Impacts of Sediment Discharge on Massey Lake

Results from 2025 Investigation

Prepared for:

Ann Arbor Charter Township

December 8, 2025

Photo taken August 24, 2023

LimnoTech

Cover image: drone photo of Massey Lake taken on August 24, 2023, showing turbid water entering the lake from gravel pit dewatering discharge upstream of the lake (photo credit: Michael Watts). Turbid conditions in the lake ceased after pit dewatering discharge stopped.

Impacts of Sediment Discharge on Massey Lake

Results from 2025 Investigation

Prepared by:
LimnoTech

December 8, 2025

Under contract to:
Ann Arbor Charter Township

EXECUTIVE SUMMARY

Ann Arbor Charter Township retained the consulting firm, LimnoTech, to conduct a study focused on Massey Lake. The primary objective was to document and assess any persistent environmental impacts resulting from the discharge of turbid water originating from recent (last three years) dewatering operations at an adjacent gravel pit. In the summer of 2025, LimnoTech performed a field investigation, collecting and analyzing bottom sediment samples. The analysis focused on concentrations of 10 metals, grain size distribution, and water column properties across six sites, including a reference location near the lake's center. These data, combined with a review of relevant scientific literature and hydrogeological reports, were used to assess the impact of recent discharges on the lake.

The investigation did not yield evidence of distinct impacts from recent dewatering operations on Massey Lake, although baseline data were not available for comparison with current conditions. Measured sediment concentrations are at or near background levels at all sites, suggesting no unnatural impacts from metal toxicity on the lake ecosystem's health. Comparisons between samples of the recent surface sediments and deeper, older sediments deposited prior to recent pit discharges revealed slightly higher average concentrations for 3 of the 10 metals analyzed (cadmium, chromium, and zinc). There were minimal differences in shallow and deep sediment grain sizes, although distinctive coarser sediment (i.e., sand) would not be carried as far into the lake as silt and clay. During sampling, the open lake waters were strongly stratified with respect to temperature and dissolved oxygen (higher at the surface).

While the metal concentrations and grain size data do not provide proof of distinct sediment impacts, the discharge likely resulted in the deposition of a higher-than-normal volume of sediment in the lake. This new sediment likely altered the lake's bathymetry (depth contours) slightly, though the absence of pre-discharge baseline data precludes quantification based on data from this study. Furthermore, available hydrogeological data are consistent with anecdotal reports of decreased groundwater discharge and subsequent relative warming of surface waters. These impacts would have been most acute during the active dewatering period.

The surface metals concentrations were below the established background soil concentration thresholds listed in State of Michigan guidance for soils and clay, except for slight exceedances for barium, copper, and zinc in a few isolated samples, including deep samples. The minor increase in surface relative to deep metal concentrations in sediments, when observed, can be attributed to several factors, including diagenesis (the natural chemical alteration of sediments after deposition, including impacts of low oxygen concentrations), seasonal variations (such as sediment disturbance by wind waves or biological activity), sediment focusing and water column scavenging (more deposition and higher concentrations in a deeper depression or offshore, as at ML-6) or, potentially, enrichment from the gravel pit's turbid discharge.

Options for mitigation include dredging to remove surface sediment, restocking impacted fauna and enhancing habitat, or the strategic installation of a weir or check dam at the creek inlet to reduce potential movement of remaining sediment in upstream wetlands into the lake. Based on available information and professional judgement, we recommend implementing biological measures (i.e., restocking and habitat enhancement) over more disruptive direct sediment mitigation. Expanded monitoring of groundwater between the lake and the gravel pit to track the recovery of natural flow would also be appropriate.

Table of Contents

List of Figures

List of Tables

1 BACKGROUND & INTRODUCTION

Massey Lake (Figure 1) in Ann Arbor Charter Township, Michigan, is a glacial kettle pond approximately 20 feet deep and covering about 12 acres, including a central basin on the eastern side with a small island, and a larger island and channels on the western side. A small dam in the southeast corner that discharges to an unnamed tributary of Fleming Creek regulates the lake level. Additional geological information and references are included in Appendix A.

Previous observations, investigations, and inspections have documented the discharge of turbid water into Massey Lake from the adjoining gravel pit to the west, as well as potential impacts on groundwater discharge to the lake. A berm failure at the gravel pit has also impacted the area near the lake. The turbid discharge to the lake, along with other issues, resulted in the issuance of a violation notice to the gravel pit operator, dated September 14, 2023, by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Separately, Ann Arbor Charter Township filed a lawsuit against the gravel pit operator, which resulted in an injunction issued in October 2023, prohibiting further dewatering and discharge from the pit.

LimnoTech was contracted by Ann Arbor Charter Township to investigate the impacts of sediment from the discharge of turbid water into the lake (see report cover photo). The LimnoTech investigation, which took place in the summer of 2025, consisted of collecting and analyzing sediment samples. Specifically, the study included the following elements:

- Sediment sampling using cores, grab samplers, and shovels to recover material from the submerged and exposed lake bed to investigate the thickness and areal extent of recent deposits.
- Chemical analysis to understand the composition of shallow, surficial sediment, in comparison with deeper natural sediment.
- Assessment of the impact of sedimentation on a reported underwater artesian spring that feeds Massey Lake, in addition to creek inflow.
- Assessment of the impacts of pit-derived sediments and altered groundwater discharge on biology and aquatic life in Massey Lake, including in the benthic zone (lake bottom).

Figure 1. Massey Lake location map.

2 METHODS

Here, we provide an overview of the approach taken to collect and analyze sediment samples from the lake, establishing the potential impacts of gravel pit sediment discharges. We also document the methods used for water column measurements. LimnoTech developed a Sampling and Analysis Plan (SAP) that outlined the fieldwork, sampling activities, and sample analysis to be performed as part of the study. Additionally, the SAP outlined the procedural and analytical requirements of the sediment sampling survey. A table of the analytical results is attached as Appendix B, field photos are in Appendix C, and a copy of the SAP is included as Appendix D, along with copies of LimnoTech's Standard Operating Procedures for sediment sampling and the use of water quality sensors.

2.1 Sampling Locations

Sampling locations (Figure 2) were selected with consideration for where the signal of potential impacts would be strongest. That is, most samples were collected in the area of the lake west of the large island that received direct influx of sediment from the creek into which gravel pit effluent was discharged (see the report cover photo). Paired samples were collected at each site to compare recent sediments at the lake bed with older sediments that were more deeply buried and unlikely to be impacted by gravel pit discharges. Surface (S) and subsurface sediments (D for "deep") were sampled at six Massey Lake (ML) locations, with sediment depths, water depths, and site coordinates shown in Table 1 and depicted on Figure 2. Five of the sites were near the creek inlet (ML-1 through ML-5, Figure 2). A reference site, ML-6, was located in the center of the lake on the east side of the large island in an area less likely to be strongly influenced by sediment deposits from gravel pit discharges due to settling of particles closer to the inlet. This site was included for comparison purposes with sediment analyses from the other sites, as well as to provide information on the water column properties in the open lake.

Table 1. Sample locations.

Station ID and Sample Depth Intervals (Inches)	Water Depth (Feet)	Location Description	Approx. Longitude in Decimal Degrees	Approx. Latitude in Decimal Degrees
ML-1 S: 0-3", D: 12-15"	5.5'	Downstream of the inlet, upstream of the channel fork	83.67141°W	42.34284°N
ML-2 S: 2.4-5.4", D: 21-24"	NA	Near fork, on exposed lakebed (shore), submerged under high water conditions	83.67108°W	42.34297°N
ML-3 S: 0-3", D: 21-24"	5.2'	At the channel fork	83.67054°W	42.34279°N
ML-4 S: 0-3", D: 21-24"	8.3'	Northeastern channel downstream of the channel fork	83.67022°W	42.34306°N
ML-5 S: 0-3", D: 21-24"	7.2'	Southwestern channel downstream of the fork	83.67037°W	42.34242°N
ML-6 S: 0-1", D: 2-3"	18.4'	Open lake background reference site	83.66838°W	42.34203°N

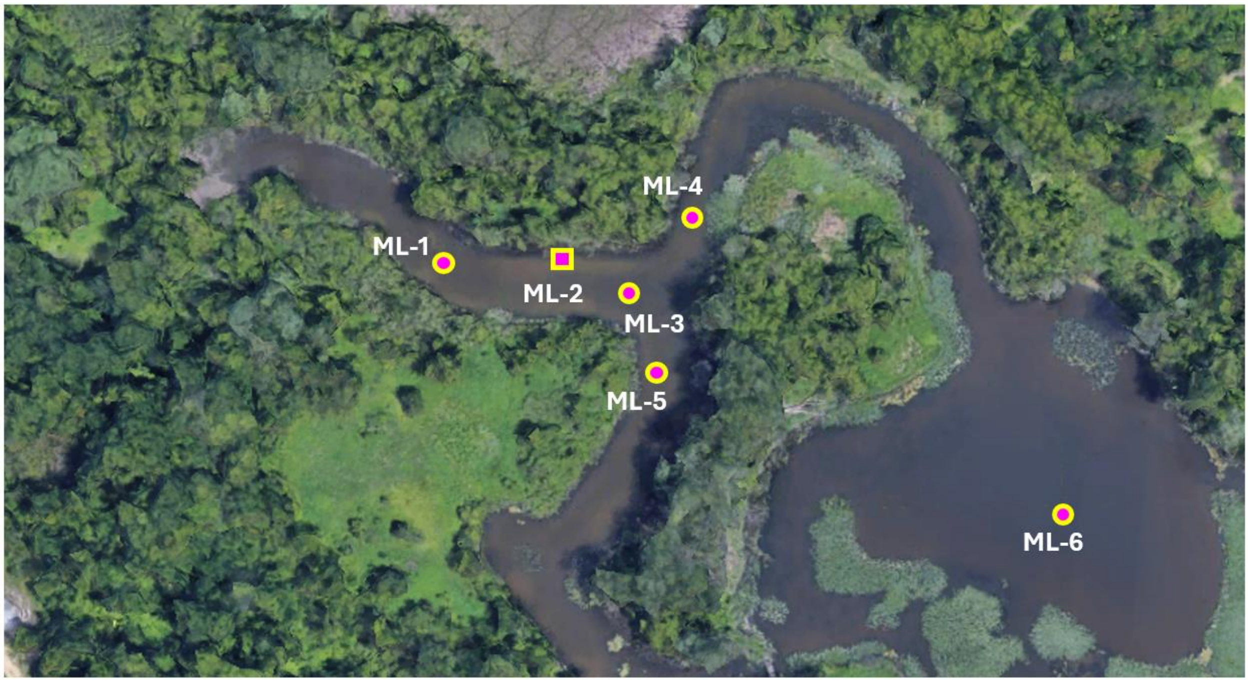


Figure 2. 2025 sediment sampling locations (approximate).

2.2 Sediment Sample Collection

LimnoTech staff conducted the sediment sampling from a small boat (Appendix C) on August 21 and 22, 2025, after completing a prior site reconnaissance on July 3, 2025. Sites ML-4, ML-3, ML-5, and ML-6 were sampled on the 21st, and sites ML-1 and ML-2 were sampled on the 22nd. The field blank was collected on the 22nd after the sampling had been completed. A Ponar grab sampler deployed with a rope was used to collect sediment at site ML-6 due to the greater water depth, which made the collection of a push core challenging. The top 1” of the Ponar sample was composited and homogenized for the shallow sample, and the sediment between 2” and 3” in depth was similarly composited and homogenized as the deep sample. For sites ML-1, ML-3, ML-4, and ML-5, an acrylic core tube was inserted into the sediment approximately two feet and removed to collect an intact sediment core. Overlying water was decanted and the sediment was extruded from the core barrel. The extruded sediment between the surface and 0.25’ was composited as the shallow sample, and the sediment from between 1.75’ and 2.0’ was composited as the deep sample. Site ML-2 was located on a portion of the lakebed that was exposed due to seasonally low water levels. A small hand shovel was used to collect sediment at this location. The shallow sample at ML-2 consisted of sediment from 0.2’ to 0.45’, and the deep portion was from 0.45’ to 1.25’. Samples were stored on ice or refrigerated until they were delivered to the analytical laboratories on August 22.

2.3 Water Column Profiles

At ML-1, ML-3, ML-4, ML-5, and ML-6, a YSI EXO multi-parameter water quality sonde was used to measure dissolved oxygen, conductivity, temperature, turbidity, and pH throughout the water column. Vertical data profiles were developed by setting the sonde to take a measurement every second and slowly lowering and raising the sonde through the water column. An integrated depth sensor also recorded the sonde's vertical position in the water column.

2.4 Sample Analysis

Samples were received by the laboratories on August 22. Sediment was analyzed by Brighton Analytical for the "Michigan 10 metals": total arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc, as well as percent solids, as described in the SAP. Additionally, sediment grain size was determined by Materials Testing Consultants (MTC) in Dexter, Michigan, using wet sieve analysis.

3 RESULTS

Here, we present the analytical results for sediment samples from the lake, which aim to document the potential impacts of gravel pit sediment discharges. We also summarize the results of the water column profiling.

3.1 Metals in Sediment

The sediment samples were analyzed for metals at Brighton Analytical, and concentrations were reported in micrograms per kilogram of sediment (µg/Kg or parts per billion [ppb]) and then converted to milligrams per kilogram (mg/Kg or parts per million [ppm]). On average, for the sites of interest (ML-1, ML-2, ML-3, ML-4, and ML-5), there were minor differences in metal concentrations between the surface and deep samples (see Figure 3; note the logarithmic vertical axis). Out of the ten metals analyzed, three had slightly higher concentrations on average in the surface samples (cadmium, chromium, and zinc) than in the deeper samples, which would not have been impacted by recent gravel pit discharges. Still, the differences were not deemed to be significant. Arsenic appears elevated in the surface sample relative to the deep sample at ML-5; chromium is elevated at ML-3, ML-4, and ML-5; and zinc is elevated at ML-5. Silver was not present above detection limits (<0.10 mg/Kg) in any sample, and selenium in the deep ML-6 sample was also not detected (<0.20 mg/Kg). Mercury was only detected in four of the twelve samples analyzed. The maximum detection, however, was only 0.064 mg/Kg in the deep ML-6 sample, compared to the detection limit of 0.050 mg/Kg, which is well within the background range (Table 2). Tables of all analytical data for individual samples are included in Appendix B.

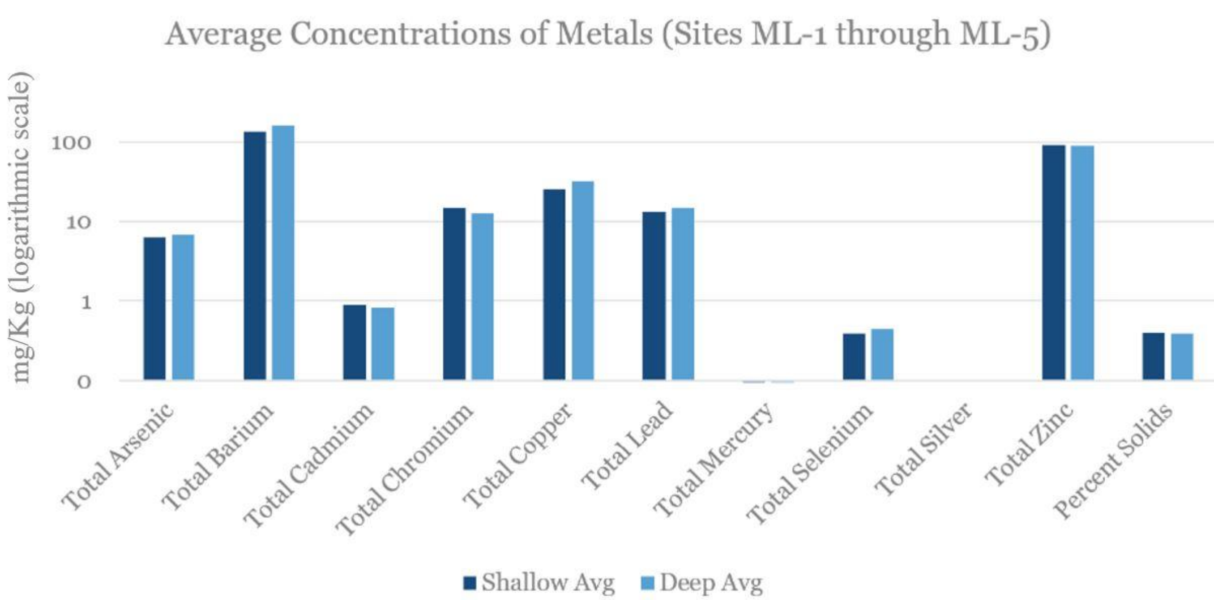


Figure 3. Average concentrations of metals in surface/shallow and deep samples for the sites of interest near the lake inlet (ML-1, ML-2, ML-3, ML-4, and ML-5).

For the reference site (Figure 4), there were minimal differences in metal concentrations between the surface and deep samples. Out of the ten metals analyzed, four had higher concentrations in the surface sample (arsenic, barium, cadmium, and chromium). For all sites, the metal concentrations fell within the range of background concentrations for metals in clay within southeast Michigan (Appendix A; EGLE, 2023a), with a few minor exceptions (Table 2): the ML-6S barium concentration was 230 mg/Kg (background limit in Appendix Table A-1 = 227 mg/Kg); the ML-4D copper value was 54.0 mg/Kg (background limit in Appendix Table A-1 = 46.9 mg/Kg); and the ML-6S and ML-6D zinc values were both 120 mg/Kg (Appendix Table A-1 limit = 102 mg/Kg). No metals exceeded direct contact cleanup criteria for residential soil (Table 2; EGLE, 2023b). All duplicate values were within 10% of the measured value, and no metals were detected in the field blank.

The sediment metal concentration data do not reveal patterns that indicate distinct impacts from gravel pit discharges, although they neither confirm nor exclude such impacts in terms of physical deposition. That is, sediment originating from the gravel pit is still likely present in the lakebed deposits. Still, it does not appear to be distinct in terms of metal concentrations from natural lake sediment. The concentrations are at or near background levels at all sites, suggesting no unnatural impacts from metal toxicity on the lake ecosystem's health. The relatively higher concentrations of several metals at the reference site, ML-6 (Figure 4), compared with the other sites, may indicate the influence of different natural geochemical processes associated with low oxygen concentrations during the summer at the reference site in the deep area of the lake (Section 3.3).

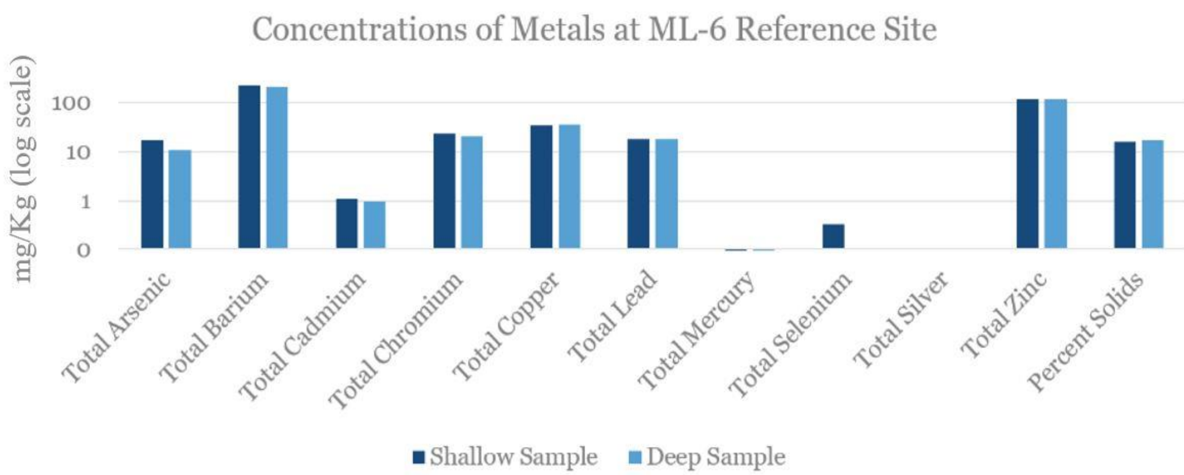


Figure 4. Surface (shallow) and subsurface (deep) metal concentrations in sediment from reference site, ML-6 (center of lake).

Table 2. Comparison of maximum and average sediment concentrations from Massey Lake with Michigan cleanup criteria for metals in contaminated soil and background values (see Appendix A). Results above background ranges are shaded.

Metal	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Selenium	Silver	Zinc
Massey Lake Highest Sediment Concentrations (mg/Kg)	17.0 @ ML-6S	230.0 @ ML-6S	1.1 @ ML-4S and ML-6S	23.0 @ ML-6S	54.0 @ ML-4D	18.0 @ ML-4D and ML-6S/6D	0.064 @ ML-6D	0.50 @ ML-5D	All <0.10	120.0 @ ML-6S/6D
Average Sediment Concentrations for All Samples (mg/Kg) and Standard Deviation (SD = #)	7.6 (4.0)	156.9 (32.5)	0.9 (0.1)	14.8 (3.9)	29.4 (9.8)	14.6 (2.7)	0.056 (0.006)	0.39 (0.09)	NA	93.2 (21.2)
Average Sediment Concentrations for Surface Samples from Sites 1-5 (mg/Kg) and Standard Deviation (SD = #)	6.1 (3.4)	133.3 (12.1)	0.9 (0.1)	14.2 (3.1)	24.8 (5.5)	13.2 (2.0)	0.051 (NA)	0.36 (0.10)	NA	87.8 (21.7)
Average Sediment Concentrations for Deep Samples from Sites 1-5 (mg/Kg) and Standard Deviation (SD = #)	6.8 (1.7)	160.0 (10.0)	0.8 (0.1)	12.6 (1.1)	32.4 (13.8)	15.0 (2.7)	0.052 (NA)	0.45 (0.05)	NA	88.8 (18.5)
EGLE (2023b) Direct Contact* Residential Soil Criteria (mg/Kg)	37	130,000	2,100	1,000,000	73,000	900	160	9,600	9,000	630,000
Appendix Table A-1 Upper Background Limit (mg/Kg)	31.4	227.0	3.1	77.0	46.9	26.2	0.58	1.20	6.0	102.0

**"Direct contact" means exposure to hazardous substances through ingestion or dermal contact.*

3.2 Sediment Grain Size

The grain size and percent solids of sediments sampled showed few differences between shallow and deep samples, except at the sites closest to the lake inlet (Figures 5 and 6). Deeper sediments at sites ML-1 and ML-2 (exposed on shore) were slightly finer (i.e., greater percentages of silt and clay) than shallow sediments. The pattern at these sites is consistent with their location closer to the lake inlet, where flowing water would be expected to carry coarser sediment to the lake, which would subsequently drop out of the water once it encountered the low-energy lake environment. Finer particles would stay in suspension for days to weeks.

The lake area near the inlet will gradually fill with sediment in the vicinity of a “creek mouth delta”. In addition, wave winnowing would be expected at the exposed site, ML-2, removing finer sediment and leaving coarser sediment as the lake level dropped over the summer and the shoreline position migrated out from the spring shoreline contour. The sand fraction of sediment from the sampling sites is dominated by fine sand (Appendix B; 59-90% of the total sand fraction, except at ML-6), with lesser amounts of medium sand, and little or no coarse sand. The trace amount of sand at ML-6 (0.2-0.7%) is coarser than at the other sites, suggesting possible ice rafting or wind transport. A trace of fine gravel (0.1-0.2%) was found in samples ML-1S, ML-2S, and ML-3D.

Without baseline data for comparison, it is not possible to determine whether the natural process of delta formation at the creek mouth has been accelerated by the input of gravel pit sediment based on the new grain size data. The percent solids value at site ML-2 was higher for the shallow sample than the deep sample due to evaporation from the exposed sediment surface and natural seasonal lowering of the water table over the summer as the lake surface dropped.

Most samples contained more than 90% silt and clay, with the values in samples from the center of the lake greater than 99% of the total sediment composition. The sediment color was consistently gray or tan in the shallow interval at sites ML-1, ML-2, ML-3, ML-4, and ML-5 (Appendix C), and dark gray to black in deeper sediments and at ML-6 (both shallow and deep). The black color is a result of the formation of iron sulfides in deeper, oxygen-free sediment layers and the accumulation of undecomposed organic debris, such as dead algae and leaf fragments (Wersin et al., 1991). The color difference between shallow and deep sediments at most sites is typical, and not necessarily indicative of a difference in recent sediment sources (e.g., the lighter gray color in surface sediments [Appendix C] is not likely diagnostic of sediment derived from gravel pit discharges versus natural sediment).

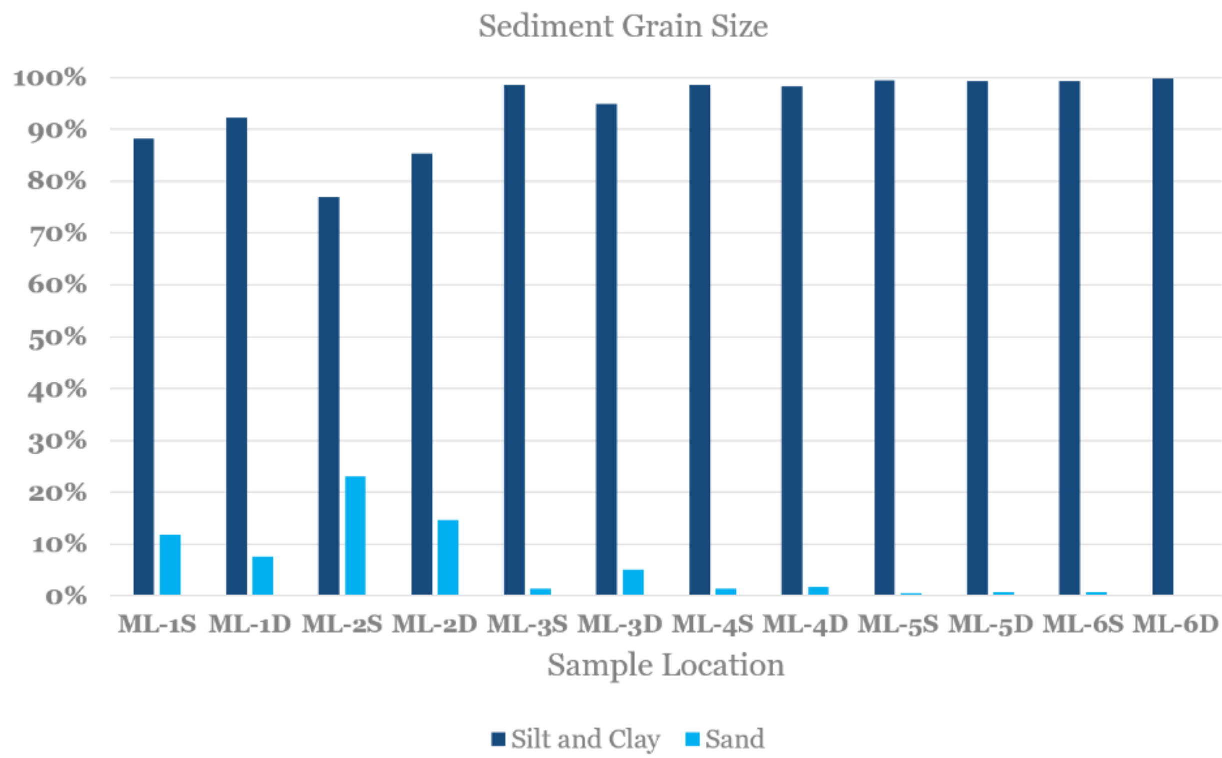


Figure 5. Results of sediment grain size analyses.

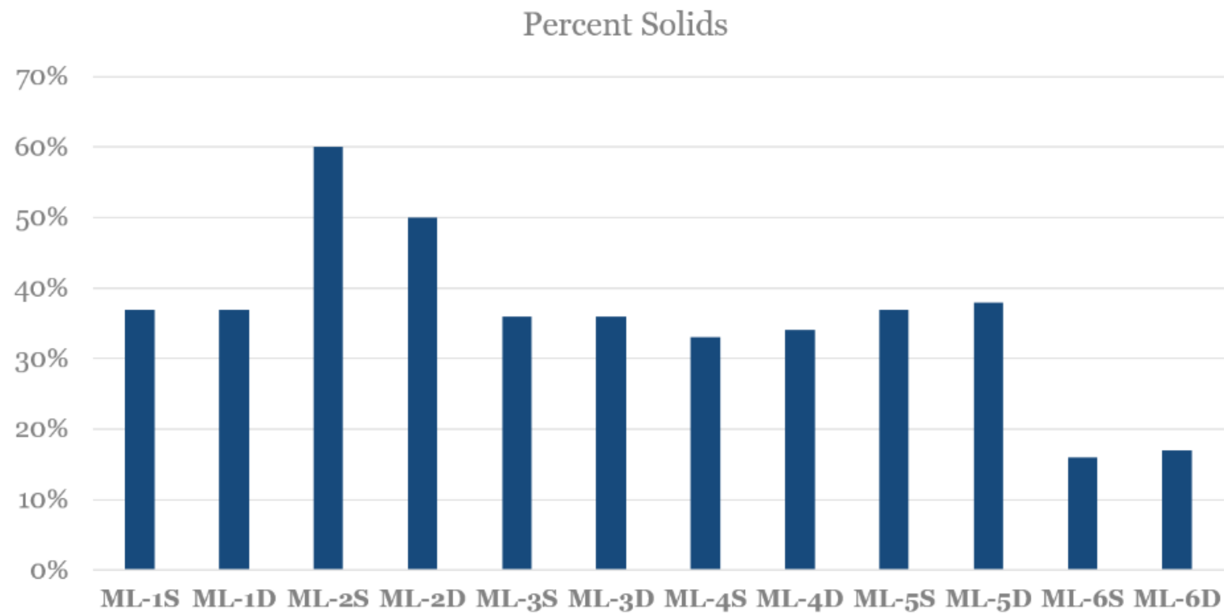


Figure 6. The results of the sediment percent solids analysis indicate that the water content exceeds 60% by weight in most samples.

3.3 Water Column Properties

Profiles of water quality parameters in the lake water column (Figures 7 and 8) were taken at all sampling sites except ML-2, which was located on shore above the water level during the sampling event. Water temperatures at the sites of interest (Figure 7) were typical for late summer, ranging from 20.1°C (68.2°F) to 22.3°C (72.3°F), with warmer water at the surface. The deepest core sampling site was ML-4 at 2.3 m (7.5 feet). The reference site (Figure 8, note different axis scales from Figure 7) was substantially deeper, 5.6 m (18.4 feet), and the bottom temperature was only 10.4 °C (50.7 °F), indicating stratification and likely groundwater influence. The mixed layer at the top of the ML-6 site was approximately 2.5 m (8.2 feet) thick, with elevated turbidity layers located just below the mixed layer and near the bottom, and a rapid decrease in oxygen saturation below the mixed layer.

The parameters other than temperature and oxygen concentration (not included in the figures below) generally exhibited less vertical variation in other water quality parameters (e.g., turbidity, specific conductance, pH) at the shallower sites (ML-1, ML-3, ML-4, and ML-5) compared to the deep reference site, ML-6. Water properties at these sites appeared to be influenced by the time of day when they were sampled, due to the varying hours of sunlight exposure they received, resulting in warming over time and oxygen production by macroalgae. Water column profiles were measured at the following times at these sites: ML-1, 9:45 AM; ML-3, 2:35 PM; ML-4, 2:01 PM; and ML-5, 4:02 PM. Site ML-1 profile data were collected early in the day on the second day of sampling. The site was also located closest to the point of creek discharge to the lake, which may have influenced the water temperature there. The oxygen saturation and pH were also higher at that site. Overall, water temperatures measured from top to bottom decreased by only 1 to 2°C at these sites. The ranges of water column values for the shallower sites above the deep turbidity layer or "nepheloid layer" were as follows: oxygen saturation = 3-44%, oxygen concentration = 0.3-4.0 mg/L (low for most fish species), specific conductance = 420-560 µS/cm, turbidity = 1-8 NTU (light transmission measurements), and pH = 6.9-7.6. The lowest oxygen saturation and concentrations were observed near the surface of the ML-4 site.

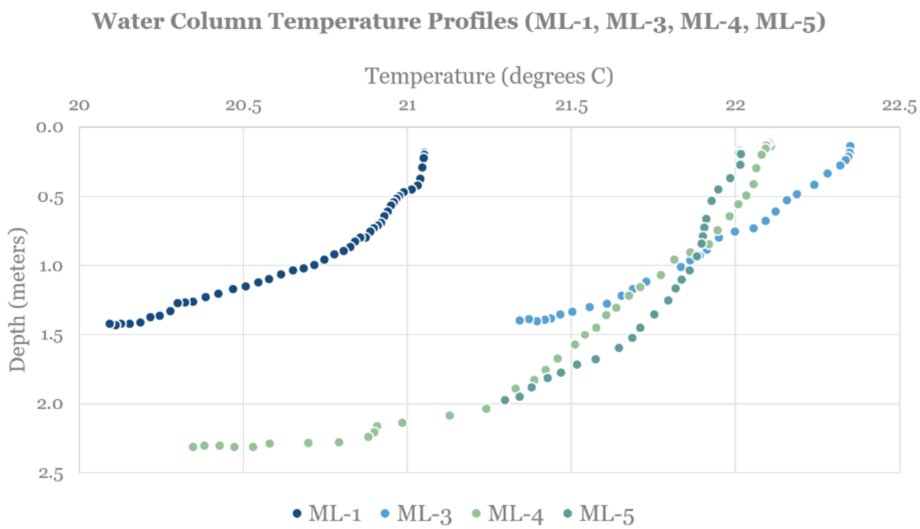


Figure 7. Water column temperature profiles for sites ML-1, ML-3, ML-4, and ML-5. Different profile lengths reflect differences in water depths among the four sites. Site ML-2 was on the exposed bank of the lake, so it has no water column profile. The observed temperatures are typical of late summer conditions in similar Michigan lakes.

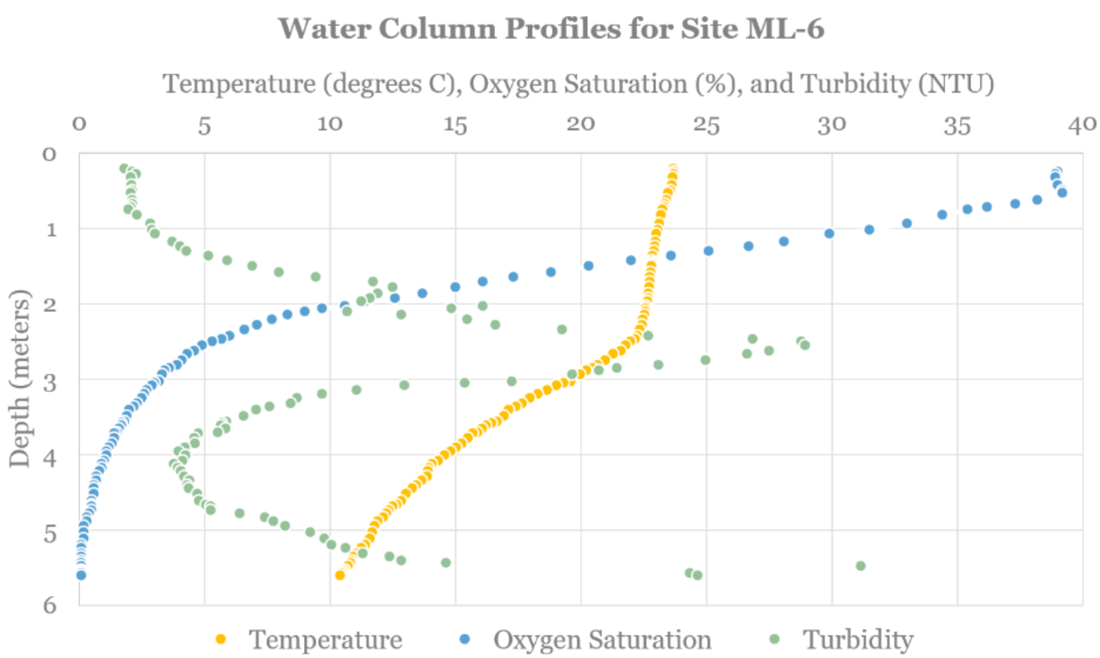


Figure 8. Water column profiles for reference site, ML-6. Turbidity units (NTU) are a measure of light transmission that is related to the amount of suspended solids and plankton in the water. Water temperatures in the deep part of the lake (10°C or 50°F) are similar to typical groundwater temperatures. Most fish require oxygen saturation over 64% or 5 mg/L for optimum health.

While water column profiles can be quite dynamic on daily and seasonal timeframes, the data collected are helpful in understanding certain aspects of how Massey Lake behaves. A primer on lake science and ecology is available at: https://mymlsa.org/wp-content/uploads/2011/06/Understanding_Lake_Ecology.pdf
The ML-6 profile provides a snapshot of summer conditions in the open lake, and the other profiles give a sense of the behavior of the channels near the lake's inlet. The open lake is strongly stratified (Boehrer and Schulze, 2008) into an upper oxygen-rich mixed layer (epilimnion, mixed by wind), where fish can thrive, and a lower unmixed layer (hypolimnion); however, the channels are not stratified. Oxygen concentrations are highest at the surface in the open lake, due to dissolved atmospheric oxygen and photosynthesis by phytoplankton. In contrast, the channels tend to have more oxygen near the bottom, primarily due to photosynthesis by benthic algae. There are no benthic algae in the deep parts of the lake due to low light penetration, and there are no fish due to the low oxygen concentrations. Oxygen declines rapidly with depth in the bottom layer of the open lake because it is consumed by decaying organic matter and is not renewed by atmospheric mixing or aquatic plants.

The turbidity maximum in the middle of the water column in the open lake around a depth of 2.5 meters (8 feet), near the sharp change in the temperature profile (the "thermocline"), is a natural phenomenon observed in many stratified lakes. This phenomenon is due to the trapping of sinking particles and chemical processes at this sharp change in water density and oxygen concentration. The lake likely mixes in the spring and fall due to density instabilities, as water has a maximum density at 4°C (39.2°F). These instabilities cause cooled surface water to sink in the fall and warmed surface water to sink in the spring, effectively "flipping" the lake. This overturning temporarily aerates the lake and disturbs the layering. Due to this seasonal mixing, it is unlikely that any lingering impacts on the water column from turbid water inputs to the lake from gravel pit sources in 2022 and 2023 remain. Ongoing groundwater impacts are less clear.

4 IMPACTS

Here, we briefly describe past impacts on Massey Lake from gravel mining operations.

4.1 Sediment Impacts

Except for runoff from the unpaved Joy Road, located to the north of the lake, the natural surface water inputs would be expected to be low in suspended sediment due to the small size of the creek that flows into the lake, the forested slopes and minimal development of the upstream watershed, and passage of the creek through wetlands before entering the lake. The input of turbid water to the lake from gravel pit dewatering discharge and berm failure has been documented by photographic and analytical evidence (see report cover). Turbid water discharges and lake inputs stopped approximately two years ago. However, fine-grained sediment deposited in the wetlands upstream of the lake, as well as sediment derived from the berm failure, could have continued to be mobilized into the lake for some time after pit discharge ceased.

Analytical data, as well as boat-based and land-based field observations, do not reveal distinct sediment deposits from gravel pit discharges. The two-year separation in time between the cessation of discharges and the sampling event reduces the likelihood that a distinct sediment layer can be recognized due to bioturbation of the sediment by organisms, sediment resuspension by storm waves and surface water inflows, and geochemical alteration of deposited sediments by interaction with underlying sediments. The upper layer sampled (typically 1 to 3 inches) may also have blended thinner sediment layers originating from settled gravel pit discharge (e.g., less than 1 inch thick) with older sediments or more recent sediments, diluting any gravel pit signature. Any deposition of sediments would likely be most substantial near the creek inlet, with decreasing deposition with distance, and transport across and out of the lake of much of the suspended silt and clay that discolored the lake surface water. Alternatively, less sediment may have reached the lake to date from pit discharges than some have suggested.

4.2 Groundwater Impacts

Based on anecdotal reports and a reasonable interpretation of available hydrogeological data, Massey Lake is fed by a combination of groundwater springs, seepage, and surface water inputs. Discharge of groundwater to the lake likely decreased during gravel pit dewatering operations, as indicated by anecdotal reports of lake water warming compared to prior years and other changes. These changes may have impacted lake biology (e.g., fish, wildlife, and plant communities). However, there is insufficient baseline data and information from during and after the dewatering period to make that determination.

Once dewatering operations ceased, groundwater inputs to the lake appear to have increased, based on anecdotal reports; however, it is unclear whether they have returned to their undisturbed state due to a lack of baseline data. As observed during LimnoTech's field activities, the water temperature of the deep layer in the lake below the surface mixed layer is consistent with that of regional groundwater (about 10 degrees C). Pre-2020 pond elevations in the gravel pit were reported as follows: Pond 1 @ 898 feet, Pond 2 @ 900 feet, and Pond 4 @ 892 feet (Haley & Aldrich, 2024; Sheet C-10). These same water levels, along with a water surface elevation for Pond 3 of 867 feet, are shown on an "Existing Conditions" figure dated October 23, 2023 (Haley & Aldrich, 2024; Sheet C-100). The water surface elevation of Massey Lake is approximately 865 feet

(Haley & Aldrich, 2024; Attachment 5, p. 2), or 27 feet below the reported baseline elevation of Pond 4 and 2 feet below the reported Pond 3 elevation in October 2023. These elevation data indicate that a variable hydraulic gradient has existed between the gravel pit ponds (at a higher elevation) and the lake.

There is limited information available on the seasonal fluctuations in lake and pond water level elevations. The elevations of water within the gravel pit ponds regularly change due to within-pit pumping. That said, the elevation difference of the ponds appears to be typically higher than the lake level. During field sampling, groundwater seepage along the lake's shoreline was observed at numerous sites, as evidenced by trickling water, iron staining, and bacterial films. This type of seepage is common during late summer, when lake levels are typically low, and shallow groundwater is flowing from surrounding saturated ground into the lake's depression. The iridescent bacterial films are sometimes mistaken for oil sheens, but they are harmless and behave differently when disturbed, breaking into angular pieces. For additional information, see this website: **https://www.michigan.gov/egle/about/organization/water-resources/glwarm/naturally-occurring-phenomena/bacteria** . Common and naturally occurring bacteria that produce these films, such as the genera *Gallionella*, *Leptothrix*, and *Crenothrix*, gain energy by the oxidation of reduced iron in groundwater, producing rusty iron oxides from iron sulfides, mixed with their slimy filaments.

There is some uncertainty about the degree of interconnection between the aquifer underlying the gravel pit and Massey Lake. No monitoring wells exist between the pit and the lake. Subsurface information compiled by Haley & Aldrich (2024), however, shows clear evidence of the extension of the upper aquifer to the east of the pit below and potentially around Massey Lake (Figures 9, 10, 11, and 12 below). The elevation of the base of the gravel layer at the east end of the pit appears to be approximately 855 feet (Figure 10), or 10 feet below the reported level of Massey Lake; the lower gravel-till contact, however, seems to be dipping upward to the east here based on limited data. Given the overall subsurface stratigraphic evidence, it is not surprising that past pit dewatering would impact groundwater discharge to Massey Lake, even if the hydraulic gradients between the pit and the lake were only reduced or made less steep rather than reversed (i.e., flow directed back toward the pit) during dewatering.

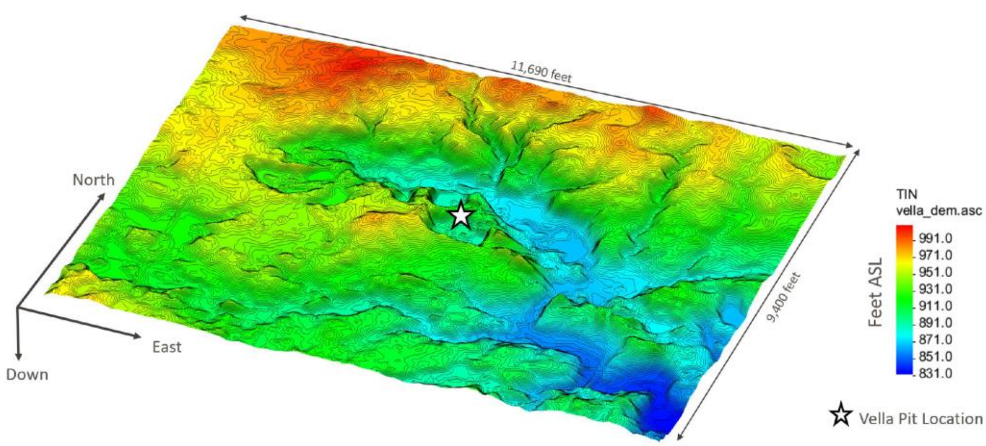


Figure 9. Reproduction of Figure 3 from the Haley & Aldrich (2024) report showing a three-dimensional perspective view of the topographic surface in the vicinity of the gravel pit and Massey Lake (to the right of the white star), with a vertical exaggeration of 5:1.

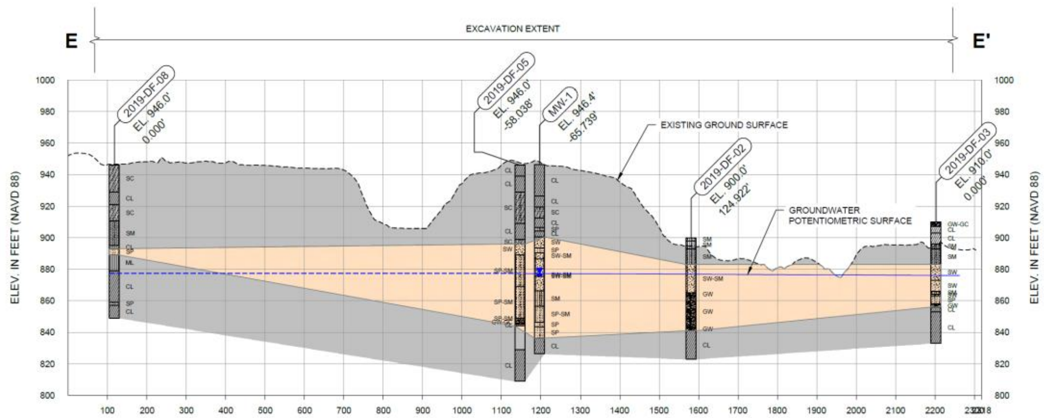


Figure 10. Reproduction of cross-section oriented from west (left side) to east (right side) from the Haley & Aldrich (2024) report, Figure 5E, showing the continuation of the sand and gravel layer (tan color) from the gravel pit toward Massey Lake.

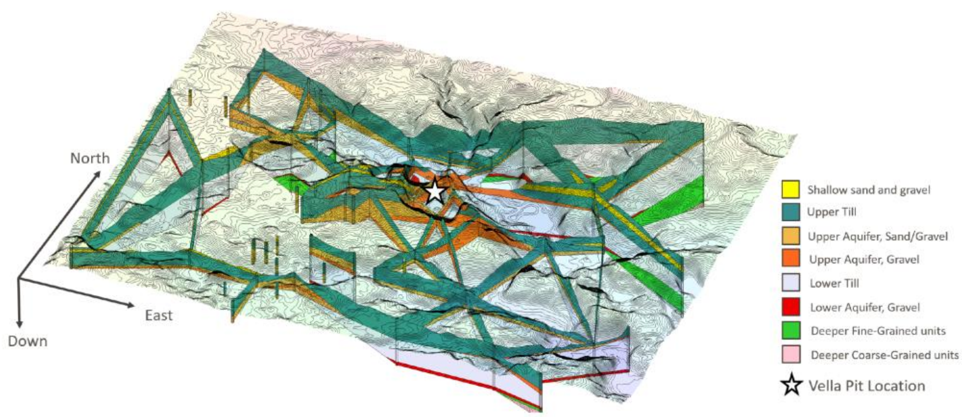


Figure 11. Reproduction of Figure 4 from the Haley & Aldrich (2024) report showing upper aquifer sand and gravel (orange layers) extending from the gravel pit beyond Massey Lake to the east (just right of the white star).

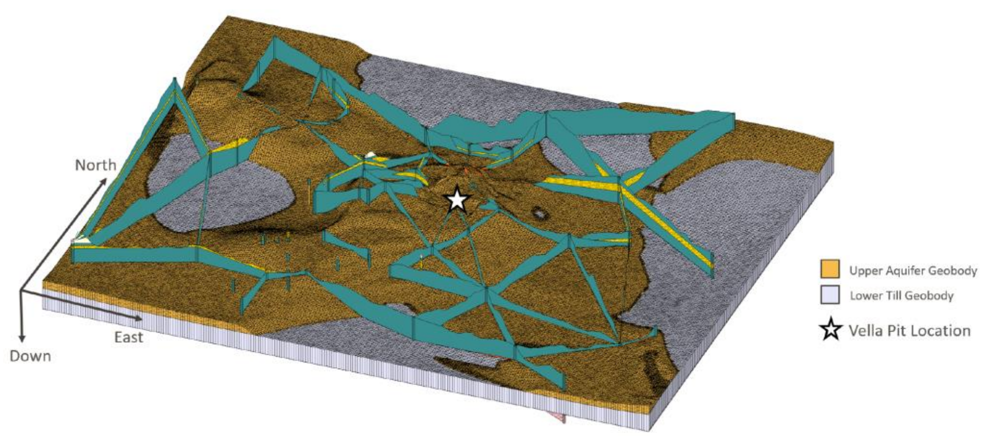


Figure 12. Reproduction of Figure 6 from the Haley & Aldrich (2024) report showing the upper aquifer "geobody" (orange layer) extending from the gravel pit beyond and beneath Massey Lake to the east (just right of the white star).

4.3 Biological Impacts

Increased turbidity and sediment deposition in Massey Lake, as well as decreased groundwater input, during the recent period of active gravel pit dewatering and discharge, would be expected to have a variety of impacts on the lake's ecosystem. Mobile lakebed organisms like crayfish, snails, clams, or worms that live in the sediment, could easily adapt to a slight increase in sediment deposition. Submerged aquatic vegetation would be impacted by sediment shading of leaves and reduced light penetration from feet to inches due to more turbid water, resulting in reduced photosynthesis and oxygen production, as well as plant death in deeper water. Lower oxygen levels in the water due to reduced photosynthesis and warmer water from reduced groundwater inflow (colder water can hold more dissolved oxygen) could impact mobile organisms like fish and tadpoles, which depend on gills for respiration. This would drive them to shallower water or surface water, where oxygen would be more abundant. Certain life stages of fish and amphibians, including eggs and juveniles, would be more vulnerable to changing water quality conditions and oxygen depletion, or thinning of the upper oxygenated zone in the lake. Turbid water could impact the feeding success of fish, birds, turtles, and other organisms that rely on clear water for effective hunting of prey.

Although the lake is naturally stratified in the summer, it is still subject to brief periods of lower water quality during the spring and fall when the lake overturns, and seasonal fluctuations in lake levels. Lake-dwelling organisms are adapted to these fluctuations. A sustained alteration of lake turbidity and dissolved oxygen, however, during the period of turbid water inflows from gravel pit discharges, would stress or kill some lake vegetation and organisms, as well as affecting their reproductive success due to impacts on eggs and juveniles. The net result would be a compression or thinning of the lake's oxygen-rich surface zone, where lake life is naturally concentrated, and potential longer-term effects on populations of fish, amphibians, and benthic organisms due to mortality, stress, and reduced reproduction during the turbid water discharge period. These stressors are consistent with anecdotal reports of declining frog and toad populations and with observations of fish concentrated near the lake surface.

5 RECOMMENDATIONS

Here, we briefly describe mitigation considerations for the lake impacts discussed above and provide our mitigation recommendations, summarized as follows:

- We do not recommend dredging of sediment or upstream dam construction to reduce the input of new sediment from wetland areas that drain to the lake.
- We recommend additional investigation of the influences of groundwater on Massey Lake.
- We recommend enhancing Massey Lake habitat quality and populations of native fish, wildlife, and vegetation.

5.1 Sediment Mitigation

One way to address sediment deposited in a wetland or lake is to remove it, restoring the natural sediment contours and chemistry, and improving lake-aquifer interconnections. If removal of sediments deposited during the recent pit discharge period is desired for ecological, bathymetric, or other reasons, the associated work duration and expense can be estimated. As the deposited sediments do not appear to be distinct from underlying sediments in terms of chemical composition or grain size, one would need to assume a sediment thickness for removal. A typical minimum sediment thickness for dredging by either mechanical or hydraulic (suction) **methods** would be 12 inches. This would be an overdredging of deposited sediment from turbid water discharges to the lake, which would only be a thin surface layer, mixed with underlying native sediment.

Removal of this much sediment over an approximate area of 12 acres would equate to 19,000 cubic yards of sediment. Given the water content of the sediment exceeding 60%, dewatering would be necessary prior to off-site disposal using Geotubes, sludge presses, or other methods. Dewatering would reduce the volume by approximately 50%. The magnitude and duration of disturbances to the lake (likely project duration of 4 to 6 months) and surrounding properties of such an operation involving heavy equipment and operations on land and water would be substantial. Ecosystem impacts of sediment removal would also be severe, likely requiring restocking of fish and replanting of lake vegetation. These negative impacts are important considerations when weighing the potential benefits of dredging.

Mitigation measures for sediment that has been deposited upstream of the lake by recent gravel pit operations may also be appropriate, including removal, or trapping through the construction of a small dam, weir, or another type of barrier upstream of the lake. Like lake dredging, sediment removal, or dam construction, these would be expensive and disruptive, possibly resulting in the movement of new sediment into the lake.

5.2 Groundwater Mitigation

In addition to past impacts on the Massey Lake water budget and thermal conditions, it is worth noting that within-pit pumping and movement of water from one pond to another can also affect current groundwater flow to Massey Lake, even with no discharge of water outside the pit. Further consideration of the impacts of past and ongoing pit operations on Massey Lake groundwater-surface water interactions, including potential installation of one or more monitoring wells between the pit and the lake, is warranted. Although fine-grained sediments in Massey Lake likely influence the degree of direct interactions between surface water in the lake and groundwater in the upper aquifer, the measured properties and geometry of the aquifer, along with anecdotal reports of springs in the lake, suggest that the two may be strongly linked. Hypothesized plugging of the spring or springs that discharge to Massey Lake during the period of dewatering and active discharge of turbid water to the lake from the pit is considered unlikely. Even moderate flow velocities of discharging groundwater from a spring in the lake bed would be sufficient to prevent fine-grained sediment from depositing in the spring vent and sealing it. A more comprehensive characterization of groundwater influences on Massey Lake would be necessary to quantify past and current impacts on the lake from gravel pit operations. We recommend a hydrogeological characterization of the upper aquifer near the lake through the installation and monitoring of one or more well clusters installed at different depths between the lake and the gravel pit.

5.3 Ecological Mitigation

Enhancing the existing habitat quality and populations of fish and wildlife in the lake and wetlands could address past biological impacts of gravel pit discharges. Examples of such actions would include stocking of young native fish (likely sunfish and bass), tadpoles, and frogs, and improving sand and gravel spawning substrate. A detailed plan laying out tiered ranges of habitat and species enhancements would be helpful in determining the level of effort desired and the goals of the stocking and enhancement program (i.e., what success would look like). Note that this type of mitigation would also be necessary for the sediment mitigation measures described above (dredging, dam construction), possibly on a larger scale.

5.4 Mitigation Recommendations

Based on field observations and reviewed data, the magnitude of past impacts on Massey Lake and upstream wetlands from turbid water inputs associated with gravel pit dewatering and berm failure would not justify intensive mitigation measures, such as dredging and upstream dam or barrier construction. A “no action” approach would be less disruptive of natural lake and wetland recovery, but it would also accept prior impacts to the lake without addressing concerns expressed by township residents about degraded conditions such as changes in water temperature, clarity, or populations of fish and frogs. Note that frog and toad populations in the Rouge River headwaters a few miles east of Massey Lake appear to be healthy, although some species that start calling earlier in the spring may be declining (Friends of the Rouge, 2025).

The additional disturbance of soil, sediment, vegetation, and surrounding properties that would be necessary to undertake such mitigation measures as dredging or dam construction would likely negatively impact the wetlands and lake for several years after construction activities were completed. In addition, the lack of baseline data would make it challenging to set restoration targets for ecosystem recovery. To be effective, a dam would have to be maintained and actively operated during storms to minimize sediment transport and prevent wetland destruction from extended periods of water ponding behind the dam. Permitting may also be an issue.

Instead of dredging or dam construction, a better approach is to enhance the existing habitat quality and populations as described above. This would consist of restocking aquatic organisms, and enhancing aquatic habitat for spawning, feeding, or protection from predators.

There are insufficient data available to quantify the impacts of past gravel pit dewatering on groundwater discharge to the lake, so appropriate mitigation measures are unclear. Regional recovery of the water table after the cessation of pit discharge appears to have led to a return of more natural groundwater discharge to the lake, according to anecdotal reports. Regarding the impacts of ongoing pumping within the gravel pit on the lake, the first step would be to delineate the hydrogeological connections between the lake and the gravel pit more thoroughly.

This type of delineation would involve, at a minimum, the installation of a closely logged soil boring and monitoring well between the lake and the pit, screened in the upper aquifer, which would allow for the measurement of water table elevations over time. Additional siting considerations would include avoiding areas that nearby domestic water supply wells may impact. A better approach than installing a single well is to install clusters of multiple wells, each screened at different depths, at two or more sites between the lake and the pit, along with a surveyed staff gauge in the lake. Ongoing within-pit pumping of water from one pond to another is likely to result in ongoing alteration of vertical and horizontal groundwater gradients between the lake and the pit, including mounding of groundwater under the northeast corner of the pit and surrounding areas, and depression of the water table in areas of active dewatering and excavation further south. If water table elevations and groundwater flow beyond the pit boundaries appear to be impacted by ongoing operations, it may be appropriate to negotiate stricter conditions on within-pit pumping.

6 CONCLUSIONS

The primary interest of Ann Arbor Charter Township in authorizing this study was to document the impacts of the discharge of turbid water to Massey Lake from the recent period of active dewatering discharge originating at the adjacent gravel pit. The LimnoTech investigation in the summer of 2025 collected and analyzed sediment samples from Massey Lake. The results of the field observations and laboratory analyses, as well as a review of scientific journal articles and other hydrogeological reports and studies, were used to assess the degree of impact from prior discharges on the lake. Water column properties were also measured to support interpretation of other data.

Results of metals concentration and grain size analyses from five sites near the creek inlet in the northwest corner of the lake, as well as a reference site near the center of the lake, showed no evidence of impacts. Comparisons of analyses of surface sediments with deeper samples at the six sites revealed evidence of slightly elevated average concentrations of a subset of the analyzed metals (i.e., cadmium, chromium, and zinc), and little contrast in sediment grain size between surface and deep samples. Concentrations of metals that were elevated in surface samples relative to deeper samples were still well below background concentration thresholds based on State of Michigan guidance.

Although metal and grain size data do not provide proof of distinct impacts of turbid water discharge on the lake, it is probable that the discharge did result in the deposition of higher-than-normal amounts of sediment in the lake. This sediment likely had a different composition than natural sediments from the undisturbed watershed upstream of the lake, even if the differences are minor or broadly within background thresholds. The sediments deposited also likely changed the bathymetry of the lake. However, the lack of a baseline bathymetric dataset for comparison and the probability that any changes were small make quantifying the changes difficult without more extensive sampling and analysis, or numerical modeling.

Prior analysis of the monitoring reports from the period of active gravel pit dewatering, July 2022 to October 2023, yielded an estimated sediment discharge mass of 76 tons (total monthly average flow x monthly average suspended solids). This estimate did not include mobilized berm failure material. Assuming a mass of approximately 2.25 tons per cubic yard of solids (sand, silt, clay), this equates to 33.8 cubic yards total. Assuming that none of the discharged sediment was trapped in the wetlands between the point of discharge and the lake, and that no discharged sediment passed through the lake and out the creek downstream, this would amount to approximately one 50th of an inch of new sediment over the 12-acre lakebed if it were evenly deposited. This is the thickness of 33.8 cubic yards of solids distributed over approximately 58,000 square yards. These rough calculations are overly conservative and simplified, but this estimate gives a sense of the potential magnitude of overall deposition from turbid water that reached the lake in the past from gravel pit discharges. Deposition could be much thicker near the lake inlet, and even thinner near the outlet, although distinctive deposition layers were not observed during sediment sampling activities.

The available hydrogeological data are consistent with anecdotal reports of decreased groundwater discharge to the lake and a relative warming of surface waters. These impacts would have been most significant during active dewatering at the adjacent gravel pit. They would have decreased (i.e., groundwater discharge to the lake would have increased, approaching its normal state) during subsequent water table recovery after active dewatering ceased at the pit.

Beyond a "no action" alternative, we considered the following options for addressing the impacts of sediment from turbid water discharge to Massey:

- Dredging and removal of surface sediment from the lake and upstream wetlands.
- Habitat enhancement and restocking of fish and frogs that may have been impacted by water temperature and chemistry changes during the period of turbid water inputs to the lake and reduced groundwater discharge.
- Installation of a weir or check dam at the creek inlet to the lake to help trap any additional sediment from recent gravel pit discharges and slope failures. Such sediment has likely been deposited in the wetlands upstream from the lake. It may be gradually being transported into the lake through normal creek flow and episodic storm pulses or snowmelt.

Of these options, we recommend habitat enhancement and restocking because they are the most effective approaches to minimizing future disturbance and maximizing ecosystem benefits.

Because past impacts on groundwater discharge to the lake from gravel pit dewatering are not well constrained, and regional water table recovery may be reducing any groundwater deficit over time, specific and practical mitigation measures are not obvious. That said, enhanced characterization and monitoring of hydrogeological conditions, including water table elevations between the lake and the pit, is warranted. Enhanced monitoring could track ongoing recovery from past dewatering, as well as detect current or future impacts of active within-pit pumping and movement of water. To accomplish this characterization, we recommend installation and monitoring of well clusters at two or more sites between the lake and the gravel pit, along with installation and monitoring of a surveyed staff gauge in the lake.

Appendices

A. Supplemental Geological Information and References

B. Sediment Analytical Data

C. Field Photos

D. Water Column Profile Data

E. Sampling and Analysis Plan (SAP)

APPENDIX A
Supplemental Geological Information and References

Massey Lake is located within a larger northwest-southeast trending subglacial tunnel valley (Kehew et al., 1999 and 2013) within the Defiance Moraine. The moraine was deposited by the Huron-Erie Glacial Lobe of the Laurentide ice sheet about 14,000 years ago. The irregularly shaped island and the ridge to the northeast of the lake may be partial exposures of a subglacial esker.

Table A-1. A portion of Table 4 from EGLE (2023a) listing background concentration values for clay within the Huron-Erie Glacial Lobe area of Michigan, which includes the Massey Lake area. Clay would be expected to have higher concentrations of many metals than other grain sizes like sand or silt.

	Dist.	Part 201 Statewide Default Background	Table 1 Upper Range Value	HURON - ERIE		
				n	2 SD	97.5 Quantiles
Aluminum (Al)	L	6,900	16,014	56	**19,049**	#
Antimony (Sb)	Np	NA	11.5	42	#	**13**
Arsenic (As)	L	5.8	22.8	237	**31.4**	#
Barium (Ba)	L	75	172	166	**227**	#
Beryllium (Be)	V	NA	1	35	**1.43**	#
Cadmium (Cd)	Np	1.2	2	196	#	**3.1**
Chromium (Cr)	L	18	55.6	139	**77**	#
Cobalt (Co)	CL	6.8	26.8	98	**27.4**	#
Copper (Cu)	L	32	50.6	192	**46.9**	#
Iron (Fe)	L	12,000	34,311	59	**36,908**	#
Lead (Pb)	CL	21	38.9	196	**26.2**	#
Lithium (Li)	L	9.8	37.9	32	**40.4**	#
Magnesium (Mg)	L	NA	36,049	20	**93,692**	#
Manganese (Mn)	L	440	1,212	53	**935**	#
Mercury (Hg)	Np	0.13	0.5	168	#	**0.58**
Molybdenum (Mo)	Np	NA	5	14	#	**5**
Nickel (Ni)	V	20	55.2	140	**43.4**	#
Selenium (Se)	V	0.41	1.3	189	**1.2**	#
Silver (Ag)	Np	1	1.4	139	#	**6**
Sodium (Na)	V	NA	519	10	**594**	#
Strontium (Sr)	Np	NA	150	6	#	**150**
Thallium (Tl)	Np	NA	2.7	39	#	**1.7**
Titanium (Ti)	N	MNL	208	1	--	--
Vanadium (V)	L	NA	59.6	28	**95.1**	#
Zinc (Zn)	L	47	118	218	**102**	#

References

Boehrer, B. and Schultze, M., 2008. Stratification of lakes. Reviews of Geophysics, 46(2), RG2005, 27 p.

[EGLE, 2023a] Michigan Department of Environment, Great Lakes, and Energy, 2023. Soil Background and Use of the 2005 Michigan Background Soil Survey. Accessed at **https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/RRD/Remediation/Resources/Soil-Background-Resource-Materials.pdf?rev=366ee3d499034314b7b5f0990e0e32b8**

[EGLE, 2023b] Michigan Department of Environment, Great Lakes, and Energy, 2023. Table 2. Soil: Residential; Part 201 Generic Cleanup Criteria And Screening Levels/Part 213 Risk-Based Screening Levels. Accessed at **https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/RRD/Remediation/Rules---Criteria/table-2-soil-residential-pdf.pdf?rev=8168e1208fc24ecda3b7caecee1d3732&hash=EE21014E931B41B397676FA2EC1ADC4F**

Friends of the Rouge, 2025. 2025 Rouge River Watershed Frog and Toad Survey. Friends of the Rouge, Plymouth, MI, 13 pages, **www.therouge.org**

Haley & Aldrich, 2024. Vella Pit Hydrogeological Investigation. Prepared for Mid Michigan Materials, Inc. Transmitted September 27, 2024.

Kehew, A.E., Ewald, S.K., Esch, J.M. and Kozlowski, A.L., 2013. On the origin of tunnel valleys of the Saginaw Lobe of the Laurentide Ice Sheet; Michigan, USA. Boreas, 42(2), pp.442-462.

Kehew, A.E., Nicks, L.P., and Straw, W.T., 1999. Palimpsest tunnel valleys: evidence for relative timing of advances in an interlobate area of the Laurentide ice sheet. Annals of Glaciology, 28, pp.47-52.

Wersin, P., Höhener, P., Giovanoli, R. and Stumm, W., 1991. Early diagenetic influences on iron transformations in a freshwater lake sediment. Chemical Geology, 90(3-4), pp.233-252.

APPENDIX B
Sediment Analytical Data

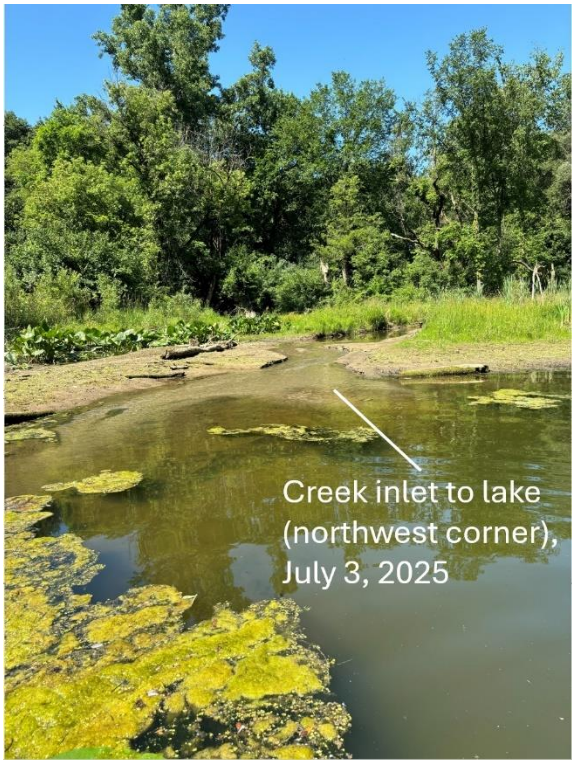
Sediment Metals Concentration and Percent Solids Data

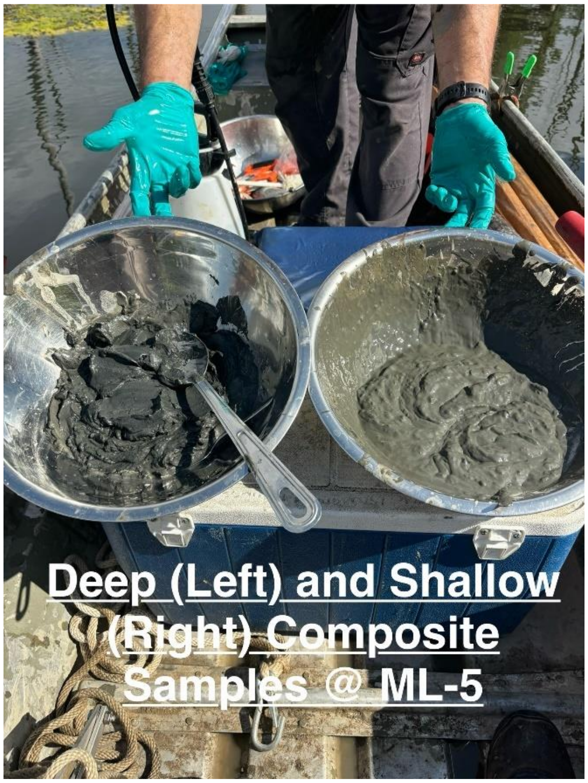
Sample ID	Total Arsenic (mg/Kg)	Total Barium (mg/Kg)	Total Cadmium (mg/Kg)	Total Chromium (mg/Kg)	Total Copper (mg/Kg)	Total Lead (mg/Kg)	Total Mercury (mg/Kg)	Total Selenium (mg/Kg)	Total Silver (mg/Kg)	Total Zinc (mg/Kg)	Percent Solids
ML-1S	5.9	130.0	0.78	12.0	21.0	11.0	Not Detected	Not Detected	Not Detected	74.0	37%
ML-1S Duplicate	5.4	120.0	0.77	11.0	21.0	12.0	Not Detected	0.25	Not Detected	74.0	39%
ML-1D	8.0	150.0	0.76	12.0	23.0	14.0	Not Detected	Not Detected	Not Detected	85.0	37%
ML-2S	4.4	150.0	0.73	11.0	18.0	11.0	Not Detected	0.46	Not Detected	59.0	60%
ML-2D	4.0	150.0	0.78	13.0	18.0	11.0	Not Detected	0.44	Not Detected	61.0	50%
ML-3S	8.7	140.0	0.93	17.0	28.0	15.0	0.051	Not Detected	Not Detected	100.0	36%
ML-3D	7.7	170.0	0.84	13.0	34.0	17.0	Not Detected	Not Detected	Not Detected	100.0	36%
ML-4S	1.1	140.0	1.10	17.0	31.0	15.0	Not Detected	0.30	Not Detected	110.0	33%
ML-4D	7.7	170.0	0.94	14.0	54.0	18.0	0.052	0.40	Not Detected	110.0	34%
ML-5S	11.0	120.0	0.96	17.0	30.0	15.0	Not Detected	0.43	Not Detected	110.0	37%
ML-5D	6.5	160.0	0.75	11.0	33.0	15.0	Not Detected	0.50	Not Detected	88.0	38%
ML-6S	17.0	230.0	1.10	23.0	35.0	18.0	0.055	0.33	Not Detected	120.0	16%
ML-6D	11.0	210.0	1.00	21.0	36.0	18.0	0.064	Not Detected	Not Detected	120.0	17%
Field Blank	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Applicable
Detection Limit	0.10	1.00	0.05	0.50	1.00	1.00	0.050	0.20	0.10	1.00	Not Applicable

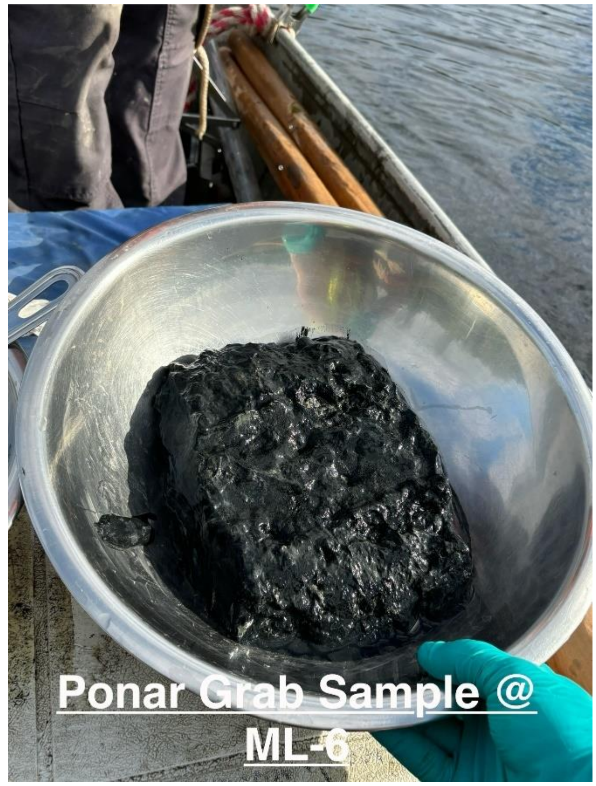
Sediment Grain Size Data

Sample ID	Fine Gravel (%)	Coarse Sand (%)	Medium Sand (%)	Fine Sand (%)	Total Sand (%)	Fines – Total Silt & Clay (%)
ML-1S	0.2	0.4	1.3	9.9	11.6	88.2
ML-1S dup	0.5	0.5	1.2	9.1	10.8	88.7
ML-1D	0.0	0.3	0.5	6.9	7.7	92.3
ML-2S	0.1	0.6	3.3	19.1	23.0	76.9
ML-2D	0.0	1.0	2.7	10.9	14.6	85.4
ML-3S	0.0	0.2	0.3	0.9	1.4	98.6
ML-3D	0.1	0.2	0.6	4.2	5.0	94.9
ML-4S	0.0	0.0	0.5	0.9	1.4	98.6
ML-4D	0.0	0.2	0.5	1.0	1.7	98.3
ML-5S	0.0	0.0	0.1	0.4	0.5	99.5
ML-5D	0.0	0.0	0.1	0.6	0.7	99.3
ML-6S	0.0	0.4	0.2	0.1	0.7	99.3
ML-6D	0.0	0.0	0.1	0.1	0.2	99.8

APPENDIX C
Field Photos




Deep (Left) and Shallow (Right) Composite Samples @ ML-5


Ponar Grab Sample @ ML-6

APPENDIX D
Water Column Profile Data

Water column profiling data from sites ML-1, ML-3, ML-4, ML-5, and ML-6 are included in the following table, along with combined plots of data from all five sites for dissolved oxygen (percent saturation and mg/L), specific conductance, turbidity, pH, and temperature. No water column data were collected from site ML-2, as this was an area of exposed lakebed.

2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/22	9:45:27	ML-1	0.203	44.2	3.93	520.3	2.73	7.62	21.056	42.34285	-83.67141	741.2
8/22	9:45:28	ML-1	0.200	44.1	3.92	520.3	2.58	7.62	21.055	42.34285	-83.67141	741.2
8/22	9:45:29	ML-1	0.198	44.1	3.92	520.2	2.54	7.62	21.055	42.34285	-83.67141	741.3
8/22	9:45:30	ML-1	0.199	44.0	3.92	520.3	2.57	7.61	21.054	42.34285	-83.67141	741.3
8/22	9:45:31	ML-1	0.200	44.0	3.91	520.2	2.46	7.62	21.055	42.34285	-83.67141	741.2
8/22	9:45:32	ML-1	0.196	44	3.91	520.2	2.47	7.62	21.055	42.34285	-83.67141	741.3
8/22	9:45:33	ML-1	0.195	43.9	3.91	520.2	2.55	7.61	21.055	42.34285	-83.6714	741.4
8/22	9:45:34	ML-1	0.196	43.9	3.91	520.2	2.51	7.61	21.055	42.34284	-83.6714	741.3
8/22	9:45:35	ML-1	0.180	43.9	3.9	520	2.69	7.61	21.055	42.34284	-83.6714	741.2
8/22	9:45:36	ML-1	0.181	43.8	3.9	520.1	2.78	7.61	21.054	42.34284	-83.6714	741.2
8/22	9:45:37	ML-1	0.19	43.8	3.89	520.2	2.67	7.61	21.053	42.34284	-83.6714	741.3
8/22	9:45:38	ML-1	0.201	43.7	3.89	520.1	2.82	7.61	21.052	42.34284	-83.6714	741.2
8/22	9:45:39	ML-1	0.228	43.7	3.88	520	2.94	7.61	21.05	42.34284	-83.6714	741.3
8/22	9:45:40	ML-1	0.292	43.6	3.88	519.6	2.87	7.61	21.047	42.34284	-83.6714	741.3
8/22	9:45:41	ML-1	0.375	43.5	3.87	519.5	2.85	7.61	21.04	42.34284	-83.6714	741.3
8/22	9:45:42	ML-1	0.422	43.4	3.86	519.3	2.73	7.61	21.032	42.34284	-83.6714	741.3
8/22	9:45:43	ML-1	0.452	43.3	3.85	518.6	2.36	7.61	21.014	42.34284	-83.6714	741.3
8/22	9:45:44	ML-1	0.473	43.2	3.84	518.6	2.21	7.61	20.99	42.34284	-83.6714	741.2
8/22	9:45:45	ML-1	0.499	43.1	3.84	518.8	2.32	7.61	20.975	42.34284	-83.6714	741.3
8/22	9:45:46	ML-1	0.52	43	3.83	518.8	2.26	7.61	20.967	42.34284	-83.6714	741.4
8/22	9:45:47	ML-1	0.545	43	3.83	518.8	2.21	7.61	20.958	42.34284	-83.6714	741.3
8/22	9:45:48	ML-1	0.571	43	3.83	518.9	2.1	7.61	20.95	42.34284	-83.6714	741.3
8/22	9:45:49	ML-1	0.613	42.9	3.82	518.9	2.13	7.61	20.94	42.34284	-83.6714	741.2
8/22	9:45:50	ML-1	0.646	42.8	3.82	519.3	2.23	7.6	20.931	42.34284	-83.6714	741.2
8/22	9:45:51	ML-1	0.694	42.7	3.81	520.4	2.22	7.6	20.92	42.34284	-83.6714	741.3
8/22	9:45:52	ML-1	0.713	42.5	3.79	521.9	2.35	7.59	20.91	42.34284	-83.6714	741.2
8/22	9:45:53	ML-1	0.735	42.2	3.77	523	2.63	7.59	20.898	42.34284	-83.6714	741.3
8/22	9:45:54	ML-1	0.759	42	3.75	524.3	2.73	7.59	20.888	42.34284	-83.6714	741.2
8/22	9:45:55	ML-1	0.799	41.8	3.73	526.8	2.66	7.59	20.874	42.34284	-83.6714	741.3

2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/22	9:45:56	ML-1	0.803	41.6	3.72	528.3	3.03	7.59	20.858	42.34284	-83.6714	741.3
8/22	9:45:57	ML-1	0.828	41.5	3.7	528.7	4.33	7.59	20.84	42.34284	-83.6714	741.3
8/22	9:45:58	ML-1	0.867	41.4	3.7	530	7.27	7.6	20.826	42.34284	-83.6714	741.2
8/22	9:45:59	ML-1	0.895	41.3	3.69	531.3	8.69	7.6	20.807	42.34285	-83.67141	741.3
8/22	9:46:00	ML-1	0.921	41.2	3.68	532.5	7.7	7.6	20.777	42.34285	-83.67141	741.3
8/22	9:46:01	ML-1	0.961	41.1	3.67	533.4	7.56	7.6	20.747	42.34285	-83.67141	741.2
8/22	9:46:02	ML-1	0.997	40.9	3.66	533.9	7.03	7.6	20.717	42.34285	-83.67141	741.3
8/22	9:46:03	ML-1	1.021	40.9	3.66	534.7	6.05	7.6	20.685	42.34285	-83.67141	741.3
8/22	9:46:04	ML-1	1.039	40.9	3.66	535.3	5.33	7.6	20.651	42.34285	-83.67141	741.3
8/22	9:46:05	ML-1	1.064	40.9	3.67	535.7	4.98	7.6	20.616	42.34285	-83.67141	741.2
8/22	9:46:06	ML-1	1.099	40.9	3.67	536.2	4.97	7.6	20.578	42.34285	-83.67141	741.3
8/22	9:46:07	ML-1	1.126	40.8	3.66	537.1	5.15	7.6	20.546	42.34285	-83.67141	741.3
8/22	9:46:08	ML-1	1.155	40.8	3.67	538.3	5.22	7.6	20.508	42.34285	-83.67141	741.2
8/22	9:46:09	ML-1	1.171	40.8	3.67	539.3	4.98	7.6	20.469	42.34285	-83.67141	741.3
8/22	9:46:10	ML-1	1.207	40.8	3.67	540.6	5.22	7.6	20.424	42.34285	-83.67141	741.3
8/22	9:46:11	ML-1	1.232	40.8	3.68	542.2	5.82	7.6	20.386	42.34285	-83.67141	741.3
8/22	9:46:12	ML-1	1.266	40.8	3.67	543.3	6.6	7.6	20.347	42.34284	-83.67142	741.3
8/22	9:46:13	ML-1	1.27	40.7	3.67	544.4	6.8	7.6	20.322	42.34284	-83.67141	741.2
8/22	9:46:14	ML-1	1.273	40.7	3.67	545.7	6.88	7.6	20.3	42.34284	-83.67141	741.3
8/22	9:46:15	ML-1	1.331	40.6	3.67	546.7	8.27	7.6	20.279	42.34284	-83.67141	741.3
8/22	9:46:16	ML-1	1.367	40.5	3.66	547.4	8.23	7.6	20.246	42.34284	-83.67141	741.3
8/22	9:46:17	ML-1	1.376	40.4	3.65	547.9	8.32	7.6	20.217	42.34284	-83.67141	741.3
8/22	9:46:18	ML-1	1.413	40.3	3.65	548.4	10.17	7.6	20.186	42.34284	-83.67141	741.2
8/22	9:46:19	ML-1	1.422	40.3	3.65	548.8	11.78	7.6	20.154	42.34284	-83.67141	741.2
8/22	9:46:20	ML-1	1.424	40.3	3.64	548.9	16.81	7.61	20.128	42.34284	-83.67141	741.2
8/22	9:46:21	ML-1	1.431	40.1	3.63	549.4	13.09	7.61	20.112	42.34284	-83.67141	741.2
8/21	14:34:12	ML-3	0.158	28.5	2.47	507.6	1.99	7.44	22.392	42.34277	-83.67057	740.6
8/21	14:34:13	ML-3	0.155	28.5	2.47	508.2	2.13	7.44	22.377	42.34277	-83.67057	740.6
8/21	14:34:14	ML-3	0.151	28.5	2.47	506.8	2.18	7.44	22.368	42.34277	-83.67057	740.6
8/21	14:34:15	ML-3	0.136	28.6	2.48	506.7	2	7.45	22.357	42.34277	-83.67057	740.6
8/21	14:34:16	ML-3	0.139	28.5	2.48	505.7	1.97	7.45	22.35	42.34277	-83.67057	740.6
8/21	14:34:17	ML-3	0.186	28.5	2.47	506.2	2	7.44	22.348	42.34277	-83.67057	740.6
8/21	14:34:18	ML-3	0.219	28.4	2.47	507.5	2.23	7.44	22.345	42.34277	-83.67057	740.6
8/21	14:34:19	ML-3	0.239	28.3	2.45	506.2	2.12	7.43	22.337	42.34278	-83.67057	740.6
8/21	14:34:20	ML-3	0.28	28.0	2.43	509	2.12	7.43	22.32	42.34278	-83.67058	740.6
8/21	14:34:21	ML-3	0.336	27.7	2.41	516	2.6	7.43	22.281	42.34278	-83.67058	740.6
8/21	14:34:22	ML-3	0.419	27.4	2.38	527.9	2.85	7.43	22.24	42.3428	-83.67059	740.6
8/21	14:34:23	ML-3	0.487	27.1	2.36	532.6	2.87	7.44	22.188	42.3428	-83.67059	740.6
8/21	14:34:24	ML-3	0.531	27.1	2.36	533.7	3.09	7.46	22.157	42.3428	-83.67058	740.6

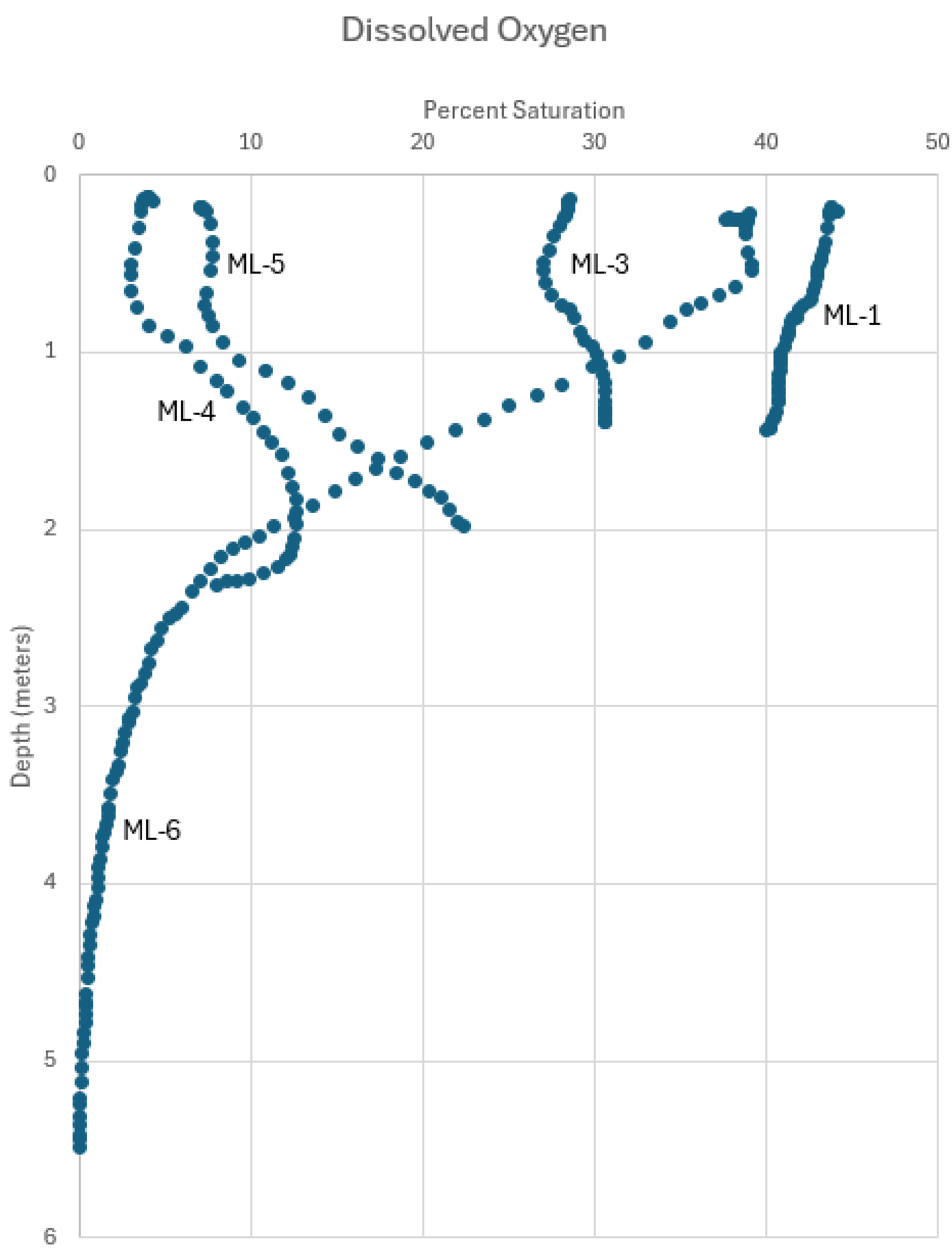
2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/21	14:34:25	ML-3	0.611	27.2	2.37	536.7	3.23	7.47	22.124	42.34279	-83.67058	740.6
8/21	14:34:26	ML-3	0.679	27.6	2.4	539.7	3.31	7.47	22.092	42.34279	-83.67057	740.6
8/21	14:34:27	ML-3	0.734	28.1	2.45	542.2	3.5	7.49	22.055	42.3428	-83.67057	740.6
8/21	14:34:28	ML-3	0.757	28.6	2.49	544.2	3.57	7.5	21.999	42.34279	-83.67057	740.5
8/21	14:34:29	ML-3	0.803	28.9	2.52	545.2	3.54	7.51	21.951	42.34279	-83.67056	740.6
8/21	14:34:30	ML-3	0.886	29.2	2.55	545.9	3.48	7.51	21.914	42.3428	-83.67056	740.6
8/21	14:34:31	ML-3	0.929	29.5	2.58	546.7	3.48	7.51	21.891	42.3428	-83.67056	740.6
8/21	14:34:32	ML-3	0.965	29.9	2.62	547.2	3.95	7.51	21.863	42.3428	-83.67056	740.6
8/21	14:34:33	ML-3	1.013	30.2	2.64	548.6	4.49	7.51	21.835	42.3428	-83.67056	740.6
8/21	14:34:34	ML-3	1.069	30.4	2.66	549.7	4.72	7.51	21.778	42.3428	-83.67055	740.6
8/21	14:34:35	ML-3	1.121	30.5	2.68	550.6	5.71	7.51	21.728	42.3428	-83.67055	740.6
8/21	14:34:36	ML-3	1.173	30.6	2.69	551.2	6.87	7.51	21.688	42.3428	-83.67055	740.6
8/21	14:34:37	ML-3	1.222	30.7	2.7	551.6	7.61	7.51	21.653	42.34279	-83.67056	740.6
8/21	14:34:38	ML-3	1.277	30.7	2.7	552	8.27	7.51	21.608	42.34279	-83.67056	740.6
8/21	14:34:39	ML-3	1.304	30.7	2.7	552.7	7.91	7.5	21.557	42.34278	-83.67056	740.6
8/21	14:34:40	ML-3	1.336	30.7	2.7	553.1	8.43	7.5	21.504	42.34277	-83.67056	740.6
8/21	14:34:41	ML-3	1.355	30.6	2.7	553.4	9.05	7.5	21.467	42.34277	-83.67057	740.6
8/21	14:34:42	ML-3	1.385	30.6	2.7	553.7	9.28	7.49	21.439	42.34276	-83.67057	740.6
8/21	14:34:43	ML-3	1.393	30.6	2.7	553.8	16.7	7.49	21.42	42.34276	-83.67057	740.7
8/21	14:01:04	ML-4	0.14	4.4	0.38	480.3	1.07	7.26	22.109	42.343	-83.67028	740.9
8/21	14:01:05	ML-4	0.116	4.1	0.36	480.1	1.18	7.26	22.103	42.343	-83.67028	740.9
8/21	14:01:06	ML-4	0.126	4.0	0.35	480.2	1.23	7.26	22.097	42.343	-83.67028	740.9
8/21	14:01:07	ML-4	0.137	3.8	0.34	480.6	1.15	7.26	22.095	42.343	-83.67027	740.9
8/21	14:01:08	ML-4	0.161	3.7	0.33	480.3	1.14	7.26	22.093	42.343	-83.67027	740.9
8/21	14:01:09	ML-4	0.201	3.7	0.32	479.3	1.19	7.26	22.081	42.34301	-83.67027	740.8
8/21	14:01:10	ML-4	0.298	3.5	0.3	479.4	1.24	7.25	22.065	42.34301	-83.67027	740.8
8/21	14:01:11	ML-4	0.414	3.3	0.29	480.7	1.36	7.25	22.057	42.343	-83.67027	740.8
8/21	14:01:12	ML-4	0.498	3.1	0.27	485.1	2.07	7.25	22.033	42.343	-83.67027	740.8
8/21	14:01:13	ML-4	0.558	3.1	0.27	500.6	2.93	7.26	22.01	42.343	-83.67027	740.8
8/21	14:01:14	ML-4	0.647	3.1	0.27	515.7	3.08	7.28	21.983	42.343	-83.67027	740.8
8/21	14:01:15	ML-4	0.746	3.4	0.29	526.1	4.41	7.33	21.946	42.34299	-83.67028	740.7
8/21	14:01:16	ML-4	0.847	4.1	0.36	539.1	4.67	7.38	21.92	42.34299	-83.67028	740.7
8/21	14:01:17	ML-4	0.909	5.2	0.45	544.1	4.51	7.39	21.863	42.343	-83.67028	740.8
8/21	14:01:18	ML-4	0.959	6.3	0.55	546.3	4.48	7.42	21.815	42.343	-83.67028	740.9
8/21	14:01:19	ML-4	1.073	7.1	0.62	550.6	4.62	7.43	21.774	42.343	-83.67028	740.8
8/21	14:01:20	ML-4	1.157	8.0	0.7	553.9	4.79	7.44	21.71	42.343	-83.67028	740.7
8/21	14:01:21	ML-4	1.221	8.7	0.77	554.3	4.93	7.44	21.676	42.343	-83.67028	740.8
8/21	14:01:22	ML-4	1.305	9.6	0.84	556.1	5.22	7.45	21.638	42.343	-83.67028	740.8
8/21	14:01:23	ML-4	1.362	10.2	0.90	556.4	5.23	7.45	21.607	42.343	-83.67028	740.8

2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/21	14:01:24	ML-4	1.451	10.8	0.95	556.9	5.19	7.46	21.577	42.343	-83.67028	740.8
8/21	14:01:25	ML-4	1.506	11.3	1.00	559.4	6.59	7.46	21.542	42.343	-83.67028	740.8
8/21	14:01:26	ML-4	1.577	11.8	1.04	560.9	7.18	7.46	21.511	42.343	-83.67028	740.8
8/21	14:01:27	ML-4	1.678	12.2	1.08	561.8	7.43	7.46	21.458	42.343	-83.67028	740.9
8/21	14:01:28	ML-4	1.759	12.5	1.1	562.2	9.08	7.45	21.423	42.343	-83.67028	740.8
8/21	14:01:29	ML-4	1.834	12.7	1.12	563	11.29	7.45	21.387	42.343	-83.67028	740.9
8/21	14:01:30	ML-4	1.895	12.7	1.12	567.9	12.73	7.44	21.331	42.343	-83.67028	740.9
8/21	14:01:31	ML-4	1.971	12.7	1.12	574.7	13.71	7.43	21.301	42.343	-83.67028	740.9
8/21	14:01:32	ML-4	2.042	12.6	1.11	589.4	16.21	7.28	21.241	42.343	-83.67028	740.7
8/21	14:01:33	ML-4	2.091	12.5	1.1	620.9	19.76	7.13	21.13	42.343	-83.67029	740.8
8/21	14:01:34	ML-4	2.143	12.3	1.1	630	20.45	7.03	20.985	42.343	-83.67029	740.8
8/21	14:01:35	ML-4	2.167	12.1	1.08	642.4	20.92	7.01	20.909	42.343	-83.67029	740.8
8/21	14:01:36	ML-4	2.211	11.6	1.04	660.9	22.42	6.96	20.899	42.343	-83.67029	740.8
8/21	14:01:37	ML-4	2.245	10.8	0.96	678.4	24.86	6.93	20.882	42.343	-83.67029	740.8
8/21	14:01:38	ML-4	2.284	10.0	0.89	680.4	25.55	6.92	20.793	42.343	-83.67029	740.8
8/21	14:01:39	ML-4	2.287	9.3	0.83	683.2	26.62	6.89	20.698	42.343	-83.67029	740.8
8/21	14:01:40	ML-4	2.29	8.7	0.78	697	27.45	6.89	20.581	42.34299	-83.67029	740.8
8/21	14:01:41	ML-4	2.317	8.0	0.71	704.2	27.53	6.89	20.531	42.34299	-83.67029	740.8
8/21	16:02:10	ML-5	0.174	7.1	0.62	419.2	1.72	7.38	22.013	42.34237	-83.67049	740.4
8/21	16:02:11	ML-5	0.174	7.1	0.62	419.5	1.72	7.38	22.012	42.34237	-83.67049	740.4
8/21	16:02:12	ML-5	0.175	7.2	0.63	419.8	1.8	7.38	22.011	42.34237	-83.67049	740.4
8/21	16:02:13	ML-5	0.186	7.2	0.63	419.8	2.01	7.38	22.011	42.34237	-83.67049	740.4
8/21	16:02:14	ML-5	0.194	7.3	0.64	420.5	1.94	7.37	22.011	42.34237	-83.67049	740.4
8/21	16:02:15	ML-5	0.196	7.5	0.65	420.4	1.8	7.37	22.018	42.34237	-83.67049	740.4
8/21	16:02:16	ML-5	0.276	7.7	0.68	420.3	1.73	7.37	22.015	42.34237	-83.67049	740.5
8/21	16:02:17	ML-5	0.37	7.8	0.69	421.8	1.57	7.36	21.984	42.34237	-83.67049	740.5
8/21	16:02:18	ML-5	0.452	7.8	0.68	428.8	1.9	7.35	21.949	42.34238	-83.6705	740.5
8/21	16:02:19	ML-5	0.534	7.7	0.67	444.9	2.69	7.35	21.927	42.34238	-83.6705	740.5
8/21	16:02:20	ML-5	0.667	7.5	0.66	530.4	3.74	7.36	21.911	42.34238	-83.6705	740.3
8/21	16:02:21	ML-5	0.73	7.4	0.65	521.1	3.91	7.37	21.905	42.34238	-83.67049	740.5
8/21	16:02:22	ML-5	0.791	7.6	0.66	504.9	3.77	7.39	21.901	42.34238	-83.67049	740.3
8/21	16:02:23	ML-5	0.844	7.8	0.69	539.7	3.76	7.42	21.897	42.34238	-83.67049	740.4
8/21	16:02:24	ML-5	0.936	8.4	0.74	538.9	3.91	7.45	21.884	42.34238	-83.67049	740.3
8/21	16:02:25	ML-5	1.038	9.4	0.82	540.2	3.93	7.47	21.86	42.34238	-83.67049	740.4
8/21	16:02:26	ML-5	1.107	10.9	0.95	544.4	4.08	7.48	21.837	42.34238	-83.67049	740.4
8/21	16:02:27	ML-5	1.168	12.2	1.06	546.1	4.27	7.48	21.818	42.34238	-83.67049	740.4
8/21	16:02:28	ML-5	1.253	13.4	1.17	549.2	4.57	7.49	21.795	42.34238	-83.67048	740.4
8/21	16:02:29	ML-5	1.354	14.3	1.25	552.1	4.69	7.5	21.754	42.34238	-83.67048	740.4
8/21	16:02:30	ML-5	1.454	15.2	1.34	552.4	4.78	7.51	21.711	42.34238	-83.67048	740.4

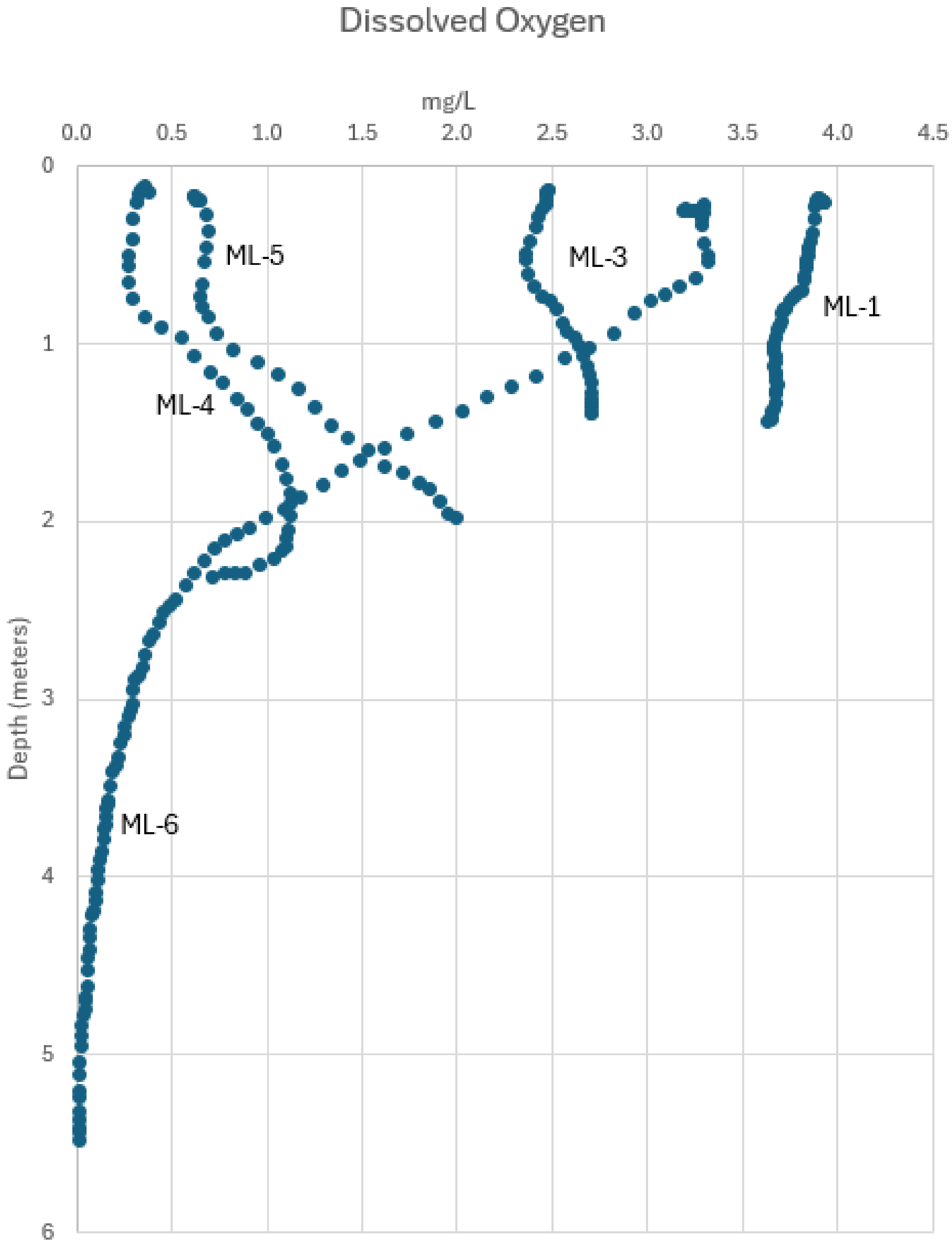
2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/21	16:02:31	ML-5	1.527	16.2	1.42	552.4	5.37	7.51	21.686	42.34238	-83.67048	740.4
8/21	16:02:32	ML-5	1.601	17.4	1.53	550.8	5.67	7.51	21.645	42.34238	-83.67048	740.5
8/21	16:02:33	ML-5	1.684	18.5	1.62	550.4	5.9	7.51	21.574	42.34238	-83.67047	740.3
8/21	16:02:34	ML-5	1.721	19.6	1.72	550.5	6.42	7.51	21.517	42.34238	-83.67047	740.4
8/21	16:02:35	ML-5	1.781	20.4	1.8	549.9	7.16	7.51	21.469	42.34238	-83.67047	740.5
8/21	16:02:36	ML-5	1.821	21.1	1.86	549.8	8.25	7.51	21.428	42.34238	-83.67047	740.3
8/21	16:02:37	ML-5	1.886	21.6	1.91	550.7	10.75	7.5	21.379	42.34238	-83.67047	740.4
8/21	16:02:38	ML-5	1.954	22.1	1.95	551.9	14.24	7.5	21.343	42.34238	-83.67046	740.4
8/21	16:02:39	ML-5	1.98	22.5	1.99	553.1	18.59	7.49	21.298	42.34238	-83.67047	740.5
8/21	17:36:51	ML-6	0.244	37.7	3.19	475.3	2.07	7.56	23.673	42.34205	-83.66839	740.1
8/21	17:36:52	ML-6	0.253	37.8	3.19	474.9	1.84	7.55	23.672	42.34205	-83.66839	740.1
8/21	17:36:53	ML-6	0.236	37.9	3.2	474.9	1.74	7.55	23.672	42.34205	-83.66839	740.2
8/21	17:36:54	ML-6	0.244	38.1	3.22	475.3	1.95	7.55	23.671	42.34205	-83.66839	740.3
8/21	17:36:55	ML-6	0.25	38.3	3.24	475.6	2.12	7.55	23.667	42.34205	-83.66839	740.1
8/21	17:36:56	ML-6	0.25	38.5	3.26	475.9	1.88	7.54	23.664	42.34205	-83.66839	740.2
8/21	17:36:57	ML-6	0.244	38.6	3.27	476	1.9	7.54	23.666	42.34205	-83.66839	740.1
8/21	17:36:58	ML-6	0.24	38.9	3.29	476	1.85	7.54	23.671	42.34204	-83.66839	740.2
8/21	17:36:59	ML-6	0.231	39.0	3.3	476.2	1.82	7.54	23.679	42.34204	-83.66839	740.2
8/21	17:37:00	ML-6	0.216	39.1	3.3	476.4	1.81	7.55	23.696	42.34204	-83.66839	740.1
8/21	17:37:01	ML-6	0.259	39.0	3.3	475	2.12	7.55	23.711	42.34204	-83.66839	740.1
8/21	17:37:02	ML-6	0.29	38.9	3.29	474	2.27	7.55	23.698	42.34203	-83.66839	740.1
8/21	17:37:03	ML-6	0.328	38.9	3.29	473.2	2.07	7.56	23.666	42.34203	-83.66839	740.1
8/21	17:37:04	ML-6	0.432	39.0	3.3	470.8	2.1	7.58	23.625	42.34203	-83.66839	740.1
8/21	17:37:05	ML-6	0.506	39.2	3.32	465.4	2.13	7.57	23.554	42.34203	-83.66839	740.1
8/21	17:37:06	ML-6	0.541	39.2	3.32	464.1	2.06	7.55	23.465	42.34203	-83.66839	740.1
8/21	17:37:07	ML-6	0.625	38.2	3.25	462.3	2.13	7.53	23.409	42.34203	-83.66839	740.1
8/21	17:37:08	ML-6	0.68	37.3	3.17	461.6	2.11	7.51	23.347	42.34203	-83.66839	740.1
8/21	17:37:09	ML-6	0.724	36.2	3.09	461.1	2.07	7.5	23.297	42.34203	-83.66839	740.1
8/21	17:37:10	ML-6	0.752	35.4	3.02	460.9	1.97	7.49	23.238	42.34202	-83.66839	740.1
8/21	17:37:11	ML-6	0.829	34.4	2.93	461.4	2.32	7.48	23.19	42.34202	-83.66839	740.2
8/21	17:37:12	ML-6	0.942	33.0	2.82	462.7	2.84	7.46	23.121	42.34202	-83.66839	740.1
8/21	17:37:13	ML-6	1.021	31.5	2.69	463.9	2.9	7.44	23.058	42.34202	-83.66839	740.1
8/21	17:37:14	ML-6	1.081	29.9	2.56	464.3	3.02	7.43	23.002	42.34202	-83.66839	740.1
8/21	17:37:15	ML-6	1.18	28.1	2.41	465	3.72	7.42	22.964	42.34202	-83.66838	740.1
8/21	17:37:16	ML-6	1.241	26.7	2.29	466.3	4.02	7.41	22.924	42.34202	-83.66838	740.1
8/21	17:37:17	ML-6	1.302	25.1	2.16	471.1	4.29	7.38	22.895	42.34202	-83.66838	740.1
8/21	17:37:18	ML-6	1.374	23.6	2.03	476.9	5.15	7.35	22.854	42.34202	-83.66838	740.1
8/21	17:37:19	ML-6	1.434	22.0	1.89	480.1	5.89	7.34	22.822	42.34201	-83.66838	740
8/21	17:37:20	ML-6	1.508	20.3	1.74	487	6.89	7.31	22.796	42.34202	-83.66838	740.1

2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/21	17:37:21	ML-6	1.585	18.8	1.62	493.9	7.98	7.29	22.774	42.34202	-83.66838	740.1
8/21	17:37:22	ML-6	1.651	17.3	1.49	498.5	9.42	7.28	22.756	42.34201	-83.66839	740.1
8/21	17:37:23	ML-6	1.711	16.1	1.39	507.8	11.71	7.27	22.739	42.34201	-83.66839	740.1
8/21	17:37:24	ML-6	1.788	15.0	1.29	516.1	12.49	7.26	22.72	42.34201	-83.66839	740.1
8/21	17:37:25	ML-6	1.865	13.7	1.18	521.4	11.9	7.24	22.696	42.34201	-83.66839	740.1
8/21	17:37:26	ML-6	1.932	12.6	1.09	529.4	11.59	7.22	22.676	42.34201	-83.66839	740.1
8/21	17:37:27	ML-6	1.976	11.4	0.99	537.9	11.24	7.22	22.639	42.34201	-83.66839	740.2
8/21	17:37:28	ML-6	2.032	10.6	0.91	536.8	16.08	7.23	22.592	42.34201	-83.66839	740.2
8/21	17:37:29	ML-6	2.068	9.7	0.84	534.7	14.83	7.24	22.563	42.34201	-83.66839	740.2
8/21	17:37:30	ML-6	2.106	9.0	0.78	538.7	10.67	7.23	22.547	42.34201	-83.66839	740.1
8/21	17:37:31	ML-6	2.154	8.3	0.72	544.2	12.84	7.17	22.516	42.34201	-83.6684	740
8/21	17:37:32	ML-6	2.216	7.7	0.67	548	15.47	7.12	22.477	42.34201	-83.6684	740.2
8/21	17:37:33	ML-6	2.287	7.1	0.62	549.2	16.6	7.07	22.428	42.34201	-83.6684	740.1
8/21	17:37:34	ML-6	2.353	6.6	0.57	549.9	19.24	7.02	22.35	42.34201	-83.6684	740.1
8/21	17:37:35	ML-6	2.436	6.0	0.52	550.7	22.67	6.98	22.258	42.34201	-83.6684	740.2
8/21	17:37:36	ML-6	2.472	5.7	0.49	552.3	26.83	6.95	22.15	42.34201	-83.6684	740.1
8/21	17:37:37	ML-6	2.503	5.3	0.46	554.7	28.78	6.93	21.955	42.34201	-83.6684	740.1
8/21	17:37:38	ML-6	2.561	4.9	0.43	558.7	28.95	6.92	21.794	42.34201	-83.6684	740.1
8/21	17:37:39	ML-6	2.629	4.6	0.4	562.5	27.5	6.89	21.585	42.34201	-83.6684	740.1
8/21	17:37:40	ML-6	2.673	4.3	0.38	567.1	26.63	6.87	21.271	42.34201	-83.6684	740.1
8/21	17:37:41	ML-6	2.751	4.1	0.36	571	24.96	6.85	20.962	42.34201	-83.6684	740.1
8/21	17:37:42	ML-6	2.815	3.9	0.35	573.1	23.08	6.85	20.665	42.34201	-83.6684	740.1
8/21	17:37:43	ML-6	2.863	3.6	0.33	574.8	21.42	6.85	20.458	42.34201	-83.6684	740.1
8/21	17:37:44	ML-6	2.892	3.4	0.31	575.6	20.72	6.84	20.219	42.34201	-83.6684	740.1
8/21	17:37:45	ML-6	2.945	3.3	0.3	575.6	19.66	6.84	19.956	42.34201	-83.6684	740.2
8/21	17:37:46	ML-6	3.032	3.2	0.29	577.3	17.26	6.83	19.607	42.34202	-83.6684	740.2
8/21	17:37:47	ML-6	3.06	3.0	0.28	580.9	15.36	6.82	19.326	42.34202	-83.6684	740.1
8/21	17:37:48	ML-6	3.091	2.9	0.27	581.2	12.98	6.82	19.026	42.34202	-83.6684	740.1
8/21	17:37:49	ML-6	3.149	2.7	0.25	583.2	11.07	6.82	18.663	42.34202	-83.6684	740.1
8/21	17:37:50	ML-6	3.205	2.6	0.25	585.3	9.7	6.83	18.283	42.34202	-83.6684	740.1
8/21	17:37:51	ML-6	3.25	2.5	0.23	588.5	8.68	6.83	17.954	42.34202	-83.6684	740.1
8/21	17:37:52	ML-6	3.331	2.3	0.22	591.6	8.43	6.84	17.644	42.34202	-83.6684	740.2
8/21	17:37:53	ML-6	3.368	2.2	0.21	593.3	7.59	6.84	17.396	42.34202	-83.6684	740.1
8/21	17:37:54	ML-6	3.412	2	0.19	595.8	7.07	6.85	17.109	42.34202	-83.6684	740.1
8/21	17:37:55	ML-6	3.493	1.9	0.18	597.3	6.56	6.85	16.925	42.34202	-83.6684	740
8/21	17:37:56	ML-6	3.57	1.8	0.17	599.2	5.87	6.85	16.658	42.34202	-83.6684	740
8/21	17:37:57	ML-6	3.586	1.7	0.17	602.3	5.68	6.86	16.432	42.34202	-83.6684	740.1
8/21	17:37:58	ML-6	3.619	1.7	0.16	604.7	5.66	6.87	16.228	42.34202	-83.6684	740.1
8/21	17:37:59	ML-6	3.663	1.6	0.16	606.8	5.84	6.88	16.073	42.34202	-83.6684	740.1
8/21	17:38:00	ML-6	3.708	1.5	0.15	608.4	5.53	6.9	15.875	42.34203	-83.66839	740.1

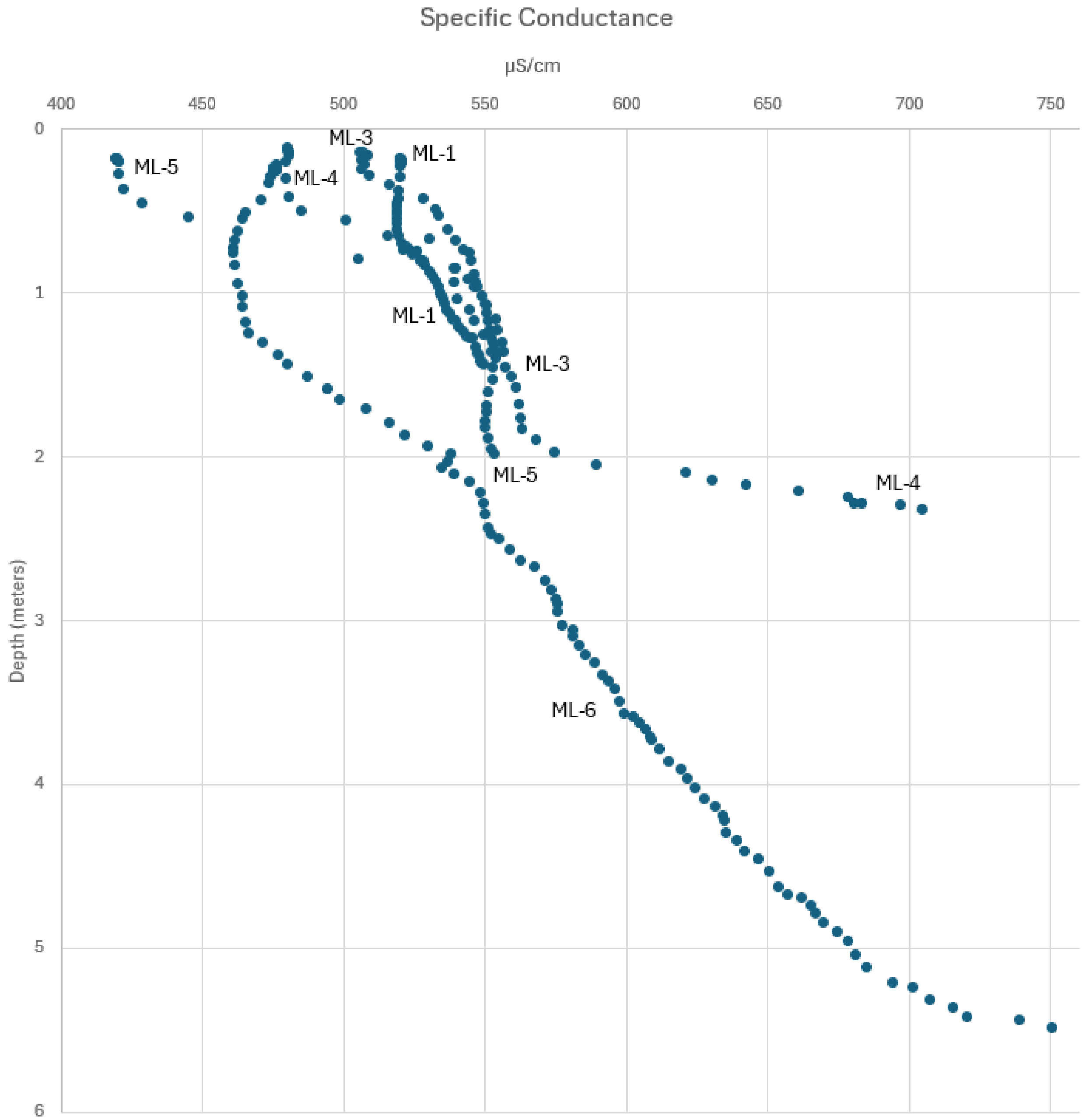
2025 Date (MM/DD)	Time (H:m:s)	Site Name	Depth m	Diss. Ox. % sat	Diss. Ox. mg/L	Spec Cond. µS/cm	Turb. NTU	pH	Temp °C	GPS Lat. °	GPS Long. °	Barom. mmHg
8/21	17:38:01	ML-6	3.728	1.4	0.14	609	4.75	6.92	15.674	42.34203	-83.66839	740.1
8/21	17:38:02	ML-6	3.787	1.4	0.14	611.8	4.6	6.93	15.484	42.34203	-83.66839	740.1
8/21	17:38:03	ML-6	3.856	1.3	0.13	615.1	4.61	6.94	15.249	42.34203	-83.66839	740.1
8/21	17:38:04	ML-6	3.906	1.2	0.12	619.2	4.22	6.95	15.027	42.34203	-83.66839	740.1
8/21	17:38:05	ML-6	3.964	1.1	0.11	621.2	3.98	6.96	14.797	42.34203	-83.66839	740.1
8/21	17:38:06	ML-6	4.018	1.1	0.11	624.4	4.25	6.97	14.569	42.34203	-83.6684	740
8/21	17:38:07	ML-6	4.085	1.0	0.1	627.4	4.11	6.98	14.299	42.34203	-83.6684	740.2
8/21	17:38:08	ML-6	4.128	0.9	0.1	631.2	3.79	6.99	14.072	42.34203	-83.6684	740.1
8/21	17:38:09	ML-6	4.187	0.9	0.09	634.2	3.93	7	13.927	42.34203	-83.6684	740.1
8/21	17:38:10	ML-6	4.219	0.8	0.08	634.6	4.06	7.02	13.902	42.34203	-83.6684	740.1
8/21	17:38:11	ML-6	4.292	0.7	0.07	635.1	4.19	7.03	13.861	42.34203	-83.6684	740.1
8/21	17:38:12	ML-6	4.344	0.7	0.07	638.7	4.4	7.04	13.651	42.34203	-83.6684	740.1
8/21	17:38:13	ML-6	4.408	0.6	0.07	641.9	4.31	7.06	13.447	42.34203	-83.6684	740.1
8/21	17:38:14	ML-6	4.455	0.6	0.06	646.3	4.36	7.07	13.275	42.34203	-83.6684	740.1
8/21	17:38:15	ML-6	4.525	0.6	0.06	650.5	4.73	7.07	13.031	42.34203	-83.6684	740.1
8/21	17:38:16	ML-6	4.622	0.5	0.06	653.7	4.78	7.05	12.846	42.34203	-83.6684	740.1
8/21	17:38:17	ML-6	4.67	0.5	0.05	657.2	5.07	7.04	12.647	42.34203	-83.6684	740.1
8/21	17:38:18	ML-6	4.694	0.5	0.05	661.6	5.24	7.04	12.483	42.34203	-83.6684	740.1
8/21	17:38:19	ML-6	4.74	0.5	0.05	665.1	5.25	7.04	12.335	42.34203	-83.66839	740.1
8/21	17:38:20	ML-6	4.783	0.4	0.04	666.6	6.39	7.05	12.253	42.34203	-83.6684	740.1
8/21	17:38:21	ML-6	4.84	0.3	0.03	669.6	7.41	7.05	12.112	42.34203	-83.6684	740.1
8/21	17:38:22	ML-6	4.893	0.3	0.03	674.4	7.76	7.06	11.915	42.34203	-83.6684	740.2
8/21	17:38:23	ML-6	4.95	0.2	0.03	678.1	8.21	7.06	11.782	42.34203	-83.6684	740.3
8/21	17:38:24	ML-6	5.04	0.2	0.02	680.9	9.23	7.07	11.681	42.34203	-83.6684	740.2
8/21	17:38:25	ML-6	5.118	0.2	0.02	684.8	9.78	7.07	11.577	42.34203	-83.66839	740.2
8/21	17:38:26	ML-6	5.207	0.1	0.01	693.9	10.06	7.06	11.405	42.34203	-83.66839	740.1
8/21	17:38:27	ML-6	5.24	0.1	0.01	700.9	10.62	7.05	11.25	42.34203	-83.66839	740
8/21	17:38:28	ML-6	5.316	0.1	0.02	707.3	11.31	7.05	11.066	42.34203	-83.66839	740.1
8/21	17:38:29	ML-6	5.362	0.1	0.02	715.3	12.37	7.06	10.941	42.34203	-83.66839	740.1
8/21	17:38:30	ML-6	5.415	0.1	0.01	720.3	12.83	7.06	10.849	42.34203	-83.66839	740
8/21	17:38:31	ML-6	5.438	0.1	0.01	738.7	14.61	7.05	10.802	42.34203	-83.66839	740.1
8/21	17:38:32	ML-6	5.485	0.1	0.01	750.1	31.16	6.98	10.708	42.34202	-83.6684	740.1



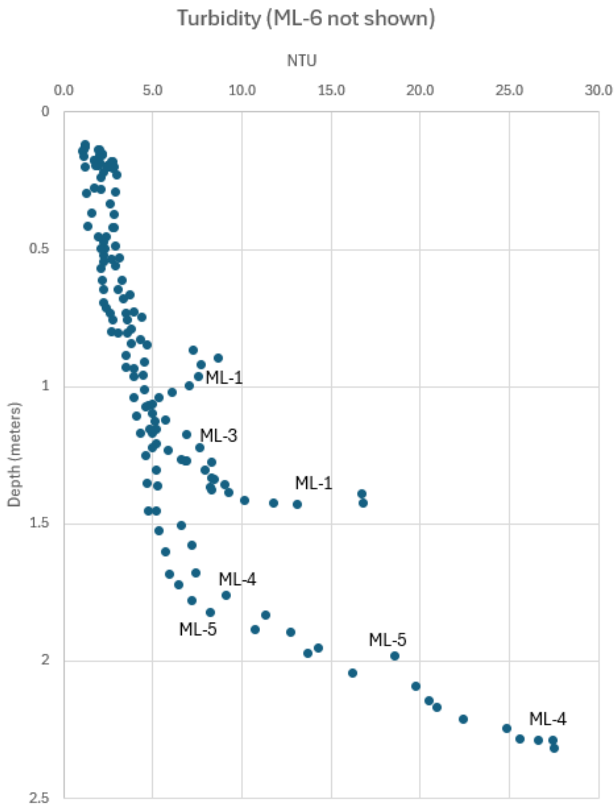
Dissolved Oxygen
Percent Saturation
0
10
20
30
40
50
0
1
2
3
4
5
6
Depth (meters)
ML-5
ML-3
ML-1
ML-4
ML-6

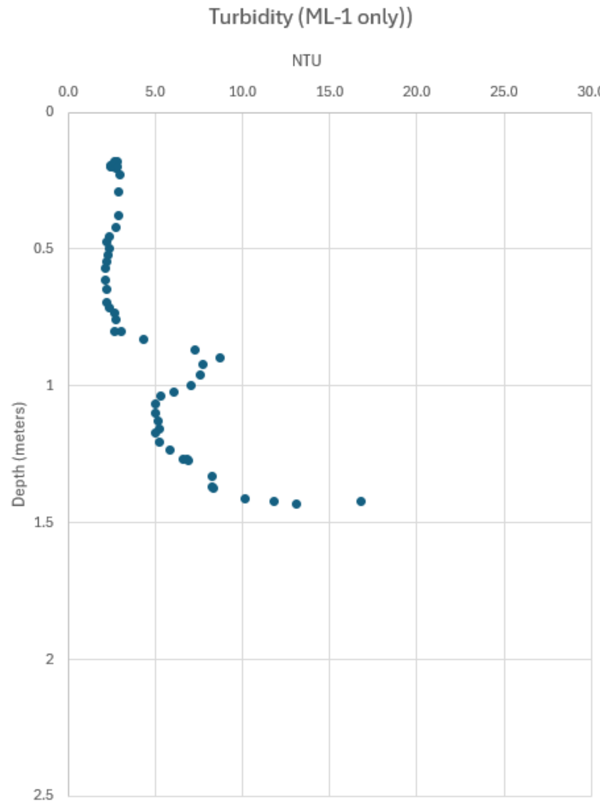


Dissolved Oxygen
mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0
1
2
3
4
5
6
Depth (meters)
ML-5
ML-3
ML-1
ML-4
ML-6

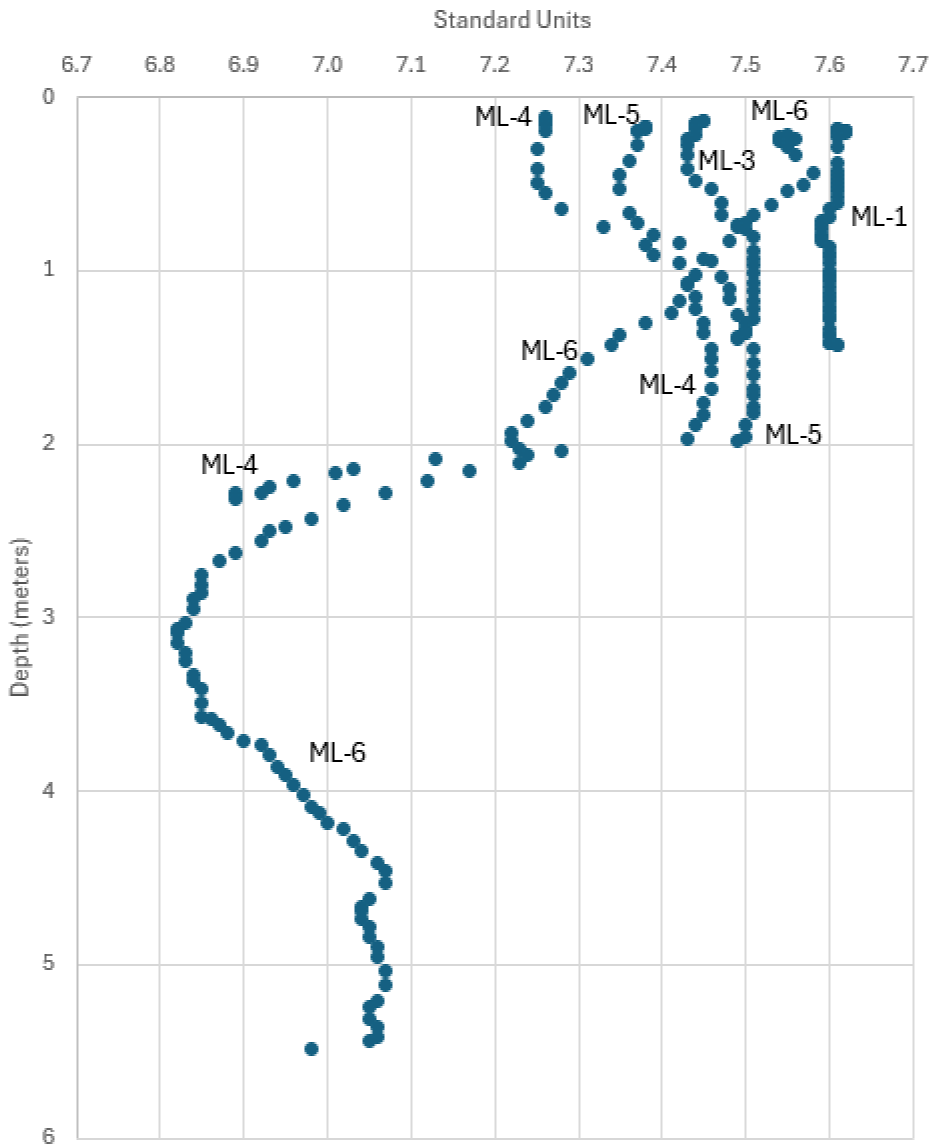


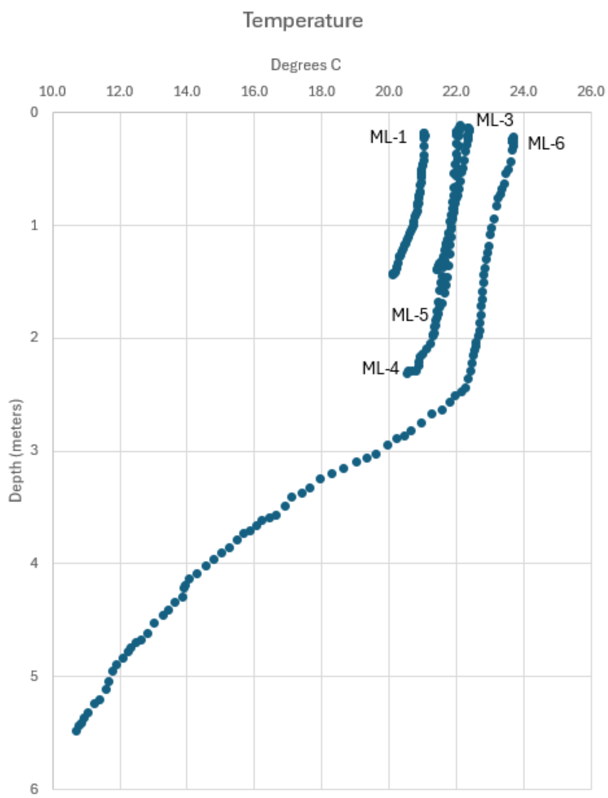
Specific Conductance
µS/cm
400
450
500
550
600
650
700
750
0
1
2
3
4
5
6
Depth (meters)
ML-5
ML-4
ML-3
ML-1
ML-1
ML-3
ML-5
ML-4
ML-6

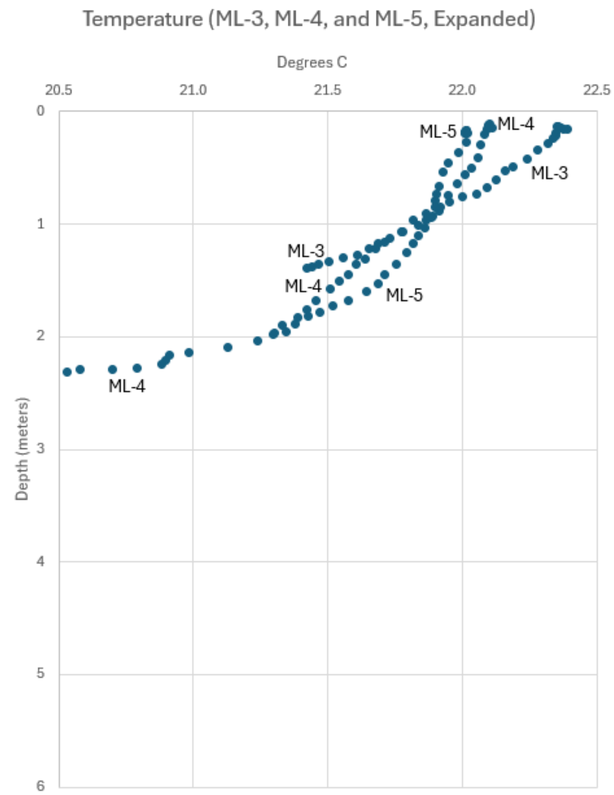

Turbidity (ML-6 not shown)
NTU
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Depth (meters)
0
0.5
1
1.5
2
2.5
ML-1
ML-3
ML-1
ML-4
ML-5
ML-5
ML-4


Turbidity (ML-1 only))
NTU
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Depth (meters)
0
0.5
1
1.5
2
2.5

pH


Standard Units
6.7
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
0
1
2
3
4
5
6
Depth (meters)
ML-4
ML-5
ML-6
ML-3
ML-1
ML-6
ML-4
ML-5
ML-4
ML-6


Temperature
Degrees C
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0
26.0
Depth (meters)
0
1
2
3
4
5
6
ML-1
ML-3
ML-6
ML-5
ML-4


Temperature (ML-3, ML-4, and ML-5, Expanded)
Degrees C
20.5
21.0
21.5
22.0
22.5
Depth (meters)
0
1
2
3
4
5
6
ML-5
ML-4
ML-3
ML-3
ML-4
ML-5
ML-4

APPENDIX E
Sampling and Analysis Plan

Available under separate cover.