MIDDLE FOY LAKE SAMPLING PROJECT — 2010

Sampling and Analysis Plan

Prepared for:

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
Water Quality Standards Section, Water Quality Planning Bureau
P.O. Box 200901
Helena, MT 59620-0901

Approvals

Paul Kusnierz (WQ Monitoring Section)	Date
Rosie Sada (WQ Monitoring and Assessment Section Manager)	Date
Mindy McCarthy (QA Officer)	Date

TABLE OF CONTENTS

1.0 Introduction and Background Information 1

2.0 Objectives and Design of the Investigation.....1
2.1 Project Objectives 1
2.2 Sampling Timeframe 1

3.0 Field Sampling Methods 1
3.1 Mid-lake Sampling Site Location 1
3.2 *In Situ* Measurements 1
3.3 Water Sample Collection. 2
3.3.1 Sestonic Chlorophyll *a* Samples 3
3.3.2 Nutrients and Other Water Chemistry Samples 3
3.4 Shoreline Assessment Procedure 4

4.0 Sample Handling Procedures 5

5.0 Laboratory Analytical Measurements 6

6.0 Quality Assurance and Quality Control Requirements.....6

7.0 Data Analysis, Record Keeping, and Reporting Requirements 6

8.0 Schedule.....6

9.0 Project Team and Responsibilities.....6

10.0 References 6

1.0 Introduction and Background Information

Middle Foy Lake is located in Flathead County, Montana near the city of Kalispell. Reported brown water coloration and possible algal blooms on the lake in 2009 prompted a request to the Monitoring and Assessment Section for the lake to be assessed. In 2010, Middle Foy Lake will be sampled for nutrients, metals, and chlorophyll-*a*. In addition, a habitat assessment will take place to determine if human impacts to the lake's riparian zone can be linked to the chemical composition of the lake.

2.0 Objectives and Design of the Investigation

2.1 Project Objectives

The work outlined in this SAP is intended to achieve the following goals:

1. Measure basic water chemistry characteristics of the lake (nutrients, TSS, TDS, common ions and metals).
2. Determine temperature, conductivity, pH and DO profiles (surface to bottom) three times during the summer stratification period.
3. Determine the sestonic chlorophyll-*a* concentration in the surface waters, to help determine trophic status.
4. Carry out systematic shoreline assessments of human-caused shoreline development and impacts.

2.2 Sampling Timeframe

Sampling will occur from July 2010 to the end of September 2010. Sampling will occur 3 times at approximately monthly intervals (28 days apart).

3.0 Field Sampling Methods

3.1. Mid-lake Sampling Site Location

Water quality samples, DO, pH, conductivity and temperature profiles will be collected at approximately mid-lake location (48.17302; -114.36958). A GIS measurement of the location will be recorded using a hand-held GPS unit. A boat will be used to reach the sampling site. The boat should be anchored at the mid-lake site. If not feasible, a sea-anchor will be deployed to minimize drift during the sampling event. Nutrients and phytoplankton chlorophyll *a* will be collected 3 times whereas metals and common ions twice. Habitat assessment will be conducted once.

3.2 In Situ Measurements

A Secchi disk measurement will be taken on the shaded side of the boat. Both the 'disappear' and 'reappear' depths will be recorded. A YSI 6600 EDS sonde with cable will be used to measure DO (mg/L & percent saturation), temperature, pH, and conductivity in a vertical profile of the lake. The water column data will be measured every 1 m from surface to bottom. If anchoring on-site is impossible and wind causes substantial lateral drift using the sea-anchor, the YSI cable may form a steep angle to the boat. If this angle becomes significant (as judged by the field crew), the cable's angle relative to the water surface will be determined so that the true instrument depth can be calculated, *a posteriori* , using Figure 3.2 and the following equations:

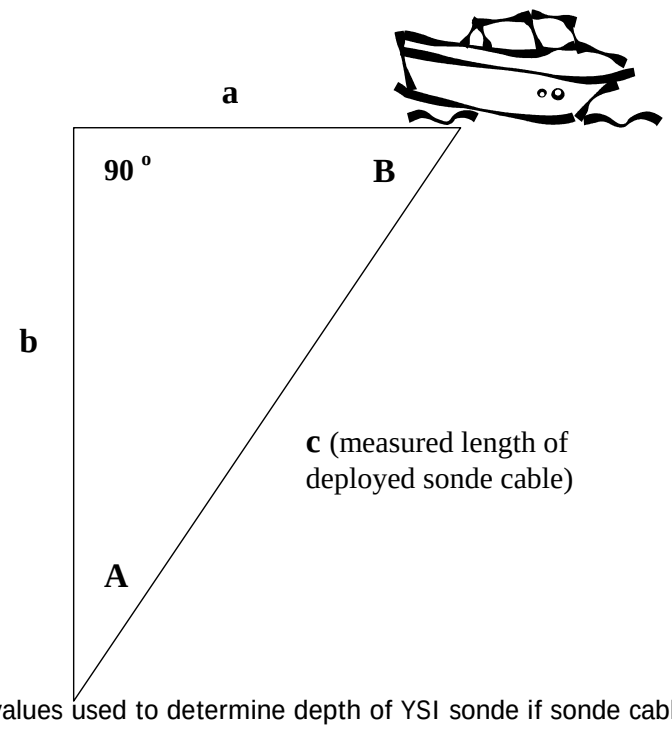

Fig. 3.2. Trigonometric values used to determine depth of YSI sonde if sonde cable forms an angle relative to the water surface.

Step 1: Estimate angle **B** using a large compass (water surface relative to cable angle)
Step 2: Determine angle **A** as: **A** = 180 – [90 + **B**]
Step 3: **b** (actual depth of sonde) = **c** cos **A**

The YSI dissolved oxygen meter will be calibrated for DO just prior to each sampling event using the 100% relative humidity calibration method (YSI 20060). The pH will be calibrated in the laboratory and checked against a 7.0 standard prior to each profile measurement. See more details in Section 6.0

3.3 Water Sample Collection

Water samples will be collected at the mid-lake location. After completing the *in situ* DO and temperature profile from surface to bottom, the extent of the epilimnion, thermocline, and hypolimnion will be determined. Water sampling is intended to occur in the productive surface waters of each lake. Therefore, an "integration zone" will be defined. This zone is defined as the photic zone of the epilimnion, determined as 3 times the Secchi depth, or from the surface to the onset of the thermocline, *whichever is shallowest*. The thermocline is defined as the depth range in the lake where the rate of temperature change is greatest in a vertical temperature profile. This equates to at least a 1 ^{o}C drop with each 1 m depth increase (Cole 1983). If the integration zone is less than 3 m deep, water samples will be taken at the surface, middle, and bottom of the depth interval. Equal volumes of water will be collected at each meter (starting from the surface) within the integration zone. All water samples from the integration zone will be composited together from discrete vertical point samples into a carboy (resulting in a depth integrated sample). The carboy will be kept in a dark ice chest or covered with a canvas cover to minimize light levels. Processing of samples from the carboy will normally be carried out on shore, but may be done on-lake if deemed safe (and necessary) by the field crew.

Prior to sampling, the carboy must be rinsed with 10% HCl, rinsed with DI water, and then rinsed with a quantity of the subsequent lake's sample water prior to filling with the discrete point samples. Sample replicates will be randomly taken on 10% of the total samples for each parameter except for chlorophyll *a.* Field blanks and filter blanks will be made during each sampling run ("trip") to evaluate contamination and detection levels under field conditions.

3.3.1 Sestonic Chlorophyll *a* Samples

Phytoplankton chlorophyll-*a* (Phy-chl *a*) will be sampled by filtering the composited lake water in the carboy on to GF/F filters, followed by freezing the filters on dry ice or in a portable deep freeze. The carboy should be gently shaken prior to each sample to assure thorough mixing of particulates. Two field replicate Chl *a* filters should be collected. The vacuum on the filters will be kept below 9.0 in. Hg to prevent cell rupture and loss of Chl *a* into the filtrate (Wetzel and Likens 1991). Place the filters folder in half (green side in) in a snap-top mini Petri dish, label, wrap with aluminum foil to exclude light, and freeze (Table 3.1). The filters will be analyzed for Chl *a* (corrected for phaeophytins) within 45 days of collection by the laboratory of Dr. Vicki Watson (University of Montana), following SOPs outlined by DEQ (see MT DEQ 2008).

3.3.2 Nutrients and other Water Chemistry Samples

Soluble Nutrients and dissolved metals: For nitrate + nitrite (NO_{2+3}) and total ammonia (NH_3 + NH_4), water from each sample will be filtered through a 0.45 um filter. Two-hundred and fifty ml of the filtrate will be placed in a HDPE bottle and frozen until analyzed (Table 3.1). Filtration will be accomplished with a large syringe connected to a disposable filter capsule or a reusable filter holder. A small amount of deionized water followed by a small amount of the sample will be washed through the filter before the filtered sample is collected. All sample bottles will be new, high-density polyethylene (HDPE). Sample bottles will be pre-rinsed three times with a small amount of the filtered sample before collecting the final filtered sample. Dissolved metals will be field filtered into a 250 ml HDPE bottle, preserved with nitric acid, and held on ice (not frozen). Only 100 ml are necessary.

Total Nutrients, TSS & TDS, Common Ions, and metals: Summary information is shown in Table 3.1. A 250 ml HDPE bottle will be used to collect TP and TN and will immediately be frozen. Common ions will be collected in two 250 ml HDPE bottles and held on ice (not frozen). One bottle will be tested for cations (including hardness and cation/anion balance) and the other for anions (including total alkalinity). The common cation sample will be preserved with nitric acid and held on ice (not frozen). The common anion sample will be held on ice (not frozen) without preservative. TSS and TDS will be collected in a 1000 ml HDPE bottle and held on ice (not frozen). NOTE THE SHORT HOLDING TIME (Table 3.1). Total recoverable metals will be collected in a 1000 ml HDPE bottle, preserved with nitric acid and held on ice (not frozen). Sediment metals will be collected in a 2000 ml HDPE bottle and held on ice (not frozen). All sample bottles will be new and triple rinsed with de-ionized water before collecting the sample.

Table 3.1. Sampling Volumes, Containers, Preservation, and Holding Times.

Analyte	Bottle Size	Container	Preservation and Storage	Holding Time
TP, TN	250 ml	HPDE	Freeze	45 days
NO_2+NO_3, NH_3+NH_4	250 ml	HPDE	Field filter 0.45 µm Freeze	45 days
Total Suspended Solids, Total Dissolved Solids	1000 ml	HPDE	Cool to <4 °C (on ice)	7 days
Common Cations (including	250 ml	HPDE	1.5 ml conc.	28 days

hardness)			HNO_3, cool to <4°C (on ice)	
Common Anions (including total alkalinity)	250 ml	HPDE	Cool to <4°C (on ice)	28 days
Total Recoverable Metals	1000 ml	HPDE	5 ml conc. HNO_3, cool to <4°C (on ice)	6 months
Total Dissolved Metals	250 ml (Only 100 ml needed)	HPDE	Field filter 0.45 um, 5 ml conc. HNO_3, cool to <4°C (on ice)	6 months
Phytoplankton chloropyll-*a*	NA	Petri dish	Freeze, dry ice	45 days

3.4 Shoreline Assessment Procedure

Foy Lake will have one assessment of shoreline physical habitat characterization following U.S. EPA EMAP lake protocols (USEPA 1993). Starting from the boat ramp, 10 equally spaced locations around the shore will be used for observation-based recordings (Figure 3.4). The latitude and longitude of each shoreline assessment site will be recorded using a hand held GPS unit. Photographs will be taken and documented for each site. The assessment forms to be used are found at: G:\WQP\MONITORING_&_ASSESSMENT\Monitoring_Projects\Lake_Data\ 2008_LakeCharacterizationFieldFormTemplate.xls.

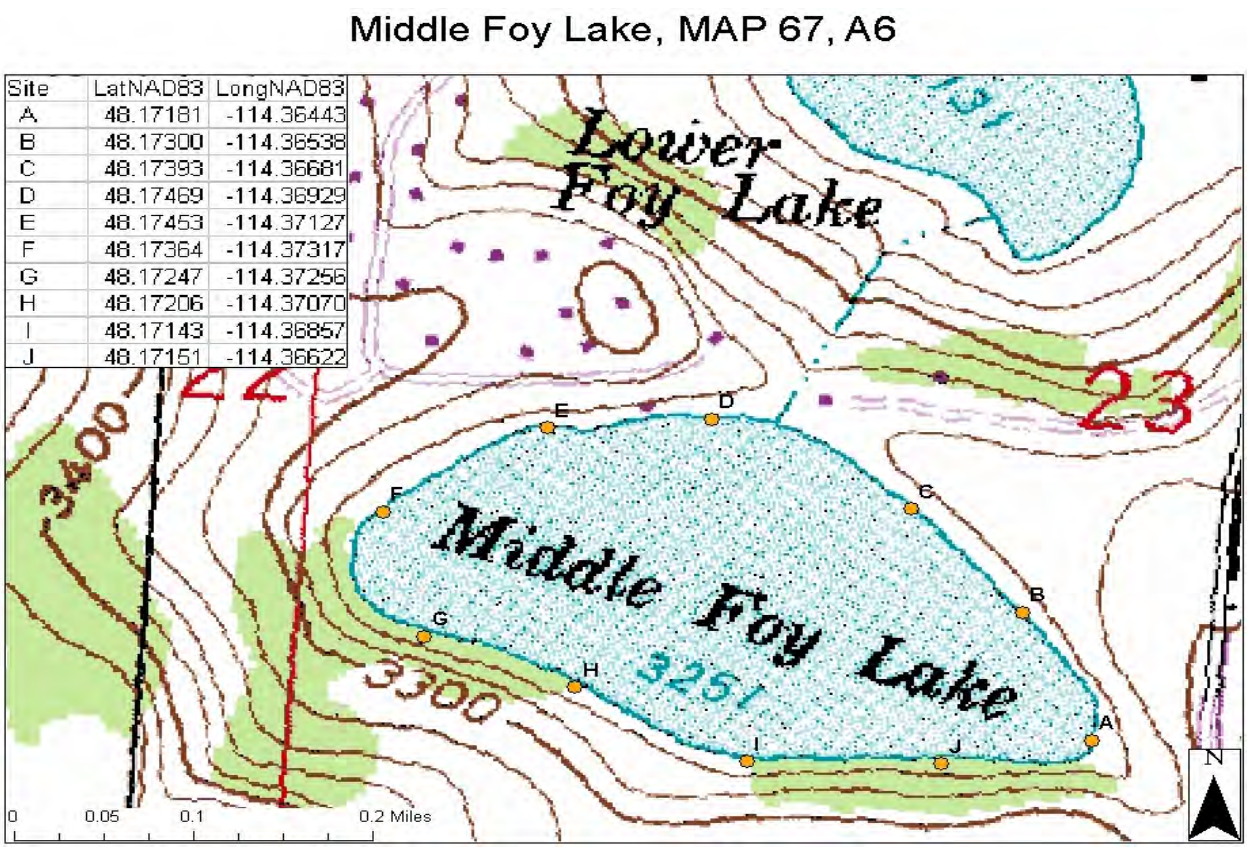

Figure 3.4. Location of habitat assessment sites on Middle Foy Lake, Flathead County, Montana.

4.0 Sample Handling Procedures

This project follows the WQPB "internal process". Appropriate storage times for water quality samples discussed in Sections 3.3 to 3.7 are shown in Table 3.3 above. Water quality samples will be delivered to the State Laboratory,

5.0 Laboratory Analytical Measurements

TABLE 5.1 Analytical Methods and Required Reporting Values

Nutrients	*Method*	*Required Report Limit (mg/l)*
Total Phosphorus	EPA 365.1	0.001
Total Nitrogen	4500-N B or C	0.01
Nitrate + Nitrite-Nitrogen	EPA 353.2	0.005
Total Ammonia-Nitrogen	EPA 350.1	0.05
Dissolved Metals	***Method***	***Required Report Limit (ug/l)***
Aluminum	EPA 200.7	30
Arsenic	EPA 200.8	3
Cadmium	EPA 200.8	0.08
Chromium	EPA 200.8	1
Copper	EPA 200.8	1
Iron	EPA 200.7	50
Lead	EPA 200.8	0.5
Silver	EPA 200.8	0.5
Zinc	EPA 200.7	10
Total Recoverable Metals	***Method***	***Required Report Limit (ug/l)***
Arsenic	EPA 200.8	3
Cadmium	EPA 200.8	0.08
Chromium	EPA 200.8	1
Copper	EPA 200.8	1
Iron	EPA 200.7	50
Lead	EPA 200.8	0.5
Selenium	EPA 200.8	1
Silver	EPA 200.8	0.5
Zinc	EPA 200.7	10
Total Recoverable Metals Digestion	EPA 200.2	N/A
Others	***Method***	***Required Report Limit (ug/l)***
Sulfate	EPA 300.0	50
Chloride	EPA 300.0	50
Alkalinity (Bicarb., Carb.)	EPA 310.2/A2320 B	1000
Calcium, Magnesium, Potassium, Sodium	EPA 200.7	1000
Cation-Anion Milliequivalent	SM 1050 A	
Total Suspended Solids	EPA 160.2	10
Total Dissolved Solids	EPA 160.1	10
Total Hardness as $CaCO_3$	A2340 B (Calc)	1000
Sodium Absorption Ratio (SAR)	Calc	

6.0 Quality Assurance and Quality Control Requirements

All QA/QC requirements followed by MT DEQ "internal process" will be instituted for this project. The QA/QC requirements are described in MT DEQ (2005).

6.1 Instrument Calibration

YSI 6600EDS or V2-4s**.** The pH will be calibrated in the laboratory using the two-point method using pH 7.0 and 10.0 standards, and checked against a 7.0 standard at the start of each day's measurements. Just prior to measurement, DO will be calibrated using the single-point, water-saturated air method (YSI 2006). Conductivity will be calibrated using a 1000 µS/cm standard in the laboratory and checked monthly. All calibrations will be recorded in the instruments' logbooks.

7.0 Data Analysis, Record Keeping, and Reporting Requirements

This project will follow the WQPB "internal process". Site Visit/Chain of Custody forms, field forms digital photos, and lab will be processed by WQPB staff following QA/QC procedures as indicated in section 6.0. The GPS coordinate system datum used will be NAD 1983 State Plane Montana, in decimal degrees, to at least the third decimal.

8.0 Schedule

The Water Quality Monitoring and Assessment staff will sample the lake as indicated in section 3.1. Data collection should be completed no later than September 30, 2010.

9.0 Project Team and Responsibilities

The Water Quality Monitoring and Assessment Section will lead this project. Paul Kusnierz will lead the monitoring and assessment project.

10.0 References

Cole, G.A., 1983. Textbook of Limnology, 3rd Edition. Waveland Press.

MT DEQ. 2005. Quality Assurance Project Plan (QAPP) Sampling and Water Quality Assessment of Streams and Rivers in Montana, 2005. *Available at* http://www.deq.state.mt.us/wqinfo/QAProgram/WQPBQAP-02.pdf.

MT DEQ. 2008. Sample Collection and Laboratory Analysis of Chlorophyll-*a*, Sampling and Analysis Plan. Document No. WQPBWQM-011, Revision 4. June 5, 2008.

USEPA. 1993. EMAP Surface Waters Lake Field Operations, Volume I. Resource Group Manual. Environmental Monitoring Systems Laboratory, 89193-3478.

Wetzel, R.G., and G.E. Likens, 1991. Limnological Analyses, 2nd Edition. Springer-Verlag.

YSI (Yellow Springs Instruments, Incorporated), 2006. YSI 6-Series Manual Supplement: Configuration and Deployment Instructions for YSI Model 6600EDS Sondes. Item No. 655467.