Devils Lake Water Improvement District

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Quality Assurance Project Plan

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Group A: Project Management

A1. Title and Approval Sheet

Paul Robertson, Lake Manager — Date
Devils Lake Water Improvement District

Steve Hanson / DEQ Volunteer Monitoring Specialist — Date

Chris Redman / DEQ Quality Assurance Officer (QAO) — Date

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Acronyms

DEQ: Oregon Department of Environmental Quality
DLWID: Devils Lake Water Improvement District
DO: Dissolved Oxygen
DQL: Data Quality Level
DOGAMI: Oregon Department of Geology and Minerals
DQM: Data Quality Matrix
GIS: Geographic Information System
EPA: US Environmental Protection Agency
EC: Electroconductivity
LASAR: Laboratory Analytical Storage And Retrieval
LIMS: Laboratory Information Management System
MPN: Most Probable Number
NA: Not Applicable
NCWT: Neskowin Creek Water Testing
pH: Power of Hydrogen Ion
QA: Quality Assurance
QAO: Quality Assurance Officer
QC: Quality Control
QAPP: Quality Assurance Project Plan
OWEB: Oregon Watershed Enhancement Board
OWRD: Oregon Department of Water Resources
SD: Secchi Depth
SOP: Standard Operating Procedure
T: Temperature
TURB: Turbidity
USDA: US Department of Agriculture
USGS: United States Geological Survey

A3. Distribution List

A digital copy of The Devils Lake Water Improvement District Quality Asurance Project Plan (QAPP) 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
Gale Ousele	Water Quality Technician	Neskowin Creek Water Testing 8105 Slab Creek Road Neskowin, OR 97149	*E. coli* testing	(503) 392-3927	galeq@oregoncoast.com
Maribeth Gibbons	Senior Scientist	WATER Environmental Services, Inc 9515 Windsong Loop NE Bainbridge Island, WA 98110	Cyanobacteria enumeration	(206) 842-9382	mvg.water@gmail.com

A5. Purpose Statement and Background

Devils Lake is a regionally significant, moderate sized coastal lake, strongly impacted by cultural eutrophication. A highly urbanized lake, Devils Lake suffers from Harmful Algal Blooms at many of the peak recreational periods in the year. Water quality concerns have been identified by researchers and are shared by the general public. Decades worth of data has been collected at various times in recent history which have

led to restoration projects and/or additional research. This QAPP seeks to qualify and grade existing data and also provides the guidance for acquisition of high quality data in the future. Much of the specifics of this QAPP thus are directed a current water quality monitoring activities, but of significant interest is the development of strategies to grade existing data as well. These strategies may be broad in scope to meet the breathe of scientific inquiry, but are designed to provide as high of level of certainty about the data's quality as may be possible with the number of years that have passed since the original data were acquired.

As to current data acquisition, the Devils Lake Water Improvement District Water Quality Monitoring Program has been designed to provide accurate, informative data to stakeholders in the watershed about the quality of water in Devils Lake. Stakeholders include the District itself who publish and post the data online, through electronic mail, and at specific kiosks around the watershed. Additional stakeholders include the media who provide water quality updates through print, radio, and the internet. Other stakeholders include local, tribal and state governments including the City of Lincoln City, Lincoln County, the Confederated Tribes of Siletz Indians, and the State of Oregon. Data are posted and used in such manners as deemed suitable by these entities. For example, Oregon Department of Health and Human Services post the data from the Cyano-Watch program on its Harmful Algal Bloom Surveillance webpage. As another example, data collected by the Devils Lake Water Improvement District which meet the quality controls and quality assurances required by DEQ are available for entry into the statewide database called Laboratory Analytical Storage And Retrieval (LASAR). Lastly, the larger stakeholders represented collectively as the public have access to the monitoring data through the District's website and other postings for individual use in assessing water quality as it may relate to their own lake activities.

A6. Project Task and Description

DLWID staff conducts fieldwork in the Devils Lake Watershed located in Lincoln County, Oregon. Sampling occurs in wadeable streams tributary to Devils Lake, in the littoral zone and in the pelagic zone of the lake. Staff collects instantaneous grab samples and composite samples for chemical, physical and biological water quality parameters. Parameters include pH, conductivity, dissolved oxygen, Secchi Depth, turbidity and temperature. Biological samples are collected for analysis of *E. coli*, and additional samples are collected for cyanobacteria and cyanotoxins analysis as part of the Cyano-Watch Program. Sampling and Analysis Plans (SAPs) exist for all of the parameters. The results of this program are used primarily for comparison to state and national recreational water quality standards. Additionally, long-term data management is also a fundamental tool for effectiveness monitoring and for identifying water quality trends.

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			

Seasonal *E. coli* monitoring					X	X	X	X	X			
Seasonal Cyano-Watch Program							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		

While the current monitoring program is what is primarily covered in this QAPP, significant other data has been collected on Devils Lake and in its watershed. These data come from a variety of sources as researchers have focused on Devils Lake since the 1950's, and increasingly in the 1970's, 80's and through to today. As much of the data collected about Devils Lake comes from researchers associated with the US Environmental Protection Agency, Oregon Department of Environmental Quality, or accredited universities and/or private laboratories much of the data can be assumed to have been collected with significant scientific rigor. While sampling and analysis methodologies, along with quality assurance and quality control protocols may have improved and certainly have changed over the decades since some of the earlier research was done on Devils Lake, given the educational background, and affiliations of many of the researchers conducting such research, a high level of quality data is assumed to have been collected. Assessing this assumption is however a priority of the QAPP such that data may be graded and thus either qualified or disqualified for certain uses including entry into DEQ's statewide database. In order to make such an assessment, a data quality matrix has been developed for historical or legacy data.

A7. Measurement Quality Objectives

For water quality data to inform decision making it is critical that the quality of the results themselves be assessed in order to understand the sampling error and the error of the measurements themselves. Sampling error occurs within the natural variability of the environmental parameter, but maybe limited or compensated for by a well designed sampling and analysis program which incorporates the distribution, sample frequency, and type of samples, and total number of samples.

Analytical error also contributes to the quality of measurement. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, and data processing, which too are limited by adherence to a well designed sampling and analysis plan.

Specific Quality Assurance Objectives for the DLWID Water Quality Monitoring Program are:

- Collect a sufficient number of samples, sample duplicates, and field blanks to evaluate the sampling and measurement error.

- Analyze a sufficient number of Quality Control (QC) standards, blanks and duplicates during analysis to effectively evaluate results against numerical Quality Assurance (QA) goals established for precision and accuracy.

- Implement sampling techniques in such a manner that the analytical results are representative of the media and conditions being sampled.

Specific Quality Assurance Objectives for the historical data assessment:

- Obtain and evaluate primary source data where available.

- Evaluate sampling and analysis plans in place for historical data where available.

- Determine qualifications and background of researchers collecting the data when available.

- Grade data based on a quality assurance matrix

Precision and Accuracy: Table 3 lists the precision and accuracy targets for standard water quality monitoring parameters collected as part of the program. The accuracy and precision limits listed in the table represent "A" level data as defined by the DEQ's field Data Quality Matrix (DQM) Version 4.0 unless noted otherwise. Any data collected which does not meet the accuracy and precision limits defined below will be downgraded to a lower data quality level (DQL) in accordance with the DQM and should only be considered in analysis after considering the cause of the data quality downgrade. For numeric targets for lower DQL's see the complete DQM at http://www.deq.state.or.us/lab/techrpts/docs/DEQ04-LAB-0003-QAG.pdf.

Table 3. Accuracy and Precision Targets

Matrix	Parameter	Precision	Accuracy	Measurement Range
Water	Temperature	± 0.5 °C	± 0.5 °C	-5 to 35 °C
Water	pH	± 0.3 SU	± 0.2 SU	0 to 14 SU
Water	Conductivity	± 10% Relative percent difference	± 7% of Std. Value	≤ 1 to 4999 µS/cm
Water	Turbidity	± 5% Relative percent difference (± 1 NTU if NTU < 20 NTU)	± 5% of Std. Value	0.02 to 1000 NTU
Water	*E. coli*	± 0.6 log	NA	≤ 1 to >2419
Water	Dissolved Oxygen	± 0.3 mg/l	± 0.2 mg/l	≤ 0.1 to 20 mg/l
Water	Cyanobacteria		NA	0 to infinity
Water	Cyanotoxin: Microcystin			0.15 µg/l[1] to 5 µg/l

[1]Lower Limit of Detection (LLD) is provided. Measurement range can be extended through dilution of samples, but the Lower limit of Quantification (LLQ) is then increased by the dilution factor.

Representativeness: Samples are collected to most accurately represent the sample areas from a recreational water use perspective. For *E. coli*, samples are taken from the nearshore where the greatest at risk population, namely small children, frequent. For the littoral zone cyanotoxin and cyanobacteria monitoring, samples are also taken from where the greatest at risk population, namely small children and pets, frequent. Similarly, most samples from the pelagic zone are taken at the surface where recreational impact is the likeliest. However, an integrated photic zone sample is also taken for long-term dataset comparability. For cyanobacteria nd cyanotoxins, littoral zone samples have the potential to record the highest values due to concentration by wind and wave action of these free-floating organisms and their toxins. The mid-lake samples from the pelagic zone surface provide a broader snap-shot of water quality lake wide, but are too impacted by wind and wave action. The integrated photic zone sample is largely collected and analyzed for comparison to long-term data sets for phytoplankton populations. Physical parameter samples are representative of the immediate instantaneous grab for which they are taken or recorded.

Comparability: This monitoring program will seek to ensure comparability between previous studies for all parameters where practical. The nature of having legacy data is that often it has not been collected and analyzed with the same methods as are used currently. Similarly sampling objectives change from researcher to researcher, and thus comparability may not be inherently possible. For example event sampling for cyanobacteria and cyanotoxins create a whole different set of data then a routine monitoring approach. Event sampling tends to capture peak concentrations, while routine monitoring might often miss these high level events, yet provide useful trend data.

Completeness: DLWID staff strives to collect all the data described within the SAP. In order to accomplish this, preprinted waterproof sampling sheets are used detailing the sampling data to be collected. However, environmental and technical limits can and do prevent such a complete record to be collected over the course of the year. Where data are not collected, an entry describing why is recorded. If insufficient data are collected that would prevent the practical use of the data, then a partial dataset may be recorded with the limitations identified.

Sensitivity: Sensitivity relates to the ability of an analytical method to quantify concentrations relevant to a study and the ability of the study design to successfully answer the monitoring question. Analytical equipment purchased is designed to meet the level of sensitivity sought. Typically analytical sensitivity is one order of magnitude greater that a reporting level might prescribe. This is the case for the pH, conductivity, turbidity, temperature, and dissolved oxygen meters the District utilizes. Bacterial samples while inherently highly variable are rigorously analyzed then calculated using the Most Probable Number (MPN). The method employed is EPA approved for reporting whole numbers less than 2419. This range is well suited for recreational water use standards. Similarly testing methodologies for cyanotoxin analysis are sensitive enough to meet the objectives of the program. Oregon Health and Human Services (DHS) has a microcystin recreational guideline of 8 ppb. The analytical method for

microcystin employed is sensitive to 0.150 with an upper limit of 5.00 ppb. Thus through a 2:1 dilution of the samples, a range of quantification can be created to bracket (0.30 to 10 ppb) the DHS standard.

A8. Training Requirements and Certification

The Devils Lake Water Improvement District Lake Manager is in charge on insuring proper training is conveyed to all parties. The current manager is Paul L. Robertson. Paul possesses a Masters of Science in Environmental Diagnosis from Imperial College London and a Bachelor of Science in Environmental Chemistry from the University of Vermont. Paul has 14 years of sampling and analytical testing experience.

Currently the District is also served by the skills of Seth Lenaerts, a Resource Assistance for Rural Environments (RARE) participant though the University of Oregon. Seth has a Bachelors of Science from University of Wisconsin, Steven Point, majoring in Land Use Planning with a minor in Soil Science.

Additionally, the Devils Lake Water Improvement District generally employs an intern each summer for water quality work. This intern's qualification range year to year, but selection criteria are high and include laboratory and field experience. Like all staff, the intern is formally trained on the protocols of the District by the Lake Manager, prior to sampling or analysis. Training includes review of the QAPP and all applicable SAPs. Additionally training videos and presentations are reviewed annually by all persons ahead of the conducting any formal analysis.

A9. Documentation and Records

Table 4. 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	Receiving Lab	5 years

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.		
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

The Devils Lake Water Improvement District Sampling Program is broken up into three categories: physical/chemical, bacterial (*E. coli*), and cyanobacterial (Cyano-Watch) parameters. The primary analytical targets for these data are to meet recreational water quality standards. Other uses of the data also are valid. Sampling is conducted generally in the summer month and shoulder months as this is the peak recreational use time on the lake. Other sampling days under a special project may also foll under this quality assurance program.

Safety is a paramount, and all samplers are thoroughly trained. A separate safety manual exists for the District which is reviewed by all members of the sampling team each year. As this is generally a summertime program, weather conditions generally do not affect the sampling protocols although high wind conditions are avoided when sampling by boat. Bacterial sampling is done from the nearshore in shallow waters easily accessible by wading or from docks and is generally unaffected by inclement weather.

E. coli: In an effort to provide useful data to the public concerning recreational use of Devils Lake, a bacteria sampling and analysis protocol has been developed for *Escherichia coli*. The sampling and analysis of *E. coli* is a standardized and recognized practice for monitoring the likely presence of pathogenic species associated with warm blooded mammals. *E. coli* sources include sewers, failed septic systems, and animals such as dogs and birds. *E. coli* are sampled weekly in the late spring, summer, and early fall months. Sampling is done during the peak use season of the lake at public recreational accesses and at major tributaries. The sample sites include Devils Lake State Park Campground, Regatta Grounds, Holmes Road Park, Sand Point Park, Thompson Creek, Brown Bear State Park, Rock Creek and the lake outlet at the D River.

Cyano-Watch: A three-fold effort has been created to document, catalog, and present data about cyanobacteria in Devils Lake as they emerge year to year. This program runs generally from July to September and is known as the Cyano-Watch program. The monitoring plan for cyanobacteria and cyanotoxins has been broken up into three major phases. Phase I includes the visual monitoring of water clarity (Secchi Depth) along with routine physical parameter monitoring. This early monitoring is conducted from the nearshore. Given a decreased clarity from phytoplankton in the water column, sampling for phytoplankton identification and enumeration is conducted as Phase II. Sampling is done at 12 sites around the lake including six pelagic and six littoral zone sites. As the budget is limited for comprehensive analysis of all sites, only two representational samples are chosen for shipping to Water Environmental Services, Inc. who conducts the

identification and enumeration. A third sample for phytoplankton enumeration is taken from the pelagic zone. This is an integrated photic zone sample and is used for long-term data set comparison.

The final phase, Phase III of the Cyano-Watch program, calls for toxicity monitoring of a specific cyanotoxin known to be harmful to human health. Microcystin is produced by many of the cyanobacteria known to be in Devils Lake and is the most studied cyanotoxin in the world. As a result, specific recreational water use limits exist for this toxin. Sampling and analysis is done at 12 lake sites. These include six littoral zone sites and six pelagic sites. Actions associated with each progressive phase of the program are made to alert the public. Development of this sampling and analysis plan has occurred with input and guidance from Oregon Department of Health and Human Services, Abraxis (a chemical testing equipment supplier), and the United States Geological Survey (USGS) publication "Guidelines for Design and Sampling to Cyanobacterial Toxin and Taste-and-Odor Studies in Lakes and Reservoirs (Graham, *et. al,* 2008).

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 of the summer and shoulder months.

Legacy Data: A myriad of data exists which will be assessed. With such diversity, sampling designs will be also highly variable. Incorporation and use of the best known methodology at the time of data acquisition will thus bear heavily on the assessment of data quality. This will vary from researcher to researcher and thus outlining specifics is impractical. Thus legacy data are largely not represented in this method section.

B2. Sampling Methods Requirements

A separate Sampling and Analysis Plan (SAP) has been created for all three of the monitoring programs: bacteria, Cyano-Watch and physical/chemical parameters. These are attached and available online (www.DLWID.org). A summary of the sampling protocols and equipment used is provided below.

Table 5. 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
E. coli	Sterile, 100 ml screw, top plastic sample cups	Sodium thiosulfate & Iced Cooler	6 hours	Sample Grabber
Cyanobacteria	Clean plastic bottles 60, 125, 250, 1000 ml	Lugol's Solution	6 months	van Dorn Bottle
Microcystin	Clean plastic bottles 125, 1000 ml	Iced Cooler		van Dorn Bottle

B3. Sample Handling and Custody Procedures

Surface water samples will be analyzed for temperature, pH, DO, and conductivity in the water body. Field results will be recorded immediately onto a preprinted field sheets. Turbidity samples will be collected into clean, labeled, 125 ml wide-mouthed plastic sample cups. Sample cups will be sealed with a clean, labeled screw top lid, transported in an iced cooler, and analyzed within the designated holding time of 48 hours at the DLWID lab.

Escherichia coli samples will be collected into sterile, labeled 100 ml sample bottles. Both the sample bottles and lids are clearly labeled as a matter of quality assurance for the lab. The samples will be transported on ice, in a cooler, and analyzed within the designated holding time (six hours).

Cyanobacteria samples are collected into clean labeled sample containers and preserved with Lugol's solution. Labels properly identify the site ID, sample date, preservation method and analysis required. Samples are transported in an iced cooler back to the DLWID lab for additional processing. Samples are packed in an iced, insulated container. Samples are shipped with a Chain of Custody form to the receiving lab within 48 hours of sampling.

Cyanotoxin samples are collected into clean, labeled sample containers and transported in an iced cooler to the DLWID lab. Samples are analyzed within the designated holding time.

B4. Analytical Methods Requirements

All analysis follows established Sampling and Analysis Plans for the District. Copies of the SAPs are attached and are available on the District's website (www.DLWID.org).

Below is a table identifying the methods and equipment needs of each of the analytical techniques.

Table 6. 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
E. coli	IDEXX, Colilert®-18	MPN	Sealer, UV light
Cyanobacteria	Microscopic enumeration	MPN	Microscope
Microcystin	ELISA	ppb	ELISA Kit, strip plate reader

B5. Quality Control Requirements

Table 7. Required 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. • Saturated Air calibrations are compared to Winkler titrations 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%
E. coli	• Daily blanks run with each sampling batch. • Split samples ran from each sampling batch. • Sampling batch consists of 1 days sample collection or 10 sample whichever is less.	• Replicates made every day or at 10% of sampling sites, whichever is greater[1] • Replicate sampling done simultaneously • A level is a difference between the logs of the values ≤ 0.6.
Cyanobacteria	• Accuracy assessed by certified outside lab	• Every day or at 10% of sampling sites, whichever is greater[1] • One field duplicate collected for each sampling day • One split sample collected for laboratory replicate
Cyanotoxin: Microcystin	• Six point calibration curve made each sample day for strip meter reader • All calibration standards ran in duplicates with values averaged • Calibration standards with values >10% difference are discarded from curve	• All samples ran in duplicate with pair of values averaged • Two samples each day ran with in dilution serving as analytical splits • Internal Control 0.750 ± 0.185

	• Internal Standard ran in duplicate with each sampling day • Sample blank ran each day, analyzed in duplicate	

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 8. 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.
IDEXX QuantiTray Sealer	• Yearly or as needed	• Take apart and clean
Incubator	• Prior to and at end of sample incubation	• Check thermometer reading
Strip plate reader	• Each monitoring day	• Power connected. • Memory intact.

Refrigerator	• Weekly	• Temperature check
Freezer	• Weekly	• Temperature check

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 9. 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 • Annually	• Air Calibration • 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
Stat Fax 303 Plus Strip Plate Reader	• Daily	• Abraxis Microcystin/Nodularins (ADDA) Elisa Kits 0.000, 0150, 0.400, 1.000, 2.000, 5.000 ppb Microcystin	• DLWID

B8. Inspection/Acceptance Requirements

All equipment, supplies, reagents, and instrumentation are securely stored in the Devils Lake Water Improvement District laboratory or the Neskowin Creek Water Testing Center. These are climate controlled facilities. 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

The Devils Lake Water Improvement District utilizes a Geographic Information System (GIS) for determining location of sampling sites, property ownership, land-use, and many other attributes about the watershed. These database files or GIS layers are obtained from reputable sources, specifically Lincoln County Planning and Development, Oregon Department of Geology and Minerals, the US Environmental Protection Agency, The US Department of Agriculture, and Oregon State University. Similarly, Streamflow and weather data may be retrieved by the District online or by contacting directly the USGS, Oregon Water Resources Department, and Oregon Climate Center for analysis and presentation purposes. Unless noted otherwise in the retrieved data, the quality of these results will be assumed to be of sufficient quality to use when analyzing DLWID's data. The limitations of all data collected will be referenced in any reports or presentations. Data acquired from non-governmental, third parties will not be uploaded into LASAR.

B10. Data Management

Accuracy and calibration data are recorded along with field data straight onto pre-printed, water proof paper. Each data parameter of interest is given a specific box for the researcher to fill in. For samples collected, boxes indicating if the sample is a grab, a replicate or a split are provided. Additional comment lines are provided for observations otherwise not collected. Data are transferred to a digital record for permanent storage and data manipulation. To increase the long-term digital integrity of the data, the Devils Lake Water Improvement District recently purchased a new computer with dual hard drives. Data are automatically stored on two separate hard drives in case of failure. Additionally, data are routinely backed up to external drives, and to web-based data storage systems.

Currently multiple spreadsheets (MS Excel) house the data, but efforts are currently underway to develop a database for data management. Data are entered into the spreadsheets by staff and by outside labs. For instance, cyanobacteria enumeration reports are prepared by Water Environmental Services, Inc. These spreadsheets are then directly archived as a permanent record. Data are also entered by Neskowin Creek Water Testing (NCWT), for the bacteria analysis. This is done to facilitate the speed of data transmission (electronic mail verse only a hard copy) as well as to reduce data entry error. Data sent by NCWT are simply copied and pasted into a spreadsheet housed by DLWID. These data are in turn used to generate data reports including graphical representation of the data which are created for publication, website dissemination and media releases.

Data are also currently being prepared for submission into DEQ's LASAR database. This is an online database managed by DEQ for data integrity. As a result data are presented to DEQ using specific submission criteria detailed in Table 10. All data in the

DEQ's database must be associated with a physical location defined by a latitude and longitude. Where existing LASAR sites do not match DLWID's sites, new LASAR IDs will need to be created. For new sites, DLWID will provide DEQ with specific coordinates in latitude and longitude from the District's GIS. The associated datum of the coordinates along with a map image of where new stations are will also be submitted.

Submitting Data: Example formats for submitting grab and continuous water quality data can be found on the DEQ's Volunteer Monitoring web page. If DLWID is submitting data for a parameter not currently on the upload template's "Raw Data" worksheet, then DLWID must specify what fields will be submitted for the new parameter. Generally these fields will include analytical organization, method, units, result value, data quality level, and comments. It may also be necessary to include laboratory batch numbers to link result values to appropriate QC results. DLWID should verify data submittal fields with their analytical laboratory and the DEQ volunteer monitoring specialist and include the fields in their approved SAP.

Table 10. DEQ Volunteer Monitoring Program Data Monitoring Procedures

Input	Action	Responsible Party	Output
Instantaneous Grab Water Quality Data			
Raw Field Data and Quality Control Results	Internal data management including review for reasonableness, completeness, data quality, existing DEQ LASAR stations, entry into electronic data storage, and formatting of data, including duplicate data, and assigned data quality level into an approved electronic format.	DLWID	Completed electronic data submittal file for DEQ.
Submitted Raw Field Data (DEQ's "original record")	Review for formatting and completeness; create new LASAR stations for new locations, assign appropriate DEQ parameter codes, sampling organization codes, and analytical organization codes.	ODEQ Volunteer Monitoring Specialist	Completed Request For Analysis (RFA) (LIMS field sheet) Needed codes for electronic upload to LIMS
Submitted Raw Field Data	Quality assurance review and reformatting data. Review and analyze all reported quality control information including splits, accuracy reports, duplicates and other results. Review/assign data quality levels to each reported result. Reformat submitted data to LIMS electronic upload comma separated values format and assign all associated LIMS codes. Email electronic upload file and RFA to ODEQ Sample Coordinator.	ODEQ Volunteer Monitoring Specialist	QA memo LIMS electronic upload comma separated file
LIMS Electronic Upload File and RFA	Create LIMS Sampling event number and upload into LIMS	ODEQ Sample Coordinator	DAR
DAR	Review for successful upload and approve	ODEQ	Approved

	DAR.	Volunteer Monitoring Specialist, ODEQ Managers	DAR
Approved DARs	Print and sign Final Report.	ODEQ Sample Coordinator	Official Printed Final Report signed.
Release Data	Transfer electronic data to LASAR	ODEQ Technical Services staff	Data accessible on the DEQ webpage
Data in LASAR	Check on sampling event loading into LASAR, review 10% of sampling events for correct data transfer.	ODEQ Volunteer Monitoring Specialist	Verified LASAR data

Group C: Assessment and Oversight

C1. Assessment and Response Actions

The quality assurance procedures defined above are essential to document the quality of the data collected; however, improving the quality of the data can only be achieved by continually assessing quality control test results and taking appropriate response actions when problems arise. Field or lab personnel should report to the project manager whenever quality control results do not meet the data quality objective and quality control results should be reviewed by the project manager after each survey is completed to assign overall data quality levels to the data being collected.

Accuracy: DLWID will determine accuracy for pH, turbidity, and conductivity grab data by measuring standards before and after each sampling. Deviation from the expected value for the standard will be compared to accuracy ranges defined in the DQM (DEQ04-LAB-0003-QAG) to assign an accuracy classification for samples collected on that day for each parameter. Field personnel should assign accuracy DQL's based on the equipment they have used.

Precision: Duplicate sample results will be used by DLWID to determine the precision of grab water quality measurement. Field and lab personnel will compare differences between duplicate values against precision requirements outlined in the DQM (DEQ04-LAB-0003-QAG) to assign data precision classifications. Having a space for assigning precision data quality levels on field sheets reminds field personnel to consider data quality at the time of analysis.

Laboratory Analytical Data: Samples analyzed by laboratories should report results to DLWID with a minimum of a method blank and LCS results for each batch of data analyzed. Method blanks should be less than the method reporting limit, and LCS results should be within the control limits identified in the approved SAP. Analytical reports submitted to the District should be reviewed immediately by the project manager or QA officer to make sure that the laboratory is meeting the project's data quality objectives. Data not within the control limits should be downgraded to "B" level data.

Split and Replicate Sample Data: Field replicates and lab splits will be compared between samplers and analysts respectively with follow-up actions taken immediately if values for a group do not compare within "B" level precision limits defined in the DQM (DEQ04-LAB-0003-QAG). Replicates are taken by the sampler into two separate containers simultaneously. Split samples are made at the lab whereas the analyst takes two aliquots of the sample for individual analyses. If comparisons do not meet the expectations of the DEQ Volunteer Monitoring Specialist or the District Quality

Assurance Officer (QAO), then additional training, equipment maintenance or other corrective action will be taken.

The District's project manager will be responsible for reviewing the entire monitoring project on a regular basis and initiating corrective actions with field and lab personnel when the data quality objective of "A" level data is not being met. Appropriate steps for resolving problems with data that occur during assessment are: re-sampling; checking for unusual sampling or analytical conditions documented in the comments; inspecting and testing equipment used to generate questionable results; and reviewing procedures to identify potential procedural errors or biases. The District's project manager should contact the DEQ volunteer monitoring specialist if problems persist after reviewing sampling and analysis procedures with field and lab staff. The cause of data quality problems should be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained.

C2. Reports to Management

Each of the District's SAP should identify how the results of quality control tests and other project assessments will be reported including to whom the information will be reported and when. Reporting should include the following:

- District field staff conducting accuracy and precision tests each day of sampling and should report the results on the field sheet unless noted otherwise in their approved SAP.
- Performance assessment results conducted by the District's QA officer will always be communicated immediately to field staff and the project manager.
- The DEQ volunteer monitoring specialist will complete summaries of QC data and provide the information to the DLWID's project manager and the DEQ QA officer. For split sampling field trips, a short report on the results will be submitted to the District within 4 weeks of the data becoming available. For each data submittal to DEQ, all relevant QC data will be summarized in QA report to be submitted to the DEQ Sample Coordinator at the time the District's data are submitted for upload into LIMS and LASAR. This QA report is scanned and becomes part of the LIMS final report.

Group D: Data Validation and Usability

D1. Reports

E. coli: The Devils Lake Water Improvement District creates weekly reports of its bacterial analysis during the monitoring season. These data summaries are map based depictions of water quality and serve to guide the recreational users of Devils Lake. These reports are posted on the District' website, posted at public recreational water access sites and are provided to the media and agencies such as the Department of Health and Human Services. Sampling generally occurs on Mondays and the reports are available by Tuesday Morning. A wider stakeholder group is also sent the weekly data through an email listserv, but generally this is not until Thursday such that additional Cyanobacterial data can be included in the weekly water quality announcements.

Cyano-Watch: Data from the cyanobacteria enumeration and cyanotoxin analyses are combined into the water quality reports during the sampling season. These reports sent to the larger stakeholders through the District's Listserv. Cyanobacteria sampling is generally every other Wednesday, with the enumeration data generally available within a 5-day turnaround. Cyanotoxin data are available the same day. Upon receipt all data are updated to the District's website.

DEQ: Data submitted to Oregon Department of Environmental Quality is done on an annual basis.

D2. Data Review, Validation, and Verification

All data generated by DLWID will be reviewed by the District's project officer or QA officer to determine if it meets the District's objectives stated in the corresponding SAP. The District's SAPs should clarify who will be reviewing the data. At the discretion of DLWID, state agency staff may be asked to review and comment on the data. The decisions to accept, qualify, or reject data for the District's use will be made by DLWID's project manager or QA officer.

All legacy data will be reviewed by DLWID against the data quality matrix for historical data (Table 11). The level of validation and verification of such data will be documented by the District. A rating system will be developed to grade the data based on this review.

For data to be entered into LASAR, the DEQ Volunteer Monitoring Specialist and the DEQ QA officer will determine if the data collected and reviewed by the DLWID meets the objectives of this QAPP. All data will be reviewed in LIMS by project lead field staff.

Decisions to accept, qualify, or reject data will be made by the volunteer monitoring specialist and DEQ QA officer. Additional information regarding the assessment of such generated data is described in section B10.

D3. Validation and Verification Methods

Validation and verification of legacy data will be conducted to the greatest reasonable level obtainable. Validation and verification procedures for DLWID and DEQ personnel should include the following basic steps:

Completeness: Each step of the data generation and management should be assessed for completeness as soon as possible. Both missing parameter results and sample information, like time, collector, equipment, etc., should be reviewed. Missing information may warrant qualifying data (i.e. "B" data).

Reasonableness: Data generated should be reviewed for reasonableness to help catch any significant errors in result values and sample information. Data which appears unreasonable should be investigated and qualified when appropriate. At a minimum a comment should be added to explain unusual values.

QC Data Review: All available QC data should be analyzed to estimate the accuracy and precision of generated results. All result values will be classified with a data quality level based on the Oregon DEQ's Data Quality Matrix Version 4.0 or later for field data (http://www.deq.state.or.us/lab/techrpts/docs/DEQ04-LAB-0003-QAG.pdf) or the Data Validation for the LASAR Database quality assurance guidance document DEQ09-LAB-0006-QAG for laboratory analytical data.

Data Transfer Errors: At least 10% of data should be verified against original records whenever data is transferred either electronically or manually from one system to another. This includes transcribing field sheet data to databases, or when DEQ reformats submitted data for upload into LIMS and then LASAR.

The DEQ Volunteer Monitoring Specialist will verify that these validation procedures are completed for data to be entered into LASAR.

D4. Reconciliation with Data Quality Objectives

The Devils Lake Water Improvement District and previous researchers who have produced what is being called legacy data are ultimately responsible for determining how they use data that may not meet or have met their data quality objectives. Additionally

all entities are also ultimately responsible to how they might use data derived from another researcher. Oregon Department of Environmental Quality strives to use only the highest quality of data and generally only use "A" level, and sometimes "B" level data. Data that is designated as "E" level may be used to assist planning additional monitoring or other uses that do not make a determination about a site's water quality. While nothing can be done to change the usefulness of legacy data, if the data generated by DLWID though is discovered to not sufficiently address its monitoring objectives, then the SAP should be revised or appended to describe any changes to the monitoring program that would help the District better achieve its objectives.

Table 11. Water Quality Data Matrix to Assess Legacy Data

		Validated	Verified
Researcher			
	Affiliation		
	Certification		
QA protocols in place			
	QAPP in place		
	SAP in place		
	Use of certified lab		
	Use of EPA approved Standard Methods		
	Staff adequately trained		
	Equipment adequately serviced		
QC procedures in place			
	Calibration of equipment		
	Use of blanks		
	Use of controls		
	Use of replicate sampling daily or at 10% or total		
	Use of split samples in analysis		
	Sampling frequency meeting sample objectives		

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Devils Lake Water Improvement District

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Post Office Box 974 ● Lincoln City, Oregon 97367
(541) 994-5330 ● FAX (541) 994-6040
www.DLWID.org

Quality Assurance Project Plan

Appendix

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Appendix A: E. coli 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
										Blanks Every 10th: _____		_____NTU
										Blank Final: _____		_____NTU

Sample Types: G-rab, C-omposite, T-urbidity, DNA

Appendix B: Cyano-Watch Sampling Worksheet

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

Date: _____ Sampler(s) Initials: _____

Weather: _____
Air Temp °C: _____ 24 hour Precip: ____mm
Wind (kph): ____ Ave _____Max _____Dir.

Calibration Record:	% DO	pH	EC	Turb

			SAMPLES				DO	DO	Temp YSI	pH	Temp Oakton	Conductivity	TURB	Secchi	Wind mph
Time	Station	ID	Composite	Species ID/Count	Toxin	DNA	% Sat	mg/L	°C		°C	µS	NTU	m	Ave Max Direction
	QC - Start														
	D River	DR-0													
	Campground	LZ-1													
	Regatta Grounds	LZ-2													
	Holmes Road Park	LZ-3													
	Sand Point	LZ-4													
	East Devils Lake Park	LZ-6													
	Mid-Lake	PZ - 1													
	NE Finger	PZ - 2													
	NW Finger	PZ -3													
	South End	PZ -4													
	East Thumb	PZ - 5													
	Deepest Point	PZ -6													
	Replicate														
	QC-End														

Comments:

Turbidity Meter Calibrated: _____ Time: _____NTU
Blank Before: _____NTU
Blanks Every 10th: _____NTU
Blank Final: _____

Appendix C: Watershed Sampling Field Worksheet

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

Date: _____ Samplers' Initials: _____

Weather: _____

Air Temp ◦C: _____ 24 hour Precip: ____mm

Wind (kph): ____ Ave _____Max _____Dir.

Calibration Record:	% DO	DO	pH	EC	Turb

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

Appendix D: 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
										Blanks Every 10th: _____		_____NTU
										Blank Final: _____		_____NTU

Sample Types: G-rab, C-omposite, T-urbidity, DNA

Appendix E: Microcystin Analytical Worksheet

Devils Lake Water Improvement District — **Cyanotoxin Monitoring: MICROCYSTIN**

Start Date: _____ Start Time: _____ Analysts: _____
End Date: _____ End Time: _____

NOTE: Samples and reagents must be at Room Temperature

DIGESTION

Microwave	0.5 ml, Punch hole in top, Microwave 7min on 70% Power, Cool, add diluent to 0.5ml mark as necessary.
Freeze/Thaw	Place 1ml in 4ml glass vial, cap and freeze on side. Repeat 3x Cycle 1 2 3
QuikLyse	1ml Sample in 4ml vial. Add 100 µl Reagent A. Cap Mix 2 min, rest 8 min. Add 10 µl Reagent B. Cap, Mix 2 min, rest 8 min, Filter.

ELISA

		Start	End
1) Standards & Samples	50 µl -- Use Duplicates Room Temperature		
2) Antibody	50 µl --- Cover & Mix 30 Seconds Incubate 90 minutes		30 Seconds
3) Wash Plates	250 µl (1X Solution) --- 3 times 1 ---- 2 ----- 3 Pat Dry on Towels		
4) Enzyme Congugate	100 µl --- Cover & Mix 30 Seconds Incubate 30 Minutes		30 Seconds
5) Wash Plates	250 µl (1X Solution) --- 3 times 1 ---- 2 ----- 3 Pat Dry on Towels		
6) Substrate aka Color	100 µl --- Protect from Sunlight Incubate 20-30 minutes		
7) Stop Solution	50 µl Sulfuric Acid		
8) Measure at 450nm			

	1	2	3	4	5	6	7	8	9	10	11	12
A	0	4										
B	0	4										
C	1	5										
D	1	5										
E	2	IC1										
F	2	IC2										
G	3											
H	3											

IC = Internal Control
MM = Microwave Method
FT = Freeze-Thaw Method
QL = Quik Lyse Method

Replicate: _____
Split Sample: _____
Reagent Blank:_____

Notes: _____
_____
_____

Other:_____

Appendix F: Microcystin Calculation Worksheet

Devils Lake Water Improvement District

Cyanotoxin Monitoring: MICROCYSTIN CALCULATIONS

Analysis Date: _____
Analysts: _____

FT= Freeze Thaw
MM= Microwave
QL= Quik Lyse

Sample ID	Sample Date	Elisa ID	Quadrant	Digestion	Dilution	Abs. @450nm	Conc. (ppb)	Calculated ppb
Standard 0		0	A-1				0.00	0.00
		0	B-1					
Standard 1		1	C-1				0.15	0.15
		1	D-1					
Standard 2		2	E-1				0.40	0.40
		2	F-1					
Standard 3		3	G-1				1.00	1.00
		3	H-1					
Standard 4		4	A-2				2.00	2.00
		4	B-2					
Standard 5		5	C-2				5.00	5.00
		5	D-2					
Internal Control		IC1	E-2				0.750 ±0.185	
		IC2	F-2					
			G-2					
			H-2					
			A-3					
			B-3					
			C-3					
			D-3					
			E-3					
			F-3					
			G-3					
			H-3					
			A-4					
			B-4					
			C-4					
			D-4					
			E-4					
			F-4					
			G-4					
			H-4					

NOTES:

Page 1 of ____

Appendix G: Chain of Custody

CHAIN OF CUSTODY RECORD

Mailing: PO Box 974
Lincoln City, OR 97367

Shipping: 820 SE Hwy 101 Suite D
Lincoln City, OR 97367

Phone: (541) 994-5330
Fax: (541) 994-6040

Shipping Date: _____

SAMPLE INFORMATION: _____

SAMPLE ID	Sample Site	Date Collected	Preservation	Analysis Required	Comments