Devils Lake Water Improvement District

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Physical & Chemical Monitoring Sampling and Analysis Plan

Written by: Paul Robertson, Lake Manager

Group A: Project Management

A1. Title and Approval Sheet

Paul Robertson, Lake Manager Devils Lake Water Improvement District	Date
Steve Hanson / DEQ Volunteer Monitoring Specialist	Date
Chris Redman / DEQ Quality Assurance Officer (QAO)	Date

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A2. Table of Contents

A3. Distribution List

A digital copy of The Devils Lake Water Improvement District Physical/Chemical Parameter Sampling and Analysis Plan (SAP) shall be available on the District's website (www.DLWID.org) with a signed paper copy kept on file at the District's office. Small changes which may occur to the document shall be identified by a systematic increase in the decimal of the version number (e.g. 1.1., 1.2, 1.3). Substantial changes are denoted by an increase to the next whole integer (e.g. 1.3, 2.1). This newest version shall replace all previous versions. Users will be able to find the updated version at the District's website, which shall be updated by the DLWID's Lake Manager. Users and signatories of this document shall be notified electronically of all changes. Users of the document are responsible for insuring they are using the most current version.

A4. Project/Task Organization

Table 1. DLWID Water Quality Monitoring Staff

Name	Title	Affiliation	Responsibility	Telephone	Email
Paul Robertson	Lake Manager & Senior Scientist	Devils Lake Water Improvement District	Project Manager & Quality Assurance Officer	541-994-5330	paul@dlwid.org
Seth Lenaerts	Water Quality Specialist	Devils Lake Water Improvement District	Sampling, Analysis and Database Management	541-994-5330	seth@dlwid.org

A5. Purpose Statement and Background

Physical Parameter Monitoring is conducted by the Devils Lake Water Improvement District to provide for an ongoing, long-term dataset of water quality parameters. Temporal changes recorded in the lake provide valuable insight into the functioning of the lake even at the weekly scale as this program is designed around. While generally this sampling program is done during the Recreational Water Use period, defined as the summer and shoulder months, the program can and has extended into other months. Standard limnological tests are conducted which are simple and quick, providing for same day testing and analysis. These include measurements for Dissolved Oxygen (DO), Temperature (T), pH, Electroconductivity (EC), Turbidity (Turb), and Secchi Depth (SD). Sampling for chemical analysis is also part of an ongoing monitoring program. Samples are acquired internally and are analyzed by an outside lab.

Parameters:

Dissolved Oxygen (DO) is monitored as it is the fundamental water quality parameter. Levels of DO are indicative of the health of the water body. All aquatic life is dependent on the quantity of dissolved

oxygen in the water. Reduced levels of Dissolved Oxygen stress fish, and can even result in fish kills. Dissolved oxygen near or at saturation levels are desirable. Measurements are recorded in milligrams per liter of water (mg/l) or parts per million (ppm).

Temperature (T) is a critical parameter of lake ecology. Lake biota is regulated by the temperature regime. Further, chemical and physical changes occur in a changing thermal environment. For example, Dissolved Oxygen and conductivity are functions of temperature as is solubility. Temperature is analyzed using temperature probes within the DO Meter and the multimeter and are reported in degrees Celsius.

The pH of a water body is a measurement of the acidity of the water. The measurement actually describes the concentration or more correctly the activity of free H30+ ions in solution. As H+ is a surrogate for the bonded H3O+ ion, the acidity is related by its concentration. By convention the concentration of the hydrogen ion is converted to a logarithmic form and multiplied by -1. As the ion concentration is therefore a logarithmic value representing the concentration of the hydrogen ion in solution the small letter p for "power" has been incorporated into the commonly express pH or power of Hydrogen. The waters of the lake and watershed are tested for pH using a calibrated electrode attached to a multimeter. Lake waters fluctuate in pH, but the range given for meeting water quality standards by the EPA is between 6.5 and 8.5 for fresh water.

Equation 1: $pH = -\log[H+]$

Electroconductivity (EC) is a measurement of the propensity for water to conduct electricity. Pure water is a very poor conductor of electrical current. It is only when solutes are dissolved in water that electricity will flow through water. The higher the amount of solutes dissolved into the water the higher the conductivity. This measurement has been standardized to measure the voltage (V) received from the flow of a current (I) between two electrodes spaced 1 centimeter apart submersed in the solution of some level of resistance (R). These values are reported in microSiemens per centimeter (µS/cm) by international convention. As the electrical current flow (I) increases with higher temperature, the EC values are automatically corrected to a standard value referenced at 25°C. The values are then technically referred to as specific electrical conductivity. The electrical conductivity increases proportionately to the concentration of solutes, therefore EC is an estimate the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. For lakes, the EC is often controlled by the geologic composition of the drainage basin, which is mostly static. Therefore changes in the EC can often be attributed to changes in the use of the landscape and/or pollution loading of the drainage system. Dissolved salts from agricultural runoff, urban sources, or roads will often increase the conductivity. Atmospheric inputs can also be a sizable contributor to the ionic strength of the lake especially in the coastal zones where ocean water increases the salt load or salinity of dry (aerosol) and wet (precipitation) deposition. This oceanic effect may extend inland about 50-100 kilometers and therefore may contribute to changes in the watershed. Other means of an increase in conductivity are driven by the sun and evaporation where solutes concentrate after evaporation of the solution.

Equation 2: $V = I \times R$

Turbidity (Turb) is a measurement of the ability for light to pass through water. Turbidity is used as a basic measurement of clarity. Clarity can be reduced by biotic and abiotic factors. Changes in clarity are from increased algal or cyanobacterial production, soil and sediment particle suspension, and/or other materials suspended in the water. Rain and wind storms may significantly affect readings. Erosion from

rainfall, runoff, and high stream velocities may result in higher concentrations of suspended particles entering the lake and therefore an increase I the turbidity reading might be expected.

Secchi Disk (SD) depth provides a low tech inexpensive method for assessing the clarity of a lake. A Secchi disk is a circular plate divided into quarters pies, painted alternately black and white. The disk is attached to a rope and lowered into the water until it is no longer visible. High Secchi readings are favorable as they represent a greater clarity in the water. Lower readings indicate turbid or discolored water. The transmission of light is dependent on the clarity of the water, and therefore the depth at which photosynthesis can occur. The rule of thumb is that the photic zone where light can penetrate to is a depth of about 2 - 3 times the Secchi disk depth. Changes in clarity are from increased algal or cyanobacterial production, soil and sediment particle suspension, and/or other materials suspended in the water. Rain and wind storms may significantly affect readings. Erosion from rainfall, runoff, and high stream velocities may result in higher concentrations of suspended particles entering the lake and therefore a decrease in Secchi disk reading might be expected. However, Secchi disk depth is primarily used as an indicator of algal abundance and a lake's general productivity. Secchi disk readings vary seasonally with changes in algal communities which are dependent on nutrients and sunlight. In shallow lakes the suspension of the sediment from wind action or recreational boat use can be a significant contributor to reduced water clarity year round. Algae blooms generally begin in spring and rise and fall though autumn. Secchi disk depth is reported to the nearest decimeter.

A6. Project Task and Description

DLWID staff conducts fieldwork in the Devils Lake Watershed located in Lincoln County, Oregon. Sampling occurs in the littoral zone of Devils Lake and in major tributaries. Staff collects instantaneous grab samples for chemical, physical and biological water quality parameters. Parameters include pH, conductivity, dissolved oxygen, Secchi Depth, turbidity and temperature. Results of this program are used primarily for internal use and for comparison to state and federal water quality standards.

Table 2. Primary water quality monitoring tasks completed in each year.

Major Tasks	J	F	M	A	M	J	J	A	S	O	N	D
Staff Training				X			X					
Seasonal WQ sampling					X	X	X	X	X			
Lab analysis					X	X	X	X	X	X		
Data processing and reporting					X	X	X	X	X	X		
Ordering of Lab Consumables				X		X				X		

A7. Measurement Quality Objectives

Refer to Quality Assurance Project Plan.

A8. Training Requirements and Certification

Refer to Quality Assurance Project Plan.

A9. Documentation and Records

Table 3. Document and Data Retention Policy.

Document or Record Name and Description	Storage Location	Storage Time
Quality Assurance Project Plan (QAPP) - project description and assurance procedures.	DLWID Lab & Website	5 years
Sampling Analysis Plans (SAPs) - specific sampling information for each sampling program.	DLWID Lab & Website	5 years
OWEB Water Quality Monitoring Guidebook - Methods manual	DLWID Lab & OWEB Website	5 years
Equipment Notebooks - records of quality control checks, calibrations and maintenance.	DLWID Lab	5 years
Field Data Sheets - Field forms containing sampling meta data and raw field data, including sample drop off time for bacterial analysis.	DLWID Lab	5 years
Laboratory Data Sheets - Lab worksheets containing analysis meta data. Worksheets contain time checkpoints during analysis, dilutions, and final data.	DLWID Lab, NCWT, & Water Environmental Services, Inc.	5 years
Chain of Custody Sheets – Sheets documenting what samples were collected, where they were collected, at what time and by whom. Forms also include who shipped the samples, when, and who received the samples.	Receiving Lab	5 years
Analytical Results – Data are archived digitally in MS Access and/or Excel	DLWID Lab	Indefinite
ODEQ Original Record- Data submitted to DEQ by DLWID for review, reformatting and upload into LIMS, usually a Microsoft Excel workbook.	DLWID Lab	5 years
Final LIMS Report - Approved result values for each volunteer dataset submitted for upload to LASAR	DEQ Laboratory: Final LIMS Report	5 years

Group B: Data Generation and Acquisition

B1. Sampling Process Design

Physical/Chemical Parameters: Physical/Chemical Parameter Monitoring is conducted by the Devils Lake Water Improvement District to provide for an ongoing, dataset of water quality parameters. Temporal changes recorded in the lake and watershed provides valuable insight into the functioning of the system. Standard limnological tests are conducted which are simple and quick, providing for same day testing and analysis. These include measurements for Dissolved Oxygen (DO), Temperature (T), pH, Electroconductivity (EC), Turbidity (Turb), and Secchi Depth (SD). Samples are taken in conjunction with the *E. coli* and Cyano-Watch programs, and thus the sampling is generally limited to the recreational use season.

Sample IDs and Descriptions:

UNIVERSAL IDs

A comprehensive renaming of the sample sites was done in September 2007. This was done to accommodate combining data from past studies and current sampling programs which required the large scale restructuring and renaming. Samples were reclassified with a prefix based on the sample location and/or the sample depth. In the case of sediment samples and open water samples, the sample latitude and longitude may be the same.

Samples taken from the littoral zone have been labeled with the prefix LZ. Likewise pelagic zone and benthic zone samples have been labeled PZ and BZ respectively. Stream samples are labeled with an abbreviation of the stream name, TC for Thompson Creek, RC for Rock Creek, SLC for Spring Lake Creek, NC for Neotsu Creek, and GC for the stream system running out of the golf course. The D River is similarly abbreviated DR. Samples taken at the confluence of the stream and the lake have been given the number 0 (e.g., NC-0). Sample sites upstream of the mouth are numbered with the increasing integer, x+1 (NC-1, NC-2, etc). As a pre-existing system labeled the outlet of the lake as 0 (zero), this sample site continues to be labeled as such. With the prefix for the D River the site is thus identified as DR-0. Sites further downstream or moving away from the lake take on increasing integers, thus DR-1, and DR-2 are sites further downstream towards the Pacific Ocean. Watershed samples not fitting other classifications are labeled with the prefix WS and generally retain historical sample ID integers such as WS-9 replacing the previous sample site 9. Current sampling is limited to Table 5, but historical watershed sampling sites are provided in Table 6 as many data exist tied to these sample sites.

Table 4. Current Sample ID and Descriptions

Universal ID	DEQ LASER ID	Historical ID	Latitude (N)	Longitude (W)	Short Description
DR – 0	10526	DLW – 0	44.967500	124.015817	D River
LZ – 1		DLW – 1	44.969817	124.008200	Campground
LZ – 2		DLW – 2	44.973800	123.999083	Regatta Grounds
LZ – 3		DLW – 3	44.990100	123.995383	Holmes Road Park
LZ – 4		DLW – 4	44.987083	123.986333	Sand Point Park
TC-1		DLW-5			Thompson Creek
LZ – 6	13912	DLW – 6	44.967783	123.997600	Brown Bear
RC-1		DLW-7			Rock Creek

D River (DR-0): Note: ***Sample Location Change (2007 – 04 – 15)***

The sample site is at the outlet of Devils Lake, the D River. A small 0.6 meter high dam is at the outlet maintained by the Devils Lake Water Improvement District for recreational water storage. Samples were formerly taken just upstream of the dam at a point where commonly the water flows through a notched section of the dam that provides for continual water flow exiting the lake and provides for fish migration. Samples are currently taken on the north side of the lake approximately 10 meters upstream from the dam. Sample is taken in the nearshore waters where access is available to the general public. A change in the landscape on the north shore during 2007 has warranted this change. A public park, The D River Park, has been created which includes parking, picnicking, and a graveled trail.

Devils Lake Campground (LZ-1): The campground is located off of NE 6th Avenue in Lincoln City, Oregon. The samples are collected off the moorage dock that is accessible by the paved trail to the water's shore. The samples including the Secchi Disk measurement are taken at the end of the dock perpendicular to the general outward flow of the lake. The campground is utilized year round, but predominately in the summer months. The sample site is used by boaters and is posted no swimming.

Regatta Grounds (LZ-2): This city park is located off of West Devils Lake Road. The park is heavily visited site in the summer months and houses a boat launch, fishing dock, and a swimming area. The park has a full service bathroom and drinking faucets. The park is frequented by picnickers and children as it has a large playground, grass area, and a swimming area. There was a resident population of geese that inhabited the general area, but were relocated to a private farm outside the watershed (2006 – 08 - 18). This relocation greatly reduced the bacterial concentrations in the area. Some non-native birds remain and may frequent the area to this date. Samples are retrieved inside of the enclosed swimming area at the midpoint of the beach. Two Secchi Disk measurements are taken from the center of the U-shaped dock that surrounds the swimming area. One measurement is taken inside the swimming area, the other on the outside of the swimming area.

Holmes Road Park (LZ-3): This city park is located at the foot of Holmes Road after it intersects West Devils Lake Road. The park is complete with a boat launch, a boat dock, and a separate fishing dock. The park has sewered flush toilets and a drinking fountain. A sewer pump station exists on the property

just uphill from the boat launch. The sample site is at the foot of the boat launch approximately 1 meter north of the boat dock. Secchi measurements are taken at the end of the boat dock.

Sand Point Park (LZ-4): This city park is at the end of Sand Point, a small peninsula in the lake. The property is in the county, but the park is owned and maintained by the Lincoln City Parks and Recreation Department. The park is small with room for only 6 vehicles. No boat launch is provided, however just before the park on the loop road, a small unimproved boat launch is available. The park has picnic tables, and a small beach. A popular swimming area is provided. The waters at the park are largely intermixed with the broad lake as the park is at the point of the peninsula. The sample is taken 1 meter off of the shore at the medial mark on the beach, in what is commonly 10-30 cm of water. This spot is chosen as it is likely where the greatest at risk population, namely young children, would swim or wade.

Thompson Creek (TC-1): This creek is the second largest input into Devils Lake and is a 303d listed stream for bacteria. The KBCH Radio tower is the nearest landmark. The creek drains forested land uphill, but passes through a built up rural landscape at its terminal end. Septic systems serve the homeowners and houses are built right to the creek bed. The creek also passes by a horse farm, followed by the KOA Campground, before passing under East Devils Lake Road and into a dredged inlet that follows the peninsula that is Sand Point. Sample points are upstream from the East Devils Lake Road Culvert, at a private road crossing above the horse farm, at the upstream of the Park Lane Culvert, and at a second private road crossing above that. A forested sample site further upstream is being investigated. There are no physical public postings of these data, but they are available online.

East Devils Lake State Park aka Brown Bear (LZ-6): This state park sits off of East Devils Lake Road near mile marker 3.3. It is known as East Devils Lake State Park or locally as Brown Bear, and is managed by the Oregon Parks & Recreation Department stationed at the campground. The park is heavily forested with a large grassy area with picnic tables scattered throughout the grounds. Pit toilets are provided upland in the park. A fire pit and refuse bin exist near the sample site. The park has two docks. The north dock is for boat launching, while the southern one is designated as the fishing dock. Inside on the south side of the offset T-shaped Fishing Dock is a small unmarked swimming area and at times of low lake level a sandy beach. The park and beach sit along a wide sweeping edge of the lake. Conditions are often choppy in and around the park as there are long fetches in either the southerly or northerly direction, aiding the formation of waves on windy days. The closest houses are to the north about 150 meters. Those homes are on septic systems. The sample site is inside the T- shaped fishing dock, on the south side, just off the shore in the small swimming area. The Secchi Depth is recorded from the end of the Fish Dock, furthest from shore.

Rock Creek (RC-1): This creek is the largest tributary of Devils Lake. It runs under East Devils Lake Road near mile marker 3.7. The creek drains from private forest land, US Forest Land, and some agricultural land in the lowlands. A cow pasture, a horse farm and llama farm are located upstream from the sample site. Human habitation is limited on or near the creek. The sample was formerly taken by the Salmon Drift Creek Watershed Council up until 2007 April 15, but is now sampled in house. The sample site is just above the east bridge on East Devils Lake Road.

Table 5. Historical Sample Sites and Descriptions

Universal ID	DEQ LASER ID	Historical ID	Latitude (N)	Longitude (W)	Short Description
DR-O		0			Lake Outlet
WS-2		2			Spring Lake
WS-7		7			NE 20th Place
WS-9		9			Bridge Near 26th
WS-19		19			Trib. S. of 35th
WS-20		20			RV Park
GC-0		21			GC @ Mouth
WS-22		22			Trib. # 22
NC-1		24			Neotsu Cr. 50th
WS-28		28			Plentywood Acres
TC-1		29			Thompson Creek
WS-32		32			Slide Site
WS-37		37			Leisure Bay
RC-1		52			Rock Creek
SC-1		53			Seid Creek
WS-55		55			3rd Ave (East)
WS-56		56			3rd Ave (West)
GC-		64			Villages @CH
GC-		65			Lincoln Palisades
GC-		66			Golf 10th Green
GC-		67			Golf 10th Fairway
GC-		68			Golf 12th Tee

Sample Descriptions based on Historic ID

0 --- Lake Outlet: Lake feeds the D River which runs under the bridge at Hwy 101. Sample is taken upstream of D River Dam. Access is from the hotel property on the south side of the lake

2 --- Spring Lake: Small impounded lake off of West Devils Lake Road Mile Marker 1.0 (WDLR 1.0) Sample is taken at the outlet of the impoundment which is a screened culvert.

7 --- NE 20th Place: Small Stream flowing out off wetlands and uplands. Sample sites is off WDLR at NE 20th Place. When road splits, stay to left and park on grassland at the bottom of the swale. Sample Site is found to the south of the graveled road by entering adjacent property.

9 --- Bridge Near 26th: Sample Site is in lentic waters flooding back under the bridge. Samples are taken upstream of the bridge on the NW side of WDLR.

19 --- Trib. S. of 35th: Sample site is north of Holmes Road at the bottom of the hill on WDLR. Sample is taken downstream of the culvert on the east side of WLDR.

20 --- RV Park: Sample site is just north of RV park and Blue Heron Marina. Sample is collected on the downstream side of the culvert the passes under WDLR. The culvert drains the wetland to the west.

21 --- GC @ Mouth: GC stands for Golf Course. Sample is taken at the lakeward (southern) side of the culvert running under Highway 101.
22 --- Trib. # 22: Found inside of Neotsu on NE Neotsu Drive, 0.2 miles from Post Office. Sample site is a small intermittent stream which forms a plunge pool at the downstream end of the culvert passing under the road.
24 --- Neotsu Cr. 50th: Moderate sized stream flowing under East Devils Lake Road (EDLR) at 220 feet from where Neotsu Drive intersect ELDR. Stream empties into Horseshoe Bay. Sample is taken on the downstream side of the culvert on the south side of the road.
28 --- Plentywood Acres: Small creek running under EDLR at milemarker ???. Sample is taken on the downstream side of the culvert.
29 --- Thompson Creek: Second largest tributary to Devils Lake. Nearest landmark is the KBCH 1400 am Radio Tower. The sample has been historically taken on the down stream side of the culvert that runs under ELDR. With bacterial sampling done on the same site (DLW-5A), samples have been collected from the upstream side of the culvert since April 2006.
32 --- Slide Site: Non descript bend in EDLR at milemarker ??? Sample is taken on the upstream side of the culvert. Noted Beaver Activity upstream of sample site.
37 --- Leisure Bay: Moderate flow heavily loaded stream flowing under ELDR at milemarker ?? Upland of wetland is a quarry or dumping operation which contributes heavily to the load.
52 --- Rock Creek: Largest tributary in watershed. Sample is taken upstream of bridge on EDLR mile marker ??
53 --- Seid Creek: Small creek that is now absorbed by wetland and is no longer an independent stream at original sample site which was at second bridge just south of the Rock Creek Bridge. Channelized flow from Rock Creek flows under the second bridge making it indistinct form Seid Creek.
55 --- 3rd Ave (East): Small pocket wetland drains under SE 3rd Avenue 0.34 miles from Hwy 101. This is the second wetland intersected by 3rd Avenue and can be found further east than the first one (Sample Site 56) and just past the Kelok Apartments. Sample is taken on the upstream side of the culvert.
56 --- 3rd Ave (West): Small pocket wetland 400 feet from Hwy 101. A small parking lot and medium sized wastewater lift station are landmarks. Sample site is upstream of the culvert.
64 --- Villages @CH
65 --- Lincoln Palisades
66 --- Golf 10th Green
67 --- Golf 10th Fairway
68 --- Golf 12th Tee

B2. Sampling Methods Requirements

Most of the sample acquisition is done through reading of calibrated analytical probes. This is true for DO, pH, Conductivity, and Temperature. Secchi Disk readings are taken in the field. Turbidity samples are collected in the field and analyzed back in the lab. Below are the sample container, preservation

techniques and holding times for samples under this protocol, followed by sampling protocol for the various parameters.

Table 6. Sample Containers, Preservation and Holding Times.

Parameter	Sample Container	Preservation Method	Holding time (Max)	Equipment
pH	N/A: In situ	None	None	Oakton pH/conductivity/temp Meter
Temperature	N/A: In situ	None	None	Oakton pH/conductivity/temp Meter & YSI 58
Conductivity	N/A: In situ	None	None	Oakton pH/conductivity/temp Meter
Dissolved Oxygen	N/A: In situ	None	None	YSI 58 Dissolved Oxygen meter
Turbidity	120 ml plastic, screw top sample cups	Iced Cooler	48 hours	Sample Grabber

Dissolved Oxygen and Temperature

Equipment

Dissolved oxygen and temperature are measured using the YSI Model 58 Dissolved Oxygen Meter. The meter self compensates for temperature changes following correct calibration. The meter is equipped with a thin membrane which allows for the passing of the dissolved oxygen into the electrolytic cell. Membranes are replaced using fresh potassium chloride solution every 3 months or more frequently as required. The machine itself is cleaned and serviced annually by Viking Instrument Laboratory.

Calibration & Set Up

- Check the connection of the probe to the meter body.
- Check the probe membrane for fit and the presence of bubbles.
- If bubbles are present replace the membrane (See manual).
- Turn the main power & setting knob to ZERO.
- Turn the O2 ZERO knob as necessary to zero the machine.
- Let the machine warm up for 15 minutes.
- Insure the SALINTY knob is set to FRESH or 0.0%.
- STIRRER knob should be OFF.
- Rinse membrane; shake off excess water such that the membrane is free of all droplets of water.
- Put the probe into the plastic boot with a moist sponge or towel.
- Do not tightly seal the plastic boot which would change the pressure, but do allow for 100% saturated air.
- Switch main knob to TEMP -5 to 45.
- Compare current temperature with saturation values found on the back of the machine.
- Switch main knob to 0.01 mg/l.
- Release outer lock ring of O2 CALIB knob.

- Turn knob until Dissolved Oxygen reading matches saturation value found on the back.
- Relock O2 CALIB knob.
- System Calibrated.
- The Saturated air calibration is compared to a Wibnkler Titration once daily.

DO & Temperature Data Acquisition Generally

- Proceed only after proper calibration. Machine should not be turned off after calibration or between sampling sites.
- Place the probe into the sample or water body and provide for a water flow past the membrane of 1 foot per second, hand mixing may be required.
- Switch Main knob to TEMP allow for equilibration and record data once stabilized.
- Switch Main knob to 0.01 mg/l and allow for stabilization of the reading and record data.
- Store probe in moist boot or clean water solution between samples.
- Do not turn off machine or the system must be rewarmed and recalibrated.
- Intense physical shock warrants a recalibration.

Lake Profiling

- Lake profiles are collected by boat at 6 specific sample sites on the lake. These sites are described in full detail elsewhere in this document, but are known as PZ-1, PZ-2, PZ-3, PZ-4, PZ-5, and PZ-6.
- Profiles are obtained by recording surface readings first followed by samples at ½ meter increments.
- The deepest reading recorded reflects data collected from the bottom of the lake.

Stream Sampling

- Streams are sampled by submersing the probe perpendicular to the thalweg.
- In fast moving (lotic), shallow streams with graveled substrates the probe is allowed to lie on the bottom of the stream as temperature nor DO have been shown to be variable in this context.
- Mucky bottom streams or in slow (lentic) waters, the probes are held well off the bottom and are stirred to provide for the 1 ft/sec flow required for accurate DO measurement.

Shoreline Sampling

- Samples are collected from fixed sites around the lake. These sampling sites are detailed in the Sample Site Identification Section.
- The probe is placed in the water generally 1-2 meters off shore and allowed to lie on the bottom when on rocky or sandy bottomed shorelines until equilibrated. The probe is then gently swirled 5 to 10 cm off the bottom until readings restabilizes.
- Samples from areas with mucky substrates follow a separate protocol which does not allow for sediment disruption. The probe is manually dangled into the water as to not touch the bottom muck. Readings are recorded as normally done.
- Dockside sampling is done generally off the end point of the dock. The probe is dangled off the edge of the dock in ½ meter deep water.

pH, Conductivity, and Temperature

Equipment: The meter currently used is an Oakton pH/Conductivity/Temperature Multimeter 10 Series, Serial Number 292144.

pH Meter Calibration: Calibration is done according to manufacturers guidelines but is summarized here.

- Insure the electrode is properly connected and clean.
- Power on the unit.
- Press MODE to Switch to pH mode as necessary.
- Rinse electrode with deionized water and place into the 7.00 working buffer solution. A fresh working solution of each pH buffer stock solution is made up monthly, and placed in clean labeled bottles. Both the lid and the bottle are clearly labeled with the buffer pH and the bottle is marked in indelible ink the date of the working solution.
- Press CAL/MEAS to switch to Calibration Mode.
- Buffer 7.00 is displayed.
- Swirl electrode gently.
- When the reading is stable READY will be displayed.
- Press ENTER to accept. Buffer 4.01 is displayed.
- Rinse the electrode with deionized water and place it in pH working buffer solution 4.
- Swirl gently until reading stabilizes and READY is displayed.
- Press ENTER to accept. Buffer 10.01 is displayed.
- Rinse electrode with deionized water, and place electrode in pH working solution 10, swirl gently.
- After reading stabilizes press ENTER.
- Calibration complete.
- If error messages are received, calibration must be repeated.

Calibration for Conductivity

- Insure the electrode is properly connected and clean.
- Power on the unit.
- Press MODE to Switch to Conductivity mode as necessary.
- Rinse electrode with deionized water, shake excess water off and place in conductivity solution.
- Press Up Arrow or Down Arrow as necessary to match calibration solution at specific temperature.
- Press ENTER to accept calibration.
- Calibration Complete.
- If error messages are received, calibration must be repeated.

pH, EC & T Data Acquisition

- Place calibrated probe into solution or water body and swirl gently.
- Record pH and Temperature.
- Press MODE to toggle between pH and Conductivity.
- Record Conductivity.
- Rinse probe and store in clean solution between use.

Turbidity

Equipment: HF Scientific Turbidimeter Fiekld Portable. Model # 20000 Serial # 5101052

Calibration:

- Press CAL—Display flashes 1000
- Insert 1000 NTU calibration standard, Press ←
- Insert 10.0 NTU Standard, Press ←
- Insert o.o2 NTU Standard, Press ←

Sampling: Samples are collected into 125 ml widemouth, clean and labeled sample cups. Samples are collected at all sample sites by inverting the sample cup and plunging the sample cup into the waterbody.

Analysis:

- Rinse the inside of a clean cuvette three time with deionised watrer
- Fill cuvette with sample
- Push cuvette firmly into optical well and index to the lowest reading.
- Measure the NTU value by pressing and releasing the ← button.
- Record the value displayed.

Secchi Disk Depth

Equipment: Standard Secchi Disk with calibrated line marked at ½ meter intervals.

Sampling: The Secchi disk is lowered though the water column until the disk is not visible. Care is taken to not disturb the substrate. The disk is then raised slowly until it is again visible and the length of rope submersed is recorded, estimated to the nearest decimeter. When the Secchi Disk is visible clear to the bottom, the Secchi Disk Depth is recorded as greater than the depth reading.

- Boat Application: Readings are taken on both the sunny and shadow side of the boat when mid-lake sampling is conducted.

- Shoreline Application: The Secchi Disk is generally dropped off the end of a dock. The reading is taken as described above.

Sampling:

Samples are collected using a vertical van Dorn beta sampler. The sampler is rinsed 3 times before collection using the Deionised Water. The sampler is then lowered into the water column at ½ meter increments for discrete grab samples. Composite samples are made up of equal volumes of samples from

multiple sample depths. Generally samples are collected at 1, 2 and 3 meter depths for composite sampling, but the specifics are recorded on the days sampling sheet.

Stream Sampling:

A grab sample is taken from each stream during the course of a sampling day in accordance with Standard Methods for the Analysis of Water and Wastewater. Samples are collected into clean labeled ½ liter High Density Polyethelylene (HDPE {2}) plastic bottles. The bottles are clearly labeled with the analytical lab's name, address, and phone number. Marked by the sampler on each bottle in indelible ink are the Client's Name, Project, Sample ID, Time, Preservation Used, and Parameters for Analysis. An example follows:

Clients Name: DLWID Project: DEVILS LAKE
Sample ID: 2
Date: 2010/02/28 Time: 14:03 Preserve: NONE
Parameters: NO2- / NO3- , TP, TSS

The date is entered in the format of yyyy/mm/dd and the time is entered using the System International 24 hour clock. Previous dates were entered using the format mm/dd/yy.

Prior to collection of the sample, the clean bottles and caps are rinsed twice with stream water, in a manner that does not disturb the substrate or sampling site. The sample collection is done at a minimum of 1 inch (2.54 cm) below the surface of the water, and preferably in at a depth capturing the mid section of the moving water. The sample is only taken from lotic or flowing waters, stagnant or lentic waters are avoided. At times of low flows when a sample bottle can not be submerged, a smaller bailing bottle maybe used to collect a sample. The bottle and cap of the bailing bottle must be clean and thoroughly rinsed with deionized water and stream water twice before collecting the grab sample.

The unpreserved samples are sealed and placed in an iced cooler for shipping to the analytical lab that same day. The sampler fills out a Chain of Custody Form to be place along with the sample shipment

B4. Analytical Methods Requirements

Analysis is by a certified lab by the following methods.

Nitrite/Nitrate Nitrogen analysis is done by Automated Cadmium Reduction, EPA # 353.2 and Standard Methods # 4500NO3F.

Total Phosphate is analyzed by an Automated Ascorbic Acid Test, EPA # 365.1 and Standard methods # 4500PF.

Total Suspended Solids is analyzed by the contracted lab by gravimetric means under EPA # 160.2 and Standard Method # 2540D.

Table 7. Analytical Methods and Equipment.

Parameter	Method	Units	Equipment
pH	Electrometric	S.U.	Oakton pH/conductivity/temp Meter
Temperature	Themistor	Celsius	Oakton pH/conductivity/temp Meter & YSI 58
Conductivity	Electrometric probe	microSiemens cm^{-1}	Oakton pH/conductivity/temp Meter
Dissolved Oxygen	temperature-compensated electrometric probe	mg/L	YSI 58 Dissolved Oxygen meter
Turbidity	Nephlometric	NTU	HF Scientific Turbidimeter

B5. Quality Control Requirements

Table 8. Require Quality Control Measurements

PARAMETER	ACCURACY	PRECISION
Grab Temperature	• Meter is calibrated by Viking Instruments, Inc. at time of annual service.	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate sampling done sequentially • A level data: difference between replicates of ≤ 0.5 C°
Conductivity	• Multimeter is calibrated at the start of the day with NIST traceable certified standard (100µS). • Probe is rinsed and compared to DI Water (<0.02µS). • Accuracy checks are made prior to and at the end of the sampling day using a secondary standard (70 µS).	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate sampling done sequentially • A level data: relative percent difference ≤ 10%

pH	• Meter is calibrated prior to each day's sampling with three NIST traceable standard buffer solutions: 4, 7, & 10. • Accuracy checks are made prior to and at the end of the sampling day using a secondary standard (pH 6.86).	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate sampling done sequentially • A level data: difference between duplicates of ≤ 0.3 S.U.
Dissolved Oxygen by Electrometric Methods	• Meter is calibrated by Viking Instruments, Inc. at time of annual service. • Meter is calibrated prior to each day's sampling with saturated air. • Calibration is compared to Winkler Titration daily.	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate sampling done sequentially • A level data: difference between duplicates of ≤ 0.3 mg/L
Turbidity	• Daily calibrations with certified standards 0.02, 10.0, 1000 NTUs. • Daily blanks run at start and end of analysis, plus after every 10 samples (<0.02 NTUs)	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate samples taken simultaneously. • A level data: relative percent difference between duplicates is ≤ 5%

B6. Instrument/Equipment Testing, Inspection & Maintenance Requirements

An instrument log accompanies each piece of analytical equipment. All service checks and inspections are recorded into the log. All reagents and supplies are checked at the start and end of the sampling day for expiration dates, damage, contamination, or degradation. Problems with any supplies (quality or quantity) and/or equipment are communicated to the Lake Manager and recorded on the dry-ease board in the lab and in maintenance logs as appropriate. Supplies are ordered on an as needed basis.

Table 9. Equipment Testing, Inspection and Maintenance Requirements

Equipment Type	Inspection Frequency	Type of Inspection
pH/Conductivity/Temp Multi-meter	• Each monitoring day	• Cables and batteries inspected. • Check storage solution fluid levels. • Calibrate •

Dissolved Oxygen Meter	• Each monitoring day • Annually	• Check probe for bubbles under membrane • Check battery power • Check cables • Check meter settings. • Zero the probe • Calibrate • Cleaning and calibration by Viking Instruments, Inc.
Turbidity Meter	• Each monitoring day	• Calibration check • Battery check • Cuvettes cleaned and inspected for scratches or smudges.

B7. Instrument Calibration and Frequency

All instruments with exception of thermometers are calibrated daily prior to use. Calibrations are recorded on the daily field and lab sheets.

Table 10. Equipment Calibration Requirements

Equipment	Calibration Frequency	Standard	Responsible Party
Oakton pH/Conductivity/Temp Multi-meter	• Daily • Daily • Annually	• pH: NIST Traceable Standard buffers 4, 7 and 10 • EC: 100µS NIST Traceable • T: Comparison to NIST Certified, calibrated meter (YSI 58)	• DLWID
YSI Model 58 Dissolved Oxygen and Temperature Meter	• Daily • Daily • Annually	• Air Calibration • Winkler Titration • NIST Certified Thermometer at 5, 10, 15, 20 and 25oC	• DLWID • Viking Instruments, Inc.
HF Scientific Micro TPW Turbidmeter: Field Portable	• Daily	• HF Scientific: 0.02 and 1000 NTUs in sealed vials • AMCOCLear: 10 NTU	• DLWID

B8. Inspection/Acceptance Requirements

All equipment, supplies, reagents, and instrumentation are securely stored in the Devils Lake Water Improvement District laboratory. This is a climate controlled facility. Time sensitive reagents are clearly labeled with a chemical inventory sticker. Each sticker contains the date received, the date the item was opened, and the date the item expires.

B9. Data Acquisition Requirements

Refer to Quality Assurance Project Plan

B10. Data Management

Refer to Quality Assurance Project Plan

Group C: Assessment and Oversight

C1. Assessment and Response Actions

Refer to Quality Assurance Project Plan

C2. Reports to Management

Refer to Quality Assurance Project Plan

Group D: Data Validation and Usability

D1. Reports

Refer to Quality Assurance Project Plan

D2. Data Review, Validation, and Verification

Refer to Quality Assurance Project Plan

D3. Validation and Verification Methods

Refer to Quality Assurance Project Plan

D4. Reconciliation with Data Quality Objectives

Refer to Quality Assurance Project Plan.

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Physical/Chemical Parameter Sampling and Analysis Plan

Appendix

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Appendix A. Lake Sampling Worksheet

Devils Lake Water Improvement District — **Lake Sampling Sheet**

Date: _____ Sampler(s) Initials: _____ Weather: _____

Calibration Record: % DO DO pH EC Turb — Air Temp °C: _____ — 24 hour Precip: ____mm

Wind (kph): _____ Ave _____Max _____Dir.

Time	Station	Depth	Samples	DO % Sat	DO mg/L	Temp YSI °C	pH	Temp Oakton °C	Conductivity µS	TURB NTU	Secchi Sun m	Secchi Shadow m
	QC -Start											
	QC and Replicate											
	QC and Replicate											
	QC-End											
	Pelagic Zone 1 (PZ-1)	Surface								Surface:		
		1.0 m								Comp:		
	Mid-Lake	2.0 m										
		3.0 m								Phytoplankton		Zooplankton
		4.-0 m								Depth MAX:		Depth Tow:
										Composite Depths:		Ring Dia:
	Pelagic Zone 2 (PZ-2)	Surface								Surface:		
		1.0 m								Comp:		
	North East Arm	2.0 m										
	B'Nai Brith	3.0 m								Phytoplankton		Zooplankton
	& Al Rice	4.-0 m								Depth MAX:		Depth Tow:
										Composite Depths:		Ring Dia:
	Pelagic Zone 3 (PZ-3)	Surface								Surface:		
		1.0 m								Comp:		
	North West Arm	2.0 m										
	Yellow House &	3.0 m								Phytoplankton		Zooplankton
	White Boat House	4.-0 m								Depth MAX:		Depth Tow:
										Composite Depths:		Ring Dia:
	Pelagic Zone 4 (PZ-4)	Surface								Surface:		
		1.0 m								Comp:		
	Southern end	2.0 m										
	Vegetated Island	3.0 m								Phytoplankton		Zooplankton
	⊥ to SE Tide on hillside									Depth MAX:		Depth Tow:
										Composite Depths:		Ring Dia:
	Pelagic Zone 5 (PZ-5)	Surface								Surface:		
		1.0 m								Comp:		
	East Thumb	2.0 m										
		3.0 m								Phytoplankton		Zooplankton
										Depth MAX:		Depth Tow:
	Pelagic Zone 6 (PZ-6)	Surface								Surface:		
		1.0 m								Comp:		
	Deepest Point	2.0 m										
	Hospital Point	3.0 m								Phytoplankton		Zooplankton
	⊥ to Sand Point	4.-0 m								Depth MAX:		Depth Tow:
		5.0 m								Composite Depths:		Ring Dia:
		6.0 m								Turbidity		
		7.0 m								Meter Calibrated: / /	Time:	
										Blank Before: _____	_____NTU	
Sample Types: G-rab, C-omposite, T-urbidity, DNA										Blanks Every 10th: _____	_____NTU	
										Blank Final: _____	_____NTU	

Appendix B. Watershed Sampling Worksheet

Devils Lake Water Improvement District — **Watershed Sampling Sheet**

Date: _____ Samplers' Initials: _____ Weather: _____

Calibration Record:	% DO	DO	pH	EC	Turb

Air Temp °C: _____ 24 hour Precip: ____mm

Wind (kph): ____ Ave _____Max _____Dir.

Time	Station	NEW #	OLD #	Grab Sample	DO % Sat	DO mg/L	Temp YSI C	pH	Temp Oakton C	Conductivity µS	TURB NTU	Flow cfs
	QC -Start											
	QC and Replicate											
	QC and Replicate											
	QC-End											
	Lake Outfall	DR-0	0									
	Spring Lake	SLC-1	2									
	NE 20th Place	WS-7	7									
	Bridge Near 26th	WS-9	9									
	Trib. S. of 35th	WS-19	19									
	RV Park	WS-20	20									
	GC @ mouth	GC-1	21									
	Trib. # 22	WS-22	22									
	Neotsu Cr. 50th	NC-1	24									
	Plentywood Acres	WS-28	28									
	Thompson Creek	TC-1	29									
	Slide Site	WS-32	32									
	Lesiure Bay	WS-37	37									
	Rock Creek	WS-52	52									
	Seid Creek	WS-53	53									
	3rd Ave (East)	WS-55	55									
	3rd Ave (West)	WS-56	56									
	LP- Below Culvert	GC-4	65									
	V @ CH- Above Culvert	GC-5	64									
	Golf 10th Fairway	GC-6	67									
	Golf 10th Fairway	GC-6	67									
	Golf 12th Tee	GC-8	68									
	Field Duplicate	FD-										

Turbidity Meter Calibrated: / / Time:

Blank Before: _____ _____NTU

Blanks Every 10th: _____ _____NTU

Blank Final: _____ _____NTU