Sheep Creek Drainage Sampling Project - 2015:
Metals, Nutrients, Escherichia-coli- DRAFT

Sampling and Analysis Plan

Prepared for:
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1.0 INTRODUCTION AND BACKGROUND

This document presents a plan for completing metals, nutrients, and *E. coli* monitoring in the Sheep Creek watershed during the 2015 field season**.**

The Water Quality Planning Bureau (WQPB) of the Montana Department of Environmental Quality (DEQ) has identified two impaired (Category 5) streams within the project area (**Table 1-1). Table 1.1** shows the waterbody segments to be sampled in 2015 and the nutrient, metals and pathogen impairment listings that appear on the 2014 303(d) list associated with these segments.

Table 1.1 – Waterbody segments in the Sheep Creek drainage to be sampled in 2015, and their associated nutrients, metals and pathogen 303(d) listings.

Waterbody ID	Waterbody Segment Name	Pollutant Group		
		Nutrients	Metals	Pathogens
MT41J002_030	**SHEEP CREEK**, headwaters to mouth (Smith River)	none	Aluminum, Iron	Escherichia coli
MT41J002_120	**MOOSE CREEK**, headwaters to mouth (Sheep Creek)	Nitrogen (Total)	none	none
–	**CALF CREEK**, headwaters to mouth (Sheep Creek)	none	none	none
-	**LITTLE SHEEP CREEK,** headwaters to the mouth (Sheep Creek)	none	none	none
-	**BIG BUTTE CREEK**, headwaters to the mouth (Sheep Creek)	none	none	none

Table 1.2 indicates the pollutant groups for which monitoring will occur on each of the waterbody segments listed in **Table 1.1**. Five waterbody segments will be monitored for nutrients, metals, sulfate, and common ions, and one waterbody will be monitored for *Escherichia coli* (*E. coli*).

Table 1.2 – Pollutant groups to be monitored on each waterbody segment in the Sheep Creek drainage in 2015.

Waterbody ID	Waterbody Segment Name	Pollutant Group					
		Nutrients	Metals	*E. coli*	Sulfate	Common Ions	Temperature
MT41J002_030	**SHEEP CREEK**, headwaters to mouth (Smith River)	X	X	X	X	X	X
MT41J002_120	**MOOSE CREEK**, headwaters to mouth (Sheep Creek)	X	X		X	X	X
_	**CALF CREEK**, headwaters to mouth (Sheep Creek)	X	X		X	X	X
_	**LITTLE SHEEP CREEK,** headwaters to the mouth (Sheep Creek)	X	X		X	X	X

Table 1.2 – Pollutant groups to be monitored on each waterbody segment in the Sheep Creek drainage in 2015.

Waterbody ID	Waterbody Segment Name	Pollutant Group					
		Nutrients	Metals	*E. coli*	Sulfate	Common Ions	Temperature
_	**BIG BUTTE CREEK**, headwaters to the mouth (Sheep Creek)	X	X		X	X	X

1.1 DESCRIPTION OF THE SHEEP CREEK DRAINAGE

The Sheep Creek drainage is in the Smith River TMDL Planning Area (TPA) and is contained within Meagher County. The town of White Sulphur Springs is located about sixteen miles to the south, and Niehart is about seven miles north of the headwaters of Sheep Creek. The drainage is in the 10030103 fourth-code hydrologic unit code (HUC), and is in the area of the Little Belt Mountains.

The headwaters of Sheep Creek are near Kings Hill Pass and the Showdown ski area. The total area of the watershed is approximately 170 square miles. Major tributaries to Sheep Creek include Calf Creek, Moose Creek, Pole Creek, Big Butte Creek, Little Sheep Creek, and Calf Creek. An underground copper mine is in the planning stages at a location near the center of the Sheep Creek drainage. Several small tributaries to Sheep Creek are located near the proposed mine and mill sites.

Most of the Sheep Creek drainage lies in the Middle Rockies level 3 ecoregion. The lower 3 stream miles of Sheep Creek are in the Northwestern Great Plains level 3 ecoregion, and in the Shields-Smith Valleys level 4 ecoregion.

Land ownership in the Sheep Creek drainage is mostly United States Forest Service and large ranches. Land uses include recreation, livestock grazing, and silviculture. Four small abandoned mines and at least one gravel quarry are present in the drainage.

Figure 1.1 shows the Sheep Creek drainage and the proposed monitoring sites on the five streams that are included in the study.

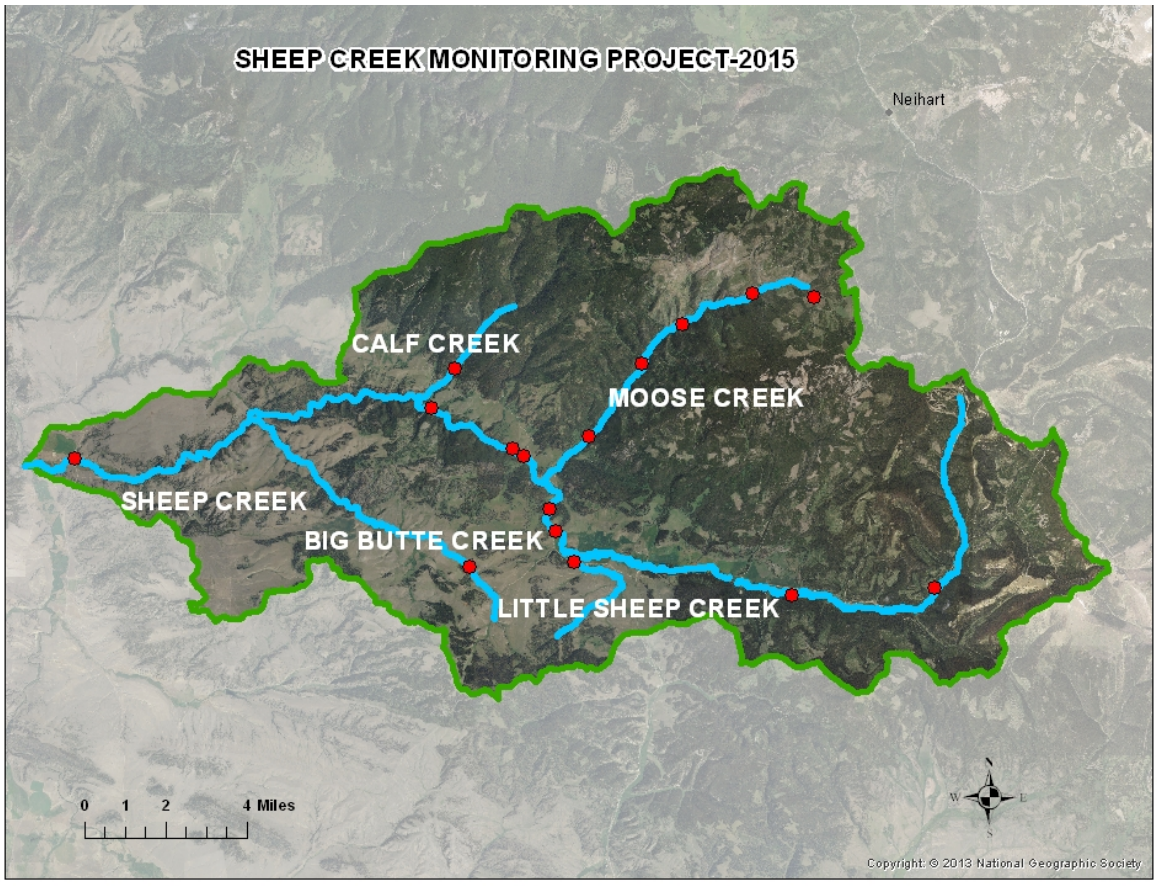

Figure 1.1 – The Sheep Creek Watershed and the locations of proposed monitoring sites on five streams

2.0 Project Objectives, Goals and Sampling Design

2.1 Project Objectives and Goals

The objectives of this project are as follows:

- Monitor and re-assess water quality for streams with existing pollutant listings: Sheep Creek (metals and *E. coli)*; Moose Creek (nutrients)
- Monitor to assess metals on Moose Creek and Nutrients on Sheep Creek
- Monitor to assess sediment on Sheep Creek
- Monitor to obtain data to document the existing background condition for nutrients, metals, common ions, sulfate, water temperature, and sediment for five streams in the Sheep Creek watershed.

The goals for this monitoring project are as follows:

- Measure physical parameters (air/water temperature, dissolved oxygen, pH, specific conductivity, turbidity NTU) *in situ* on all waterbody segments (**Table 1.1**)
- Measure flow (discharge) on all studied waterbody segments during each sampling event(**Table 1.1**)
- Collect nutrients (total phosphorus (TP), total nitrogen (TN), and nitrate + nitrite (NO_{2+3}), total suspended solids (TSS), chlorophyll-*a*/Ash-Free Dry Weight (AFDW), and macroinvertebrate samples on Sheep Creek, Moose Creek, Calf Creek, Little Sheep Creek, and Big Butte Creek (**Table 1.2**)
- Collect metals (total recoverable and dissolved metals fractions, total suspended solids (TSS), and sediment metals samples on Sheep Creek, Moose Creek, Calf Creek, Little Sheep Creek, and Big Butte Creek (**Table 1.2**)
- Collect sulfate and common ions samples on Sheep Creek, Moose, Creek Calf Creek, Little Sheep Creek, and Big Butte Creek (**Table 1.2**)
- Monitor temperature on Sheep Creek, Moose, Creek Calf Creek, Little Sheep Creek, and Big Butte Creek (**Table 1.2**)
- Collect *E.coli* samples on Sheep Creek (**Table 1.2)**
- A separate sampling and analysis plan is being prepared to describe the sediment monitoring component of the Sheep Creek drainage study.

2.2 SAMPLING TIMEFRAME

For waterbodies being monitored for metals, the initial sampling event will occur during high flow conditions, anticipated to be in mid- May. One additional sampling event will occur during low flow conditions in July. DEQ metals monitoring protocols state that, ideally, at least thirty-three percent of the data set should be from samples during high flow conditions. The remaining samples should be collected during baseflow conditions (DEQ, July 2012). Sediment metals samples will also be collected during baseflow conditions. Common ions, bicarbonate and sulfate will be collected during the metals sampling events.

Nutrient sampling events for will take place during the "growing season" for the Middle Rockies Level III Ecoregion (July 1 – September 30), and at least 30 days will pass between sampling events at each site (Suplee & Sada de Suplee, 2011). An additional round of sampling for nutrients will take place in May to obtain data for the time period that proceeds the growing season. For waterbodies being monitored for nutrients, three sampling events will occur during low flow conditions in July, August, and September. One round of sampling in August will include benthic chlorophyll-*a/*ash-free dry weight and macroinvertebrates.

The standards for *E. coli* are "based on a minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period" (ARM 17.30.620(2)). The applicable water quality standard is, as follows: "from April 1 through October 31, the geometric mean number of *E. coli* may not exceed 126 colony forming units per 100 milliliters and 10% of the total samples may not exceed 252 colony forming units per 100 milliliters during any 30-day period" (ARM 17.30.623(2); DEQ 2012a). Two individual sampling events will occur at each of the seven sites on Sheep Creek within the 30-day period from July 1 – August 1, 2015.

TSS, *in situ* chemistry measurements, and channel discharge will be measured at each site during each site visit.

Temperature monitoring will take place from approximately mid-June through September 2015.

Sediment monitoring will occur in August. That phase of the project is described by a different sampling and analysis plan.

3.0 FIELD SAMPLING METHODS

All field procedures described in this Sampling and Analysis Plan are documented in DEQ's Water Quality Planning Bureau Field Procedures Manual For Water Quality Assessment Monitoring (DEQ 2012b) unless otherwise noted. Please refer to Appendix C for a list the data that will be collected at each site.

3.1 SAMPLING PLANNING AND SITE SELECTION

Specific site locations on each segment listed in Table 1.1 were identified using GIS, topographic maps, existing site locations, field reconnaissance and coordination with the Tintina Resources mine staff and their contractors. A complete list of the stream segments and proposed monitoring sites is located in Appendix A. A brief description of each site which states the rationale for including these sites is also included. These sites are proposed locations and changes may be made based on site access permission or other unforeseen problems. Basic considerations for determining sampling locations are discussed in DEQ (2012b).
The lower approximate three miles of Sheep Creek lie in the Shields-Smith Valleys level 4 ecoregion (Northwestern Great Plains level 3 ecoregion). This area is a transitional ecoregion, with numeric nutrient standards that are different than those for the other ecoregions of this study. The rest of the Sheep Creek drainage and all other sampling sites are in the Middle Rockies level 3 ecoregion, and the Big Snowy-Little Belt Carbonate Mountains level 4 ecoregion.

Appendix B summarizes the sampling to be conducted per monitoring trip for each waterbody.

3.1 GENERAL SAMPLING SEQUENCE

To minimize site disturbance which may bias samples, at each site we will collect parameters that are most sensitive to disturbance before monitoring parameters that are less sensitive to disturbance. The general sequence is as follows:

1. Chemistry parameters (e.g., *in situ* field measurements, water chemistry)
2. Biological parameters (e.g., benthic algae, macroinvertebrates)
3. Physical parameters (e.g., flow, photographs, channel morphology)

3.2 PHYSICAL PARAMETERS

3.2.1 IN SITU FIELD MEASUREMENTS

DEQ uses several models of one-time and continuous field instruments for measuring parameters including dissolved oxygen, pH, specific conductivity, water temperature, and turbidity, and stage height.

Collecting Instantaneous Field Measurements *In Situ* using field meters

Instantaneous field measurements will be collected in situ during each sampling event at each sampling site. These measurements will be collected prior to the collection of water samples or other physical disturbances to the water column or substrate. Instrument-specific operation manuals contain instructions on use of individual field meters used to record continuous field measurements. See Section 6 for information on calibrating instruments.

Specific Conductivity - The specific conductance value (µS) recorded on the Site Visit Form is the temperature compensated conductivity value obtained from the YSI 85 shown when the ^{o}C symbol is flashing on and off on the display screen. The YSI 85 automatically adjusts this reading to a calculated value which would have been read if the sample had been at 25^{o}C. Additionally, continuous specific conductivity will be recorded at one site on Sheep Creek at one-half hour increments using a YSI 6600 sonde.

Dissolved Oxygen - *In situ* calibration will be performed before use at each site to allow the YSI 85 meter to account for the approximate altitude of the region in which the monitoring site is located. After, a measurement of oxygen (mg/L) will be recorded from the YSI 85 onto the Site Visit Form.

Water Temperature - A measurement of water temperature (^{o}C) from the YSI 85 meter will be recorded on the Site Visit Form.

pH -A measurement of pH from the hand-held pH meter will be recorded on the Site Visit Form for each water chemistry sampling event. Additionally, continuous pH will be recorded at one site on Sheep Creek at one-half hour increments using a YSI 6600 sonde.

Air temperature - A hand-held thermometer will be placed in a shaded area with sufficient air circulation and allowed to stabilize for approximately 15 minutes. A measurement of air temperature (^{o}C) from the hand-held thermometer will be recorded on the Site Visit Form.

Turbidity - Nephelometric Units (NTU) will be measured during each water sampling event using a YSI 6600 meter. The meter readings will be recorded on the Site Visit Form.

Collecting Continuous Water Temperature data

Continuous water temperature data will be collected at some monitoring sites including all of the sites on Sheep Creek by using OnSet Hobo data loggers. Continuous air temperature will be collected at one location on Sheep Creek near the middle of the drainage.

3.2.2 Flow Measurement (Total Discharge)

Channel discharge will be measured at each site during each sampling event by using either the quantitative flow meter method or the semi-quantitative float method (DEQ 2012b). While quantitative flow meter method is preferred, the float method is acceptable when high flows or other conditions pose a safety hazard and prevent wading.

3.2.3 Field Photographs to Document the Sites

Digital photographs will be taken (at a minimum) at the "F" site of each monitoring location (DEQ 2012b), facing upstream, downstream and across the channel. Additional photos may be taken to

document any relevant site-specific characteristics that are observed. For each photo, the photo number and a brief description will be recorded on the Photograph Locations and Description Form.

3.2.4 SITE COMMENTS

Pertinent site comments or observations by field personnel will be recorded on the Summary Form.

3.3 WATER SAMPLE COLLECTION

After *in situ* measurements are complete, chemistry samples will be collected at each site. All water and benthic sediment samples will be collected in new acid-washed high-density polyethylene (HDPE) bottles unless otherwise noted. Detailed methodology for each type of sample collection described below can be found in DEQ (2012b). **Table 3.1** summarizes sample containers, holding times and preservation.

3.3.1 CHEMISTRY SAMPLES

Nutrients and TSS

For each sample, the bottle and lid will be triple-rinsed with a small amount of ambient stream water prior to grabbing the final sample. TN will be collected in a single 250ml HDPE bottle and kept on ice (not frozen) until analyzed. TP and NO_{2+3} will be collected in a single 250ml HDPE bottle, will be preserved with sulfuric acid and kept on ice (not frozen) until analyzed. TSS will be collected in a single 500 ml HDPE bottle and kept on ice (not frozen) until analyzed. (**Table 3.1**)

Total Recoverable Metals

For each sample, the bottle and lid will be triple-rinsed with a small amount of ambient stream water prior to grabbing the final sample. Total recoverable metals will be collected in a single 250ml HDPE bottle, will be preserved with nitric acid and kept on ice (not frozen). Hardness will be calculated from the total recoverable metals bottle. (**Table 3.1**)

Dissolved Metals

For dissolved metals fractions, water will be filtered through a 0.45 µm filter into a 250 ml HDPE bottle. Filtration will be accomplished with a 60 cm^3 syringe connected to a disposal 0.45 µm filter capsule. A small amount of the sample will be wasted through the filter first, and the sample bottle and lid will be triple-rinsed with a small amount of filtrate before the final filtered sample is collected. For dissolved metals, at least 50 ml of the filtrate will be placed in a 250 ml HDPE bottle, preserved with nitric acid and kept on ice (not frozen) until analyzed (**Table 3.1**).

Common Ions, Sulfate

For each sample, the bottle and lid will be triple-rinsed with a small amount of ambient stream water prior to grabbing the final sample. Common ions and sulfate will be collected in a single 500 ml HDPE bottle and kept on ice (not frozen) until analyzed.

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

Analyte	Bottle Size	Container	Preservation	Storage	Holding time
Total Persulfate Nitrogen (TPN)	250 ml	HDPE bottle	None	Cool to <6 °C	28 days
TP, NO_2+NO_3	250 ml	HDPE bottle	sulfuric acid	(on ice)	28 days
Total Suspended Solids	1000 ml	HDPE bottle	None		7 days
Total Recoverable Metals	250 ml	HDPE bottle	nitric acid		180 days

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

Analyte	Bottle Size	Container	Preservation	Storage	Holding time
Dissolved Metals	250 ml	HDPE bottle	0.45 um field filtered; nitric acid		180 days
Common Ions, Sulfate, Alkalinity (Bicarb., Carb.)	500 ml	HDPE bottle	None		28 days (Common Ions, Sulfate)/14 days (Alkalinity (Bicarb., Carb.)
Sediment Sample-Metals	2000 ml	HDPE wide mouth	None		180 days
E.coli	100 ml	HDPE bottle	None	≤ 10 °C (on ice)	6 hours
Chlorophyll-*a*	N/A	Ziplock bag (hoop), Petri dish (template), or centrifuge tube (core)	None	Freeze (on dry ice)	28 Days (pH≥6)/ ASAP(pH<6)
Macroinvertebrates	1000 ml	HPDE bottle	Ethanol	No ice	NA

Water samples for E.coli

The *E. coli* field sampling methods, sampling handling and processing methods, and analysis methods follow the SOPs as written in the document titled, "Sample Collection, Handling and Analysis of *Escherichia Coli*" (DEQ.2014). Grab samples are collected using 100 ml glass IDEXX bottles that are sterilized and treated with sodium thiosulfate. *E. coli* are analyzed in the field using the IDEXX, Inc. Colilert™ method. Coliform densities are reported as most probable number count per 100 ml. The maximum sample holding time is 6 hours. Field splits are collected to measure total method error are included in the sampling design at a frequency of 30%. Field splits are two or more samples separated from a larger sample. Split samples are processed in the field or laboratory as discrete samples and their difference is evaluated. This difference represents total method error (e.g., heterogeneity of site, reproducibility of sampling technique, sorting error, and identification error). Relative Percent Difference (RPD) is used to evaluate results differences between two replicate samples.

3.4 BIOLOGICAL SAMPLES

Biological samples will be collected after chemistry sampling is completed.

3.4.1 Benthic algae for chlorophyll-a and ash-free dry weight analysis

Benthic algae will be collected at the sites indicated in Appendix B. Benthic algae samples will be collected at 11 transects following the EMAP reach-wide procedure (Peck et al. 2006; DEQ 2011c). Samples will be collected using either the template, hoop or core methods, depending on the dominant substrate and/or algae type present.

Hoop samples will be stored in zip-lock bags wrapped in aluminum foil, template samples on filters in petri dishes or centrifuge tubes wrapped in aluminum foil, and cores in centrifuge tubes wrapped in aluminum foil. All samples will be frozen (using dry ice) until analyzed. Field personnel will indicate on the Site Visit form whether or not the laboratory will composite samples according to collection method (i.e., hoop, core,

template). Ash-free dry weight will be analyzed from the same chlorophyll-*a* samples. Weighted averages for chlorophyll-*a* and ash-free dry weight will be calculated. Only samples collected by using the hoop and template methods will be included in the ash-free dry weight weighted average.

At least one digital photograph will be taken at each transect where quantitative benthic algae samples are collected. These photos will depict a close-up aerial view of the stream substrate where the sampling took place. To enhance photo quality, a polarized lens will be used to reduce glare and rock samples may be taken out of the water to the bank and photographed if water conditions do not allow for a clear view. For each photo, the photo number and a brief description will be recorded on the Photograph Locations and Description Form.

Aquatic Plant Tracking Form and Aquatic Plant Visual Assessment forms will be completed for every site where benthic algae sampling occurs (DEQ 2011c, 2012b).

3.4.2 Macroinvertebrate samples

Macroinvertebrate samples will be collected at some sites as indicated in Appendix B. Samples will be collected at 11 transects following the EMAP reach-wide procedure (Peck *et al.* 2006, DEQ 2012b). A kick net with 500 µm mesh will be used to collect the sample at each transect and kick samples from each transect will be composited in 1 liter HDPE bottles and preserved (topped off) with 95% ethanol (EtOH) (**Table 3.3**).

4.0 SAMPLE HANDLING PROCEDURES

Field samples will be collected and preserved in accordance to Section 3. DEQ monitoring crews will be responsible for proper labeling, sample custody documentation and storage in accordance to the specifications in the Field Procedures Manual and QAPP (WQPB 2012). Water chemistry, sediment metals and algae samples will be delivered to Energy Laboratory, Inc., and macroinvertebrate samples and periphyton samples will be delivered to Rhithron, Inc. for analysis.

5.0 LABORATORY ANALYTICAL MEASUREMENTS

Chemistry samples will be analyzed according to the methods listed in Table 5.1. In addition, table 5.1 lists the required reporting limits to effectively evaluate the data to meet the project objectives.

Table 5.1 - Analytical Methods and Required Reporting Values

Water Sample – Nutrients		
Analyte	**Method**	**Req. Report Limit (ug/L)**
Total Persulfate Nitrogen (TPN)	A 4500-N-C	40
Total Phosphorus as P	EPA 365.1	3
Nitrate-Nitrite as N	EPA 353.2	10
Water Sample - Suspended Solids & Total Dissolved Solids		
Analyte	**Method**	**Req. Report Limit (µg/L)**
TSS	EPA 2540D	4000
TDS	EPA2540 C	4000

Water Sample - Dissolved Metals		
Metal	**Method**	**Req. Report Limit (µg/L)**
Aluminum	EPA 200.7	9
Antimony	EPA 200.8	0.5
Arsenic	EPA 200.8	1
Barium	EPA 200.8	0.5
Cadmium	EPA 200.8	0.03
Chromium	EPA 200.8	10
Copper	EPA 200.8	2
Iron	EPA 200.7	20
Lead	EPA 200.8	0.3
Magnesium	EPA 200.7	1000
Manganese	EPA 200.7	5
Nickel	EPA 200.7	2
Selenium	EPA 200.8	1
Silver	EPA 200.8	0.2
Strontium	EPA 200.7	20
Thallium	EPA 200.8	0.2
Zinc	EPA 200.7	8
Water Sample - Total Recoverable Metals		
Metal	**Method**	**Req. Report Limit (µg/L)**
Antimony	EPA 200.8	0.5
Arsenic	EPA 200.8	1
Barium	EPA 200.8	0.5
Cadmium	EPA 200.8	0.03
Chromium	EPA 200.8	10
Copper	EPA 200.8	2
Iron	EPA 200.7	20
Lead	EPA 200.8	0.3
Magnesium	EPA 200.7	1000
Manganese	EPA 200.7	5
Nickel	EPA 200.7	2
Selenium	EPA 200.8	1
Silver	EPA 200.8	0.2
Strontium	EPA 200.7	20
Thallium	EPA 200.8	0.2
Zinc	EPA 200.7	8
Total Hardness	A2340B (calculated)	1000
Total Recoverable Metals Digestion	EPA 200.2	N/A
Benthic Algae	**Method**	**Req. Reporting Limit**
Chlorophyll -*a*	A 10200H	N/A
Ash Free Dry Weight	A 10300 (C5)	N/A

6.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Quality Assurance/Quality Control (QA/QC) procedures for the monitoring will consist of calibrating field meters and collecting field QC samples.

6.1 CALIBRATING FIELD METERS

Laboratory Calibrations

All field instruments will be calibrated in the laboratory before they are taken into the field. These calibrations will be performed in accordance with instrument-specific acceptance criteria, operations manuals, QAPPs and SOPs. Calibration information will be recorded in the instruments' calibration log(s) and will remain with the instrument at all times (DEQ 2012b).

Instrument Accuracy Checks

OnSet Temperature Data loggers

Pre-deployment and post-retrieval accuracy checks will be conducted for the data loggers, following the procedures in the DEQ document titled, "Temperature Data Loggers Instructions".

Field Calibrations

Some field meters require in situ field calibration in addition to laboratory calibration before they are used in the field. YSI 85 field meters must be calibrated for dissolved oxygen before they are used at each monitoring site. For all dissolved oxygen field calibrations, the following information is recorded in the instrument logbook: 1) date, 2) time, 3) site location, 4) elevation, and 5) the initials of the analyst performing the calibrations. Hand-held pH meters must be calibrated daily using a two-point calibration. Calibration instructions for each meter are located in the user manual which is kept in each instrument's case.

6.2 FIELD QUALITY CONTROL SAMPLES

Field Duplicate samples

For each type of routine water or sediment chemistry parameter, duplicate samples will be collected during each trip for at least 10% of the total number collected throughout the sampling season. Sites where duplicate samples will be prepared will be randomly selected. When collecting duplicate samples, a sampling location will be chosen that allows for two samples to be taken side-by-side upstream from any previous disturbances. To collect duplicate samples, all procedures performed in collecting, labeling and preserving the routine sample will be followed so that two identical samples have been collected at the same site. Duplicate samples will be submitted to the analytical laboratory along with routine samples.

Field blanks

Field blanks are prepared in the field each time that routine water samples are to be delivered to the analytical laboratory. Field blanks are prepared in the field after sampling the last site of a multi-site sampling trip, or mid-trip if sample holding times require samples to be delivered to the lab part-way through a multi-site sampling trip. Field blanks will be prepared using distilled water provided by the analytical laboratory which field personnel will keep in clean, triple-rinsed HDPE bottles. One field blank will be prepared and submitted per routine sample type collected throughout the trip. Preparing field

blanks will follow the same sample collection, labeling and preservation procedures as those used to collect routine samples, except that distilled water is used instead of stream water.

7.0 HANDLING SAMPLING RECORDS

Site Visit Forms, field forms, and digital photos will be processed by WQPB staff using QA/QC procedures described in the QAPP (WQPB 2012). Analytical laboratories will provide results to DEQ in the required EDD format. DEQ will perform the necessary data evaluations and will manage the data in accordance with the QAPP.

8.0 SCHEDULE

The Water Quality Monitoring and Assessment staff will sample four streams in the Sheep Creek drainage at the proposed sites (Appendix A). Appendix B summarizes the sampling to be conducted per monitoring trip for each waterbody. The sampling events for nutrient monitoring will occur in May, July, August, and September, 2015. The sampling events for metals monitoring will occur in May and July, 2015. The sampling events for E.coli monitoring will occur in July and August, 2015. Data collection should be completed no later than September 30, 2015 (Suplee and Sada de Suplee, 2011). Continuous water temperature data will be collected at some sites, including all of the sites on Sheep Creek, from approximately mid-June through September, 2015.

9.0 PROJECT TEAM AND RESPONSIBILITIES

The Water Quality Monitoring and Assessment Section will lead the monitoring component of the project. Darrin Kron will oversee the overall Monitoring and Assessment activities. Alan Nixon will lead the nutrients, metals, temperature and pathogen monitoring projects. Additional Monitoring and Assessment Section staff and Watershed Management staff will provide monitoring support in the field. Watershed Management staff (Jordan Tollefson and Lou Volpe) will provide stakeholder outreach, site access support, and assist with monitoring. Dean Yashan will oversee the overall Watershed Management and TMDL activities for this project.

10.0 REFERENCES

DEQ (Montana Department of Environmental Quality). 2006. Sample Collection, Handling and Analysis of *Escherichia Coli*. Water Quality Planning Bureau. WQPBWQM-014. Available at: http://deq.mt.gov/wqinfo/qaprogram/sops.mcpx.

DEQ (Montana Department of Environmental Quality). 2011a. Water Quality Assessment Method. Helena, MT: Montana Department of Environmental Quality.

DEQ (Montana Department of Environmental Quality). 2012. Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

DEQ (Montana Department of Environmental Quality). 2011b. Sample Collection and Laboratory Analysis of Chlorophyll *a* Standard Operating Procedure. Prepared by Suplee, M., February 2011. Document No. WQPBWQM-011, Revision 5.

DEQ (Montana Department of Environmental Quality). 2012a. Administrative Rules of Montana.

DEQ (Montana Department of Environmental Quality). 2012b. Water Quality Planning Bureau Field Procedures Manual For Water Quality Assessment Monitoring Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

DEQ (Montana Department of Environmental Quality). 2012c. Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure. Document No. WQPBWQM-009, Revision 3.

Nevers, M.B., and R. L. Whitman. Accessed 2012. Lake Monitoring Field Manual. US Geological Survey, Lake Michigan Ecological Research Station, Porter, Indiana. Accessed 6/4/2012. Available at http://www.glsc.usgs.gov/_files/research/InlandLakesManual.pdf.

Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D.J. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M.R. Cappaert. 2006. Environmental Monitoring and Assessment Program – Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams. EPA 620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Suplee, M.W., and R. Sada de Suplee. 2011. Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels. Helena, MT: Montana Dept. of Environmental Quality.

Suplee, Michael W., Vicki Watson, Walter K. Dodds, and Chris Shirley, 2012. Response of Algal Biomass to Large-Scale Nutrient Controls in the Clark Fork River, Montana, United States. *Journal of the American Water Resources Association* (JAWRA): 1-14. DOI: 10.1111/j.1752-1688.2012.00666.x.

WQPB (Water Quality Planning Bureau). 2012. Madison Use Status Assessment Quality Assurance Project Plan. Helena, MT: Montana Dept. of Environmental Quality. Project ID: MO6-USA-01.

APPENDIX A – PROPOSED MONITORING SITE LOCATIONS IN THE SHEEP CREEK DRAINAGE IN 2015

Table A-1. Monitoring site locations in Sheep Creek Drainage 2015

Site ID	Site Name	Station ID	Latitude	Longitude	Site Description and Rationale
Sheep Creek	1A	M10SHEPC01	46.8075	-111.1586	Site is near the mouth, at the Smith Creek Road bridge. Site is the located in the Shields-Smith Valleys level 4 ecoregion. This reach is Strahler Order 4.
Sheep Creek	1B	new site	46.8280	-110.9740	Site is upstream of Calf Creek (DEQ reference stream), near Calf Creek Ranger Station.
Sheep Creek	1C	M10SHEPC02	46.8142	-110.9313	Site is downstream of Sheep Creek CG. A potential internal reference reach for the sediment monitoring phase of the study.
Sheep Creek	1D	new site	46.8114	-110.9254	Site is at the Sheep Creek CG. Site is downstream of the proposed mine site and downstream of Moose Creek. This site is near the center of the drainage, and is Strahler Order 3.
Sheep Creek	1E	new site	46.7927	-110.9115	Site is about 1 mile upstream of Moose Creek, and downstream of the proposed mine site.
Sheep Creek	1F	new site	46.7849	-110.9082	Site is upstream of Coon Creek, and downstream of the location of the proposed mine.
Sheep Creek	1G	new site	46.7638	-110.7851	Site is at the USFS campground off Highway 89, about 6 miles upstream of the proposed mine. The reach is Strahler Order 2. Site is 9 miles from the headwaters.
Sheep Creek	1H	M10SHEPC03	46.7672	-110.7107	Upper most site, about 1/2 mile downstream of Nugget Creek, and about 5 miles from the headwaters.
Moose Creek	2A	new site	46.8190	-110.8920	Site is the lower most accessible site, about 2 miles from the mouth.
Moose Creek	2B	new site	46.8450	-110.8650	Site is downstream of Allan Creek, about 2.5 miles upstream of the lowermost site.
Moose Creek	2C	new site	46.8597	-110.8442	Site is downstream of Coyote Creek and 1.8 miles upstream of Site 2B.
Moose Creek	2D	new site	46.8710	-110.8080	Site is downstream of un-named tributary and 2.5 miles upstream of Site 2C.
Moose Creek	2E	new site	46.8700	-110.7760	Upper most site, about 2 miles from the headwaters and 2.2 miles upstream of Site 2D.

Calf Creek	3A	new site	46.8424	-110.9623	Site is about 1 mile upstream of the mouth at the Forest Service road crossing
Little Sheep Creek	4A	new site	46.7740	-110.8980	Tributary to Sheep Creek. Site is near mouth, downstream of Coon Creek. Site is near the proposed mine.
Big Butte Creek	5A	new site	46.7716	-110.9528	Site is on USFS, about 2.5 miles from the headwaters, and about 1.25 miles down gradient from the proposed mine and mill sites.

APPENDIX B - NUMBER OF SAMPLES TO BE COLLECTED PER PARAMETER AND PER WATERBODY SEGMENT IN THE SHEEP CREEK DRAINAGE IN 2015

Trip Visit Number	Parameter Group	Waterbody Name (# of potential sites)				
		Sheep Creek (7)	Moose Creek (5)	Calf Creek (1)	Little Sheep Creek (1)	Big Butte Creek (1)
1 (May)	Metals -TR	7	5	1	1	1
	Metals-Dissolved	7	5	1	1	1
	Nutrients (TN, TP, NO2+3)	7	5	1	1	1
	TSS, *in situ* measurements (pH, temperature, DO, SC, NTU & flow	7	5	1	1	1
	Common Ions, bicarbonate, sulfate	7	5	1	1	1
2 (June)	Temperature (datalogger deployment)	7	1	1	1	1
3 (July)	Metals -TR	7	5	0	1	1
	Metals-Dissolved	7	5	0	1	1
	Sediment metals	7	3	0	1	1
	Nutrients (TN, TP, NO_{2+3})	7	5	0	1	1
	TSS, in situ measurements (pH, temperature, DO, SC, NTU & flow	7	5	0	1	1
	E. coli	7	0	0	0	0
4 (July)	E. coli	7	0	0	0	0
5 (August)	Nutrients (TN, TP, NO_{2+3})	7	5	0	1	1
	TSS, in situ measurements (pH, temperature, DO, SC, NTU & flow	7	5	0	1	1
	Chlorophyll *a* & Ash-Free Dry Weight	7	5	0	1	1
	Macroinvertebrates	3	3	0	0	0

6	Nutrients (TN, TP, NO2+3)	7	5	0	1	1
(September)	TSS, in situ measurements (pH, temperature, DO, SC, NTU & flow	7	5	0	1	1
7						
	Temperature (datalogger retrieval)	7	1	1	1	1
(September)						
Sample Count Totals	Metals -TR	14	10	1	2	2
	Metals-Dissolved	14	10	1	2	2
	Sediment metals	7	3	1	1	1
	Nutrients (TN, TP, NO_{2+3})	21	15	1	3	3
(FS2015)	TSS, in situ measurements (pH, temperature, DO, SC, NTU & flow	28	20	1	4	4
	Common Ions, bicarbonate, sulfate	28	20	1	4	4
	E. coli	14	0	0	0	0
	Chlorophyll *a* & Ash-Free Dry Weight	7	5	0	1	1
	Macroinvertebrates	3	3	0	0	0

APPENDIX C - A LIST OF THE DATA THAT WILL BE COLLECTED AT EACH SITE IN 2015

Waterbody	Site ID	Station Site Description	Latitude	Longitude	Nutrients, TSS	Metals, Total Recoverable	Metals, Dissolved	Sediment Metals	Common Ions, Bicarbonate, Sulfate,	*E. coli*	Chl-*a*/AFDW	Macroinvertebrates	Periphyton	Sediment Monitoring (Separate SAP)	DO, SC, pH, Turbidity (NTU)-*in situ*	pH, Conductivity-Continuous (YSI Sonde)	Temperature (Continuous)
Sheep Creek	1A	Sheep Creek, nr mouth at Sheep Creek Road bridge	46.80750	-111.15860	3	2	2	1	3	2	1	1	1	1	4	0	1
Sheep Creek	1B	Sheep Creek, d/s of Calf Cr, nr Calf Cr Ranger Station	46.82800	-110.97400	3	2	2	1	3	2	1	0	0	0	4	0	1
Sheep Creek	1C	Sheep Creek, d/s of Sheep Creek CG	46.81424	-110.93133	0	0	0	0	0	0	0	1	1	1	1	0	0

Sheep Creek	1D	Sheep Creek, at Sheep Creek CG	46.81141	-110.92538	3	2	2	1	3	2	1	1	1	1	4	0	1
Sheep Creek	1E	Sheep Creek, about 1 mi u/s of Moose Cr, on USFS	46.79268	-110.91151	3	2	2	1	3	2	1	0	0	0	4	1	1
Sheep Creek	1F	Sheep Cr, u/s of Coon Cr, and d/s of Little Sheep Cr	46.78490	-110.90820	3	2	2	1	3	2	1	0	0	0	4	0	1
Sheep Creek	1G	Sheep Creek, at the USFS CG, about 6 mi u/s of the Tintina	46.76380	-110.78510	3	2	2	1	3	2	1	1	1	1	4	0	1

		mine															
Sheep Creek	1H	Sheep Creek, of HWY 89, about 1/2 mi d/s of Nugget Cr, about 6 mi below headwaters	46.76720	-110.71070	3	2	2	1	3	2	1	0	0	0	4	0	1
Moose Creek	2A	Moose Cr, about 2 mi from the mouth, on the Moose Creek Road (FR 204), nr	46.81900	-110.89200	3	2	2	1	3	0	1	1	0	0	4	0	1

		lower USFS boundary															
Moose Creek	2B	Moose Cr, d/s of Allan Cr	46.84500	-110.86500	3	2	2	1	3	0	1	0	0	0	4	0	1
Moose Creek	2C	Moose Cr, d/s of Coyote Cr	46.85967	-110.84416	3	2	2	1	3	0	1	0	0	0	4	0	0
Moose Creek	2D	Moose Cr, d/s of un-named tributary	46.87100	-110.80800	3	2	2	0	3	0	1	1	0	0	4	0	0
Moose Creek	2E	Moose Cr, about 2 mi below the headwaters	46.87000	-110.77600	3	2	2	0	3	0	1	0	0	0	4	0	0
Calf Creek	3A	Calf Creek, about	46.84243	-110.96230	1	1	1	1	1	0	0	0	0	0	1	0	1

		1 mile from the mouth														
Little Sheep Creek	4A	Little Sheep Cr, nr mouth, d/s of Coon Cr	46.77400	-110.89800	3	2	2	1	3	0	1	1	0	0	4	0	1
Big Butte Creek	5A	Black Butte Cr, on USFS, d/s of Bar Z and Ray Russell's land	46.77160	-110.95277	3	2	3	1	3	0	1	1	0	0	4	0	1