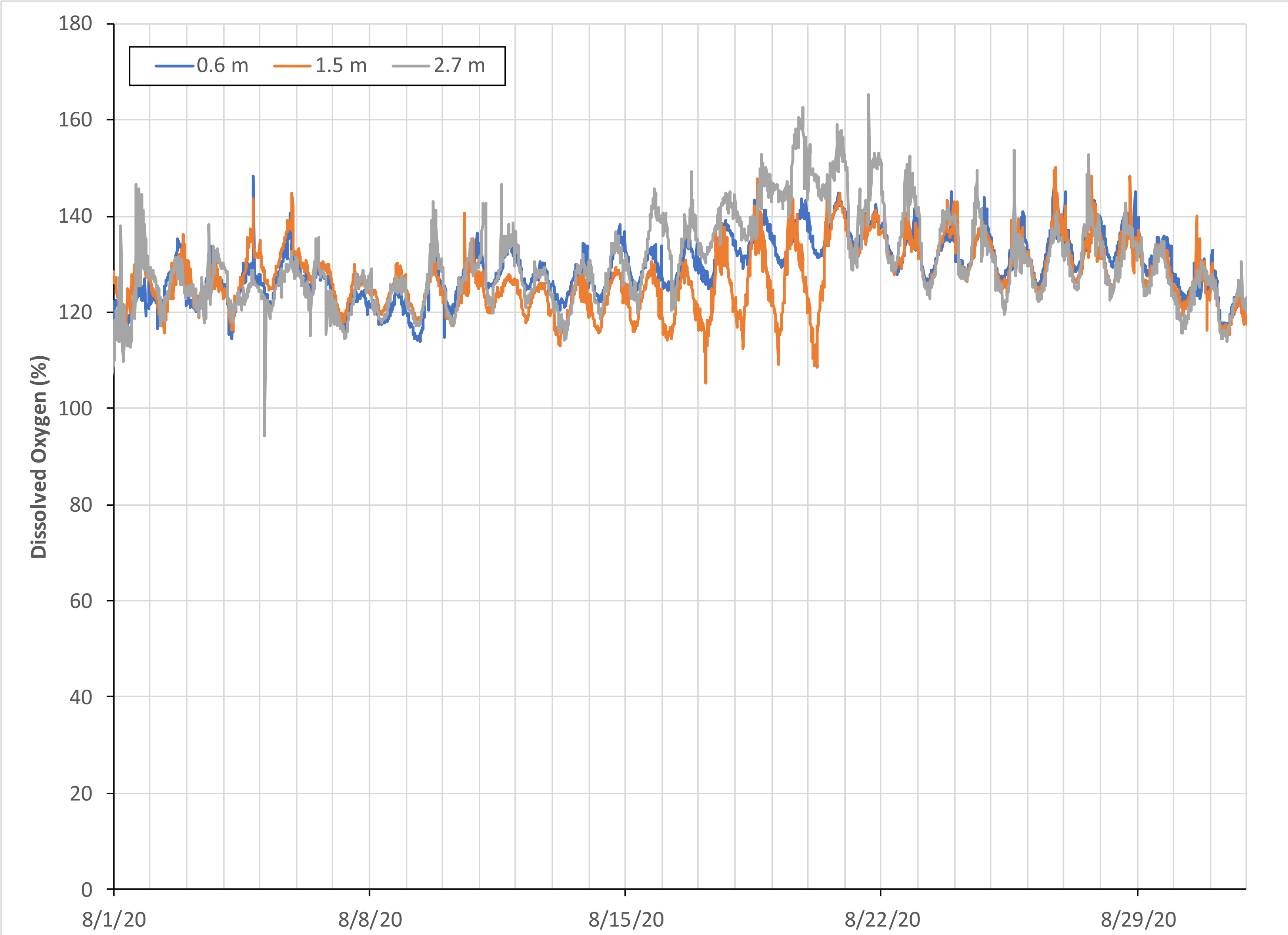


**Figure A43.** Continuous DO percent saturation at station DAILY C during August 2020.

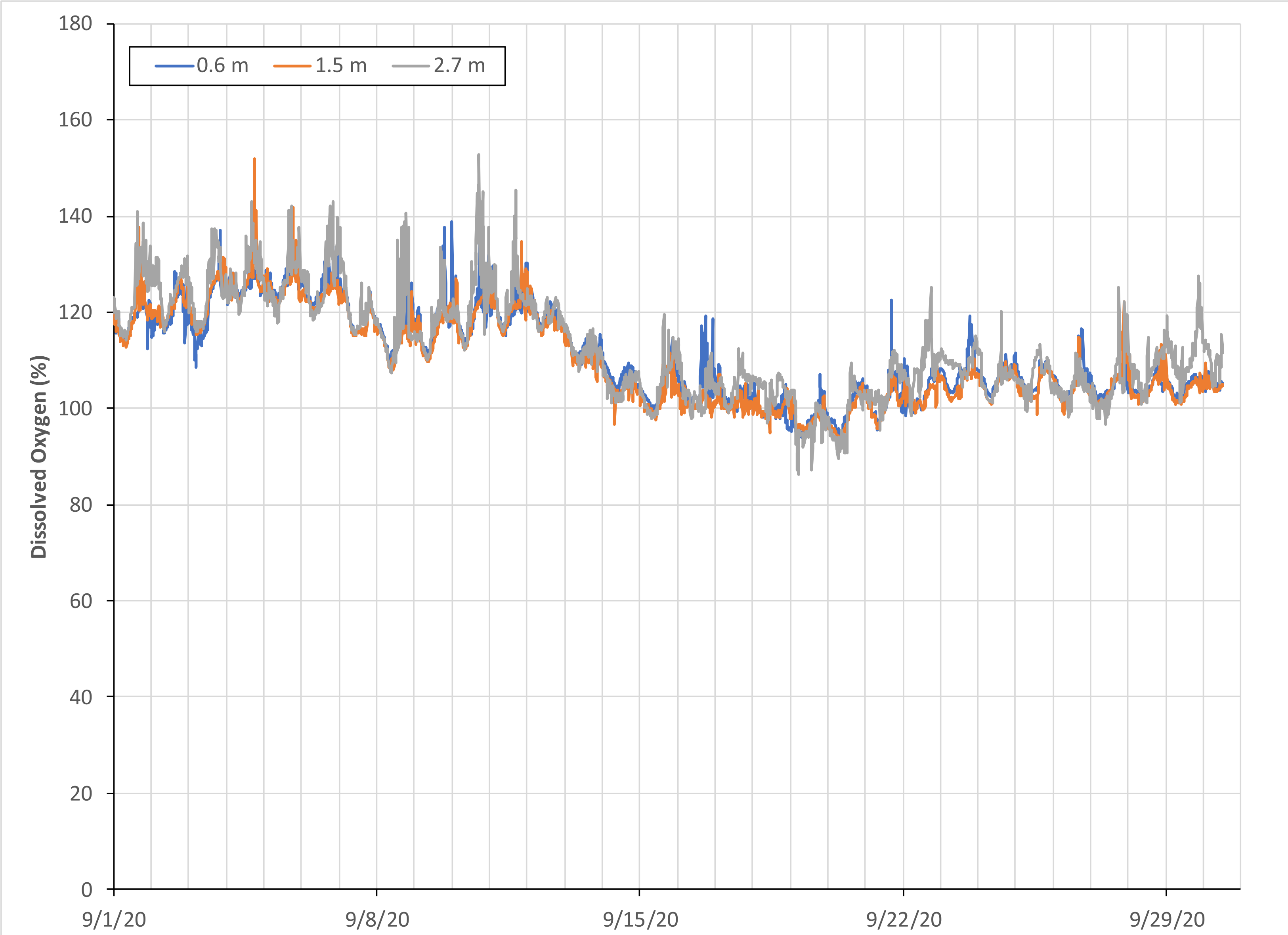


**Figure A44.** Continuous DO percent saturation at station DAILY C during September 2020.

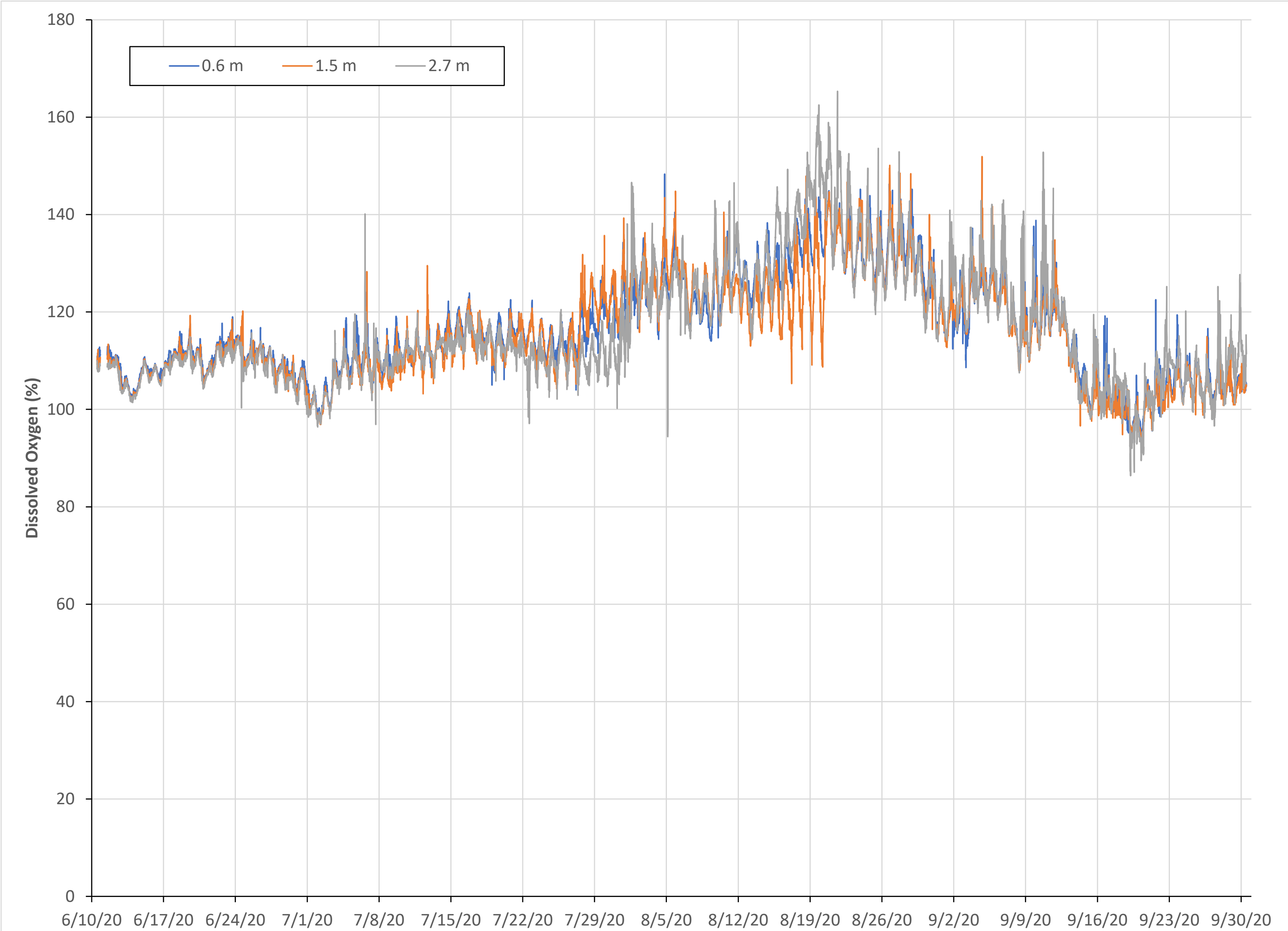


**Figure A45.** Continuous DO percent saturation at station DAILY C during June - September 2020.

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# APPENDIX B

## Floating Wetland Monitoring Data

Table B-1. Site FW-1 i*n situ* water quality data, 2020.

| Date | Depth | Time | Temperature (⁰C) | pH | Conductivity (µs/cm) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 6/23/2020 | 0.5 | 9:50 AM | 20.69 | 8.18 | 96.9 | 10.39 |
| 6/23/2020 | 1 | | 20.66 | 8.2 | 97 | 10.4 |
| 6/23/2020 | 2 | | 20 | 8.31 | 99.7 | 10.93 |
| 7/1/2020 | 0.5 | 8:12 AM | 20.65 | 7.95 | 120.9 | 9.5 |
| 7/1/2020 | 1 | | 20.69 | 8.05 | 120.8 | 9.5 |
| 7/1/2020 | 2 | | 20.71 | 8.09 | 121.1 | 9.52 |
| 7/14/2020 | 0.5 | 10:00 AM | 21.05 | 8.05 | 136.5 | |
| 7/14/2020 | 1 | | 20.92 | 8.08 | 136.7 | |
| 7/14/2020 | 2 | | 20.89 | 8.08 | 136.6 | |
| 8/11/2020 | 0.5 | 8:15 AM | 22.89 | 8.28 | 167.5 | 9.12 |
| 8/11/2020 | 1 | | 22.87 | 8.35 | 167.7 | 9.17 |
| 8/11/2020 | 2 | | 22.85 | 8.36 | 167.7 | 9.19 |
| 8/27/2020 | 0.5 | 9:30 AM | 22.07 | 8.77 | 190 | |
| 8/27/2020 | 1 | | 22.11 | 8.77 | 190 | |
| 8/27/2020 | 2 | | 22.11 | 8.74 | 190 | |
| 9/10/2020 | 0.5 | 8:55 AM | 19.86 | 8.58 | 212 | 8.98 |
| 9/10/2020 | 1 | | 19.95 | 8.6 | 212 | 8.98 |
| 9/10/2020 | 2 | | 19.89 | 8.61 | 212 | 9.01 |
| 9/23/2020 | 0.5 | 9:45 AM | 18.59 | 8.39 | 226 | 8.75 |
| 9/23/2020 | 1 | | 18.59 | 8.44 | 226 | 8.78 |
| 9/23/2020 | 2 | | 18.59 | 8.42 | 226 | 8.76 |

Table B-2. Site FW-2 i*n situ* water quality data, 2020.

| Date | Depth | Time | Temperature (⁰C) | pH | Conductivity (µs/cm) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 6/23/2020 | 0.5 | 9:50 AM | 20.71 | 8.25 | 97.2 | 10.39 |
| 6/23/2020 | 1 | | 20.67 | 8.25 | 97.3 | 10.46 |
| 6/23/2020 | 2 | | 20.36 | 8.3 | 98.8 | 10.7 |
| 7/1/2020 | 0.5 | 8:12 AM | 20.71 | 8.09 | 120.8 | 9.64 |
| 7/1/2020 | 1 | | 20.73 | 8.11 | 121 | 9.59 |
| 7/1/2020 | 2 | | 20.73 | 8.12 | 121.1 | 9.61 |
| 7/14/2020 | 0.5 | 10:00 AM | 21.04 | 8.09 | 136.6 | |
| 7/14/2020 | 1 | | 20.93 | 8.11 | 136.6 | |
| 7/14/2020 | 2 | | 20.89 | 8.12 | 136.7 | |
| 8/11/2020 | 0.5 | 8:15 AM | 22.93 | 8.35 | 168.1 | 9.17 |
| 8/11/2020 | 1 | | 22.88 | 8.37 | 167.8 | 9.19 |
| 8/11/2020 | 2 | | 22.85 | 8.37 | 168 | 9.21 |
| 8/27/2020 | 0.5 | 9:30 AM | 22.11 | 8.8 | 190 | |
| 8/27/2020 | 1 | | 22.08 | 8.8 | 190 | |
| 8/27/2020 | 2 | | 22.12 | 8.78 | 189.5 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9/10/2020 | 0.5 | 8:55 AM | 19.91 | 8.61 | 212 | 9 |
| 9/10/2020 | 1 | | 19.98 | 8.61 | 211 | 8.97 |
| 9/10/2020 | 2 | | 19.97 | 8.61 | 212 | 9.01 |
| 9/23/2020 | 0.5 | 9:45 AM | 18.57 | 8.44 | 226 | 8.77 |
| 9/23/2020 | 1 | | 18.57 | 8.46 | 226 | 8.78 |
| 9/23/2020 | 2 | | 18.57 | 8.42 | 226 | 8.8 |

Table B-3. Site FW-3 i*n situ* water quality data, 2020.

| Date | Depth | Time | Temperature (°C) | pH | Conductivity (µs/cm) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 6/23/2020 | 0.5 | 9:50 AM | 20.72 | 8.26 | 97.5 | 10.37 |
| 6/23/2020 | 1 | | 20.66 | 8.27 | 97.6 | 10.45 |
| 6/23/2020 | 2 | | 20.56 | 8.29 | 97.2 | 10.58 |
| 7/1/2020 | 0.5 | 8:12 AM | 20.68 | 9.52 | 120.7 | 9.52 |
| 7/1/2020 | 1 | | 20.71 | 9.55 | 120.8 | 9.55 |
| 7/1/2020 | 2 | | 20.73 | 9.55 | 121 | 9.55 |
| 7/14/2020 | 0.5 | 10:00 AM | 21.12 | 8.1 | 136.6 | |
| 7/14/2020 | 1 | | 21.01 | 8.11 | 136.7 | |
| 7/14/2020 | 2 | | 20.9 | 8.12 | 136.6 | |
| 8/11/2020 | 0.5 | 8:15 AM | 22.99 | 8.36 | 168 | 9.18 |
| 8/11/2020 | 1 | | 22.92 | 8.37 | 168.1 | 9.2 |
| 8/11/2020 | 2 | | 22.86 | 8.37 | 167.9 | 9.21 |
| 8/27/2020 | 0.5 | 9:30 AM | 22.05 | 8.84 | 188 | |
| 8/27/2020 | 1 | | 22.08 | 8.81 | 188 | |
| 8/27/2020 | 2 | | 22.09 | 8.81 | 189 | |
| 9/10/2020 | 0.5 | 8:55 AM | 19.92 | 8.6 | 212 | 9.01 |
| 9/10/2020 | 1 | | 20.04 | 8.6 | 212 | 9.01 |
| 9/10/2020 | 2 | | 20.03 | 8.6 | 211 | 9 |
| 9/23/2020 | 0.5 | 9:45 AM | 18.57 | 8.42 | 226 | 8.79 |
| 9/23/2020 | 1 | | 18.56 | 8.45 | 226 | 8.77 |
| 9/23/2020 | 2 | | 18.57 | 8.44 | 227 | 8.79 |

Table B-4. Site FWREF i*n situ* water quality data, 2020.

| Date | Depth | Time | Temperature (°C) | pH | Conductivity (µs/cm) | DO (mg/L) |
|---|---|---|---|---|---|---|
| 6/23/2020 | 0.5 | 9:50 AM | 20.69 | 8.29 | 97.5 | 10.5 |
| 6/23/2020 | 1 | | 20.65 | 8.29 | 97.2 | 10.45 |
| 6/23/2020 | 2 | | 20.18 | 8.33 | 99.1 | 10.75 |
| 7/1/2020 | 0.5 | 8:12 AM | 20.72 | 8.09 | 120.7 | 9.7 |
| 7/1/2020 | 1 | | 20.71 | 8.12 | 121 | 9.63 |
| 7/1/2020 | 2 | | 20.72 | 8.13 | 121.1 | 9.64 |
| 7/14/2020 | 0.5 | 10:00 AM | 21.08 | 8.11 | 136.6 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7/14/2020 | 1 | | 20.98 | 8.13 | 136.7 | |
| 7/14/2020 | 2 | | 20.88 | 8.14 | 136.6 | |
| 8/11/2020 | 0.5 | 8:15 AM | 22.96 | 8.36 | 167.9 | 9.22 |
| 8/11/2020 | 1 | | 22.92 | 8.37 | 167.9 | 9.23 |
| 8/11/2020 | 2 | | 22.88 | 8.37 | 167.9 | 9.26 |
| 8/27/2020 | 0.5 | 9:30 AM | 22.14 | 8.84 | 189 | |
| 8/27/2020 | 1 | | 22.15 | 8.83 | 189 | |
| 8/27/2020 | 2 | | 22.14 | 8.82 | 190 | |
| 9/10/2020 | 0.5 | 8:55 AM | 20.09 | 8.59 | 212 | 9.01 |
| 9/10/2020 | 1 | | 20.09 | 8.59 | 212 | 9.02 |
| 9/10/2020 | 2 | | 20.06 | 8.59 | 212 | 9.01 |
| 9/23/2020 | 0.5 | 9:45 AM | 18.58 | 8.48 | 226 | 8.79 |
| 9/23/2020 | 1 | | 18.58 | 8.47 | 226 | 8.79 |
| 9/23/2020 | 2 | | 18.59 | 8.49 | 226 | 8.77 |

Figure B-1. Total phosphorus results from FWREF at 1m and beneath the floating wetland structures at 1 m (averaged from 3 locations).

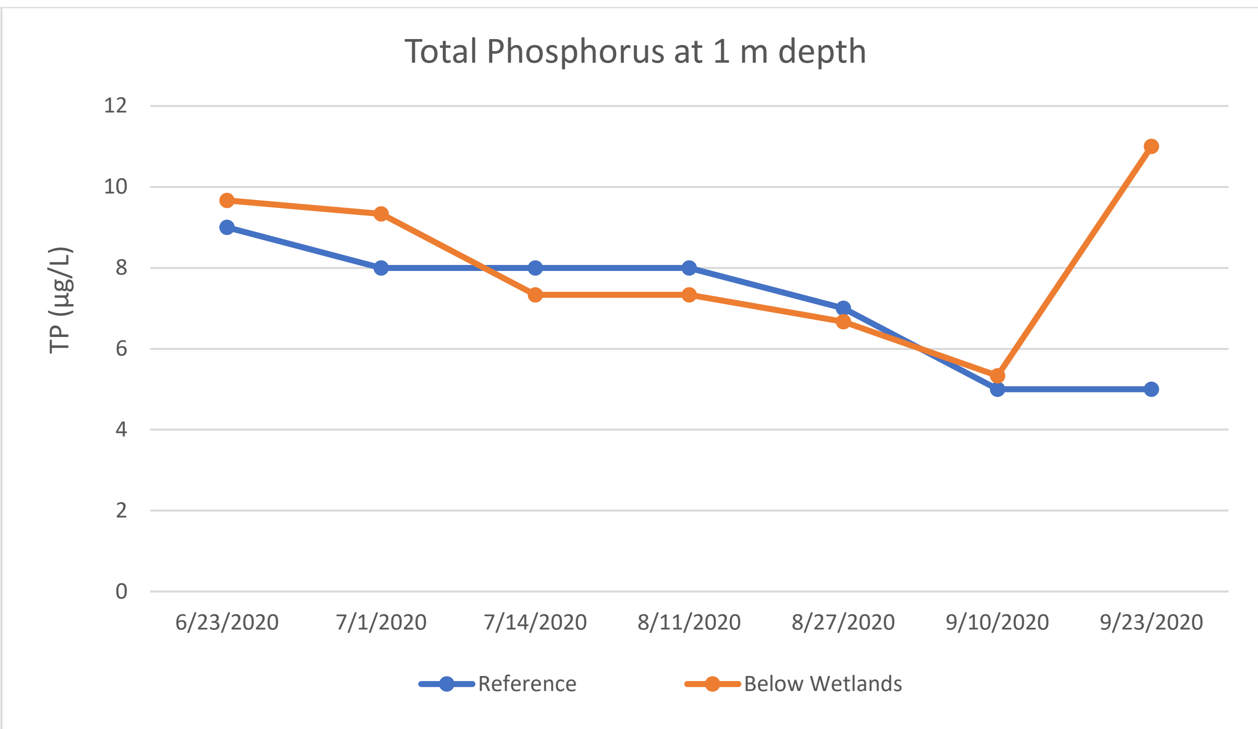


Figure B-2. Total nitrogen and nitrate plus nitrite results from FWREF at 1m and beneath the floating wetland structures at 1 m (averaged from 3 locations).

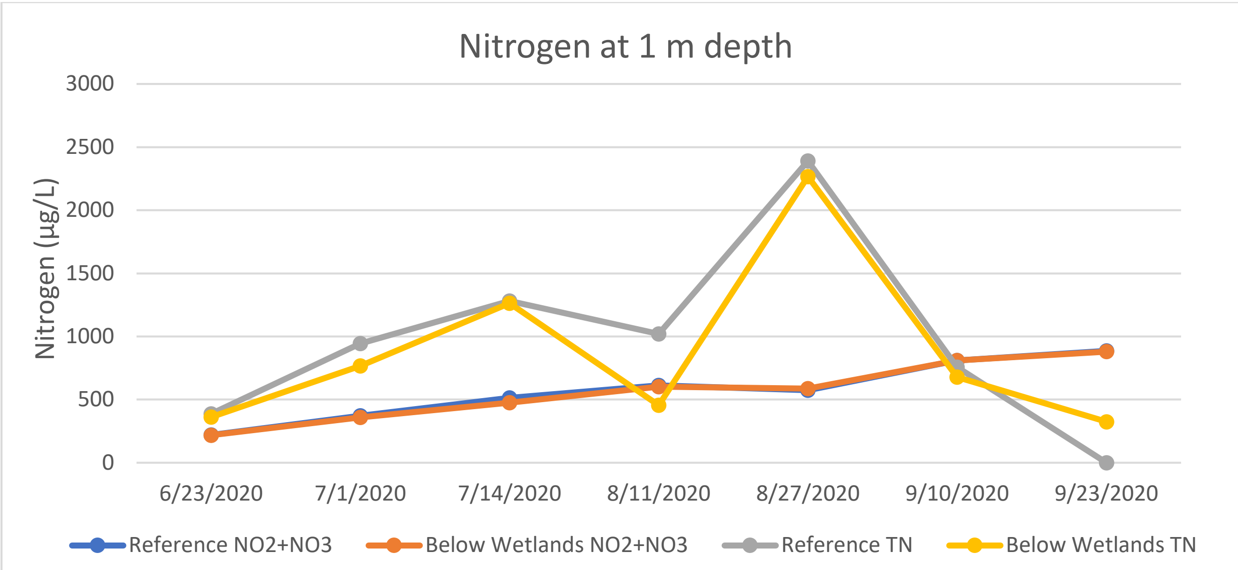



Figure B-3. Chlorophyll a results from FWREF at 1m and beneath the floating wetland structures at 1 m (averaged from 3 locations).

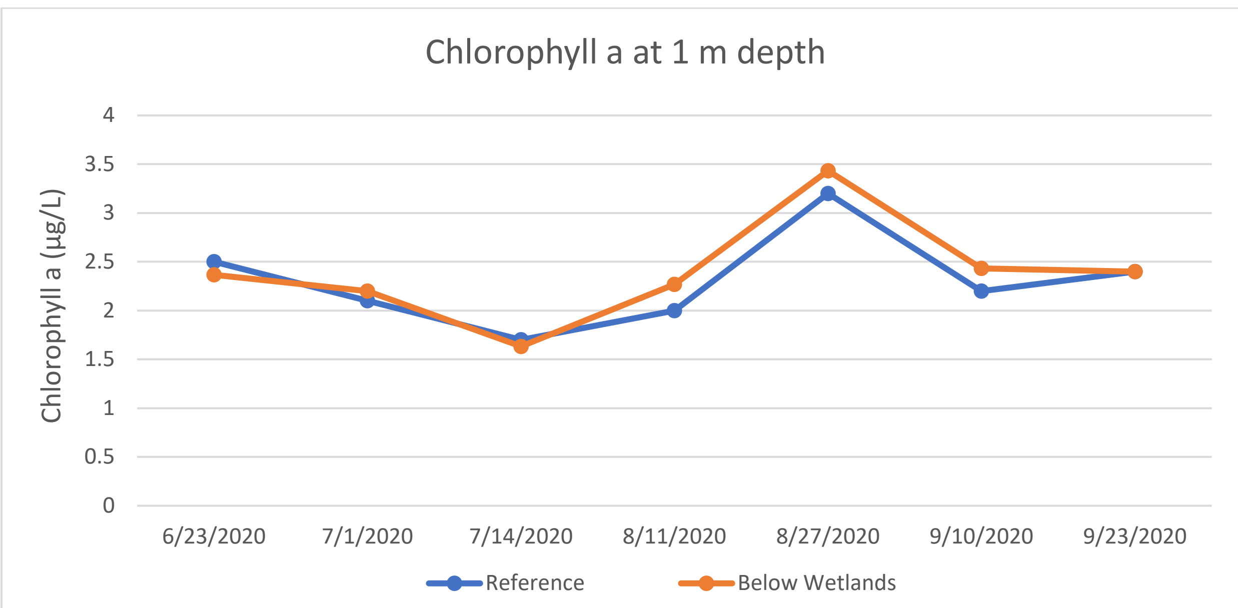
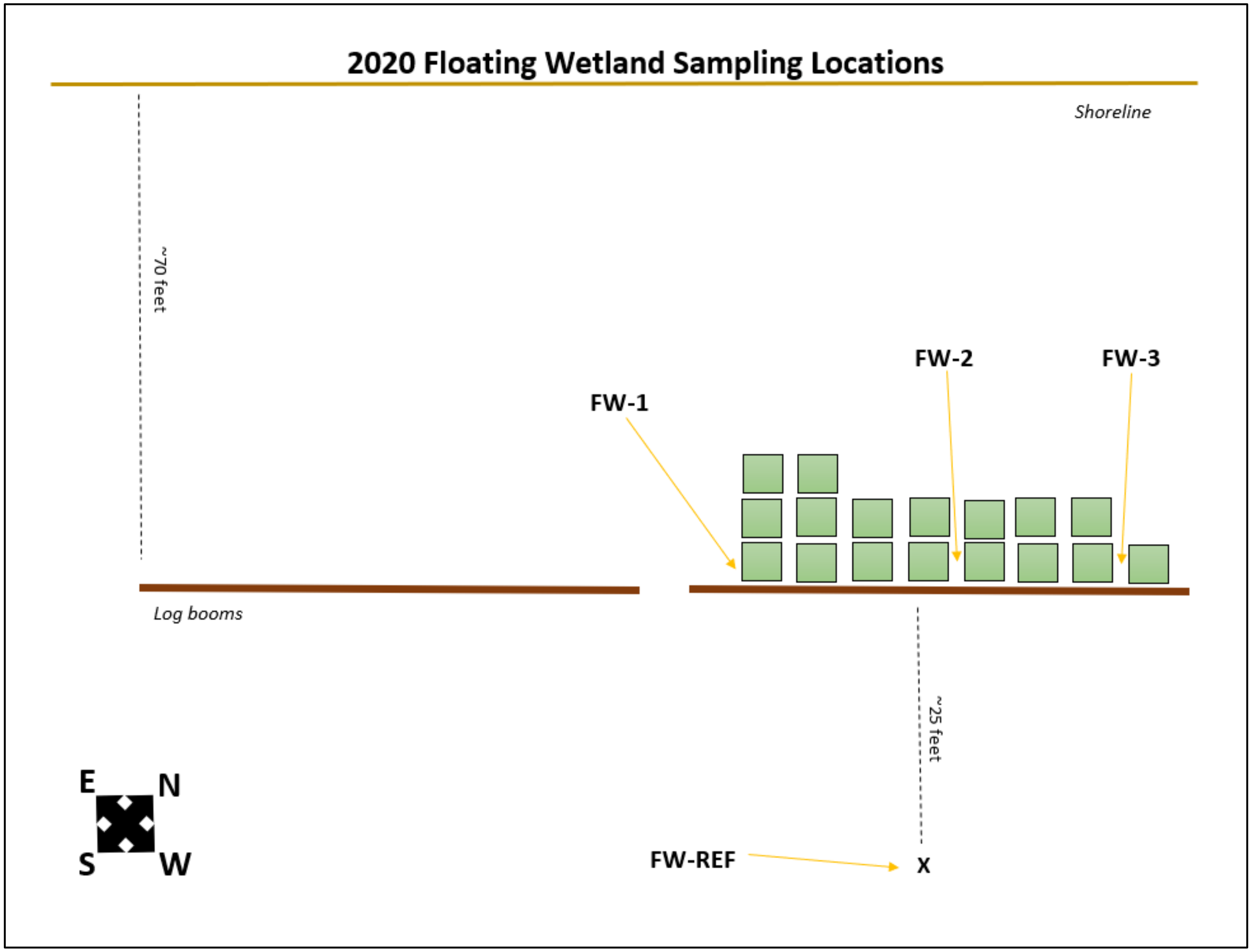


Figure B-4. Floating wetland nutrient sampling and *in situ* monitoring locations, 2020.



# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


| | | | |
|---|---|---|---|
| **CASE FILE NUMBER:** | **1714480** | | **PAGE 1** |
| **REPORT DATE:** | **07/27/20** | | |
| **DATE SAMPLED:** | **06/23/20** | **DATE RECEIVED:** | **06/24/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TOTAL-N (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.012 | 0.215 | 0.364 | 2.4 | <0.1 |
| FW2 | 0.008 | 0.219 | 0.345 | 2.1 | <0.1 |
| FW3 | 0.009 | 0.221 | 0.373 | 2.6 | <0.1 |
| FWREF | 0.009 | 0.220 | 0.388 | 2.5 | <0.1 |

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| | | | |
|---|---|---|---|
| **CASE FILE NUMBER:** | **1714480** | | **PAGE 2** |
| **REPORT DATE:** | **07/27/20** | | |
| **DATE SAMPLED:** | **06/23/20** | **DATE RECEIVED:** | **06/24/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TOTAL-N (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | SM204500NC | SM1810200H | SM1810200H |
| DATE ANALYZED | 06/29/20 | 06/24/20 | 06/30/20 | 06/26/20 | 06/26/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.050 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | BATCH | BATCH |
| ORIGINAL | 0.011 | 0.230 | 0.357 | 6.7 | 0.8 |
| DUPLICATE | 0.011 | 0.232 | 0.355 | 6.7 | 0.8 |
| RPD | 0.96% | 0.87% | 0.58% | 0.00% | 0.00% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | | |
| ORIGINAL | 0.011 | 0.230 | 0.357 | | |
| SPIKED SAMPLE | 0.062 | 0.431 | 1.45 | | |
| SPIKE ADDED | 0.050 | 0.200 | 1.00 | | |
| % RECOVERY | 101.99% | 100.50% | 108.94% | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.091 | 0.400 | 0.484 | | |
| TRUE | 0.094 | 0.408 | 0.499 | | |
| % RECOVERY | 96.81% | 98.04% | 96.99% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.050 | NA | NA |

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


**CASE FILE NUMBER:** **1714656** **PAGE 1**

**REPORT DATE:** **07/27/20**

**DATE SAMPLED:** **07/01/20** **DATE RECEIVED:** **07/02/20**

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.010 | 0.362 | 0.853 | 2.5 | <0.1 |
| FW2 | 0.010 | 0.370 | 0.892 | 2.0 | <0.1 |
| FW3 | 0.008 | 0.347 | 0.556 | 2.1 | <0.1 |
| FWREF | 0.008 | 0.371 | 0.945 | 2.1 | <0.1 |

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**CASE FILE NUMBER:** 1714656 **PAGE 2**
**REPORT DATE:** 07/27/20
**DATE SAMPLED:** 07/01/20 **DATE RECEIVED:** 07/02/20
**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 07/13/20 | 07/02/20 | 07/09/20 | 07/07/20 | 07/07/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | BATCH | BATCH |
| ORIGINAL | 0.009 | 0.018 | 87.9 | 13 | <0.1 |
| DUPLICATE | 0.009 | 0.019 | 82.8 | 14 | <0.1 |
| RPD | 3.71% | 6.73% | 5.99% | 4.88% | NC |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | | |
| ORIGINAL | 0.009 | 0.018 | 87.9 | | |
| SPIKED SAMPLE | 0.060 | 0.222 | 109 | | |
| SPIKE ADDED | 0.050 | 0.200 | 20.0 | | |
| % RECOVERY | 101.85% | 102.11% | 104.26% | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.098 | 0.404 | 6.06 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 104.26% | 99.02% | 103.59% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

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| | | | |
|---|---|---|---|
| **CASE FILE NUMBER:** | **1714968** | | **PAGE 1** |
| **REPORT DATE:** | **07/27/20** | | |
| **DATE SAMPLED:** | **07/14/20** | **DATE RECEIVED:** | **07/15/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.006 | 0.463 | 1.20 | 1.4 | <0.1 |
| FW2 | 0.008 | 0.484 | 1.33 | 1.5 | <0.1 |
| FW3 | 0.008 | 0.481 | 1.26 | 2.0 | <0.1 |
| FWREF | 0.008 | 0.513 | 1.28 | 1.7 | <0.1 |

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|---|---|---|---|
| **CASE FILE NUMBER:** | **1714968** | | **PAGE 2** |
| **REPORT DATE:** | **07/27/20** | | |
| **DATE SAMPLED:** | **07/14/20** | **DATE RECEIVED:** | **07/15/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 07/20/20 | 07/16/20 | 07/21/20 | 07/20/20 | 07/20/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | BATCH | BATCH |
| ORIGINAL | 0.009 | 0.125 | 131 | 6.0 | 7.5 |
| DUPLICATE | 0.009 | 0.127 | 132 | 5.0 | 6.7 |
| RPD | 2.03% | 2.29% | 0.69% | 18.31% | 11.21% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | | |
| ORIGINAL | 0.009 | 0.125 | 131 | | |
| SPIKED SAMPLE | 0.062 | 0.349 | 151 | | |
| SPIKE ADDED | 0.050 | 0.200 | 20.0 | | |
| % RECOVERY | 106.26% | 112.33% | 99.30% | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.097 | 0.429 | 6.10 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 103.19% | 105.13% | 104.27% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

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| | | | |
|---|---|---|---|
| **CASE FILE NUMBER:** | **1715718** | | **PAGE 1** |
| **REPORT DATE:** | **10/20/20** | | |
| **DATE SAMPLED:** | **08/11/20** | **DATE RECEIVED:** | **08/12/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.007 | 0.591 | 0.520 | 2.3 | <0.1 |
| FW2 | 0.008 | 0.605 | 0.437 | 2.2 | <0.1 |
| FW3 | 0.007 | 0.614 | 0.407 | 2.3 | <0.1 |
| FWREF | 0.008 | 0.613 | 1.02 | 2.0 | <0.1 |

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| | | |
|---|---|---|
| **CASE FILE NUMBER:** | **1715718** | **PAGE 2** |
| **REPORT DATE:** | **10/20/20** | |
| **DATE SAMPLED:** | **08/11/20** | **DATE RECEIVED: 08/12/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 08/17/20 | 08/12/20 | 08/13/20 | 08/14/20 | 08/14/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | BATCH | BATCH |
| ORIGINAL | 0.009 | 0.211 | 97.6 | 4.9 | 7.3 |
| DUPLICATE | 0.009 | 0.212 | 98.1 | 5.8 | 7.0 |
| RPD | 1.00% | 0.31% | 0.53% | 16.67% | 3.75% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | | |
| ORIGINAL | 0.009 | 0.211 | | | |
| SPIKED SAMPLE | 0.066 | 0.407 | | | |
| SPIKE ADDED | 0.050 | 0.200 | | | |
| % RECOVERY | 113.69% | 97.91% | OR | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.094 | 0.409 | 5.82 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 100.00% | 100.25% | 99.49% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


**CASE FILE NUMBER:** 1716177 **PAGE 1**

**REPORT DATE:** 10/20/20

**DATE SAMPLED:** 08/27/20 **DATE RECEIVED:** 08/28/20

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.007 | 0.576 | 5.56 | 3.2 | <0.1 |
| FW2 | 0.006 | 0.592 | 0.602 | 3.7 | 0.2 |
| FW3 | 0.007 | 0.597 | 0.637 | 3.4 | <0.1 |
| FWREF | 0.007 | 0.574 | 2.39 | 3.2 | <0.1 |

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**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

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|---|---|---|---|---|
| **CASE FILE NUMBER:** | **1716177** | | **PAGE 2** | |
| **REPORT DATE:** | **10/20/20** | | | |
| **DATE SAMPLED:** | **08/27/20** | **DATE RECEIVED:** | **08/28/20** | |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 09/08/20 | 08/28/20 | 09/02/20 | 08/31/20 | 08/31/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | FWREF | BATCH | BATCH | BATCH |
| ORIGINAL | 0.007 | 0.574 | 114 | 18 | 2.8 |
| DUPLICATE | 0.007 | 0.588 | 116 | 18 | 2.5 |
| RPD | 0.85% | 2.40% | 1.58% | 0.00% | 10.49% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | FWREF | BATCH | | |
| ORIGINAL | 0.007 | 0.574 | | | |
| SPIKED SAMPLE | 0.055 | 0.773 | | | |
| SPIKE ADDED | 0.050 | 0.200 | | | |
| % RECOVERY | 96.27% | 99.37% | OR | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.095 | 0.392 | 5.53 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 101.06% | 96.08% | 94.53% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

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OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


**CASE FILE NUMBER:** **1716583** 

**REPORT DATE:** **10/20/20**

**DATE SAMPLED:** **09/10/20** **DATE RECEIVED:** **09/11/20**

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.006 | 0.810 | 0.976 | 2.7 | 0.1 |
| FW2 | 0.005 | 0.808 | 0.606 | 2.7 | <0.1 |
| FW3 | 0.005 | 0.813 | 0.456 | 1.9 | 0.4 |
| FWREF | 0.005 | 0.809 | 0.758 | 2.2 | <0.1 |

# IEH ANALYTICAL LABORATORIES

**LABORATORY & CONSULTING SERVICES**

**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


**CASE FILE NUMBER:** 1716583 

**REPORT DATE:** 10/20/20

**DATE SAMPLED:** 09/10/20 **DATE RECEIVED:** 09/11/20

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 09/22/20 | 09/12/20 | 09/21/20 | 09/16/20 | 09/16/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | BATCH | BATCH |
| ORIGINAL | 0.025 | <0.010 | 68.5 | 7.5 | 11 |
| DUPLICATE | 0.025 | <0.010 | 67.3 | 6.9 | 12 |
| RPD | 1.46% | NC | 1.76% | 7.41% | 4.65% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | BATCH | | |
| ORIGINAL | 0.025 | <0.010 | | | |
| SPIKED SAMPLE | 0.078 | 0.204 | | | |
| SPIKE ADDED | 0.050 | 0.200 | | | |
| % RECOVERY | 106.20% | 102.22% | OR | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.097 | 0.402 | 5.61 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 103.19% | 98.53% | 95.90% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

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OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# IEH ANALYTICAL LABORATORIES

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|---|---|---|---|
| **CASE FILE NUMBER:** | **1717097** | | **PAGE 1** |
| **REPORT DATE:** | **10/20/20** | | |
| **DATE SAMPLED:** | **09/23/20** | **DATE RECEIVED:** | **09/24/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**CASE NARRATIVE**

Four water samples were received by the laboratory in good condition and analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

**SAMPLE DATA**

| SAMPLE ID | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| FW1 | 0.012 | 0.871 | 0.389 | 2.1 | 0.3 |
| FW2 | 0.014 | 0.876 | 0.245 | 2.7 | <0.1 |
| FW3 | 0.007 | 0.892 | 0.341 | 2.4 | 0.4 |
| FWREF | 0.005 | 0.886 | <0.200 | 2.4 | <0.1 |

# IEH ANALYTICAL LABORATORIES

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**3927 AURORA AVENUE NORTH, SEATTLE, WA 98103**

**PHONE: (206) 632-2715 FAX: (206) 632-2417**


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|---|---|---|---|
| **CASE FILE NUMBER:** | **1717097** | | **PAGE 2** |
| **REPORT DATE:** | **10/20/20** | | |
| **DATE SAMPLED:** | **09/23/20** | **DATE RECEIVED:** | **09/24/20** |

**FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM AVISTA**

**QA/QC DATA**

| QC PARAMETER | TOTAL-P (mg/L) | N03+N02 (mg/L) | TKN (mg/L) | CHLOR_a (ug/L) | PHAEO_a (ug/L) |
|---|---|---|---|---|---|
| METHOD | SM18 4500PF | SM184500N03F | EPA 351.1 | SM1810200H | SM1810200H |
| DATE ANALYZED | 10/06/20 | 09/25/20 | 09/30/20 | 09/30/20 | 09/30/20 |
| DETECTION LIMIT | 0.002 | 0.010 | 0.200 | 0.1 | 0.1 |
| DUPLICATE | | | | | |
| SAMPLE ID | BATCH | BATCH | FW REF | BATCH | BATCH |
| ORIGINAL | 0.011 | 0.096 | <0.200 | 2.7 | 2.9 |
| DUPLICATE | 0.011 | 0.097 | <0.200 | 2.4 | 3.0 |
| RPD | 1.47% | 0.48% | NC | 11.76% | 2.99% |
| SPIKE SAMPLE | | | | | |
| SAMPLE ID | BATCH | BATCH | FW REF | | |
| ORIGINAL | 0.011 | 0.096 | <0.200 | | |
| SPIKED SAMPLE | 0.061 | 0.290 | 1.77 | | |
| SPIKE ADDED | 0.050 | 0.200 | 2.00 | | |
| % RECOVERY | 100.53% | 97.00% | 88.50% | NA | NA |
| QC CHECK | | | | | |
| FOUND | 0.094 | 0.406 | 5.34 | | |
| TRUE | 0.094 | 0.408 | 5.85 | | |
| % RECOVERY | 100.00% | 99.51% | 91.28% | NA | NA |
| BLANK | <0.002 | <0.010 | <0.200 | NA | NA |

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OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Damien Gadomski

Damien Gadomski, PhD
Laboratory Manager

# APPENDIX C

## Avista 2020 Water Quality Article

Avista Connections

# Protecting the health of our waterways

The Spokane River provides us all with clean and affordable electricity, and much more, including a home for fish, habitat for wildlife and opportunities for recreation. We are committed to helping protect and enhance the health of the river. One way we work toward that end is in our fishery efforts in the river and nearby lakes.

Avista's Long Lake Dam creates the reservoir known as Lake Spokane, a great place to swim, boat, fish and live. As part of our operations on Lake Spokane, we monitor the water, particularly the fluctuation of oxygen and temperature. This helps us better understand conditions important to the fish who live in the lake.

Lake Spokane is managed to promote both warm water and cold-water fish, and to support sports fishing and native fish restoration. “Cold water fish, such as trout, are looking for water with cooler temperatures and high oxygen levels. That’s the sweet spot,” said Monica Ott, environmental scientist with Avista. “To better understand their preferred areas we are exploring temperature and oxygen levels available in the shallower areas of the lake.”

Avista has monitored Lake Spokane for more than 10 years, in partnership with the Washington Department of Ecology. This year we implemented a new technique using automated recorders affixed to buoys at three different locations on the lake. This allows us to get readings of temperature and oxygen every 15 minutes, at varying depths.

Staff visit each buoy every other week throughout the summer and download the data, which we share with the Department of Ecology. Additionally, staff visit other baseline locations on the lake, from which we have recorded data for the past decade and capture manual readings. At those sites, Monica measures temperature, pH, conductivity and oxygen from the bottom of the lake to the surface.

“It gives us a vertical profile of the water column and allows us to compare data so that its relevant to our past data.”

In 2012, Avista initiated a 10-year plan to improve total dissolved oxygen in Lake Spokane. The data Monica collects helps us better understand the number of factors that contribute to the lake’s health.

One effort Avista has undertaken with the Washington Department of Fish and Wildlife to improve the lakes health is carp removal. Carp, an invasive species, often uproot and disturb vegetation, ultimately reducing oxygen levels in the lake. By removing carp, there are fewer invasive species competing with native species for the same habitat. In addition, excess phosphorus is removed from the watershed, which improve oxygen levels.

Another mitigation effort is a bulkhead removal program. Avista works with agency stakeholders and landowners to restore lakefront property to a more natural shoreline, to reduce erosion, add shoreline habitat and improve water quality on the lake.

Education is also key. “We want to let people know what water quality means, how dissolved oxygen gets improved and what they can do to make a difference,” said

Monica. Partnering with state agencies and local homeowners, Avista is one of many stakeholders who have an impact on the lake. “We’re all in this together,” she said.

---

**To learn more about how you can help improve dissolved oxygen in Lake Spokane, check out the Avista educational videos.**

Shoreline health

**Tags:**
Rivers

**Share**

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# APPENDIX D

## Agency Consultation

AVISTA
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220-3727

January 29, 2021

Jordan Bauer, Water Quality Program
Washington Department of Ecology
Eastern Regional Office
4601 N Monroe Street
Spokane, WA 99205-1295

**Subject: Lake Spokane Dissolved Oxygen Water Quality Attainment Plan, 2020 Annual Summary Report**

Dear Jordan:

I have enclosed the Lake Spokane Dissolved Oxygen Water Quality Attainment 2020 Annual Summary Report (Annual Report) for your review and approval. The Annual Report was completed in accordance with the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), required by the Spokane River Hydroelectric Project License (License) Appendix B, Section 5.6.C of the Washington Department of Ecology (Ecology) Section 401 Water Quality Certification.

The Annual Report provides a summary of the 2020 monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions for the upcoming year.

As we discussed in our January 21 meeting, Avista has collected baseline nutrient monitoring from 2010-2018. Over this timeframe we have covered the full spectrum of flows that are likely to exist in the Spokane River under current license conditions. As such, no lake monitoring is proposed for 2021. Avista will continue discussions with Ecology concerning future monitoring efforts, in coordination with Ecology's Dissolved Oxygen TMDL 10-Year Assessment.

Avista will continue to implement the carp removal program in Lake Spokane in 2021. Similar to 2020, Avista will partner with Washington Department of Fish and Wildlife (WDFW) targeting an approximate five-week sampling event during spring spawning. Additionally, in 2021 Avista will continue to summarize phosphorus removal and work with Ecology to determine the credits acquired through implementing the reasonable and feasible measures outlined in the DO WQAP.

We would appreciate your review of the Annual Report by **March 1, 2021**. This will allow us time to incorporate your comments and recommendations, if you have any, and submit it to the Federal Energy Regulatory Commission by **April 1, 2021**.

Please feel free to call me at (509) 495-4651 if you have any questions about the Annual Report.

Sincerely,

Monica Ott

Monica Ott
Water Quality Specialist
Enclosure (1)

cc: Chad Atkins, Ecology
Chad Brown, Ecology
Meghan Lunney, Avista

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
*4601 N. Monroe Street • Spokane, Washington 99205-1295 • (509) 329-3400*

February 18, 2021

Monica Ott
Avista Corp.
1411 East Mission Avenue
PO Box 3727
Spokane, WA 99220

**RE: Request for Ecology Review and Approval – Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2020 Annual Summary Report – Spokane River FERC Project No. 2545**

Dear Monica Ott:

The Department of Ecology (Ecology) has reviewed Avista's submittal of the "2020 Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2020 Annual Summary Report". This report was received by Ecology on January 29, 2021, via email. The report was completed in accordance with the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), required by Section 5.6 (C) of Ecology's 401 Certification (Certification) and consistent with Spokane River Hydroelectric Project No. 2545 (License) Appendix B.

As was noted in 2020, Ecology remains concerned about progress toward achieving the DO responsibility identified in the Spokane River and Lake Spokane DO Total Maximum Daily Load and the DO WQAP. It will be important for discussions on quantifying total phosphorus (TP) reductions to-date as well as reduction strategies to continue in 2021. Furthermore, we suggest providing footnote information for Table 2 to explain the difference between the TP removed in 2017 and 2020 given the carp collected. It appears the total phosphorus removed does not accurately reflect the carp numbers collected for those years given their similarity. Otherwise, Ecology has no additional comments and **approves** the "Lake Spokane DO WQAP 2020 Annual Summary Report."

We look forward to ongoing discussions regarding the DO WQAP for quantifying TP reduction, attainment of the DO standard, and next steps according to WAC173-201A-510.

Please contact me with any questions at (509) 688-9403 or jordan.bauer@ecy.wa.gov.

Sincerely,

Jordan Bauer
Hydropower Compliance Coordinator
Water Quality Program

JB:red
cc: Meghan Lunney, Avista
Chad Atkins, Ecology
Chad Brown, Ecology

## ECOLOGY COMMENTS AND AVISTA RESPONSES

On February 18, 2021, Ecology provided a comment letter of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan 2020 Summary Report (Report), dated January 29, 2021. Avista's responses to Ecology's comments are provided as follows.

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**Ecology Comment 1:**

As noted in 2020, Ecology remains concerned about progress toward achieving the DO responsibility identified in the Spokane River and Lake Spokane DO Total Maximum Daily Load and the DO WQAP. It will be important for discussions on quantifying total phosphorus (TP) reductions to-date as well as reduction strategies to continue in 2021.

Avista Response

Starting as early as 2008, prior to License and Certification issuance, Avista and Ecology began discussing Avista's proportional level of DO responsibility in Lake Spokane. This included a strategy to reduce nonpoint nutrient sources around Lake Spokane, focusing on total phosphorus removal that would subsequently improve dissolved oxygen. This strategy is first documented in Avista's Potential Reasonable and Feasible Improvements and/or Mitigation Measures for Dissolved Oxygen in Lake Spokane, dated December 28, 2009. Ecology agreed with this strategy, as can be seen in its March 4, 2010 letter to Avista stating "Ecology believes the letter identifies promising potential reasonable and feasible DO improvement measures in advance of a fully developed Water Quality Attainment Plan (WQAP). We also feel there is proper emphasis on nonpoint source control actions on near shore properties and land uses." Ecology adopted this same approach in the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load Water Quality Improvement Report (DO TMDL), revised February 2010, which states that to meet Avista's proportional level of DO responsibility "The preferred method of pollutant reduction is to reduce nonpoint source [phosphorus] contributions to the reservoir by implementing BMPs and pollutant controls on lands that would otherwise directly contribute pollutants to the reservoir."

Pursuant to the 2009 License and Certification issued for Avista's Spokane River Project, in 2012 Avista submitted the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP). The DO WQAP noted that DO had to be converted to phosphorus to quantify the DO benefits of potential reasonable and feasible measures. To make this conversion, the DO WQAP included a trading factor that translated DO deficits into equivalent amounts of phosphorus that would account for the DO deficits identified in the DO TMDL. It also further examined and prioritized nine reasonable and feasible potential measures based on criteria including, but not limited to, calculations of the potential reduction in the total phosphorus load, practicality and frequency of implementation, likelihood of success, DO response time, and longevity of phosphorus load reduction. Ecology and FERC approved this strategy with the approval of the DO WQAP in 2012.

Over the past 10 years, Avista has implemented a variety of these reasonable and feasible measures including wetland acquisition, restoration, and enhancement projects in the watershed, along with other measures (i.e. carp removal) to comply with this total phosphorus load reduction requirement. Based on the DO/phosphorus trading factor set out in the approved DO WQAP, and the reasonable and feasible measures it has implemented since 2013, Avista is confident it has made substantial progress on reducing phosphorus into the lake.

Avista and Ecology have been discussing quantification of the phosphorus reduction benefits of these measures during 2020. Avista looks forward to continued discussions and reaching consensus on the appropriate methodologies utilized for phosphorus reduction quantification during 2021.

**Ecology Comment 2:**

Furthermore, we suggest providing footnote information for Table 2 to explain the difference between the TP removed in 2017 and 2020 given the carp collected. It appears the total phosphorus removed does not accurately reflect the carp numbers collected for those years given their similarity.

### Avista Response

Avista has revised the text to include footnote information and clarification for Table 2.