Water Quality Sampling at Ada Hayden Heritage Park

June 28, 2023, to October 2, 2023

and

March 26, 2024, to October 16, 2024

Prepared by the State Hygienic Laboratory at the University of Iowa

Limnology Section

for the

City of Ames

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Coralville
UI Research Park
2490 Crosspark Road
Coralville, Iowa 52241-4721
Phone 319-335-4500
Phone 800-421-IOWA

Ankeny
Iowa Laboratories Facility
2220 South Ankeny Blvd
Ankeny, Iowa 50023-9093
Phone 515-725-1600
Fax 515-725-1642

Lakeside Laboratory
1838 Highway 86
Milford, Iowa 51351-7267
Phone 712-337-3669
www.lakesidelab.org

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Summary

Water quality monitoring was conducted by the State Hygienic Laboratory (SHL) Limnology Section staff at Ada Hayden Heritage Park from June 28, 2023, to October 2, 2023, and from March 26, 2024, to October 16, 2024. Samples were collected from the north and south cells of Ada Hayden Lake, the three wetlands that discharged to the lake, and the lake outlet.

Samples were collected twice per month at approximately two-week intervals in the north and south cells of the lake. Lake sampling was conducted at the maximum depth location in each cell. Field measurements, depth profiles, and integrated depth samples were collected from each cell during each visit. Eight sets of lake samples were collected in 2023, and 12 sets of lake samples were collected in 2024.

Lake sampling demonstrated that Ada Hayden Lake is a mesotrophic to eutrophic lake, like many lakes in Iowa. Both cells of the lake showed strong thermoclines throughout the entire sampling period and reduced dissolved oxygen concentrations below the thermocline, indicative of a eutrophic lake pattern (Carlson and Simpson 1996).

Measured algal toxins (microcystin, cylindrospermopsin, anatoxin-a, and saxitoxin) were below the detection limit in both cells of the lake during the sample periods, except for samples collected on October 16, 2024. Samples collected from both cells on that date had results for saxitoxin that were slightly greater than the detection limit.

The inlets and outlets of the north, middle, and south wetlands were sampled once per month and after significant rainfall events. According to the National Weather Service, precipitation was less than normal during June, July, August, and September of 2023 and only one rainfall event was sampled in the wetland tributaries. Precipitation was above normal in March, April, and May of 2024 and five rainfall events were sampled.

The north, middle, and south wetlands were effective at reducing nitrate + nitrite nitrogen and total nitrogen during dry conditions and during rainfall events. Specific conductivity also showed a reduction in concentration before entering the lake. Conversely chlorophyll *a* was generally greater in outlet samples verses the inlet samples of each wetland over both years. Other solids, *E. coli*, and nutrients were more variable.

The lake outlet was sampled once per month, concurrent with lake and wetland tributary sampling. Results from the lake outlet samples were similar to the results from the south cell depth integrated samples, with the exception of *E. coli*. In 2024, the geometric means of *E. coli* concentrations were higher in the lake outlet samples than in the south cell depth integrated samples (84 MPN/100 ml vs <10 MPN/100 ml, respectively). The geometric means of *E. coli* concentrations in the lake outlet and south cell were the same in 2023.

Methods

SHL Limnology Section staff collected samples from the north and south cells of Ada Hayden Lake, the lake outlet, and the inlets and outlets of the north, middle, and south wetlands (Figure 1). Samples were collected during the months of June, July, August, September, and October of 2023 and April, May, June, July, August, September, and October 2024 (Table 1, Table 2).

Analyses such as field measurements were performed in the field, while analysis of grab samples and integrated depth samples were performed in the laboratory (Table 3, Table 4). All analyses were performed according to accepted methods and SHL standard operating procedures (Table 5, SHL 2024a, SHL 2024b, SHL 2024a, and SHL 2024b). All samples were preserved immediately after collection and transported to SHL for analysis.

Lake Sampling

Integrated depth samples, depth profiles, and field measurements were performed at the north and south cells of the lake twice per month at approximately two-week intervals. Sampling was conducted near the deepest point in each cell. Sampling locations were determined using bathymetric maps, depth sensors, and global positioning systems. During each visit, limnologists returned as close as possible to these sites, anchored the boat to maintain position, and collected the necessary samples.

A depth profile was performed using a YSI EXO 1S multiparameter sonde. Measurements were taken at 0.5 m to 1.0 m intervals, starting just below the surface and continuing until just above the lake substrate to avoid fouling the sonde with sediment. Measurements were stored in the sonde and were reviewed on site to determine a thermocline. A thermocline was defined as a 1° C change in temperature within a 1.0 m change in depth (SHL 2024a).

Field parameters reported for each cell were measured at a depth of 0.5 m below the surface using a YSI EXO 1S multiparameter sonde. Secchi disk transparency was measured using a standard Secchi disk (Carlson and Simpson 1996, SHL 2024a).

Integrated depth samples were collected above the thermocline, if present, using a two-meter water column sampler (Carlson and Simpson 1996). If a thermocline was not present, or deeper than two meters, the integrated depth sample was taken to a depth of two meters.

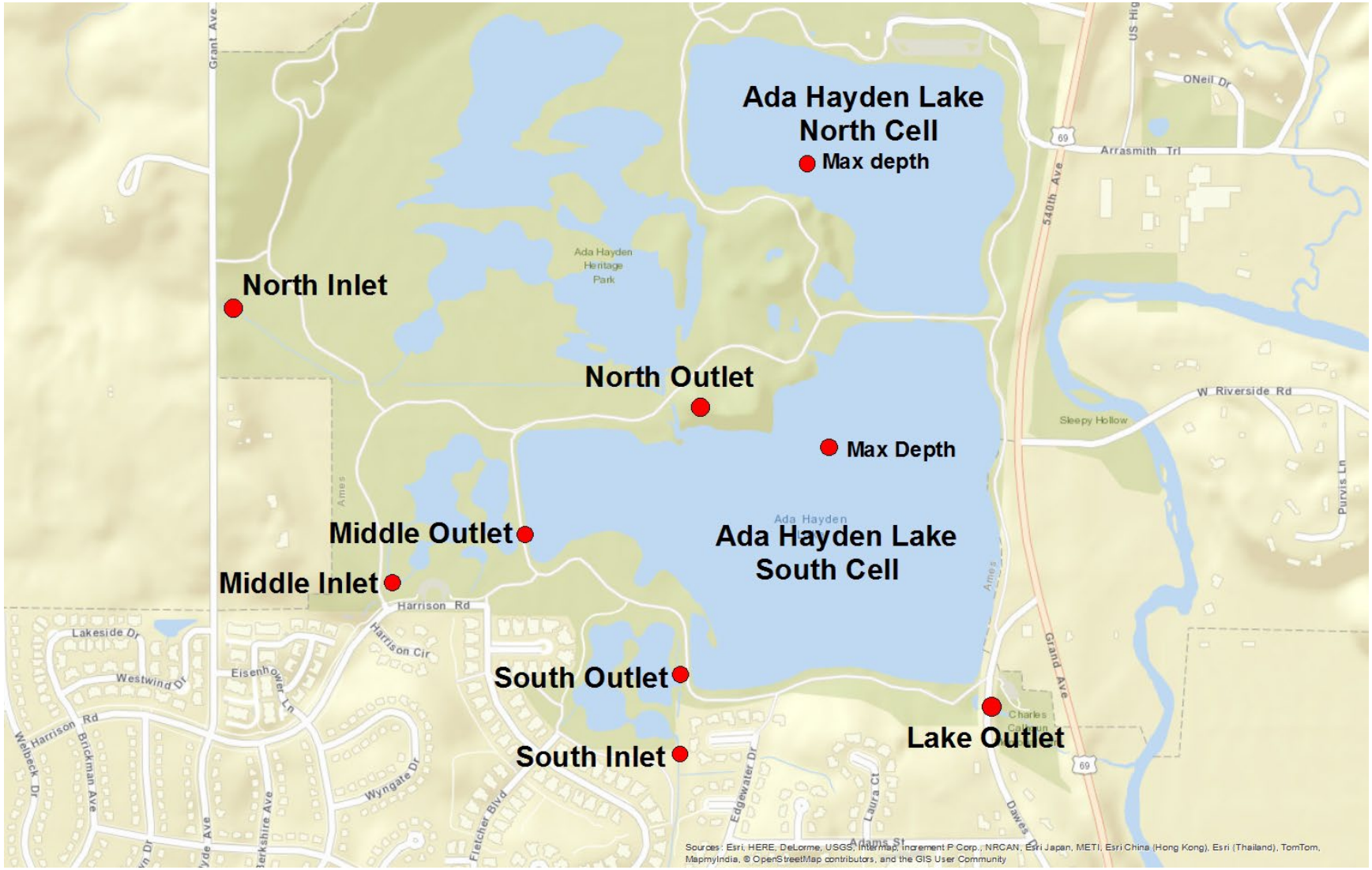

Figure 1. Map showing the approximate location of lake sampling sites, wetland inlet and outlet sampling sites, and lake outlet sampling site.

Table 1. Collection dates, sampling locations, and samples collected at the Ada Hayden Heritage Park during the 2023 sampling season. Samples collected are denoted with an 'X', samples that were not collected because the streams were dry are denoted with a 'D', and wetland inlet/outlet samples collected after a rainfall event are denoted with a 'R'. Samples collected from the south and north cells of Ada Hayden Lake include a depth integrated sample and field measurements.

Date Collected	South Cell	North Cell	Lake Outlet	North Wetland Inlet	North Wetland Outlet	Middle Wetland Inlet	Middle Wetland Outlet	South Wetland Inlet	South Wetland Outlet
6/28/2023	X	X	X	X	D	X	X	X	X
7/10/2023	X	X							
7/13/2023			X	R	R	R	R	R	R
7/26/2023	X	X	X	X	D	X	D	X	D
8/10/2023	X	X							
8/22/2023	X	X	X	X	D	X	D	X	X
9/6/2023	X	X							
9/21/2023	X	X	D	X	D	X	D	X	D
10/2/2023	X	X							

Table 2. Collection dates, sampling locations, and samples collected at the Ada Hayden Heritage Park during the 2024 sampling season. Samples collected are denoted with an 'X', samples that were not collected because the streams were dry are denoted with a 'D', and wetland inlet/outlet samples collected after a rainfall event are denoted with a 'R'. Samples collected from the south and north cells of Ada Hayden Lake include a depth integrated sample and field measurements.

Date Collected	South Cell	North Cell	Lake Outlet	North Wetland Inlet	North Wetland Outlet	Middle Wetland Inlet	Middle Wetland Outlet	South Wetland Inlet	South Wetland Outlet
3/26/2024				R	D	R	D	R	R
4/17/2024				R	D	R	R	R	R
4/24/2024	X	X	X	X	D	X	X	X	X
5/2/2024				R	R	R	R	R	R
5/9/2024	X	X		R	R	R	R	R	R
5/22/2024	X	X	X	X	X	X	X	X	X
6/13/2024	X	X							
6/19/2024				R	R	R	R	R	R
6/27/2024	X	X	X	X	D	X	D	X	D
7/11/2024	X	X							
7/25/2024	X	X	X	X	X	X	X	X	X
7/30/2024				X	X	X	X	X	X
8/15/2024	X	X							
8/28/2024	X	X	D	X	D	D	D	X	D
9/12/2024	X	X							
9/30/2024	X	X	D	X	D	D	D	X	D
10/16/2024	X	X							

Table 3. Water quality parameters and sample type for samples collected from the north and south cells of the lake at Ada Hayden Heritage Park.

Parameter	Type of Sample
Temperature	Field measurement
pH	Field measurement
Dissolved oxygen	Field measurement
Secchi Disk Transparency	Field measurement
Thermocline Depth	Field measurement
Total Depth	Field measurement
Depth Profile	Field measurement
Conductivity	Integrated depth sample
Turbidity	Integrated depth sample
Orthophosphate (Dissolved Phosphorus)	Integrated depth sample
Total Phosphorus	Integrated depth sample
Nitrite + Nitrate as N	Integrated depth sample
Total Kjeldahl Nitrogen	Integrated depth sample
Total Suspended Solids	Integrated depth sample
E. coli bacteria	Integrated depth sample
Microcystin	Integrated depth sample
Anatoxin	Integrated depth sample
Saxitoxin	Integrated depth sample
Cylindrospermopsin	Integrated depth sample
Chlorophyll *a*	Integrated depth sample

Table 4. Water quality parameters and sample type for samples collected from the tributary inlets and outlets of the north, middle, and south wetlands and the lake outlet.

Parameter	Type of Sample
Temperature	Field measurement
pH	Field measurement
Dissolved Oxygen	Field measurement
Stream Discharge	Field measurement
Conductivity	Grab Sample
Turbidity	Grab Sample
Chlorophyll *a*	Grab sample
Nitrite + Nitrate as N	Grab sample
Total Kjeldahl Nitrogen	Grab sample
Orthophosphate (Dissolved Phosphorus)	Grab sample
Total Phosphorus	Grab sample
Total Suspended Solids	Grab sample
E. coli bacteria	Grab sample

Table 5. Water quality parameters and methods for samples collected from the north and south cells of Ada Hayden Lake, the tributary inlets and outlets of the north, middle, and south wetlands, and the lake outlet.

Parameter	Method
Temperature	SM 2550 B
pH	SM 4500 h+ B
Dissolved oxygen	ASTM d 888-09
Conductivity	SM 2510 B
Turbidity	SM 2130 B
Secchi Disk Transparency	Welch 1948
Thermocline Depth	Birge 1904
Total Depth	Buchanan Somers 1969
Stream Discharge	USGS CA8
Orthophosphate (Dissolved Phosphorus)	EPA 365.1
Total Phosphorus	EPA 365.1
Nitrite + Nitrate as N	EPA 353.2
Total Kjeldahl Nitrogen	EPA 351.2
Total Suspended Solids	USGS i-3765-85
E. coli bacteria	Colilert MPN
Microcystin	Total Microcystins and Nodularians in Drinking Water by ELISA, EPA 546
Anatoxin	Anatoxin-a Screen, Immunoasssay
Saxitoxin	Saxitoxin Screen, Immunoasssay
Cylindrospermopsin	Cylindrospermopsin Screen, Immunoasssay
Chlorophyll *a*	EPA 445.0 rev 1.2

Wetland Sampling

Water samples were collected upstream (inlet) and downstream (outlet) from the north, middle, and south wetlands once per month under ambient conditions and six times after rainfall events. Field parameters were measured using a YSI EXO 1S multiparameter sonde and instantaneous flow was measured using a Price AA current meter, Pygmy current meter, or Sontek FlowTracker II. Samples requiring laboratory analysis were preserved immediately after collection and transported to the SHL for analysis.

The north wetland inlet samples were collected from a small stream on the west side of the park on the east side of Grant Avenue (Figure 2). The north wetland outlet samples were collected from the culvert draining the north wetland, prior to the discharge entering the lake.

Middle wetland inlet samples were collected from a small stream near the southern edge of the park on Stone Brook Road and the outlet samples were collected from a three-culvert structure where the middle wetland discharged into the lake (Figure 3).

Samples were collected at the south wetland inlet from a small tributary upstream of the south wetland and the south wetland outlet was sampled from a concrete structure downstream of the wetland, prior to where the south wetland discharged into the lake (Figure 4).

Lake Outlet Sampling

The lake outlet samples were collected immediately downstream of the lake overflow structure at the culvert on the downstream side of the walking path (Figure 5). Grab samples were collected at the outlet of the lake once per month. Field parameters were measured using a YSI EXO 1S multiparameter sonde and instantaneous flow was measured using a Price AA current meter, Pygmy current meter, or Sontek FlowTracker II. Samples requiring laboratory analysis were preserved immediately after collection and transported to the SHL for analysis.

Calculations

A quantitation limit is the lowest value that can be accurately reported due to limitations of procedures and equipment. If a result is less than the quantitation limit it is reported as less than the quantitation limit. For example, if a quantitation limit is 0.05 mg/L, results less than 0.05 mg/L are reported as <0.05 mg/L. When performing calculations, a value of one half of the quantitation limit was used when a result of less than the quantitation limit was reported.

When computing basic statistics for the results, the geometric mean of *E. coli* results was calculated since it may provide a better estimate of the true mean because of the non-linear growth rate of bacteria (Robertson 1932).

Figure 2. Photographs of the sampling locations at the north wetland inlet (top) and outlet (bottom).

Figure 3. Photographs of the sampling locations at the middle wetland inlet (top) and outlet (bottom).

Figure 4. Photographs of the sampling locations at the south wetland inlet (top) and outlet (bottom).

Figure 5. Photographs of the outlet of Ada Hayden Lake showing the overflow structure (top) and the location where samples were collected (bottom).

Results

Samples were collected on nine separate visits to Ada Hayden Heritage Park in 2023 and 17 separate visits in 2024 (Table 1, Table 2). Results for all analyses can be found in the appendices.

Lake Sampling

Sixteen integrated depth samples were collected during eight visits in 2023, and 24 integrated depth samples were collected during 12 visits in 2024 (Table 1, Table 2). Results for all lake sampling analyses can be found in Appendix A. In 2023, nitrate + nitrite nitrogen was not detected above 0.1 mg/L for either cell. TKN ranged from 0.5 to 1.0 mg/L in 2023 with no clear trend (Table A5). Nitrate + nitrite nitrogen and TKN readings were present early in the sampling season in both cells in 2024 but were not detected later in the year (Table A6). TSS concentrations ranged from 2 mg/L to 17 mg/L over the two-year study period with no clear trend over the sampling periods (Table A7, Table A8). The average TSS was 43% greater in the south cell in 2024 than in 2023. Similarly, average TSS was 59% greater in the north cell in 2024 than in 2023.

Orthophosphate concentrations and total phosphorus concentrations were small or not detectable in the lake cells over the two-year period (Table A5, Table A6). Total phosphorus was not detected in 2023 and in 2024 only 7 of 24 samples were at or above detection limit (0.02 mg/L), with the highest measured detection being 0.04 mg/L. Orthophosphate concentrations were less than the quantitation limit for every depth integrated sample in both cells in both years.

Chlorophyll *a* ranged from 2 to 7 mg/L in 2023 and from 4 to 16 mg/L in 2024 (Table A9, Table A10). The average chlorophyll *a* concentration difference between cells was minor, with no difference in 2023 and only 0.5 mg/L difference between cells in 2024. The difference between the years was more pronounced, with the average chlorophyll *a* concentration being 57% greater in the south cell and 63% greater in the north cell in 2024. *E. coli* was generally less than the quantitation limit with 7 of 40 samples at or above detection limit ranging from 10 to 240 MPN/100mL (Table A9, Table A10).

Concentrations of microcystin, cylindrospermopsin, and anatoxin-a were less than the quantitation limit in all samples for both 2023 and 2024 (Table A11 Table A12). In October 2024, saxitoxins were found to be marginally above the quantitation limit (0.022 µg/L) in both cells, with south cell and north cell values being 0.022 µg/L and 0.033 µg/L respectively.

Individual field measurements near the lake surface (dissolved oxygen, pH, and temperature) were similar between lake cells, showing no remarkable results and reflecting seasonal changes (Table A1, Table A2). The average dissolved oxygen readings were slightly higher in the south cell for both 2023 and 2024, in which dissolved oxygen was 3.4% and 4.2% higher respectively. The same pattern was observed for the average pH, in which the south cell was 2.3% and 1.2% higher in 2023 and 2024. Averages temperatures showed no difference between lake cells. Secchi disk transparency depth varied throughout the sampling seasons in 2023 and 2024 showing no distinct trend (Table A3, Table A4).

Average Secchi depth was 14% and 4% greater in the south cell of Ada Hayden in 2023 and 2024 respectively (Table A3, Table A4). Thermoclines were observed on all visits in both cells, except for April 24, 2024, when the north and south cell water temperatures were similar along the entire water column and didn't meet the thermocline criterion definition (Figure A1, Figure A2, Figure A5, Figure A6). The maximum thermocline depths were observed in 2024 with depths of 8.8 meters in the north cell and 9.3 meters in the south cell (Table A3, Table A4). Dissolved oxygen also followed this stratification pattern (Figure A3, Figure A4, Figure A7, Figure A8).

Turbidity and specific conductivity results were consistent throughout each year. Values for both parameters were slightly higher in the north cell than in the south cell. Average specific conductivity ranged from 401 µmho/cm to 408 µmho/cm in the south cell versus 412 µmho/cm to 418 µmho/cm in the north cell. Similarly, turbidity averages ranged higher in the north cell 1.5 to 1.9 NTU compared to the south cell 1.2 to 1.8 NTU (Table A7, Table A8).

Wetland Sampling

Wetland inlets and outlets were visited five times during 2023 and 12 times during 2024 (Table 4, Table 5). A total of 21 samples were collected in 2023 and 57 samples were collected in 2024. Samples were analyzed for the parameters listed in Table 2. Wetland inlet and outlet sites frequently had little flow or were dry during both sampling years; 27% of possible wetland samples in 2023 and 21% of possible wetland samples in 2024 were not collected because the sites were dry when visited. Results for all wetland inlet and outlet analyses can be found in Appendix B.

According to the National Weather Service climate summary for Ames, Iowa, precipitation was 19% less than normal in 2023 (Table 6). Monthly total precipitation was less than normal from March through October of 2023 and only one set of rainfall event samples was collected in 2023. Wetland outlets were frequently dry during the 2023 sampling season (Table 6).

Annual precipitation was greater in 2024 than in 2023 and was similar to the annual climate normal precipitation (Table 6). Precipitation was greater than normal in March, April, and May and five rainfall events were sampled by mid-June. Precipitation declined in August, September, and October of 2024 and no more rainfall event samples were collected for the remainder of the sampling period. The north wetland outlet, middle wetland inlet and outlet, and the south wetland outlet were dry during September.

Table 6. Monthly total and annual precipitation (inches) during the 2023 and 2024 sampling periods and climate normal total precipitation (inches, 1991 – 2020) for Ames, Iowa (National Weather Service Station Ames 5 SE, IA, www.nws.gov).

Year	Mar	Apr	May	June	July	Aug	Sept	Oct	Annual
2023	1.56	3.29	3.11	3.21	3.46	4.05	3.34	2.28	31.36
2024	3.28	4.44	8.74	4.96	4.96	2.12	0.64	1.76	38.16
1991 – 2020 Climate Normal	2.18	3.80	5.31	5.41	4.51	4.73	3.84	2.65	38.06

North Wetland

The north wetland inlet and outlet were visited 17 times over the two-year study period. Both the inlet and outlet were occasionally dry, and over the two field seasons the inlet was dry during two visits and the outlet was dry during seven of the visits. Six of the sample collections were during rainfall events. In 2023, the concentrations of most analyses were less in outlet samples than in inlet samples, with the exception of chlorophyll *a* and *E. coli* (Table B9, Table B10). Analyte results were more mixed in 2024; however, there were reductions in the concentration of nitrate + nitrite nitrogen (71%), total nitrogen (65%), turbidity (71%), and specific conductivity (20%) from the inlet samples vs the outlet samples. Alternatively, chlorophyll *a* results demonstrated a 130% increase from inlet to outlet samples.

Middle Wetland

Over the two-year study period, the middle wetland inlet was sampled on 15 of 17 visits and the outlet was sampled on 10 of the 15 visits. Six of these trips were during rainfall events. The greatest changes in average concentration between inlet and outlet samples occurred among nitrate + nitrite nitrogen, total nitrogen, chlorophyll *a*, and specific conductivity (Table B19, Table B20). Overall concentration of nitrate + nitrite nitrogen decreased by 97% in 2023 and 84% in 2024, total nitrogen decreased by 84% in 2023 and 73% in 2024, and specific conductivity decreased 52% in 2023 and 28% in 2024. Similar to the north wetland, average chlorophyll *a* results were greater in the outlet samples than in inlet samples, with an average overall increase of 257% in 2023 and 229% in 2024.

South Wetland

The south wetland inlet and outlet were also visited 17 times during the two-year study period. While the inlet was always flowing, the outlet was dry 5 times (Table 1, Table 2). Six pairs of samples were collected from the south wetland inlet and outlet during rainfall events. In both years, average concentrations of TKN, total phosphorus, turbidity, chlorophyll *a*, and TSS were increased in samples collected from the wetland outlets compared to samples collected from the wetland inlets (Table B29, Table B30). Average concentrations of nitrate + nitrite nitrogen, total nitrogen, orthophosphate, specific conductivity, and *E. coli* decreased in samples collected from the wetland outlets. Similar trends were observed when comparing results for the inlet and outlet samples collected after rainfall events or during dry weather.

Lake Outlet Sampling

Four outlet samples were collected in 2023 and 2024 for a total of 8 samples over two years. (Table 4). The analytical results for all lake outlet samples can be found in Appendix C. The lake outlet was dry for one sampling visit in 2023 and on two sampling visits in 2024. Orthophosphate was below the detection limit for all samples. Total phosphorus was also largely insignificant with the highest result being 0.04 mg/L. Chlorophyll *a* ranged from 3 to 12 mg/L, with results similar to Ada Hayden Lake south cell results. Turbidity measured at the lake outlet was relatively low, reading <3 NTU for all measurements over the two years. Lake outlet flows

peaked in 2024 with 16 cfs on May 22nd and averaged 2.2 cfs in 2023 and 5.4 cfs in 2024 over 4 sample periods in each year. Temperature and pH showed no unexpected results (Table C1, Table C2), with dissolved oxygen readings similar between years. *E. coli* results were relatively low or below our detection limit (<10) with only high result (1,800 MPN/100ml) on July 25, 2024 (Table C2).

Discussion

Lake Sampling

Both cells of Ada Hayden Lake developed strong thermoclines and the depth of the thermoclines generally increased throughout the sampling periods, which is typical of a eutrophic lake. Thermoclines are generally not present during ice melt and early spring when water temperature, and thus density, are relatively uniform throughout the water column. Temperature differences between the hypolimnion (cooler, lower layer of water) and epilimnion (upper layer) gradually increase stratification throughout the summer and then decrease once again, as cooler weather returns in the fall. This pattern was observed in both lake cells each year. Both sampling seasons were completed before stratification had dissipated and fall turnover occurred.

Much of the water below the thermocline is deeper than light can penetrate, therefore algae is not able to produce oxygen. A decline in oxygen concentration below the thermocline is common in eutrophic lakes (Carlson and Simpson 1996). Dissolved oxygen levels were depleted below the thermoclines in the hypolimnion and were often near or below the quantitation limit (<0.1 mg/L) in both cells.

Concentrations of four algal toxins that could be detrimental to human health, microcystin, cylindrospermopsin, anatoxin-a, and saxitoxin, were not detected in any samples collected in 2023 just one sample in 2024. In lake samples collected on October 16, 2024, saxitoxin was 0.022 µg/L in the south cell and 0.033 µg/L in the north cell. During both years, microcystin concentrations were less than the State advisory threshold for cyanobacteria toxins, which is 8 µg/L of total microcystins. The EPA 10-day drinking water health advisory recommendations for microcystin are less than or equal to 0.3 µg/L for children less than six years of age and 1.6 µg/L for children greater than 6 years of age and adults, and for cylindrospermopsin are less than or equal to 0.7 µg/L for children less than six years of age and 3.0 µg/L for children greater than 6 years of age and adults (USEPA 2015). All results for microcystin and cylindrospermopsin were less than the EPA health advisory levels during the entire study.

Average results for parameters such as chlorophyll *a* and Secchi disk transparency signify the Ada Hayden Lake cells range between eutrophic and mesotrophic states. Eutrophic lakes are characterized by high nutrient content, high primary production, and variable surface and benthic oxygen concentrations (Goldman and Horne 1983). This characterization can be further separated into three trophic states: mesotrophic, eutrophic, and hypereutrophic (Balmer and Kendall 2016, Table 7). According to the Iowa DNR, mesotrophic lakes have intermediate levels of nutrients and algal productivity, eutrophic lakes high levels of nutrients and frequent algal blooms, while hypereutrophic lakes have extremely high levels of nutrients, frequent algal blooms, low water quality, and low oxygen concentration (Balmer and Kendall 2016).

Carlson's trophic state index (TSI) is a calculation that allows the comparison of the trophic state of different lakes using a single parameter index, based on the concentration of chlorophyll *a* (TSI(CHL)), total phosphorus (TSI(TP)), or Secchi depth (TSI(SD) (Carlson 1977). The Iowa DNR uses TSI(SD) and TSI(CHL) to help determine the trophic state of Iowa lakes and considers lakes with a TSI value of 40 to 50 to be mesotrophic, 51 to 70 eutrophic, and 71 and greater hypereutrophic (Balmer and Kendall 2016).

TSI(CHL), TSI(SD), and TSI(TP) values were calculated for Ada Hayden Lake (Table A13, Table A14). Over the two-year study period, 20% of all TSI scores were in the eutrophic range, 80% were in the mesotrophic range, and no measured value being in the hypereutrophic range. In 2023, 98% of the TSI scores were in the mesotrophic range and 2% were in the eutrophic range. In 2024 there was a greater number of results in the eutrophic range with 68% of the TSI scores were in the mesotrophic range and 32% were in the eutrophic range. A two-year study in 2017 and 2018 showed 71% of all TSI scores were in the eutrophic range, 24% were in the mesotrophic range, and 5% were in the hypereutrophic range. Carlson and Simpson (1996) described possible relationships between TSI(CHL), TSI(SD), and TSI(TP). For example, if TSI(CHL) is similar to TSI(SD), light attenuation in the water column is dominated by algae and the lake may be phosphorus limited. This pattern was observed during all sampling occasions for both cells in 2023 and most sampling occasions in 2024, suggesting that the lake cells may have been phosphorus limited.

Table 7. Ranges of chlorophyll *a* concentration, total phosphorus concentration, Secchi transparency depth, and trophic state index (TSI) values for mesotrophic, eutrophic, and hypereutrophic lakes. Adapted from Balmer and Kendall (2016).

Trophic State	Chlorophyll *a* (µg/L)	Total Phosphorus (µg/L)	Secchi Depth (m)	TSI
Mesotrophic	2.6 - 20	12 - 24	2 - 4	40 - 50
Eutrophic	21 – 56	25 – 96	0.5 – 2	51- 70
Hypereutrophic	57+	97+	<0.5	71+

Wetland Sampling

Differences in water quality between the water entering and leaving the wetlands may help determine if the wetlands help reduce the amount of nutrients and sediment delivered to the lake. Reductions in specific conductivity, nitrate + nitrite nitrogen, total nitrogen, and E. *coli* (with exception of 2023 north wetland outlet) showed that wetlands created a consistent sink for these measured parameters with results lower in the wetland outflows vs inflows. Also, wetland outflows were often dry, providing a complete nutrient sink during low precipitation periods. TKN, orthophosphate, and total phosphorus results were more variable, and it is less clear if the wetlands are a sink or a source of these nutrients. Turbidity and TSS often had higher results in wetland outlet samples but also showed high variability. Chlorophyll *a* was consistently greater in the wetland outlet samples; this is likely because the wetlands were sources of nutrients that allowed the growth of algae which was then discharged to the lake.

Lake Outlet Sampling

Results for the lake outlet samples closely matched the south cell results, as expected due to the proximity of sampling locations and the relationship of the sources to each other. One exception was the average result for *E. coli* in 2024, which was greater in the lake outlet samples than the south cell samples (84 MPN/100 ml and <10 MPN/100 ml, respectively). This difference was influenced by a high *E. coli* result on July 25, 2024, which was 1,800 MPN/100 ml. Results for *E. coli* on the same date in the south cell were 240 MPN/100 ml.

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Appendix A – Lake Sampling Results

Table A1. Dissolved oxygen (mg/L), pH (no units), and temperature (°C) measured at the south and north cells of Ada Hayden Lake, June through October 2023. Measurements were made at approximately 0.5 m below the surface.

Date Collected	South Cell Dissolved Oxygen (mg/L)	North Cell Dissolved Oxygen (mg/L)	South Cell pH (no units)	North Cell pH (no units)	South Cell Temperature (°C)	North Cell Temperature (°C)
6/28/2023	10.0	8.7	8.5	8.4	24.0	23.8
7/10/2023	10.1	9.0	8.8	8.6	24.6	24.5
7/26/2023	8.7	8.5	8.7	8.2	28.4	28.6
8/10/2023	8.7	8.5	8.7	8.5	26.7	26.6
8/22/2023	8.4	8.6	8.8	8.7	28.1	28.4
9/6/2023	8.0	8.2	8.6	8.6	25.0	24.9
9/21/2023	8.4	8.5	8.6	8.6	21.3	21.0
10/2/2023	8.6	8.8	8.5	8.6	22.2	22.5
Average	8.9	8.6	8.7	8.5	25.0	25.0
Minimum	8.0	8.2	8.5	8.2	21.3	21.0
Maximum	10.1	9.0	8.8	8.7	28.4	28.6

Table A2. Dissolved oxygen (mg/L), pH (no units), temperature (°C) measured at the south and north cells of Ada Hayden Lake, April through October 2024. Measurements were made at approximately 0.5 m below the surface.

Date Collected	South Cell Dissolved Oxygen (mg/L)	North Cell Dissolved Oxygen (mg/L)	South Cell pH (no units)	North Cell pH (no units)	South Cell Temperature (°C)	North Cell Temperature (°C)
4/24/2024	10.4	10.8	8.2	8.4	11.7	12.3
5/9/2024	9.6	9.7	8.3	8.2	16.2	16.3
5/22/2024	9.9	9.8	8.4	8.4	19.9	20.0
6/13/2024	12.2	11.3	8.5	8.5	23.6	23.8
6/27/2024	10.0	9.2	8.6	8.6	27.4	27.5
7/11/2024	11.8	10.0	8.8	8.5	26.3	26.0
7/25/2024	10.8	10.0	8.8	8.6	26.8	26.9
8/15/2024	8.0	8.3	8.7	8.4	24.0	23.9
8/28/2024	8.8	8.5	8.5	8.6	27.2	27.2
9/12/2024	8.7	8.4	8.4	8.5	22.7	22.8
9/30/2024	9.4	9.1	8.6	8.3	22.2	22.1
10/16/2024	7.1	7.0	8.0	7.8	16.9	16.7
Average	9.7	9.3	8.5	8.4	22.1	22.1
Minimum	7.1	7.0	8.0	7.8	11.7	12.3
Maximum	12.2	11.3	8.8	8.6	27.4	27.5

Table A3. Secchi depth (m) and thermocline depth (m) measured at the south and north cells of Ada Hayden Lake, June through October 2023. Measurements were made at approximately 0.5 m below the surface.

Date Collected	South Cell Secchi Depth (m)	North Cell Secchi Depth (m)	South Cell Thermocline Depth (m)	North Cell Thermocline Depth (m)
6/28/2023	2.3	2.8	4.5	4.5
7/10/2023	3.4	3.6	4.5	4.5
7/26/2023	2.9	2.6	3.5	3.5
8/10/2023	3.3	2.3	5.0	4.5
8/22/2023	2.2	1.9	2.0	2.5
9/6/2023	3.0	2.1	6.0	5.5
9/21/2023	2.8	2.5	7.0	6.5
10/2/2023	3.8	3.0	6.5	6.5
Average	3.0	2.6	4.9	4.8
Minimum	2.2	1.9	2.0	2.5
Maximum	3.8	3.6	7.0	6.5

Table A4. Secchi depth (m) and thermocline depth (m) measured at the south and north cells of Ada Hayden Lake, April through October 2024. Measurements were made at approximately 0.5 m below the surface.

Date Collected	South Cell Secchi Depth (m)	North Cell Secchi Depth (m)	South Cell Thermocline Depth (m)	North Cell Thermocline Depth (m)
4/24/2024	2.7	1.9	0.0	0.0
5/9/2024	3.0	3.2	5.0	4.0
5/22/2024	2.3	3.2	4.5	4.5
6/13/2024	2.4	2.4	4.5	3.5
6/27/2024	2.3	2.3	3.0	3.0
7/11/2024	2.1	1.8	4.5	4.3
7/25/2024	1.7	1.4	3.0	3.0
8/15/2024	2.5	2.0	5.3	5.4
8/28/2024	2.0	2.0	1.8	1.8
9/12/2024	2.3	2.2	6.1	6.1
9/30/2024	1.8	1.6	6.3	6.3
10/16/2024	2.3	2.0	9.3	8.8
Average	2.3	2.2	4.4	4.2
Minimum	1.7	1.4	0.0	0.0
Maximum	3.0	3.2	9.3	8.8

Table A5. Nitrate+nitrite nitrogen (NOx-N, mg/L), total kjeldahl nitrogen (TKN, mg/L), total phosphorus (mg/L), and orthophosphate (mg/L) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, June through October 2023.

Date Collected	South Cell NOx-N (mg/L)	North Cell NOx-N (mg/L)	South Cell TKN (mg/L)	North Cell TKN (mg/L)	South Cell Total Phosphorus (mg/L)	North Cell Total Phosphorus (mg/L)	South Cell Ortho-phosphate (mg/L)	North Cell Ortho-phosphate (mg/L)
6/28/2023	<0.1	<0.1	0.56	0.66	<0.02	<0.02	<0.02	<0.02
7/10/2023	<0.1	<0.1	0.55	0.60	<0.02	<0.02	<0.02	<0.02
7/26/2023	<0.1	<0.1	0.56	1.00	<0.02	<0.02	<0.02	<0.02
8/10/2023	<0.1	<0.1	0.55	0.54	<0.02	<0.02	<0.02	<0.02
8/22/2023	<0.1	<0.1	0.58	0.52	<0.02	<0.02	<0.02	<0.02
9/6/2023	<0.1	<0.1	0.57	0.52	<0.02	<0.02	<0.02	<0.02
9/21/2023	<0.1	<0.1	0.53	0.61	<0.02	<0.02	<0.02	<0.02
10/2/2023	<0.1	<0.1	0.50	0.55	<0.02	<0.02	<0.02	<0.02
Average	<0.1	<0.1	0.55	0.63	<0.02	<0.02	<0.02	<0.02
Minimum	<0.1	<0.1	0.50	0.52	<0.02	<0.02	<0.02	<0.02
Maximum	<0.1	<0.1	0.58	1.00	<0.02	<0.02	<0.02	<0.02

Table A6. Nitrate+nitrite nitrogen (NOx-N, mg/L), total kjeldahl nitrogen (TKN, mg/L), total phosphorus (mg/L), and orthophosphate (mg/L) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, April through October 2024.

Date Collected	South Cell NOx-N (mg/L)	North Cell NOx-N (mg/L)	South Cell TKN (mg/L)	North Cell TKN (mg/L)	South Cell Total Phosphorus (mg/L)	North Cell Total Phosphorus (mg/L)	South Cell Ortho-phosphate (mg/L)	North Cell Ortho-phosphate (mg/L)
4/24/2024	<0.25	0.15	0.78	0.72	0.02	0.03	<0.02	<0.02
5/9/2024	0.67	0.17	0.76	0.78	0.04	0.02	<0.02	<0.02
5/22/2024	0.85	0.28	0.74	0.49	0.02	0.02	<0.02	<0.02
6/13/2024	0.68	<0.25	0.65	0.61	<0.02	<0.02	<0.02	<0.02
6/27/2024	0.41	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
7/11/2024	<0.25	<0.25	0.56	0.53	0.03	<0.02	<0.02	<0.02
7/25/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
8/15/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
8/28/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
9/12/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
9/30/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
10/16/2024	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
Average	0.30	<0.25	<0.5	<0.5	0.02	<0.02	<0.02	<0.02
Minimum	<0.25	<0.25	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02
Maximum	0.85	0.28	0.78	0.78	0.04	0.03	<0.02	<0.02

Table A7. Total suspended solids (TSS, mg/L), specific conductivity (µmho/cm), and turbidity (NTU) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, June through October 2023.

Date Collected	South Cell TSS (mg/L)	North Cell TSS (mg/L)	South Cell Specific Conductivity (µmho/cm)	North Cell Specific Conductivity (µmho/cm)	South Cell Turbidity (NTU)	North Cell Turbidity (NTU)
6/28/2023	3	4	410	420	1.6	1.8
7/10/2023	2	2	410	420	1.2	1.1
7/26/2023	2	2	400	420	1.3	1.4
8/10/2023	2	2	390	410	1.4	1.6
8/22/2023	3	3	390	400	2.2	2.1
9/6/2023	2	3	410	420	<0.1	1.5
9/21/2023	3	2	420	420	1.0	1.3
10/2/2023	2	3	430	430	<0.1	1.0
Average	2.4	2.6	408	418	1.2	1.5
Minimum	2	2	390	400	<0.1	1.0
Maximum	3	4	430	430	2.2	2.1

Table A8. Total suspended solids (TSS, mg/L), specific conductivity (µmho/cm), and turbidity (NTU) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, April through October 2024.

Date Collected	South Cell TSS (mg/L)	North Cell TSS (mg/L)	South Cell Specific Conductivity (µmho/cm)	North Cell Specific Conductivity (µmho/cm)	South Cell Turbidity (NTU)	North Cell Turbidity (NTU)
4/24/2024	3	6	460	460	1.6	2.3
5/9/2024	3	4	460	450	1.8	2.1
5/22/2024	6	4	440	450	2.9	1.8
6/13/2024	4	4	400	410	2.2	2.2
6/27/2024	2	3	390	400	1.2	1.8
7/11/2024	4	4	370	400	1.8	1.9
7/25/2024	3	4	350	370	2.4	2.7
8/15/2024	3	3	370	390	1.4	1.7
8/28/2024	3	3	380	390	1.4	1.2
9/12/2024	2	2	390	400	1.4	1.5
9/30/2024	4	4	390	400	2.0	1.9
10/16/2024	7	17	410	420	1.9	2.0
Average	3.7	4.8	401	412	1.8	1.9
Minimum	2	2	350	370	1.2	1.2
Maximum	7	17	460	460	2.9	2.7

Table A9. Chlorophyll *a* (mg/L), and *E. coli* (MPN/100 ml) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, June through October 2023.

Date Collected	South Cell Chlorophyll *a* (mg/L)	North Cell Chlorophyll *a* (mg/L)	South Cell *E. coli* (MPN/100 ml)	North Cell *E. coli* (MPN/100 ml)
6/28/2023	6	5	<10	<10
7/10/2023	4	3	<10	<10
7/26/2023	3	3	<10	<10
8/10/2023	5	3	<10	41
8/22/2023	6	6	<10	<10
9/6/2023	5	7	<10	<10
9/21/2023	6	6	<10	<10
10/2/2023	2	4	<10	<10
Average	4.6	4.6	<10	<10
Minimum	2	3	<10	<10
Maximum	6	7	<10	41

Table A10. Chlorophyll *a* (mg/L), total phosphorus (mg/L), orthophosphate (mg/L), and *E. coli* (MPN/100 mL) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, April through October 2024.

Date Collected	South Cell Chlorophyll *a* (mg/L)	North Cell Chlorophyll *a* (mg/L)	South Cell *E. coli* (MPN/100 mL)	North Cell *E. coli* (MPN/100 mL)
4/24/2024	6	16	<10	<10
5/9/2024	4	6	10	<10
5/22/2024	9	5	150	63
6/13/2024	10	9	<10	<10
6/27/2024	4	6	<10	<10
7/11/2024	12	8	<10	20
7/25/2024	10	10	240	<10
8/15/2024	12	13	<10	<10
8/28/2024	6	6	<10	<10
9/12/2024	6	7	<10	<10
9/30/2024	9	10	<10	10
10/16/2024	11	10	<10	<10
Average	8.3	8.8	<10	<10
Minimum	4	5	<10	<10
Maximum	12	16	240	63

Table A11. Microcystin (µg/L), cylindrospermopsin (µg/L), anatoxin-a (µg/L), and saxitoxins (µg/L) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, June through October 2023.

Date Collected	South Cell Microcystin /Nodularins (µg/L)	North Cell Microcystin /Nodularins (µg/L)	South Cell Cylindro-spermopsin (µg/L)	North Cell Cylindro-spermopsin (µg/L)	South Cell Anatoxin-a (µg/L)	North Cell Anatoxin-a (µg/L)	South Cell Saxitoxins (µg/L)	North Cell Saxitoxins (µg/L)
6/28/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
7/10/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
7/26/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
8/10/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
8/22/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
9/6/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
9/21/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
10/2/2023	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
Average	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
Minimum	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
Maximum	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022

Table A12. Microcystin (µg/L), cylindrospermopsin (µg/L), anatoxin-a (µg/L), and saxitoxins (µg/L) in depth integrated samples collected from the south and north cells of Ada Hayden Lake, April through October 2024.

Date Collected	South Cell Microcystin/ Nodularins (µg/L)	North Cell Microcystin/ Nodularins (µg/L)	South Cell Cylindro-spermopsin (µg/L)	North Cell Cylindro-spermopsin (µg/L)	South Cell Anatoxin-a (µg/L)	North Cell Anatoxin-a (µg/L)	South Cell Saxitoxins (µg/L)	North Cell Saxitoxins (µg/L)
4/24/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
5/9/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
5/22/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
6/13/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
6/27/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
7/11/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
7/25/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
8/15/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
8/28/2024	*	<0.30	*	<0.05	<0.16	<0.16	<0.022	<0.022
9/12/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
9/30/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
10/16/2024	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	0.022	0.033
Average	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
Minimum	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	<0.022	<0.022
Maximum	<0.30	<0.30	<0.05	<0.05	<0.16	<0.16	0.022	0.033

*Sample was lost.

Table A13. Trophic state index (TSI) values for integrated depth samples collected from the south and north cells of Ada Hayden Lake, June through October 2023. TSI values were calculated for chlorophyll *a* concentration (TSI(chl *a*)), Secchi transparency depth (TSI(SD)), and total phosphorus concentration (TSI(TP)).

Date Collected	South Cell TSI(chl *a*)	North Cell TSI(chl *a*)	South Cell TSI(SD)	North Cell TSI(SD)	South Cell TSI(TP)	North Cell TSI(TP)
6/28/2023	48.2	46.4	48.3	45.4	37.4	37.4
7/10/2023	44.2	41.4	42.4	41.5	37.4	37.4
7/26/2023	41.4	41.4	44.7	46.2	37.4	37.4
8/10/2023	46.4	41.4	42.8	48.0	37.4	37.4
8/22/2023	48.2	48.2	48.6	50.8	37.4	37.4
9/6/2023	46.4	49.7	44.2	49.3	37.4	37.4
9/21/2023	48.2	48.2	45.2	46.8	37.4	37.4
10/2/2023	37.4	44.2	40.8	44.2	37.4	37.4
Average	45.0	45.1	44.6	46.5	37.4	37.4
Minimum	37.4	41.4	40.8	41.5	37.4	37.4
Maximum	48.2	49.7	48.6	50.8	37.4	37.4

Table A14. Trophic state index (TSI) values for integrated depth samples collected from the south and north cells of Ada Hayden Lake, April through October 2024. TSI values were calculated for chlorophyll *a* concentration (TSI(CHL)), Secchi transparency depth (TSI(SD)), and total phosphorus concentration (TSI(TP)).

Date Collected	South Cell TSI(CHL)	North Cell TSI(CHL)	South Cell TSI(SD)	North Cell TSI(SD)	South Cell TSI(TP)	North Cell TSI(TP)
4/24/2024	48.2	57.8	45.7	50.8	47.3	53.2
5/9/2024	44.2	48.2	44.2	43.2	57.3	47.3
5/22/2024	52.2	46.4	48.0	43.2	47.3	47.3
6/13/2024	53.2	52.2	47.4	47.4	37.4	37.4
6/27/2024	44.2	48.2	48.0	48.0	37.4	37.4
7/11/2024	55.0	51.0	49.3	51.5	53.2	37.4
7/25/2024	53.2	53.2	52.4	55.2	37.4	37.4
8/15/2024	55.0	55.8	46.8	50.0	37.4	37.4
8/28/2024	48.2	48.2	50.0	50.0	37.4	37.4
9/12/2024	48.2	49.7	48.0	48.6	37.4	37.4
9/30/2024	52.2	53.2	51.5	53.2	37.4	37.4
10/16/2024	54.1	53.2	48.3	50.0	37.4	47.3
Average	50.6	51.4	48.3	49.3	42.0	41.2
Minimum	44.2	46.4	44.2	43.2	37.4	37.4
Maximum	55.0	57.8	52.4	55.2	57.3	53.2

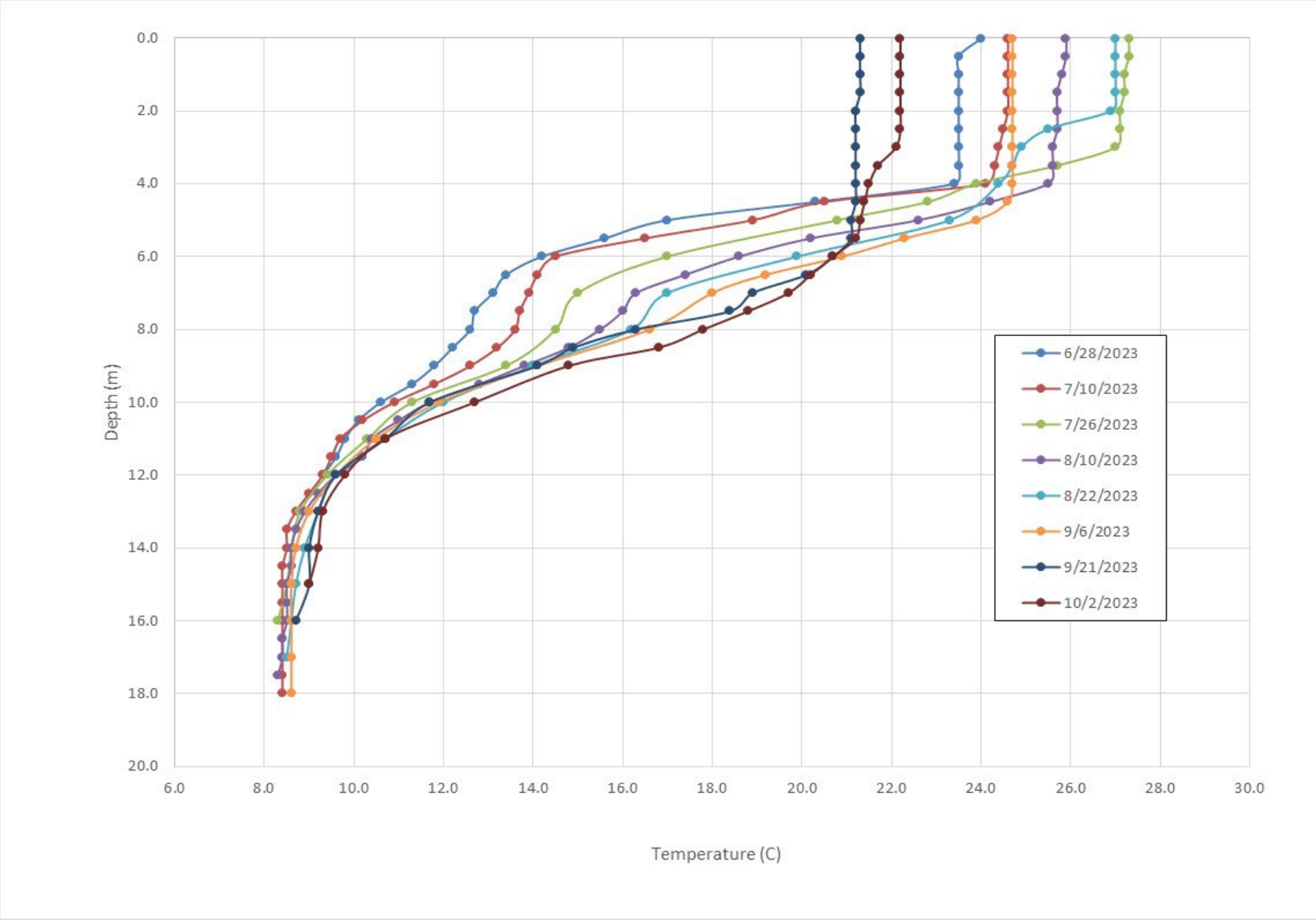

Figure A1. Temperature (°C) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the south cell of Ada Hayden Lake, June through October 2023.

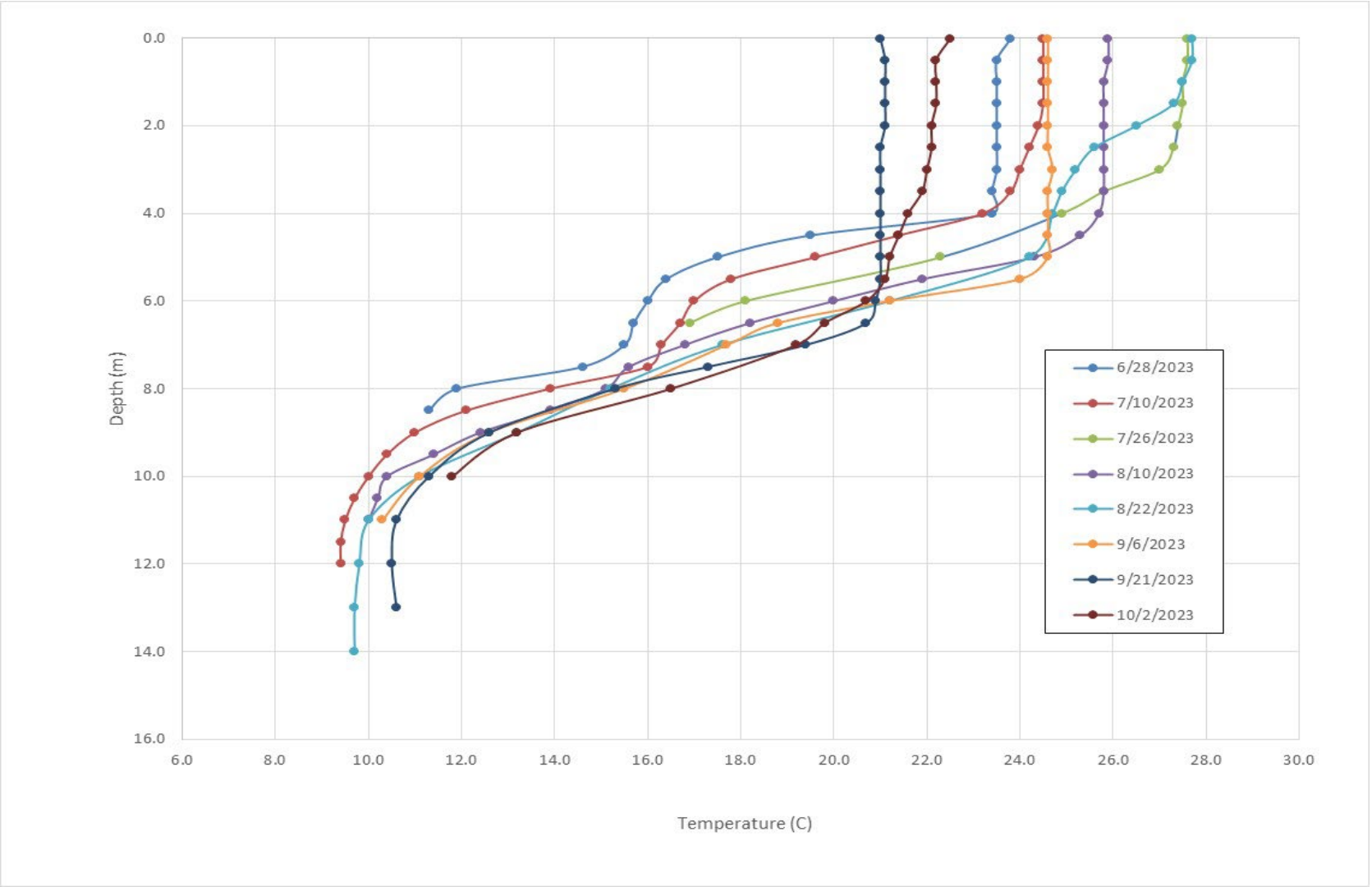

Figure A2. Temperature (°C) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the north cell of Ada Hayden Lake, June through October 2023.

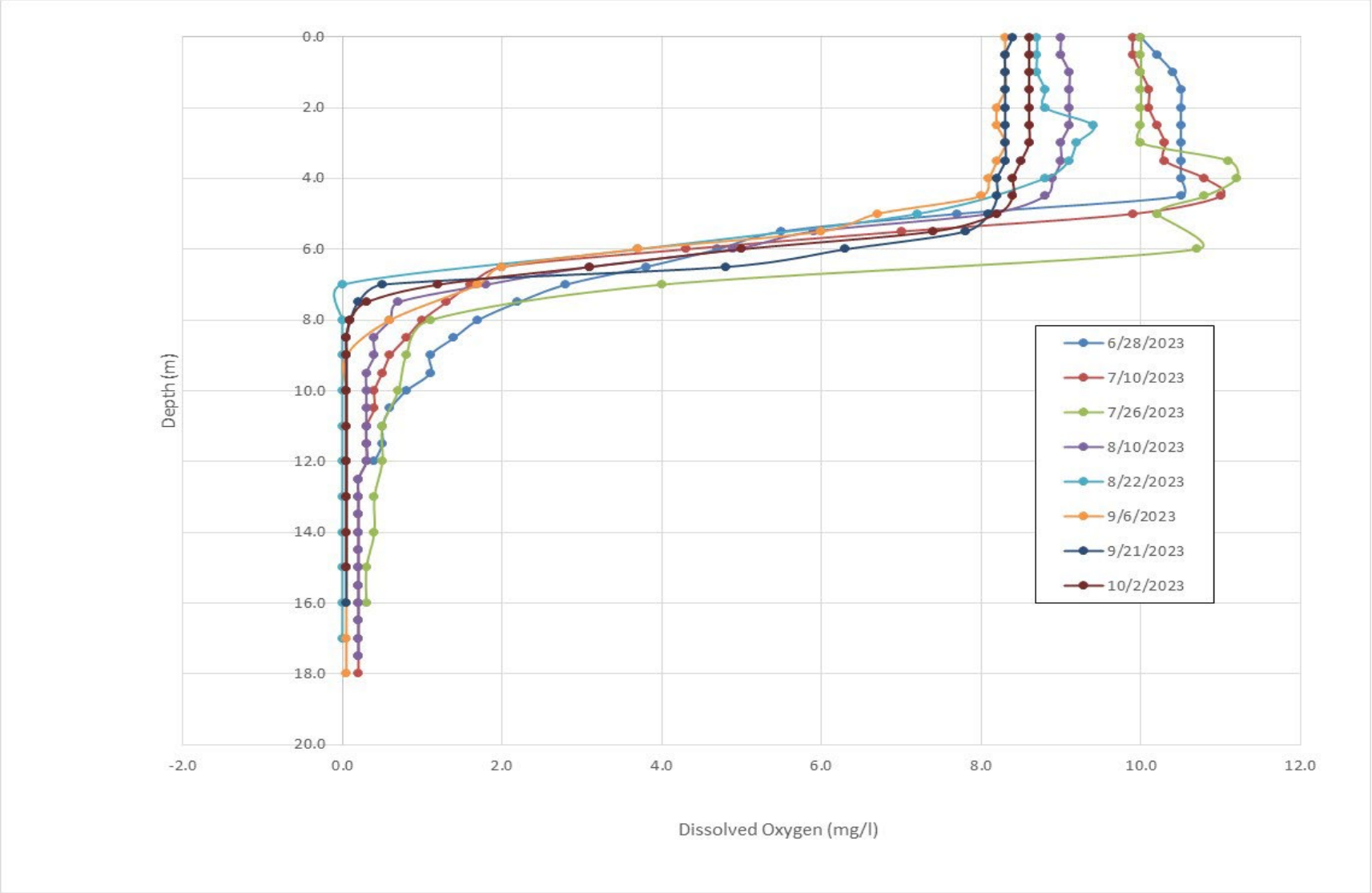

Figure A3. Dissolved oxygen (mg/L) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the south cell of Ada Hayden Lake, June through October 2023.

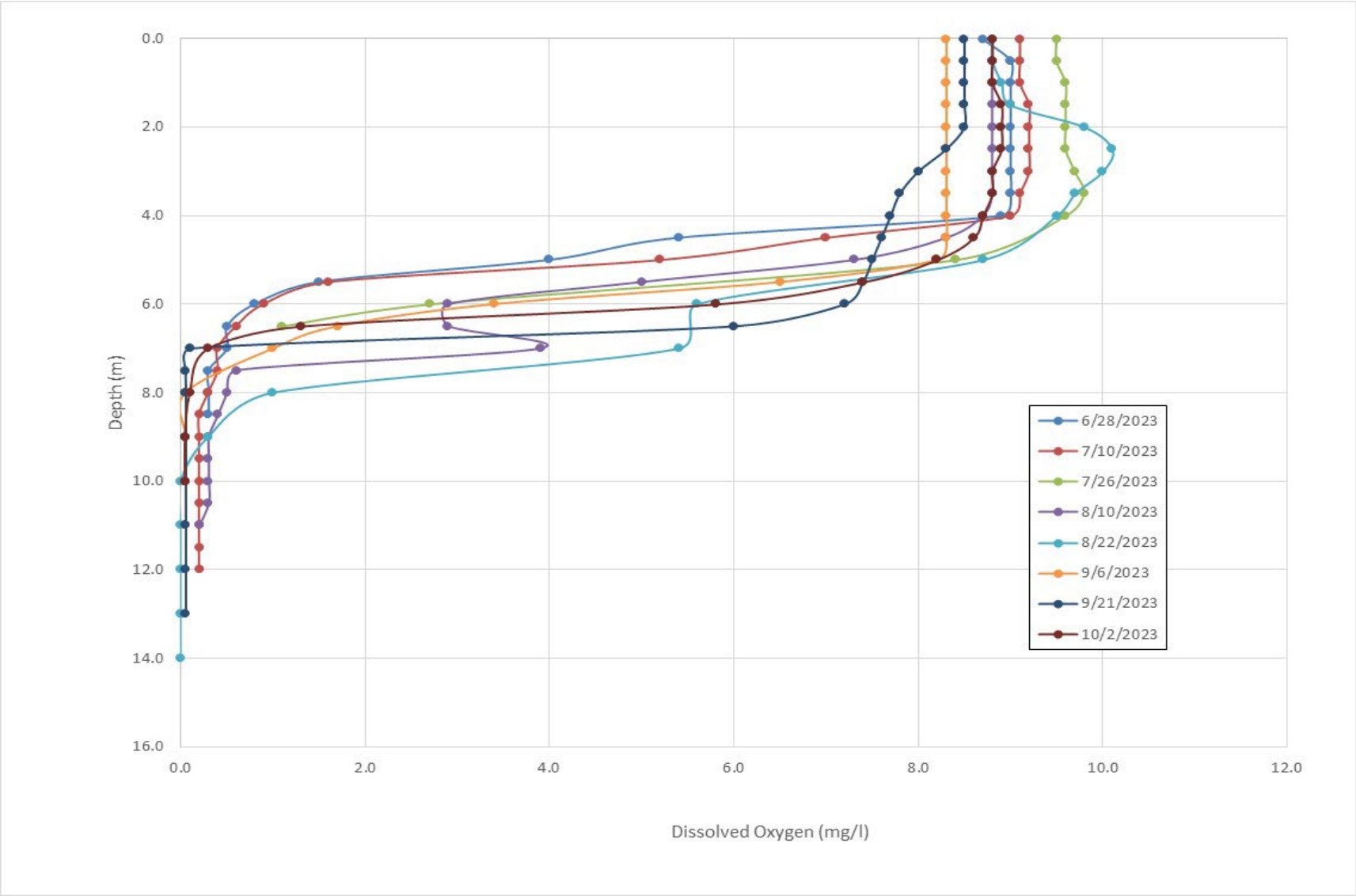

Figure A4. Dissolved oxygen (mg/L) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the north cell of Ada Hayden Lake, June through October 2023.

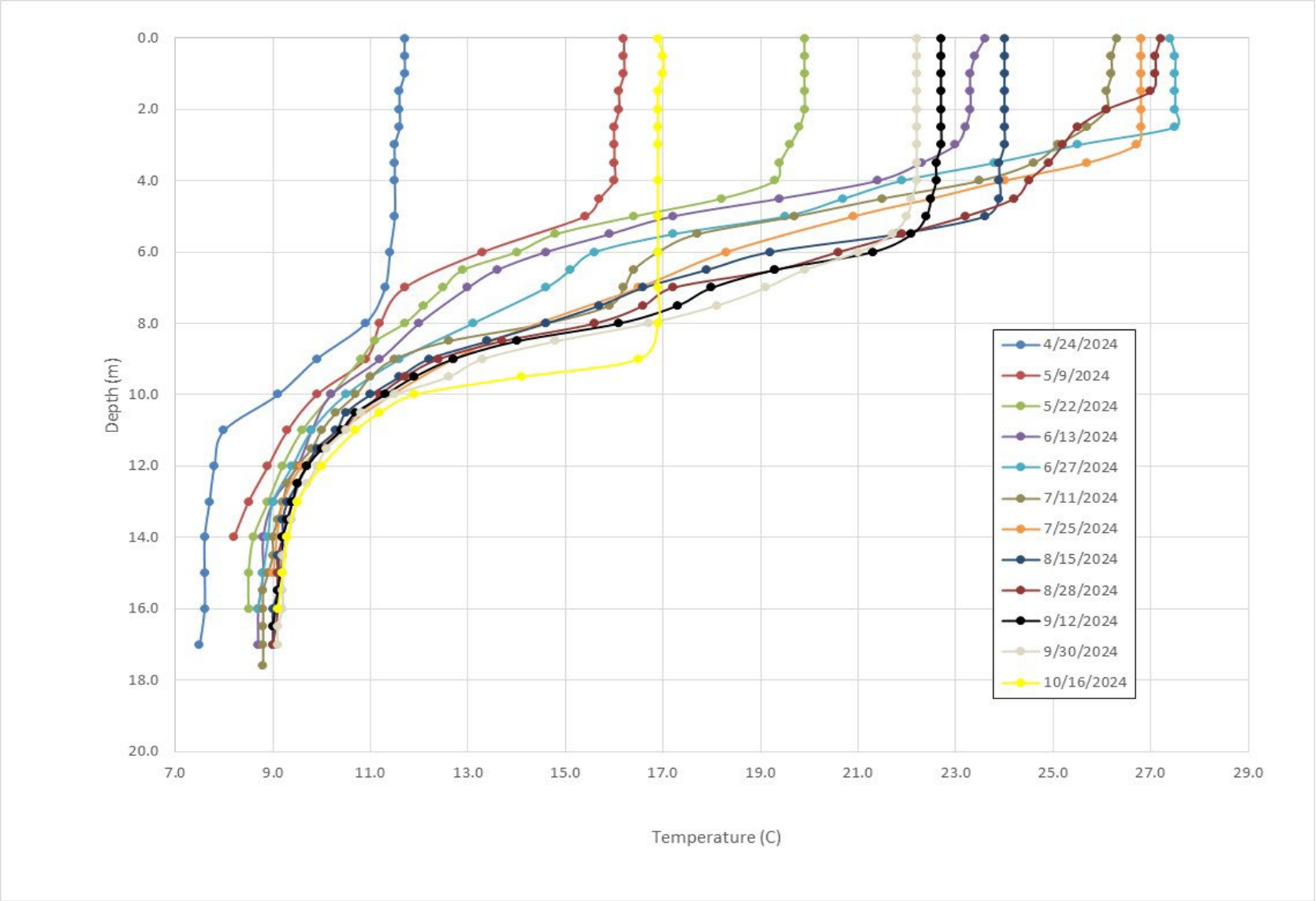

Figure A5. Temperature (°C) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the south cell of Ada Hayden Lake, April through October 2024.

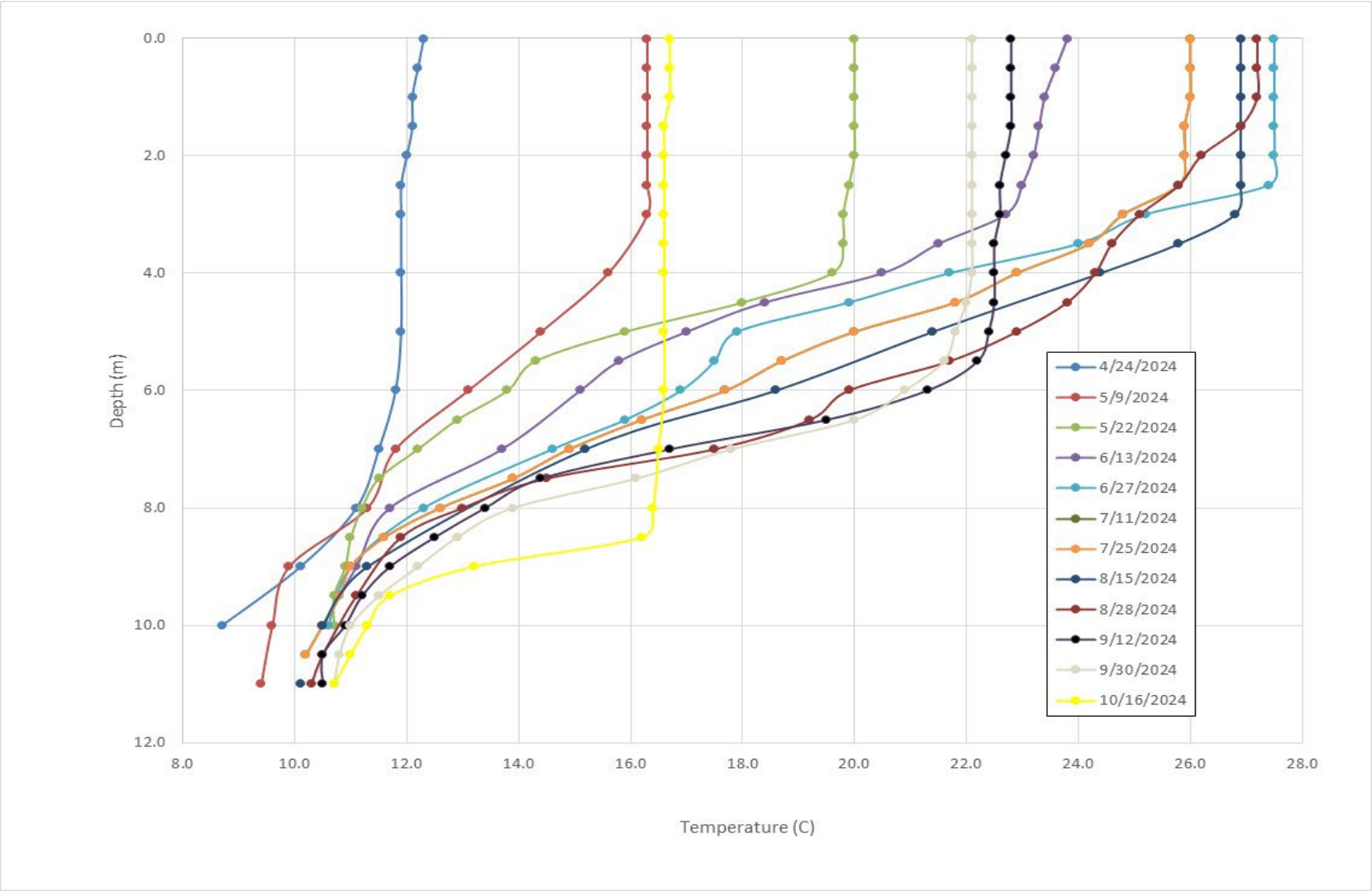

Figure A6. Temperature (°C) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the north cell of Ada Hayden Lake, April through October 2024.

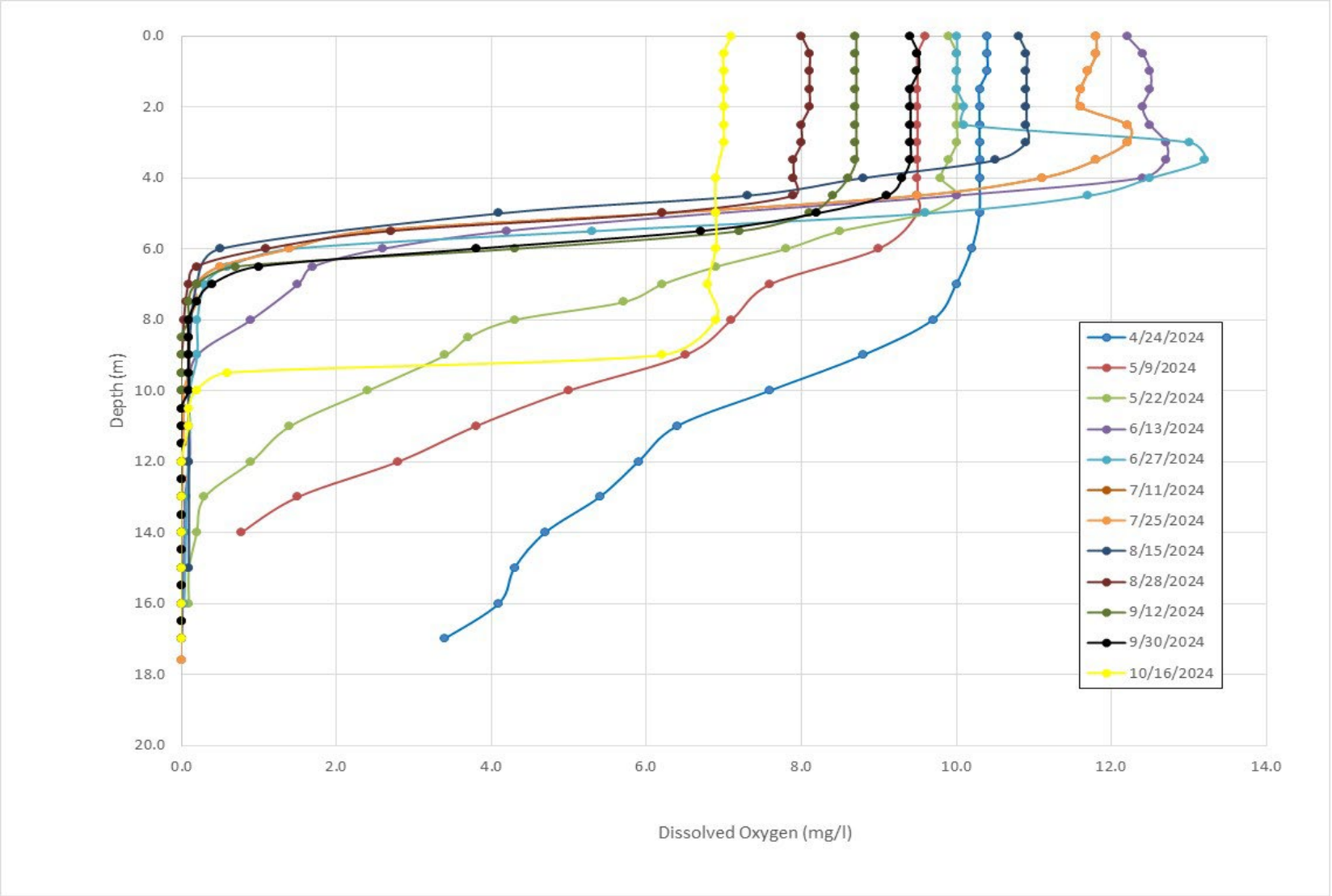

Figure A7. Dissolved oxygen (mg/L) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the south cell of Ada Hayden Lake, April through October 2024.

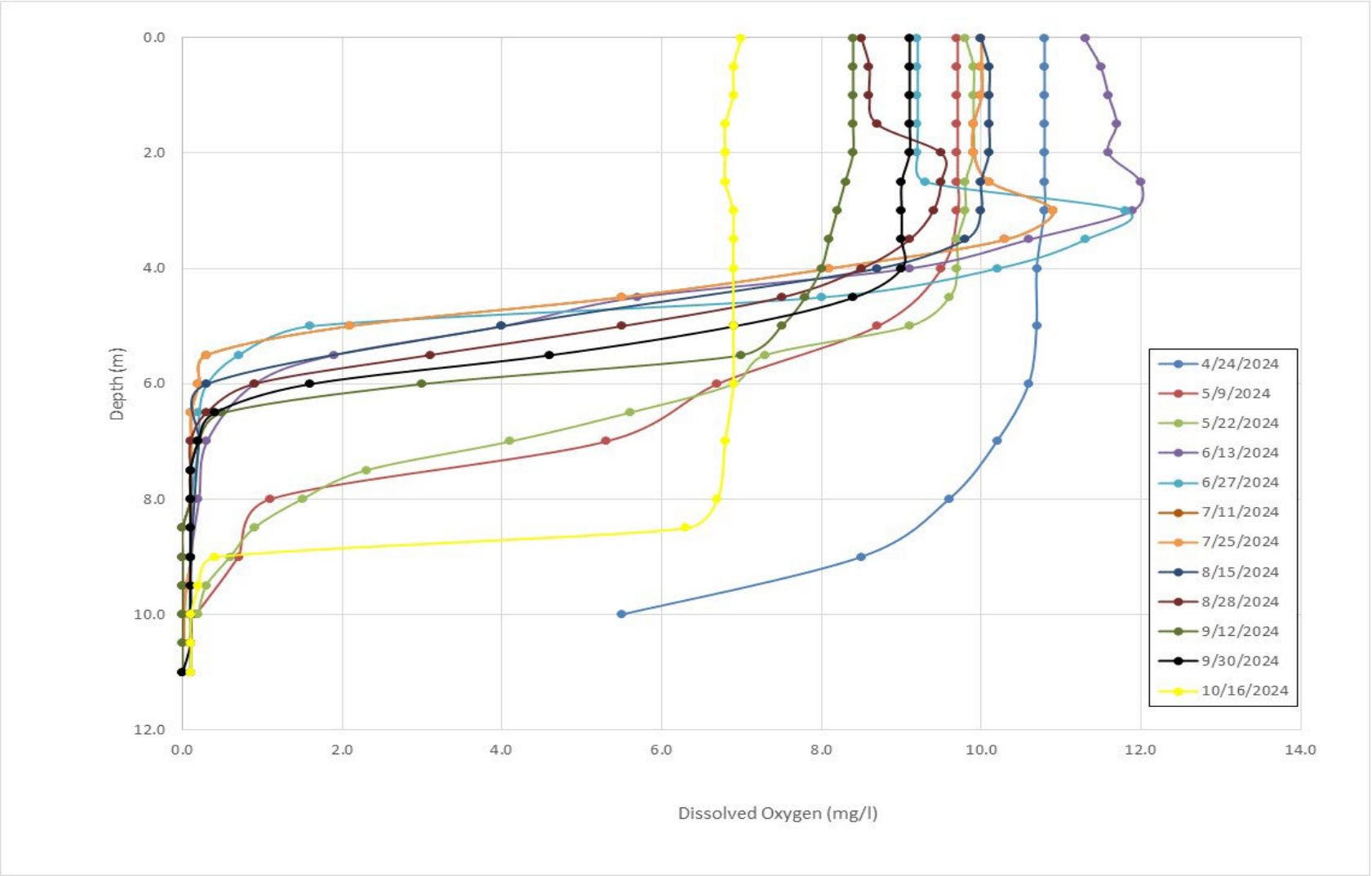

Figure A8. Dissolved oxygen (mg/L) measured at approximately 0.5 m or 1.0 m increments from the lake surface to the lake substrate in the north cell of Ada Hayden Lake, April through October 2024.

Appendix B – Wetland Sampling Results

Table B1. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the north wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
6/28/2023	8.7	D	8.1	D	17.5	D	780	D
7/13/2023	7.8	5.9	7.5	7.4	19.2	21.9	620	670
7/26/2023	8.0	D	8.1	D	20.1	D	830	D
8/22/2023	8.3	D	8.1	D	21.6	D	820	D
9/21/2023	8.7	D	8.1	D	15.4	D	760	D
Average	8.3	5.9	8.0	7.4	18.8	21.9	762	670
Minimum	7.8	5.9	7.5	7.4	15.4	21.9	620	670
Maximum	8.7	5.9	8.1	7.4	21.6	21.9	830	670

Table B2. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the north wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
3/26/2024	11.7	D	7.7	D	5.3	D	730	D
4/17/2024	10.6	D	7.9	D	9.6	D	760	D
4/24/2024	15.9	D	8.4	D	10.8	D	740	D
5/2/2024	9.0	4.3	7.4	7.5	11.3	14.4	560	560
5/9/2024	8.9	8.3	7.5	7.8	12.0	17.1	610	550
5/22/2024	8.4	7.2	7.4	7.7	13.8	18.5	570	540
6/19/2024	9.0	6.0	7.4	7.2	17.5	21.6	650	600
6/27/2024	8.7	D	8.0	D	16.7	D	810	D
7/25/2024	8.1	5.8	8.0	7.1	19.3	23.5	750	550
7/30/2024	7.9	5.1	7.6	7.2	19.2	22.2	750	540
8/28/2024	6.8	D	7.8	D	21.0	D	670	D
9/30/2024	8.1	D	7.8	D	13.7	D	750	D
Average	9.4	6.1	7.7	7.4	14.2	19.6	696	557
Minimum	6.8	4.3	7.4	7.1	5.3	14.4	560	540
Maximum	15.9	8.3	8.4	7.8	21.0	23.5	810	600

Table B3. Turbidity (NTU), flow rate (cfs), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the north wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
6/28/2023	3.7	D	1.5	D	500	D
7/13/2023	19	2.6	5.8	<0.1	2000	4600
7/26/2023	3.6	D	0.3	D	2000	D
8/22/2023	9.1	D	0.1	D	1000	D
9/21/2023	8.1	D	<0.1	D	3100	D
Average	8.7	2.6	1.6	<0.1	1440	4600
Minimum	3.6	2.6	<0.1	<0.1	500	4600
Maximum	19	2.6	5.8	<0.1	3100	4600

Table B4. Turbidity (NTU), flow rate (cfs), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the north wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
3/26/2024	8.6	D	6.1	D	41	D
4/17/2024	1.8	D	1.4	D	120	D
4/24/2024	<1.0	D	1.0	D	51	D
5/2/2024	150	3.4	13	0.2	1600	160
5/9/2024	55	8.1	13	5.3	500	85
5/22/2024	80	28	20	15	790	4900
6/19/2024	19	<1.0	4.8	<0.1	3200	360
6/27/2024	9.6	D	0.8	D	820	D
7/25/2024	3.1	3.3	0.8	<0.1	31	190
7/30/2024	3.1	3.7	1.3	<0.1	860	610
8/28/2024	2.2	D	<0.1	D	2200	D
9/30/2024	3.2	D	0.1	D	1100	D
Average	28	8.0	5.2	3.4	416	375
Minimum	<1.0	<1.0	<0.1	<0.1	31	85
Maximum	150	28	20	15.0	3200	4900

Table B5. Nitrate + nitrite nitrogen (mg/L), total Kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* (mg/L) measured at the inlet and outlet of the north wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Inlet Chlorophyll *a*	Outlet Chlorophyll *a*
6/28/2023	14	D	0.53	D	<1	D
7/13/2023	8.7	1.8	0.97	0.83	7	12
7/26/2023	9.3	D	0.54	D	1	D
8/22/2023	5.3	D	0.58	D	1	D
9/21/2023	1.8	D	0.73	D	8	D
Average	7.8	1.8	0.67	0.83	4	12
Minimum	1.8	1.8	0.53	0.83	<1	12
Maximum	14	1.8	0.97	0.83	8	12

Table B6. Nitrate + nitrite nitrogen (mg/L), total kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* (mg/L) measured at the inlet and outlet of the north wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Chlorophyll *a* Inlet	Chlorophyll *a* Outlet
3/26/2024	12	D	0.8	D	5	D
4/17/2024	11	D	0.4	D	10	D
4/24/2024	12	D	0.5	D	13	D
5/2/2024	7.4	3.1	2	0.9	63	30
5/9/2024	14	8.0	1.2	1.3	6	32
5/22/2024	15	7.8	1.4	1.5	5	45
6/19/2024	16	0.3	0.7	0.7	7	1
6/27/2024	22	D	<0.50	D	2	D
7/25/2024	9.9	<0.25	<0.50	0.7	2	16
7/30/2024	10	<0.25	<0.50	<0.50	3	11
8/28/2024	3.3	D	<0.50	D	1	D
9/30/2024	1.0	D	<0.50	D	2	D
Average	11	3.2	0.7	0.9	10	23
Minimum	1.0	<0.25	<0.50	<0.50	1	1
Maximum	22	8.0	2.0	1.5	63	45

Table B7. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the north wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
6/28/2023	0.12	D	0.07	D	7	D
7/13/2023	0.22	0.17	0.15	0.10	41	3
7/26/2023	0.12	D	0.10	D	9	D
8/22/2023	0.20	D	0.16	D	13	D
9/21/2023	0.18	D	0.15	D	23	D
Average	0.17	0.17	0.13	0.10	19	3
Minimum	0.12	0.17	0.07	0.10	7	3
Maximum	0.22	0.17	0.16	0.10	41	3

Table B8. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the north wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
3/26/2024	0.23	D	0.17	D	16	D
4/17/2024	0.07	D	0.05	D	3	D
4/24/2024	0.04	D	0.03	D	2	D
5/2/2024	0.55	0.14	0.16	0.07	380	6
5/9/2024	0.34	0.15	0.20	0.04	94	18
5/22/2024	0.46	0.22	0.27	0.05	110	47
6/19/2024	0.16	0.24	0.13	0.24	50	<1.0
6/27/2024	0.07	D	0.07	D	20	D
7/25/2024	0.09	0.52	0.09	0.33	6	3
7/30/2024	0.09	0.68	0.09	0.61	7	5
8/28/2024	0.19	D	0.17	D	2	D
9/30/2024	0.12	D	0.10	D	4	D
Average	0.20	0.33	0.17	0.22	58	13
Minimum	0.07	0.14	0.05	0.04	2	<1.0
Maximum	0.55	0.68	0.03	0.61	380	47

Table B9. Overall means, means for samples collected after rainfall event*, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the north wetland at Ada Hayden Heritage Park. Samples were collected from June through September 2023.

Parameter	Inlet	Outlet	Inlet Rainfall Event*	Outlet Rainfall Event*	Inlet No Rain	Outlet No Rain**
Nitrate + Nitrite Nitrogen (mg/L)	7.8	1.8	8.7	1.8	7.6	-
TKN (mg/L)	0.67	0.83	0.97	0.83	0.6	-
Total Nitrogen (mg/L)	8.5	2.6	9.7	2.6	8.2	-
Total Phosphorus (ug/L)	0.17	0.17	0.22	0.17	0.16	-
Orthophosphate (ug/L)	0.13	0.10	0.15	0.10	0.12	-
Turbidity (NTU)	8.7	2.6	19	2.6	6.1	-
Chlorophyll *a* (mg/L)	4	12	7	12	3	-
Total Suspended Solids (mg/L)	19	3	41	3	13	-
Specific Conductivity (umho/cm)	762	670	620	670	798	-
E. coli (MPN/100 mL)**	1720	4600	2000	4600	1650	-

*Means could not be calculated since only one significant rainfall occurred during sampling season

**Outlet stream was dry during every sampling besides the event sample

Table B10. Overall means, means for samples collected after rainfall event, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the north wetland at Ada Hayden Heritage Park. Samples were collected from March through September 2024.

Parameter	Inlet	Outlet	Inlet Rainfall Event	Outlet Rainfall Event	Inlet No Rain	Outlet No Rain
Nitrate + Nitrite Nitrogen (mg/L)	11.1	3.2	11.7	2.9	10.5	4.0
TKN (mg/L)	0.7	0.9	0.90	0.79	0.48	1.08
Total Nitrogen (mg/L)	11.8	4.1	12.6	3.7	11.0	5.1
Total Phosphorus (ug/L)	0.20	0.33	0.24	0.30	0.16	0.37
Orthophosphate (ug/L)	0.13	0.22	0.13	0.24	0.12	0.19
Turbidity (NTU)	28	8	39.6	3.9	16.4	15.7
Chlorophyll *a* (mg/L)	10	23	15.7	18.5	4.2	30.5
Total Suspended Solids (mg/L)	58	13	91.7	7.4	24.0	25.0
Specific Conductivity (umho/cm)	696	557	677	563	715	545
E. coli (MPN/100 mL)	416	375	1054	304	832	2545

Table B11. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the middle wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
6/28/2023	8.10	7.70	7.80	7.60	19.0	22.0	730	400
7/13/2023	7.80	6.00	7.70	7.80	21.5	24.2	630	320
7/26/2023	7.90	D	8.10	D	20.2	D	880	D
8/22/2023	8.10	D	8.00	D	21.7	D	870	D
9/21/2023	3.40	D	7.90	D	16.2	D	670	D
Average	7.10	6.90	7.90	7.70	19.7	23.1	756	360
Minimum	3.40	6.00	7.70	7.60	16.2	22.0	630	320
Maximum	8.10	7.70	8.10	7.80	21.7	24.2	880	400

Table B12. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the middle wetland, March through July 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
3/26/2024	11.3	D	7.7	D	6.5	D	610	D
4/17/2024	8.9	7.9	7.8	7.7	11.8	15.3	610	510
4/24/2024	11.7	9.9	7.9	7.9	10.2	12.9	810	500
5/2/2024	9.7	10.6	7.4	8.3	12.6	14.6	420	470
5/9/2024	9.1	7.7	7.6	7.7	13.7	16.1	570	440
5/22/2024	8.9	6.7	7.7	7.5	16.2	18.4	560	340
6/19/2024	8.5	5.7	7.4	7.2	20.3	22.8	480	440
6/27/2024	8.8	D	8.0	D	20.6	D	730	D
7/25/2024	9.6	6.0	8.1	7.5	21.8	24.1	630	360
7/30/2024	7.0	8.5	7.4	8.6	21.1	26.4	420	320
Average	9.4	7.9	7.7	7.8	15.5	18.8	584	423
Minimum	7.0	5.7	7.4	7.2	6.5	12.9	420	320
Maximum	11.7	10.6	8.1	8.6	21.8	26.4	810	510

Table B13. Turbidity (NTU), flow rate (cfs), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the middle wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
6/28/2023	3.5	1.9	0.3	<0.1	2800	200
7/13/2023	2.6	5.3	0.7	1.9	640	1200
7/26/2023	1.8	D	<0.1	D	2000	D
8/22/2023	1.6	D	<0.1	D	1900	D
9/21/2023	5.9	D	<0.1	D	6500	D
Average	3.1	3.6	0.2	1.0	2134	490
Minimum	1.6	1.9	<0.1	<0.1	640	200
Maximum	5.9	5.3	0.7	1.9	6500	1200

Table B14. Turbidity (NTU), flow rate (cfs), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the middle wetland, March through July 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
3/26/2024	6.0	D	1.5	D	260	D
4/17/2024	2.9	3.0	0.3	0.3	640	<10
4/24/2024	<1.0	2.0	0.2	<0.1	340	<10
5/2/2024	50	5.0	7.7	12	4400	30
5/9/2024	15	14	3.0	5.0	930	1700
5/22/2024	15	28	3.4	3.0	1700	4100
6/19/2024	10	2.0	0.9	3.0	2900	4100
6/27/2024	2.0	D	0.1	D	360	D
7/25/2024	1.1	2.0	0.2	<0.1	360	<10
7/30/2024	4.9	1.0	0.9	<0.1	8200	98
Average	11	7.1	1.8	2.9	1019	101
Minimum	<1.0	1.0	0.1	<0.1	260	<10
Maximum	50	28	7.7	12.0	8200	4100

Table B15. Nitrate + nitrite nitrogen (mg/L), total Kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* concentration (mg/L) measured at the inlet and outlet of the middle wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Inlet Chlorophyll *a* (mg/L)	Outlet Chlorophyll *a* (mg/L)
6/28/2023	4.8	<0.1	1.0	0.6	27	13
7/13/2023	2.9	<0.1	0.8	0.7	6	36
7/26/2023	4.9	D	0.5	D	<1	D
8/22/2023	4.1	D	0.4	D	<1	D
9/21/2023	0.7	D	0.9	D	3	D
Average	3.5	<0.1	0.7	0.7	7	25
Minimum	0.7	<0.1	0.4	0.6	<1	13
Maximum	4.9	<0.1	1.0	0.7	27	36

Table B16. Nitrate + nitrite nitrogen (mg/L), total Kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* concentration (mg/L) measured at the inlet and outlet of the middle wetland, March through July 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Inlet Chlorophyll *a* (mg/L)	Outlet Chlorophyll *a* (mg/L)
3/26/2024	2.4	D	0.55	D	1	D
4/17/2024	1.9	<0.1	0.36	0.81	4	19
4/24/2024	4.1	<0.1	0.34	0.63	2	15
5/2/2024	1.6	0.8	1.30	0.54	5	44
5/9/2024	3.6	2.0	0.63	0.80	3	19
5/22/2024	3.5	1.4	0.70	0.96	3	13
6/19/2024	2.9	0.4	0.91	0.60	28	13
6/27/2024	10	D	<0.50	D	2	D
7/25/2024	5.3	<0.25	<0.50	<0.50	19	32
7/30/2024	2.9	<0.25	0.65	<0.50	5	27
Average	3.8	0.6	0.6	0.6	7	23
Minimum	1.6	<0.1	<0.50	<0.50	1	13
Maximum	10	2.0	1.3	1.0	28	44

Table B17. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the middle wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
6/28/2023	0.08	0.06	<0.02	<0.02	6	3
7/13/2023	0.08	0.08	0.06	<0.02	4	6
7/26/2023	0.06	D	0.05	D	2	D
8/22/2023	0.06	D	0.05	D	4	D
9/21/2023	0.07	D	0.03	D	9	D
Average	0.07	0.07	0.04	<0.02	5	5
Minimum	0.06	0.06	<0.02	<0.02	2	3
Maximum	0.08	0.08	0.06	<0.02	9	6

Table B18. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the middle wetland, March through July 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
3/26/2024	0.11	D	0.08	D	9	D
4/17/2024	0.05	0.06	0.02	<0.02	2	4
4/24/2024	0.03	0.04	0.02	<0.02	1	3
5/2/2024	0.20	0.06	0.09	<0.02	110	11
5/9/2024	0.13	0.14	0.08	0.08	13	14
5/22/2024	0.19	0.19	0.14	0.09	18	18
6/19/2024	0.13	0.03	0.06	<0.02	15	3
6/27/2024	<0.02	D	0.02	D	2	D
7/25/2024	0.02	0.04	<0.02	<0.02	6	2
7/30/2024	0.07	0.04	0.04	<0.02	7	3
Average	0.09	0.08	0.06	0.03	18	7
Minimum	<0.02	0.03	<0.02	<0.02	1	2
Maximum	0.20	0.19	0.14	0.09	110	18

Table B19. Overall means, means for samples collected after rainfall event*, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the middle wetland at Ada Hayden Heritage Park. Samples were collected from June through September 2023.

Parameter	Inlet	Outlet	Inlet Rainfall Event**	Outlet Rainfall Event*	Inlet No Rain	Outlet No Rain
Nitrate + Nitrite Nitrogen (mg/L)	3.5	0.1	2.9	<0.1	3.6	0.05
TKN (mg/L)	0.72	0.56	0.78	0.70	0.71	0.60
Total Nitrogen (mg/L)	4.2	0.66	3.7	0.70	4.3	0.65
Total Phosphorus (ug/L)	0.07	0.07	0.08	0.08	0.07	0.06
Orthophosphate (ug/L)	0.04	0.01	0.06	<0.02	0.04	0.01
Turbidity (NTU)	3.1	3.6	2.6	5.3	3.2	1.9
Chlorophyll *a* (mg/L)	7	25	6	36	7.8	13
Total Suspended Solids (mg/L)	5.0	4.5	4	6	5.3	3.0
Specific Conductivity (umho/cm)	756	360	756	360	788	400
E. coli (MPN/100 mL)	2134	490	640	1200	3300	200

*Means could not be calculated since only one significant rainfall occurred during sampling season

Table B20. Overall means, means for samples collected after rainfall event, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the middle wetland at Ada Hayden Heritage Park. Samples were collected from March through July 2024.

Parameter	Inlet	Outlet	Inlet Rainfall Event	Outlet Rainfall Event	Inlet No Rain	Outlet No Rain
Nitrate + Nitrite Nitrogen (mg/L)	3.8	0.6	2.6	0.7	5.7	0.5
TKN (mg/L)	0.6	0.6	0.7	0.6	0.4	0.6
Total Nitrogen (mg/L)	4.4	1.2	3.3	1.3	6.1	1.1
Total Phosphorus (ug/L)	0.09	0.08	0.12	0.07	0.06	0.09
Orthophosphate (ug/L)	0.06	0.03	0.06	0.02	0.05	0.04
Turbidity (NTU)	11	7	15	5	5	11
Chlorophyll *a* (mg/L)	7	23	8	24	7	20
Total Suspended Solids (mg/L)	18	7	26	7	7	8
Specific Conductivity (umho/cm)	584	423	518	436	683	400
E. coli (MPN/100 mL)	1019	101	2888	1187	690	1370

Table B21. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the south wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
6/28/2023	7.5	8.7	8.0	8.4	18.4	24.5	870	300
7/13/2023	8.3	7.7	8.1	8.7	18.9	24.9	840	190
7/26/2023	7.0	D	8.0	D	21.5	D	870	D
8/22/2023	8.7	2.2	8.2	7.5	23.2	29.1	850	330
9/21/2023	8.1	D	8.0	D	17.2	D	710	D
Average	7.9	6.2	8.1	8.2	19.8	26.2	828	273
Minimum	7.0	2.2	8.0	7.5	17.2	24.5	710	190
Maximum	8.7	8.7	8.2	8.7	23.2	29.1	870	330

Table B22. Dissolved oxygen (mg/L), pH (no units), temperature (°C), and specific conductivity (µmho/cm) measured at the inlet and outlet of the south wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Dissolved Oxygen (mg/L)	Outlet Dissolved Oxygen (mg/L)	Inlet pH (no units)	Outlet pH (no units)	Inlet Temperature (°C)	Outlet Temperature (°C)	Inlet Specific Conductivity (µmho/cm)	Outlet Specific Conductivity (µmho/cm)
3/26/2024	11.8	10.7	8.1	7.7	7.1	6.0	860	540
4/17/2024	9.5	6.7	7.8	7.7	11.6	14.8	680	520
4/24/2024	15.2	8.0	8.4	8.0	10.1	13.3	1000	470
5/2/2024	9.6	7.2	7.4	7.7	12.3	14.8	280	450
5/9/2024	9.5	6.8	7.9	7.8	13.2	15.9	900	540
5/22/2024	9.4	6.7	8.0	7.4	14.7	17.1	920	260
6/19/2024	8.8	5.4	7.8	7.5	19.6	23.9	600	480
6/27/2024	8.1	D	8.1	D	19.5	D	990	D
7/25/2024	8.9	5.8	8.2	8.4	20.8	25.8	900	230
7/30/2024	7.2	5.1	7.6	7.8	20.9	25.1	370	230
8/28/2024	5.5	D	7.8	D	22.6	D	480	D
9/30/2024	9.2	D	8.2	D	16.7	D	900	D
Average	9.4	6.9	7.9	7.8	15.8	17.4	740	413
Minimum	5.5	5.1	7.4	7.4	7.1	6.0	280	230
Maximum	15.2	10.7	8.4	8.4	22.6	25.8	1000	540

Table B23. Turbidity (NTU), flow rate (CFS), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the south wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
6/28/2023	1.7	32	0.1	<0.1	13000	330
7/13/2023	<0.1	31	0.6	0.2	1400	1700
7/26/2023	1.5	D	0.1	D	6500	D
8/22/2023	1.0	13	<0.1	<0.1	2600	20
9/21/2023	<0.1	D	<0.1	D	7700	D
Average	0.9	25	0.2	0.1	4730	224
Minimum	<0.1	13	<0.1	<0.1	1400	20
Maximum	1.7	32	0.6	0.2	13000	1700

Table B24. Turbidity (NTU), flow rate (CFS), and *E. coli* (MPN/100mL) measured at the inlet and outlet of the south wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Turbidity (NTU)	Outlet Turbidity (NTU)	Inlet Flow Rate (CFS)	Outlet Flow Rate (CFS)	Inlet *E. coli* (MPN/100mL)	Outlet *E. coli* (MPN/100mL)
3/26/2024	1.6	26	1.0	3.6	4100	890
4/17/2024	2.4	65	0.4	0.6	6100	1400
4/24/2024	<1.0	50	0.2	<0.1	590	41
5/2/2024	12.0	22	6.9	8.6	1500	320
5/9/2024	1.8	31	2.6	3.1	1000	1400
5/22/2024	1.1	24	2.3	1.8	1500	5200
6/19/2024	1.7	26	0.5	3.0	1500	3100
6/27/2024	<1.0	D	0.1	D	1800	D
7/25/2024	<1.0	21	0.2	<0.1	5500	10
7/30/2024	9.8	20	0.6	0.4	6900	180
8/28/2024	3.3	D	<0.1	D	>24000	D
9/30/2024	<1.0	D	<0.1	D	2600	D
Average	3	32	1.2	2.4	2779	444
Minimum	<1.0	20	<1	<1	590	10
Maximum	12	65	7	8.6	>24000	5200

Table B25. Nitrate + nitrite nitrogen (mg/L) total Kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* concentration (mg/L) measured at the inlet and outlet of the south wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Chlorophyll *a* Inlet (mg/L)	Chlorophyll *a* Outlet (mg/L)
6/28/2023	3.6	<0.1	0.8	1.4	<1	100
7/13/2023	4.8	0.2	0.3	1.6	<1	190
7/26/2023	2.4	D	0.5	D	1	D
8/22/2023	2.9	<0.1	0.4	1.3	<1	61
9/21/2023	1.2	D	0.4	D	1	D
Average	3.0	<0.1	0.5	1.4	1	117
Minimum	1.2	<0.1	0.3	1.3	<1	61
Maximum	4.8	0.2	0.8	1.6	1	190

Table B26. Nitrate + nitrite nitrogen (mg/L) total Kjeldahl nitrogen (TKN, mg/L), and chlorophyll *a* concentration (mg/L) measured at the inlet and outlet of the south wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Nitrate+Nitrite Nitrogen (mg/L)	Outlet Nitrate+Nitrite Nitrogen (mg/L)	Inlet TKN (mg/L)	Outlet TKN (mg/L)	Chlorophyll *a* Inlet (mg/L)	Chlorophyll *a* Outlet (mg/L)
3/26/2024	4.0	0.7	0.36	0.89	1	9
4/17/2024	3.1	0.6	0.43	1.40	3	37
4/24/2024	3.4	0.4	0.37	1.10	2	53
5/2/2024	1.2	1.3	0.55	0.87	3	34
5/9/2024	5.3	2.9	0.40	0.98	1	19
5/22/2024	5.8	1.2	0.48	0.84	<0.1	10
6/19/2024	3.0	<0.25	<0.50	1.20	<0.1	79
6/27/2024	3.5	D	<0.50	D	<0.1	D
7/25/2024	3.9	<0.25	<0.50	1.10	<0.1	110
7/30/2024	2.4	<0.25	0.71	1.10	2	110
8/28/2024	0.9	D	<0.50	D	4	D
9/30/2024	1.4	D	<0.50	D	<0.1	D
Average	3.2	0.8	0.34	1.05	2	51
Minimum	0.9	<0.25	<0.50	0.84	<0.1	9
Maximum	5.8	2.9	0.71	1.40	4	110

Table B27. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the south wetland, June through September 2023. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
6/28/2023	0.06	0.18	0.05	<0.02	1	37
7/13/2023	0.05	0.23	0.04	0.03	1	49
7/26/2023	0.08	D	0.06	D	2	D
8/22/2023	0.07	0.16	0.05	0.03	1	9
9/21/2023	0.07	D	0.06	D	1	D
Average	0.07	0.19	0.05	0.02	1	32
Minimum	0.05	0.16	0.04	<0.02	1	9
Maximum	0.08	0.23	0.06	0.03	2	49

Table B28. Total phosphorus (mg/L), orthophosphate (mg/L), and total suspended solids (TSS, mg/L) measured at the inlet and outlet of the south wetland, March through September 2024. Samples were not collected if the site was dry (D).

Date Collected	Inlet Total Phosphorus (mg/L)	Outlet Total Phosphorus (mg/L)	Inlet Ortho-phosphate (mg/L)	Outlet Ortho-phosphate (mg/L)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
3/26/2024	0.04	0.11	0.04	0.02	1.0	33
4/17/2024	0.05	0.20	0.03	<0.02	24.0	94
4/24/2024	0.03	0.15	0.03	<0.02	<1.0	67
5/2/2024	0.09	0.10	0.08	<0.02	12.0	38
5/9/2024	0.04	0.12	0.04	0.02	1.0	46
5/22/2024	0.05	0.14	0.05	0.04	2.0	29
6/19/2024	0.04	0.14	0.04	<0.02	1.0	33
6/27/2024	0.07	D	0.06	D	1.0	D
7/25/2024	0.05	0.14	0.05	<0.02	1.0	26
7/30/2024	0.07	0.14	0.05	<0.02	7.0	31
8/28/2024	0.13	D	0.08	D	44.0	D
9/30/2024	0.07	D	0.07	D	2.0	D
Average	0.06	0.14	0.05	0.02	8.0	44
Minimum	0.03	0.10	0.03	<0.02	<1.0	26
Maximum	0.13	0.20	0.08	0.04	44	94

Table B29. Overall means, means for samples collected after rainfall event*, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the south wetland at Ada Hayden Heritage Park. Samples were collected from June through September of 2023.

Parameter	Inlet	Outlet	Inlet Rainfall Event*	Outlet Rainfall Event*	Inlet No Rain	Outlet No Rain
Nitrate + Nitrite Nitrogen (mg/L)	3.0	0.11	4.8	0.24	3.0	0.05
TKN (mg/L)	0.47	1.4	0.34	1.6	0.55	1.4
Total Nitrogen (mg/L)	3.5	1.5	5.1	1.8	3.6	1.5
Total Phosphorus (ug/L)	0.07	0.19	0.05	0.23	0.07	0.17
Orthophosphate (ug/L)	0.05	0.02	0.04	0.03	0.05	0.02
Turbidity (NTU)	0.9	25	<0.1	31	1.4	23
Chlorophyll *a* (mg/L)	0.70	117	<1	190	<1	80
Total Suspended Solids (mg/L)	1.2	32	1	49	1.3	23
Specific Conductivity (umho/cm)	828	273	840	190	863	315
E. coli (MPN/100 mL)	4730	224	1400	1700	7366	175

*Means could not be calculated since only one significant rainfall occurred during sampling season, values listed in the column are the results from one sample.

Table B30. Overall means, means for samples collected after rainfall event, and means for samples not collected after rainfall events for grab samples collected from the inlet and outlet of the south wetland at Ada Hayden Heritage Park. Samples were collected from March through September of 2024.

Parameter	Inlet	Outlet	Inlet Rainfall Event	Outlet Rainfall Event	Inlet No Rain	Outlet No Rain
Nitrate + Nitrite Nitrogen (mg/L)	3.2	0.8	3.2	1.0	3.2	0.6
TKN (mg/L)	0.3	1.1	0.5	1.1	0.3	1.0
Total Nitrogen (mg/L)	3.5	1.9	3.7	2.1	3.5	1.6
Total Phosphorus (ug/L)	0.06	0.14	0.06	0.14	0.07	0.14
Orthophosphate (ug/L)	0.05	0.02	0.05	0.01	0.06	0.02
Turbidity (NTU)	3	32	4.9	31.7	1.1	31.7
Chlorophyll *a* (mg/L)	1.4	51	1.7	48	1.0	58
Total Suspended Solids (mg/L)	8.0	44	7.7	46	8.4	41
Specific Conductivity (umho/cm)	740	413	615	460	865	320
E. coli (MPN/100 mL)	2779	444	3517	1215	5998	1750

Appendix C – Lake Outlet Sampling Results

Table C1. Dissolved oxygen (mg/L), pH, field temperature (°C), flow rate (CFS), turbidity (NTU), and *E. coli* (MPN/100mL) measured at the lake outlet, June through August 2023.

Date Collected	Dissolved Oxygen (mg/L)	pH (no units)	Temperature (°C)	Flow Rate (CFS)	Turbidity (NTU)	*E. coli* (MPN/100mL)
6/28/2023	10.6	8.7	23.8	1.80	1.7	<10
7/13/2023	9.6	8.8	25.6	4.50	1.3	31
7/26/2023	8.8	8.7	27.2	1.40	1.4	<10
8/22/2023	8.7	8.7	27.4	1.10	2.0	<10
Average	9.4	8.7	26.0	2.2	1.6	<10
Minimum	8.7	8.7	23.8	1.1	1.3	<10
Maximum	10.6	8.8	27.4	4.5	2.0	31

Table C2. Dissolved oxygen (mg/L), pH, field temperature (°C), flow rate (CFS), turbidity (NTU), and *E. coli* (MPN/100mL) measured at the lake outlet, April through July 2024.

Date Collected	Dissolved Oxygen (mg/L)	pH (no units)	Temperature (°C)	Flow Rate (CFS)	Turbidity (NTU)	*E. coli* (MPN/100mL)
4/24/2024	10.2	8.2	11.5	0.7	1.2	<10
5/22/2024	9.7	8.5	20.0	16.0	2.1	86
6/27/2024	8.9	8.7	27.7	2.4	1.0	63
7/25/2024	10.3	9.0	26.9	2.6	2.9	1800
Average	9.8	8.6	21.5	5.4	1.8	84
Minimum	8.9	8.2	11.5	0.7	1.0	<10
Maximum	10.3	9.0	27.7	16.0	2.9	1800

Table C3. Nitrate + nitrite nitrogen (mg/L), orthophosphate (mg/L), total phosphorus (mg/L), chlorophyll *a* (mg/L), specific conductivity (µmho/cm), total Kjeldahl nitrogen (TKN, mg/L), and total suspended solids (TSS, mg/L) and measured at the lake outlet, June through August 2023.

Date Collected	Nitrate+Nitrite Nitrogen (mg/L)	Ortho-phosphate (mg/L)	Total Phosphorus (mg/L)	Chlorophyll *a* (mg/L)	Specific Conductivity (µmho/cm)	TKN (mg/L)	TSS (mg/L)
6/28/2023	<0.10	<0.020	<0.02	6	410	0.58	3
7/13/2023	<0.10	<0.020	<0.02	5	400	0.51	2
7/26/2023	<0.10	<0.020	<0.02	3	400	0.63	2
8/22/2023	<0.10	<0.020	<0.02	7	390	0.49	4
Average	<0.10	<0.020	<0.02	5.3	400	0.55	2.8
Minimum	<0.10	<0.020	<0.02	3	390	0.49	2
Maximum	<0.10	<0.020	<0.02	7	410	0.63	4

Table C4. Nitrate + nitrite nitrogen (mg/L), orthophosphate (mg/L), total phosphorus (mg/L), chlorophyll *a* (mg/L), specific conductivity (µmho/cm), total Kjeldahl nitrogen (TKN, mg/L), and total suspended solids (TSS, mg/L) and measured at the lake outlet, April through July 2024.

Date Collected	Nitrate+Nitrite Nitrogen (mg/L)	Ortho-phosphate (mg/L)	Total Phosphorus (mg/L)	Chlorophyll *a* (mg/L)	Specific Conductivity (µmho/cm)	TKN (mg/L)	TSS (mg/L)
4/24/2024	<0.25	<0.02	0.04	6	460	1.00	3
5/22/2024	0.80	<0.02	<0.02	8	450	0.60	5
6/27/2024	0.38	<0.02	<0.02	3	390	<0.50	2
7/25/2024	<0.25	<0.02	0.02	12	350	<0.50	5
Average	0.34	<0.02	0.02	7.3	413	0.53	4
Minimum	0.05	<0.02	0.01	3	350	<0.50	2
Maximum	0.80	<0.02	0.04	12	460	1.00	5