LITTLE BIGHORN WATERSHED METALS BASELINE MONITORING

SAMPLING AND ANALYSIS PLAN

Prepared for the Montana Department of Environmental Quality

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Introduction

The Crow Indian Reservation, located in south central Montana, encompasses 2.3 million acres of land. It is home to the Crow people, or the "Apsaalooke" meaning "Children of the Large Beaked Bird". An estimated 7,900 tribal members reside on the Crow Reservation. A large percentage of residents obtain their water from the Little Bighorn River, which flows northward across the reservation. It drains land used for livestock grazing, irrigated and dryland crop production, forestland, and developed areas for communities and natural resource production. The Little Bighorn River also drains the western half of the Wolf Mountains which are underlain by coal. The drainage from the Wolf Mountains where energy resources related to coal may be extracted are the focus of this document. Energy development projects that have been proposed in the past include a new surface coal mine and a coal-to-liquids plant. If realized, these projects could have a 70 year operational phase and be among the largest industrial developments in Montana. One proposal estimates that a project could strip mine 38,000 tons of coal a day and consume 1.3 to 4.9 billion liters of water per day for the liquefaction process alone (Gies 2011). Energy development in the Wolf Mountains would have the potential to impact water quality in the Little Bighorn River, and with current coal prices and exports to Asia, it is very possible that coal mining will occur in the Wolf Mountains at some point in the future. In order to understand water quality impacts from coal mining, it is imperative to collect baseline water quality data before any development occurs. Geologic formations with the potential for mining underlie the majority of the Wolf Mountains which drains most of the eastern portion of the Little Bighorn watershed.

The Little Bighorn River is integral to the Tribe's cultural and economic life, any current or potential future impairment of the river needs to be identified. Surface water monitoring is needed to provide a baseline of the current conditions of the Little Bighorn River, as well as to track changes in water quality over time. See Crow Bighorn River QAPP (Sigler, 2011) for additional information on site history and the tribal regulatory framework.

Project Objectives

Discussion of potential coal mining and a coal-to-liquid project has raised interest in potential water quality impacts and baseline water quality conditions. To address these interests, the goal of this project is:

• To determine baseline water quality (e.g., metal and salt) conditions in the Little Big Horn River, Owl Creek and tributaries in advance of potential coal strip mining and coal bed methane development in the Wolf Mountains on the Crow Indian Reservation.

Through the collection of water quality data, the project will provide the following products:

- Publically available data routed into MT DEQ EQUIS database and ultimately housed in EPA STORET.
- A summary report written collectively by team members (Table 4), spearheaded by Mari Eggers. This report will be provided to Little Bighorn College (LBHC), MT

DEQ, and the Crow Tribal Environmental Program. The report will summarize the monitoring activities and will tabulate the water quality and sediment results for easy comparison to MT and/or EPA water quality standards. MT standards are not applicable on the reservation but may be used for a frame of reference since the Crow tribe currently does not have water quality standards.

This Sample Analysis Plan (SAP) focuses on identification of baseline water quality and stream sediment metal concentrations in anticipation of potential coal strip mining and coal bed methane extraction in the Wolf Mountains. However, there are parallel objectives or possible objectives that were identified during the writing of the SAP which are outside the scope of this work but may be addressed in subsequent efforts. These include:

- Baseline water quality conditions specifically relevant to construction and operation of a coal to liquids plant. A coal to liquids plant would use extensive water resources which would require an inventory of hydrologic conditions and potential impacts. A coal to liquids plant could also result in release of volatile organic compounds (VOCs) and/or other refinery process byproducts in the vicinity of the plant which would have specific monitoring plan considerations.
- Coal strip mining over large surface areas can cause disruption in the natural groundwater recharge and discharge patterns which can alter groundwater levels, quantities, and qualities. Monitoring of water levels and quality in wells adjacent to proposed mining areas in advance of development could help to establish baseline groundwater conditions.
- Hydraulic fracturing of shale beds to release natural gas and the potential water quality and quantity implications is a topic gaining attention across Montana and the United States. This topic has not specifically been discussed relative to the Crow Reservation because most hydraulic fracturing in shale beds is currently focused in the northeast and other portions of the state. Hence, baseline water quality for parameters relevant to hydraulic fracturing are not a focus of this work, but bromide is included in the parameter list because it has been promoted as a possible metric for assessing fracing influence on water resources.
- Assessment of mercury and other bio-accumulating metals in the biomass of fish has also been suggested as a possible future data collection endeavor if impacts from mining indicate that mercury is an issue.

Sampling Design

Sampling locations were identified based on their distribution across the watershed upstream of Crow Agency and likelihood to show a water quality response to the proposed Many Stars coal mining operation in the Wolf Mountains. Six sample sites were selected with consideration of accessibility (legality, site approach, availability of roads), spatial position in the watershed (relative to confluences), and stream condition (width vs. depth), and are outlined in Table 2. All six sites will be visited during each sampling event (Figure 1).

Two site visits will be conducted, one before the hydrograph spikes in the spring, and the second during high flow conditions. Pending additional funding from Little Big Horn College (LBHC) and Montana State University, two additional sample events would occur after the high flow conditions in July and September, see Figure 2. These two additional sampling events (with identical parameter lists and QC) will follow protocols outlined in this SAP. Availability of Little Bighorn College (LBHC) resources (e.g., field vehicle) before June 30th may make it necessary for additional sampling to occur before that date.

Sampling protocol and design were developed to best represent current baseline metals conditions in water and sediment in the watershed. Water samples are representative of current conditions (snapshot in time) whereas sediment samples yield results that are representative of metals that have been deposited over time. Together, water and sediment metals analyses will form the baseline data for this project. During each site visit, volunteers will collect water quality grab samples, instantaneous discharge (flow), and field parameters with a YSI 556 multi-probe. During the spring event before high flow, sediment will be collected in conjunction with the parameters noted above. The suite of water quality and sediment parameters slated to be analyzed originated from discussions with MDEQ (Patrick Lizon, Pete Schade, Amy Steinmentz, Randy Apfelbeck, Devin Cleary), and Anita Moore-Nall (Consulting Geologist).

Based on these discussions, water will be analyzed for dissolved and total recoverable metals. Dissolved analyses will include aluminum, arsenic, cadmium, lead and uranium. Total recoverable will include all of the same tests as the dissolved except aluminum. In addition to the dissolved and total recoverable analyses, calcium, magnesium (total hardness), and sodium, bromide, fluoride, sulfate, total suspended and dissolved solids will be included as supporting analyses to help interpret the metals data. The stream sediment sample analyses will include: arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, selenium, thallium, uranium, and zinc. Silver was removed from the analysis because MTDEQ had not found silver in the past in this area.

Samples will be collected at each site during each visit. A set of quality control (QC) samples (a duplicate and a blank) will be collected at one of the six sites during each sampling event. The QC site will rotate each visit as specified in Table 6. Samples collected for metals will be handled according to Standard Operating Procedures (SOP) and shipped to the DEQ contracted laboratory (Energy Laboratories) for analysis. Metal concentration data will be evaluated relative to MT DEQ standards in the context of specific conductance, TSS, and hardness data.

Instantaneous discharge (flow) will be measured so that pollutant loads can be calculated. A Marsh McBirney Flow Meter owned by LBHC will be used to provide consistent and accurate results. Discharge will be measured for each site on each visit (if it is safe) with the exception of the sites on the Little Big Horn River where the USGS gage near Hardin will be used as a proxy.

Measurement of field parameters is a basic operating procedure when other water quality data is collected, and will provide context for interpreting basic stream

conditions and other data. Volunteers will collect field parameters including specific conductance, pH and temperature using an YSI 556.

From these combined efforts, a report summarizing findings will be collectively written by team members. Attached to this document (Appendix B) are the Standard Operating Procedures (SOP) which outline step-by-step procedures for all fieldwork, information on field equipment use and calibration, and example datasheets.



Figure 1: Sample sites



Figure 2: 10 year average hydrograph for the Little Bighorn River with projected sampling events

2012 Lab Parameters				
Dissolved Analysis Aluminum, Arsenic, Cadmium, Lead, Uranium,				
Total Recoverable Analysis	Arsenic, Cadmium, Lead, Uranium			
Total Recoverable for	Arsenic, Barium, Beryllium, Cadmium, Chromium,			
Stream Sediment Applysis	Copper, Iron, Lead, Mercury, Selenium, Thallium,			
Stream Seument Analysis	Uranium, Zinc			
Supporting Analysis	TDS, TSS, Sodium, Bromide, Chloride, Sulfate			
Hardness	Calcium, Magnesium			

 Table 1 Lab parameters to be analyzed during 2012.

Site ID	Site Name	Waterbody	Latitude	Longitude	Site Description	Rational for site selection
AWW_BC_UPBC	Upper Bear Creek	Bear Creek	45.13697	-107.18822	Located in Crow Tribal Trust lands. Upper most site in plan, along Bear Creek (UPBC). Flows directly out of Wolf Mountains.	Most upstream access, immediately adjacent to Wolf Mountains.
AWW_OC_SOLO	Southern Little Owl	Little Owl Creek	45.1787	-107.20461	Located along southern Little Owl (SOLO) Creek, adjacent to the Wolf Mountains. Public road, sample immediately adjacent to the road.	Tributary draining a large portion of the Wolf Mountains, north of Bear Creek.
AWW_SC_SXPS	Sioux Pass	Sioux Pass Creek	45.25631	-107.29368	Creek flows out of Sioux Pass (SXPS). Public road, sample immediately adjacent to road downstream of culvert.	Tributary draining a large portion of the Wolf Mountains, north of Little Owl Creek.
AWW_OC_MSTM	Mainstem Owl	Owl Creek	45.28913	-107.3482	Mainstem Owl (MSTM) Creek just before confluence with Little Bighorn River. Public road access, sample immediately adjacent to road, downstream of culvert.	Drains the majority of the Wolf Mountains. Site is upstream of the Little Bighorn confluence.
AWW_LB_SPSD	Spear Siding Site	Little Bighorn River	45.18078	-107.38806	Spear Siding (SPSD) Bridge over the Little Bighorn River. Non- wadable. Known as LBHR-050 in the Bighorn River QAPP.	Serves as the upstream, baseline site on the Little Bighorn River. Known as LBHR-050 in the Bighorn River QAPP.
AWW_LB_TRPT	Treatment Plant	Little Bighorn River	45.59336	-107.46501	Location of Crow Agency water treatment plant (TRPT) and intake. Non-wadable.	Downstream site, intake location of Crow Agency's drinking water.

Table 2: Sample site IDs, names, coordinates, descriptions and rationale.

Project Team Responsibilities

The project manager will be John Doyle of Apsaalooke Water and Wastewater Authority. Assisting him will be Larry Kindness and Jimmy Real Bird, also of Apsaalooke Water and Wastewater Authority. Together, they will conduct in-field sampling and assist with report composition. Mari Eggers and Tamra Old Coyote of Little Bighorn College will conduct a training for the Apsaalooke Water and Waste Water Authority representatives, and provide advisory and technical assistance for data collection, sample shipping, and data management. Additional project guidance and oversight will come from Myron Shields, Brandon Good Luck, Anne Camper, and Adam Sigler. Project team responsibilities are provided in Table 4.

Name/Title	Project Responsibilities	Contact Information	Best Time to Contact
John Doyle; Apsaalooke Water and Wastewater Authority	Overall project manager, data collection, and assist with report composition	<u>johndoyle91@gmail.com</u> 638-2867 (home) 679-0363 (cell-text works well, as coverage is limited)	
Larry Kindness; Little Bighorn College and Apsaalooke Water and Wastewater Authority	Data collection and assist with report composition	kindnesslarry@yahoo.com	Early morning until 12:00
Jimmy Real Bird; Crow Tribe and Apsaalooke Water and Wastewater Authority	Data collection and assist with report composition	Jamesr@crownations.net 638-3795	Morning
Mari Eggers; Water Quality Project Leader, Little Bighorn College	Train Apsaalooke Water and Waste Water Authority representatives, equipment maintenance, data collection, handling of samples/coordinating sample delivery, data entry, report composition with input from all data collection participants	<u>eggersm@lbhc.edu</u> (406) 994-3064	

Name/Title	Project Responsibilities	Contact Information	Best Time to Contact
Tami Old Coyote; Water Quality Project Coordinator, Little Bighorn College	Train Apsaalooke Water and Waste Water Authority representatives, equipment maintenance, data collection, handling of samples/coordinating sample delivery, and assist with report composition	oldcoyotet@lbhc.edu (406) 638-3145 (office) (406) 281-2945 (cell) Little Big Horn College 8645 South Weaver Drive P.O. Box 370 Crow Agency, MT 59022	Anytime
Brandon Good Luck; Crow Tribal EPA	Project oversight for Tribal concerns and regulatory insight	bgoodluck@crownations.n et 638-3884	8-5
Anne Camper; Professor, Civil Engineering and Associate Dean, College of Engineering Montana State University	Project oversight and technical insight	<u>anne_c@erc.montana.edu</u> (406) 994-4906	
Adam Sigler; MSUEWQ Water Quality Specialist, Montana State University	Data collection and management training for Mari Eggers and Tami Old Coyote	asigler@montana.edu (406) 994-7381 Sigler Lab, MSU PO Box 173120, Bozeman, MT, 59717-3120	9-5

Table 3: Project team members and responsibilities.

Sampling Methods

Sampling will be conducted according to the SOPs outlined in Appendix B of this document. A Site Visit Form will be completed for each site visit and will include all field data collected and an inventory of the grab samples collected for analysis at the DEQ contracted laboratory. Site locations will be corroborated using Appendix A of this document and/or a GPS, and the method will be documented on the site visit form. The GPS coordinate system datum will be NAD 1983 State Plane Montana, in decimal degrees to at least the fourth decimal. Photographs will be taken using a digital camera.

Field Parameters

Field parameter data will be collected with an YSI 556. This meter will be calibrated according to manufacturer instructions, outlined in the SOP, on the same day before sampling occurs and calibration logs will be kept for each meter

Parameter	Meter	Measurement Range	Resolution	Accuracy
Temperature	YSI 556	-5 to 45° C	0.1° C	±0.15° C
рН	YSI 556	0.0 to 14.00 units	0.01 units	±0.2 units
Specific	YSI 556	0 to 200 mS/cm	0.001	±0.5% of reading or
Conductivity			mS/cm to	±0.001 mS/cm
			0.1 mS/cm	

Table 4: Field instruments and performance characteristics.

Flow (Discharge) Measurement

Stream discharge data will be collected at all water quality monitoring sites using a Marsh McBirney flow meter, with the exception of the sites on the Little Big Horn River for which the USGS gage near Hardin will be used as a proxy. The attached SOPs (Appendix B) outlines step-by-step procedures for all fieldwork, information on field equipment use and calibration, and provides example datasheets.

Water Sample Collection and Handling for Laboratory Analysis

Grab samples will be collected for delivery to the DEQ contracted lab for chemistry analysis using acid washed, polyethylene bottles for water and glass bottles for sediment, provided by the testing laboratory. Table 5 details the analytical methods and handling procedures for each parameter. Table 1 lists parameters to be analyzed.

Bottles shall be rinsed three times with stream water prior to sampling. Samples will be collected in a well-mixed portion of each stream. During sampling, the sample bottle opening should face upstream and should be drawn through the water column once, carefully avoiding disturbance of bottom sediments. Samples will not be preserved or filtered in the field but will be stored on ice until shipment to the lab where they will be split, preserved and filtered. Sediment samples will be collected with plastic spoons or a turkey baster from at least 5 depositional zones that are representative of the conditions at each site. The sediment will be collected in a glass bottle provided by the lab. The sediment will be fractionated by the lab through a 60 micron sieve before conducting the metals analysis. Thorough instructions for water and sediment collect can be found in appendix B.5.

Water	Parameter	Preferred Method	Alternate Method	Req. Report Limit ug/L	Holding Time Days	Bottle	Preservative
a e	Aluminum ^D	EPA 200.7	EPA 200.8	30			
D) & erak	Arsenic ^{D, TR}	EPA 200.8	EPA 200.7	3			
ed (cov	Cadmium ^{D, TR}	EPA 200.8	EPA 200.7	0.08			
solv I Re (T	Lead ^{D, TR}	EPA 200.8	EPA 200.7	0.5			
Dis Tota	Uranium ^{D, TR}	EPA 200.8	EPA 200.7	30	180		
	Calcium	EPA 200.7	EPA 200.8	1000			
	Magnesium	EPA 200.7	EPA 200.8	1000			
	Sodium	EPA 200.7	EPA 200.8	1000		1L HDPE	
sis*	Bromide	E300.0		500		plastic	≤6°C
ting Analy	Fluoride	A 4500 F-C	EPA 300.0	100	28	bottle	
por	Sulfate	EPA 300.0	-	1000			
Sup	Total Suspended Solids (TSS)	A2540 D		4000	7		
	Total Dissolved Solids (TDS)	A2540 C		4000	7		
* Energy Lab	os will split samples for di	ssolved, total recove	erable & suppor	ting analyses. 1	This will inclu	de the filtering a	and preservation
Sediment	Parameter	Preferred Method	Alternate Method	Req. Report Limit mg/kg	Holding Time Days	Bottles	Preservative
	Arsenic	EPA 200.7	EPA 200.8	< 1			
	Barium	EPA 200.8	EPA 200.7	0.1		1-1L WIDE	
s	Beryllium	EPA 200.8	EPA200.7	0.5		glass	
Ilysi	Cadmium	EPA 200.8	EPA200.7	0.2	180	container	
Ana	Chromium	EPA 200.8	EPA200.7	9	100	for stream	
diment	Copper	EPA 200.7	EPA 200.8	15		sediment	
	Iron	EPA 200.8	EPA 200.7	10			None
ı Se	Lead	EPA 200.8	EPA 200.7	5		1-1L HDPE	
earr	Mercury	EPA 7471B		0.05	28	hottle	
Str	Selenium	EPA 200.8	EPA 200.7	0.1	-	for	
	Thallium	EPA 200.8	EPA 200.7	0.1	180	ambient	
	Uranium	EPA 200.7	EPA 200.8	9	_	water	
	Zinc	EPA 200./	EPA 200.8	20			

Table 5. Lab parameter analytical methods, reporting limits, hold times, and preservatives

Collection of Quality Control Samples

Water quality grab samples will be taken at each of the six sites during each sampling event. At one of the six sites, additional QC samples will be taken consisting of a duplicate and a blank. The site chosen for these extra samples will rotate beginning with the Northern-most site and working south as specified in table 7 (with greater detail in the SOPs). Although this SAP applies only to the first two sampling events, additional sampling is slated to occur. Therefore, the QC location should continue to rotate through the sites in the ordered specified.

Site ID	Site Name	Order of Quality Control Samples
AWW_LB_TRPT	Treatment Plant	1 st site visit: Pre-high flow 2012
AWW_OC_MSTM	Mainstem Owl	2 nd site visit: Peak flow 2012
AWW_SC_SXPS	Sioux Pass	3 rd site visit: Baseflow/late Summer 2012
AWW_OC_SOLO	Southern Little Owl	4 th site visit: Baseflow/Fall 2012
AWW_LB_SPSD	Spear Siding Site	5 th site visit: undetermined date
AWW_BC_UPBC	Upper Bear Creek	6 th site visit: undetermined date

 Table 6: Site Schedule for Quality Control samples.

A field blank is prepared by transporting laboratory-grade deionized (DI) water to the field (provided by the laboratory) and pouring it into sample containers provided by the lab. The blank will be prepared at the same time that the samples are collected from the stream. A co-located duplicate sample is a second stream sample collected at the same time in the same way that the regular stream sample is collected. A co-located sample will highlight the variability of instream parameters. Duplicate and blank samples will be collected at the same location for each event. The site where QC samples are collected will rotate between events. Duplicate and blank samples are labeled according to the labeling protocol below which does not identify the type of sample to the lab. Blank and duplicate samples are handled and delivered to the lab in the same manner that regular samples are handled.

Sample labels should be filled out with company (Apsaalooke Water and Wastewater Authority), the date, the time, the sample ID, and sample type. The sample ID is very important and includes the year, the month, the day, the site ID and a letter indicating the QC type (regular, blank or duplicate) and the sample type (water or sediment).

<u>Sample ID = Year-Month-Day-SiteID-Sample QC Type Letter-Sample Type</u>
<u>QC Type Letter</u>
A = Regular Sample
B = Duplicate Sample
C = Blank Sample
Sample Type Letter
W = Water
S = Sediment

Sample ID Examples:

A regular water sample collected at the Upper Bear Creek site on June 15th, 2011 would be labeled:

20110615- BCUPBC-A-W A duplicate at the same place and time as above: 20110615- BCUPBC-B-W

A blank at the same place and time as above:

20110615- BCUPBC-C-W

A regular sediment sample collected at the Treatment Plant site on the Little Bighorn on August 9th, 2012 would be labeled:

20120809- LBTRPT –A-S (sediment sample) 20120809- LBTRPT –SEIVING (water sample to be used in wet sieving)

Note: For simplicity and brevity for sample bottle labels, these IDs do not include the AWW portion of the site IDs which will be added to the sample ID before uploading the data to databases.

Immediately following grab-sample collection, samples will be put on ice. The MT DEQ contract analytical lab chain of custody forms will be used to document and track all samples collected during the project. Chain of custody forms will be completed for each set of samples submitted to the laboratory. Appendix F includes a special instruction sheet for Energy Labs that should be printed and included with the samples and the chain of custody.

Quality Assurance and Quality Control Requirements

In order for water quality data to be useful, it needs to be an accurate representation of conditions in the water body at the time the samples were collected. This requires proper sample handling and processing and then assessment of data to ensure quality. Data quality objectives (DQOs) state the required quality of data for the intended use and data quality indicators (DQIs) are the specific criteria that data are assessed by to determine quality. Definitions and a list of DQIs are included in the glossary. These indicators are assessed by collecting quality control (QC) samples and then performing quality assurance (QA) checks on those samples.

QC samples are blank, duplicate and spike samples collected or created in the lab and/or the field for evaluation of quality indicators. Once the lab results are returned for the QC samples, QA is the process of assessing the data through use of indicators to determine data quality.

Data Quality Objectives

Efforts have been made to produce a **spatially representative** dataset by selecting sites in four different waterbodies that would likely see impact from the

proposed development. See Table 3 for a description of the rational for site selection. Efforts will be made to conduct sampling at different points on the hydrograph (see Figure 2) to capture low and high flow data. MT DEQ funding will pay for two sample events and additional sampling will be conducted if additional funding is available.

Provisions are in place to ensure **sensitivity** of data collected to differences in stream water quality and **comparability** of data collected to other datasets. These provisions include the collection of grab samples and field QC for submission to a certified laboratory and assessment of QC data relative to data quality indicators. Data that does not meet quality criteria will be qualified appropriately in the culmination report and during the MT EQIUS submission process.

In order to ensure the highest degree of data **completeness** possible, each collection day will have a designated leader. This leader will be responsible for filling out datasheets and reviewing them before leaving a site. Mari Eggers will review datasheets for completeness and will follow-up with the designated leader if the datasheets are not completed.

Data Quality Indicators

Quality assurance and quality control (QAQC) can be broken down into a field and a laboratory component. The field component consists of collection of blank and duplicate samples and comparison of data to criteria. The laboratory component consists of assessment of data for blanks as well as duplicate samples analyzed by the lab. Blank samples should ideally yield results indicating "no detection" of the analyte in question. Duplicate samples should ideally produce identical results. Methods are not perfect however, so the criteria outlined in the following two sections are used to assess if data is of acceptable quality.

Quality Assurance for Field Quality Control Samples

Field quality control samples are typically collected for 10% of all samples collected; this means 1 in 10 samples. For this project, 1 in 6 samples will be designated as QC samples, or 17% of all samples. The first QC location will be at the treatment plant site (AWW_LB_TRPT) for the first sampling event. The second sampling event will perform QC analysis at the mainstem Owl site (AWW_OC_MSTM). Each set of field QC samples will include a blank and a duplicate for each analyte being sampled for. Accuracy for field QC samples will be assessed by ensuring that blank samples return values less than the data quality indicator criteria specified in Table 8. Blanks are run for water samples but not for sediment samples. If a blank sample returns a result greater than the threshold, all data for that parameter from that batch of samples may need to be qualified. The exception is that data with a value greater than 10 times the detected value in the blank does not need to be qualified. Precision for field QC samples will be assessed by ensuring that relative percent difference (RPD) between duplicates is less than 25%. RPD is calculated using the equation below. In addition to these

accuracy/precision checks, it will be necessary to check that all samples were processed within their specified hold times.

RPD as $\% = ((D1 - D2)/((D1 + D2)/2)) \times 100$

Where:

D1 is first replicate result

D2 is second replicate result

Parameter	Field Blank Threshold	Field Duplicate RPD		
Water				
Aluminum	30 μg/L	< 25% RPD		
Arsenic	3 μg/L	< 25% RPD		
Bromide	500 μg/L	< 25% RPD		
Cadmium	0.08 µg/L	< 25% RPD		
Calcium	1000 μg/L	< 25% RPD		
Fluoride	100 μg/L	< 25% RPD		
Lead	0.5 μg/L	< 25% RPD		
Magnesium	1000 μg/L	< 25% RPD		
Sodium	1000 μg/L	< 25% RPD		
Sulfate	1000 μg/L	< 25% RPD		
Uranium	30 μg/L	< 25% RPD		
Total Suspended Solids	4000 μg/L	< 25% RPD		
Total Hardness as CaCO ₃	See Ca & Mg	< 25% RPD		
Stream Sediment				
Arsenic		< 25% RPD		
Barium		< 25% RPD		
Beryllium		< 25% RPD		
Cadmium		< 25% RPD		
Chromium		< 25% RPD		
Copper		< 25% RPD		
Iron		< 25% RPD		
Lead		< 25% RPD		
Mercury		< 25% RPD		
Selenium		< 25% RPD		
Thallium		< 25% RPD		
Uranium		< 25% RPD		
Zinc		< 25% RPD		

Table 7: Data quality indicator criteria for field QC samples

Quality Assurance for Lab Quality Control Samples

Certified laboratories run QC samples for at least 10% of their sample volume. Integrity of laboratory data will be determined by comparing results for laboratory QC samples to the data quality indicator criteria in Table 8. Reports with lab QC results and data quality indicator calculations should be provided by the lab with each set of sample results. Each of the quality indicator criteria in Table 8 must be checked for each analyte for each batch of samples submitted to the lab. This process is easier if a matrix is used to systematically check the numbers. An example of a completed matrix is provided on page 25.

Parameter	Parameter Method		Lab Duplicates (RPD)	Lab Control LCS/LFB (% recovery)	Matrix Spike/ Matrix Spike Dup (% recovery)	
Water						
Aluminum	EPA 200.7/200.8	30	< 20% RPD	85%-115%	70%-130%	
Arsenic	EPA 200.8	3	< 20% RPD	85%-115%	70%-130%	
Bromide	EPA 300.0	500	< 20% RPD	90%-110%	90%-110%	
Cadmium	EPA 200.8	0.08	< 20% RPD	85%-115%	70%-130%	
Calcium	EPA 200.7	1000	< 20% RPD	85%-115%	70%-130%	
Fluoride	EPA 300.0	100	< 20% RPD	90%-110%	90%-110%	
Lead	EPA 200.8	0.5	< 20% RPD	85%-115%	70%-130%	
Magnesium	EPA 200.7	1000	< 20% RPD	85%-115%	70%-130%	
Sodium	EPA 200.7	1000	< 20% RPD	85%-115%	70%-130%	
Sulfate	EPA 300.0	1000	< 20% RPD	90%-110%	90%-110%	
Uranium	EPA 200.8	30	< 20% RPD	85%-115%	70%-130%	
Total Hardness as CaCO ₃	A2340 B (Calculated)	See Ca & Mg	< 20% RPD	See Ca & Mg	See Ca & Mg	
Sodium Absorption Ratio (SAR)	Sodium Absorption Ratio (SAR) Calculated		< 20% RPD	See Na	See Na	
Total Suspended Solids	EPA 160.2	4000	< 5% RPD	70%-130%	-	
Total Dissolved Solids	A2540 C	4000	< 5% RPD	90%-110%	-	

 Table 8: Data quality indicator criteria for lab QC water samples

Parameter	Method	Method Blanks (mg/kg)	Lab Duplicates (RPD)	Lab Control LCS/LFB (% recovery)	Matrix Spike/ Matrix Spike Dup (% recovery)
Stream Sediment					
Arsenic	EPA 200.7	< 1	< 20% RPD	85%-115%	70%-130%
Barium	EPA 200.7	0.1	< 20% RPD	85%-115%	70%-130%
Beryllium	EPA 200.8	0.5	< 20% RPD	85%-115%	70%-130%
Cadmium	EPA 200.8	0.2	< 20% RPD	85%-115%	70%-130%
Chromium	EPA 200.8	9	< 20% RPD	85%-115%	70%-130%
Copper	EPA 200.8	15	< 20% RPD	85%-115%	70%-130%
Iron	EPA 200.7	10	< 20% RPD	85%-115%	70%-130%
Lead	EPA 200.8	5	< 20% RPD	85%-115%	70%-130%
Mercury	EPA 7471B	0.05	< 20% RPD	80%-120%	80%-120%
Selenium	EPA 200.8	0.1	< 20% RPD	85%-115%	70%-130%
Thallium	EPA 200.8	0.1	< 20% RPD	85%-115%	70%-130%
Uranium	EPA 200.8	9	< 20% RPD	85%-115%	70%-130%
Zinc	EPA 200.7	20	< 20% RPD	85%-115%	70%-130%

 Table 9: Data quality indicator criteria for lab QC sediment samples

Qualifying Data that fails data quality criteria

If any of the data quality objectives for field or laboratory QC samples fail the criteria above, all data for that analyte for that sample batch must be qualified accordingly. Note that a blank which exceeds the threshold does not automatically mean all data for that sample batch must be qualified. Sample results with values greater than 10 times the detected value in the blank do not need to be qualified. A narrative in the annual sampling report should outline what data was qualified and for what reason. The data will also need to be qualified during the process of uploading to MT EQUIS using the appropriate qualifier codes. A list of data qualifier codes is provided on page 26.

Training

- Mari Eggers and Tami Old Coyote of Little Bighorn College will provide training for the Apsaalooke Water and Waste Water Authority representatives before sampling commences. Training will include water sample collection protocols, use of the YSI 556 multi-probe for field parameter collection, use of the March McBirney for flow calculations, and the shipment of samples including maintaining chains of custody.
- Adam Sigler of the MSU Water Quality Extension office will provide Mari Eggers and Tami Old Coyote with an overview of the sample analysis plan and ensure that they are comfortable conducting monitoring and training other volunteers on the methods.

Data Analysis, Record Keeping & Reporting Requirements

Copies of laboratory analytical reports and electronic data deliverable spreadsheets will be provided by the DEQ contract analytical lab to both Mari Eggers and DEQ. Mari Eggers will review the laboratory data to ensure lab results are within reporting limits (including the laboratory QA/QC samples) prior to data entry into MT EQUIS. A review of field and analytical data will be conducted following receipt of the laboratory data package that includes all items on the QC Checklist on page 24. Data qualifiers provided on page 26 will be assigned to data in both hardcopy and electronic form that does not meet these target quality control criteria.

Data generated during this project will be stored on field forms and in laboratory reports obtained from the laboratories. Site Visit and Chain of Custody forms will be properly completed for all samples. Written field notes, field forms, and digital photos will be processed by field staff following QA/QC procedures to screen for data entry errors. Data from all sampling events will be entered into EQUIS.

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Little Bighorn Analytical Budget 2012-2013

							Aluminum	Arsenic	Cadmium	Lead	Uranium	Digestion	Arsenic	Cadmium	Lead	Uranium	TDS	TSS	Sodium	Bromide	Fluoride	Sulfate	Calcium	Magnesium
							7.00	7.00	7.00	7.00	7.00	10.00	7.00	7.00	7.00	7.00	8.00	8.00	7.00	10.00	10.00	7.00	7.00	7.00
									Dissolved				Total Re	coverable	Analysis				Support	ing Analysi	5		Hard	ness
	# Sites	Water Visits	Sediment Visits	QC Samples per Visit	QC Water Total	QC Sediment Totals	Aluminum	Arsenic	Cadmium	Lead	Uranium	Digestion	Arsenic	Cadmium	Lead	Uranium	TDS	TSS	Sodium	Bromide	Fluoride	Sulfate	Calcium	Magnesium
												Number	of Samples	s										
QC	1	2	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Little Big Horn Main Stem	2	2	1	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Owl Creek	2	2	1	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Bear Creek	1	2	1	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sioux Creek	1	2	1	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total Samples	6	8	4	1	2	1	14	14	14	14	1 14	14	14	14	14	14	14	14	14	14	14	14	14	14
Total Cost							\$98.00	\$98.00	\$98.00	\$98.00	\$98.00	\$140.00	\$98.00	\$98.00	\$98.00	\$98.00	\$112.00	\$112.00	\$98.00	\$140.00	\$140.00	\$98.00	\$98.00	\$98.00
samples are collected. Or	Digestion	C samples	(dups) is ne	Barium	diment Beryllium	Cadmium	Chromium	Dissolve Copper	d Budget	\$490.00	Mercury	TR Budget Selenium	Thallium	\$532.00 Uranium	Zinc		Supporting	Paramete	ers Budge	t		\$896.00		
	15.00	10.00	7.00	10.00	10.00	7.00	7.00	7.00	7.00	7.00	20.00	10.00	10.00	7.00	7.00									
			-	-		Sedin	nent: Total R	ecoverabl	e Metals Sui	te	-													
	Digestion	Seiving	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Selenium	Thallium	Uranium	Zinc									
							Numbe	r of Samp	les							1								
QC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
Little Big Horn Main Stem	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2									
Owl Creek	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2									
Bear Creek	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
Sioux Creek	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
Total Samples	7	7	7	7	7	7	7	7	7	7	7 7	7	7	7	7									
Total Cost	\$105.00	\$70.00	\$49.00	\$70.00	\$70.00	\$49.00	\$49.00	\$49.00	\$49.00	\$49.00	\$140.00	\$70.00	\$70.00	\$49.00	\$49.00									
																	Total Cost							
												Sediment			\$987.00		\$2,905.00							

Quality Control Checklist

Name:

Collection Date:

Sample ID:

QC of Lab Results from Energy:

Answer each question with either a 'yes' (Y) or 'no' (N) or the appropriate parameter and provide your initials and the date at the end of each question. Highlight any parameters that do not meet quality control standards.

Shipping container/cooler in good condition?
Custody seals intact on shipping contained/cooler?
Custody seals intact on sample bottles?
Chain of custody present?
Chain of custody signed when relinquished and received?
Chain of custody agrees with sample labels?
Samples in proper container/bottle?
Sample containers intact?
Sufficient sample volume for indicated test?
All samples received within holding time? (Exclude analyses that are considered field
parameters such as pH, DO, Res CI, Sulfite, Ferrous Iron, etc.)
Container/Temp blank temperature
Water – VOA vials have zero headspace?
Water – pH acceptable upon receipt?
QC from completed Matrix:
Analyses carried out as described within the SAP?
Reporting detection limit met the project-required detection limit?
All blanks were less than the project-required detection limit?
If any blanks exceeded the project-required detection limit, is associated data is flagged?

_____ Laboratory blanks/duplicates/matrix spikes/lab control samples were analyzed at a minimum 10% frequency?

_____ Laboratory blanks/duplicates/matrix spikes/lab control samples were all within the required control limits defined within the SAP? _____

Example QAQC matrix

Below is an example of a matrix for use in addressing whether all data quality criteria are met for each analyte for each batch of samples. This table can be created using the thresholds from tables 16 and 17 in this SAP. QC numbers from the lab and calculated from the field are filled in, and compared to thresholds to perform QC checks.



Data qualifiers and descriptions

Result Qualifier	Result Qualifier Description
В	Detection in field and/or trip blank
D	Reporting limit (RL) increased due to sample
	matrix interference (sample dilution)
Н	EPA Holding Time Exceeded
J	Estimated: The analyte was positively identified
	and the associated numerical value is the
	approximate concentration of the analyte in the
	sample.
R	Rejected: The sample results are unusable due
	to the quality of the data generated because
	certain criteria were not met. The analyte may
	or may not be present in the sample.
U	Not Detected: The analyte was analyzed for, but
	was not detected at a level greater than or equal
	to the level of the adjusted Contract Required
	Quantitation Limit (CRQL) for sample and
	method.
UJ	Not Detected/Estimated: The analyte was not
	detected at a level greater than or equal to the
	adjusted CRQL or the reported adjusted CRQL is
	approximate and may be inaccurate or
	imprecise.

QA/QC Terms

Accuracy. A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low bias.

Analyte. Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias. Often used as a data quality indicator, bias is the degree of systematic error present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed.

Blind sample. A type of sample used for quality control purposes, a blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Comparability. A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness. A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

Data users. The group(s) that will be applying the data results for some purpose. Data users can include the monitors themselves as well as government agencies, schools, universities, businesses, watershed organizations, and community groups.

Data quality indicators (DQIs). DQIs are attributes of samples that allow for assessment of data quality. These include precision, accuracy, bias, sensitivity, comparability, representativeness and completeness.

Data quality objectives (DQOs). Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include data quality indicators (DQIs) such as accuracy, precision, representativeness, comparability, and completeness. DQOs specify the quality of the data needed in order to meet the monitoring project's goals. The planning process for ensuring environmental data are of the type, quality, and quantity needed for decision making is called the **DQO process.**

Detection limit. Applied to both methods and equipment, detection limits are the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain and report as greater than zero.

Duplicate sample. Used for quality control purposes, duplicate samples are two samples taken at the same time from, and representative of, the same site that are carried through all assessment and analytical procedures in an identical manner. Duplicate samples are used to measure natural variability as well as the precision of a method, monitor, and/or analyst. More than two duplicate samples are referred to as *replicate samples*.

Environmental sample. An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Equipment or rinsate blank. Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see *field blank*).

Field blank. Used for quality control purposes, a field blank is a "clean" sample (e.g., distilled water) that is otherwise treated the same as other samples taken from the field. Field blanks are submitted to the analyst along with all other samples and are used to detect any contaminants that may be introduced during sample collection, storage, analysis, and transport.

Instrument detection limit. The instrument detection limit is the lowest concentration of a given substance or analyte that can be reliably detected by analytical equipment or instruments (see *detection limit*).

Matrix. A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Measurement Range. The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method detection limit (MDL). The MDL is the lowest concentration of a given substance or analyte that can be reliably detected by an analytical procedure (see *detection limit*).

Precision. A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Relative percent difference (RPD) is an example of a way to calculate precision by looking at the difference between results for two duplicate samples.

Protocols. Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Quality assurance (QA). QA is the process of ensuring quality in data collection including: developing a plan, using established procedures, documenting field activities, implementing

planned activities, assessing and improving the data collection process and assessing data quality by evaluating field and lab quality control (QC) samples.

Quality assurance project plan (QAPP). A QAPP is a formal written document describing the detailed *quality control* procedures that will be used to achieve a specific project's data quality requirements. This is an overarching document that might cover a number of smaller projects a group is working on. A QAPP may have a number of sample analysis plans (SAPs) that operate underneath it.

Quality control (QC). QC samples are the blank, duplicate and spike samples that are collected in the field and/or created in the lab for analysis to ensure the integrity of samples and the quality of the data produced by the lab.

Relative percent difference (RPD). RPD is an alternative to *standard deviation*, expressed as a percentage and used to determine precision when only two measurement values are available. Calculated with the following formula:

RPD as % = ((D1 – D2)/((D1 + D2)/2)) x 100 Where: D1 is first replicate result D2 is second replicate result

Replicate samples. See duplicate samples.

Representativeness. A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Sample analysis plan (SAP). A SAP is a document outlining objectives, data collection schedule, methods and data quality assurance measures for a project.

Sensitivity. Related to *detection limits*, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. The more sensitive a method is, the better able it is to detect lower concentrations of a variable.

Spiked samples. Used for quality control purposes, a spiked sample is a sample to which a known concentration of the target analyte has been added. When analyzed, the difference between an environmental sample and the analyte's concentration in a spiked sample should be equivalent to the amount added to the spiked sample.

Split sample. Used for quality control purposes, a split sample is one that has been equally divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods.

Standard reference materials (SRM). An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest. Employed in the determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

Standard operating procedures (SOPs). An SOP is a written document detailing the prescribed and established methods used for performing project operations, analyses, or actions.

True value. In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

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Bookmark not defined.	
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Appendix A. Sample site descriptions, directions, and pictures

Note about sampling order:

The sample sites can be visited in any order, but directions for Mainstem Owl Creek, Sioux Pass Creek, Southern Little Owl Creek, and Upper Bear Creek start downstream (Northwest) and head upstream (South East). The following order is recommended.

Little Bighorn River- Treatment Plant (AWW_LB_TRPT)

Latitude/Longitude: 45.59336, -107.46501 NAD83

Driving Directions: From downtown Crow Agency, head west on Makawasha Ave. After the overpass, turn left onto Long Street. (There are two streets in a row named "Long", take the second, longer street which is dirt). Head south on this road until it dead ends into the Little Bighorn River at the water treatment plant.

Site Description: There are multiple ways to access the River near the intake. It is non-wadable. Discharge measurements come from a gauge, so there is no need to take a flow measurement here.



View from the road, approaching the river, treatment plant, and parking area



The intake for the treatment plant



Upstream



Downstream

Owl Creek- Mainstem Owl (AWW_OC_MSTM)

Latitude/Longitude: 45.28913, -107.3482 NAD83

Driving Directions: Head South on Owl Creek road (from the Lodgegrass/I-90 overpass), turn right onto 40 Mile Road. Go 0.6 miles and park just before the bridge.

Site Description: Access appears safest on the downstream side of the bridge. About 5 meters downstream of the bridge there is a slight constriction, measure discharge here. This is a wadable site.

Notes: The access road is a maintained, county road.



View from parking on north side of bridge



Downstream, view of sampling location.



Upstream

Sioux Pass Creek - Sioux Pass (AWW_SC_SXPS)

Latitude/Longitude: 45.25631, -107.29368 NAD83

Driving Directions: Head South on Owl Creek Road (from the Lodgegrass/I-90 overpass). Approximately 2.9 miles after 40 Mile Road, look for a yellow right hand turn sign followed immediately by a yellow 'pavement ends' sign. Turn right onto Owl Creek Road (which is now a gravel road). At this turn, reset your odometer. At approximately 0.6 miles, you reach the first creek crossing. You will see the creek pass under the road, park here.

Site Description: On the downstream side of the culvert/road, there is a large, grassy bench to facilitate safe access to the stream. Walk approximately 6 meters downstream to where a slight constriction is. Get your discharge measurement here. **Notes:** Public access, county-maintained road.







Downstream, sampling location



Upstream

Little Owl Creek – Southern Little Owl (AWW_OC_SOLO)

Latitude/Longitude: 45.1787, -107.20461 NAD83

Driving Directions: Head South on Owl Creek Road (from the Lodgegrass/I-90 overpass). Look for a yellow right hand turn sign followed immediately by a yellow 'pavement ends' sign. Turn right onto Owl Creek Road (which is now a gravel road). At this turn, reset your odometer. (If you were to continue straight on the original paved Owl Creek Road, it would have turned to gravel and become Sioux Pass Road). Continue on the gravel Owl Creek Road (you drive past the Sioux Pass Creek site at mile 0.6). At 1.4 miles, Owl Creek Road makes a right turn. Stay left on Bear Creek Road. At 8.5 miles, park on the side of the road.

Site Description: Upstream of the culvert appears to have less vegetation and easier access.

Notes: Easy access, county maintained road.



Parking looking North



Parking looking South



Downstream



Upstream, sample site

Bear Creek- Upper Bear Creek Site (AWW_BC_UPBC)

Latitude/Longitude: 45.13511, -107.18011 NAD83

Driving Directions: Head South on Owl Creek Road (from the Lodgegrass/I-90 overpass). Look for a yellow right hand turn sign followed immediately by a yellow 'pavement ends' sign. Turn right onto Owl Creek Road (which is now a gravel road). At this turn, reset your odometer. (If you were to continue straight on the original paved Owl Creek Road, it would have turned to gravel and become Sioux Pass Road). Continue on the gravel Owl Creek Road for 1.4 miles, where Owl Creek Road makes a right turn. Stay left on Bear Creek Road (you pass the Upper Owl Creek Site at 8.5 miles). At 11.8 miles from where you initially reset your odometer, you reach a fork. At this fork, the right road continues to the Moss Stark Ranch. Instead, take the left fork, and continue on to the location where Bear Creek crossed the road at 12.2 miles.

Site Description: Sample on the downstream side of the culvert where there is a larger bench.

Notes: Sample site located on Crow Tribal Trust land. The gravel/dirt road is rutted out in places, prone to being greasy after rain, and snow drifts might be present in the early spring. A 4-wheel drive vehicle is highly recommended. PVC pipes in multiple diameters are present, perhaps remnants of groundwater wells?



The turn around and parking location.



The upstream side of the road and culvert. the road and parking location.



The downstream side of the culvert. sample here.

Little Bighorn - Spear Sighting Site (AWW_LB_SPST)

Lat/Long: 45.18078, -107.38806 NAD83

Driving Directions: From Lodegrass, drive south on the frontage road. Continue South approximately 9.5 miles until you reach a bridge. Park on the side of the road **Site Description:** This site is at a bridge over the Little Big Horn River. This site is non-wadable. Discharge measurements will come from a gauge. Macrophyte growth is evident down-stream of the bridge proximal to the right bank.

Notes: In the Bighorn River QAPP, this site is known as (LBHR-050). Historically, this has been a grab sample site but the exact locality is not known.





Spear Sighting bridge

Spear Sighting bridge, looking downstream



Spear Sighting bridge, looking upstream

Appendix B. Standard Operating Procedures

B.1 Field Supply Checklist

General

- Field Visit Forms
- □ Crow Metals SAP/SOP
- Hand Held Thermometer for Measuring Air Temperature
- □ Cell phone and phone numbers (for emergencies)
- □ Field forms/data sheets (photocopied, preferably on "Rite-in-the-Rain" paper)
- □ Clipboard & pens/pencils & Sharpies (waterproof markers)
- Calculator
- First aid kit
- Trash bag
- Sunscreen, insect repellent
- 🗆 Rain gear
- Hip boots/waders
- Paper towels
- □ Kim-wipes
- □ Clear packing tape (for covering bottle labels and shipping samples)
- Ziploc freezer bags (gallon-size) for ice
- □ Ice (cubed)
- □ Nitrile, powderless (latex-free) gloves
- 🗅 Life jacket

Physical Attributes

- Stream Flow Datasheet
- 🗆 GPS unit
- □ Extra batteries for GPS (probably AA)
- □ Maps (topographic, if needed) *optional*
- Digital camera (with additional memory card and battery)
- □Marsh McBirney Flow meter
 - top setting rod
 - 2 extra D batteries
 - □ 1 tape measure (100 ft)
 - 4 chaining pins or bank stakes
 - □ 1 hammer *optional*
- 🗅 YSI 556 meter
 - \square pH 7.00, pH 10.00, 447 μS TDS (specific conductivity) calibration solutions
 - calibration log
 - users manual
 - □ extra batteries for YSI (4 C batteries)
 - Phillips screwdriver for changing batteries
 - □ Tap water for rinsing YSI probe and storage in the YSI cup after sampling
- I small squirt bottle of deionized (DI) water to clean YSI meter probes
- □thick waterproof black marker

Continued on next page.

Water Samples

- □ Site Visit Form
- DI water (for chemistry blank when applicable)
- Cooler containing:
 - plastic sample bottles
 - □chain-of-custody forms and
 - pre-paid mailing label (Energy Labs)

Sediment Samples (materials for needed for one site)

- □ 1 1L wide mouth glass bottle
- □ 1 large plastic spoon or turkey baster
- 1 1000 ml squeeze bottle (or squirt bottle) of dilute nitric acid (5%) for washing equipment between sites (1 ampule of nitric acid to 1000mL of DI water
- □ 1 1000 ml bottle of DI water for rinsing equipment after acid wash
- □ 1 1000 ml plastic bottle to fill with stream water
- □ 1 large cooler for sample storage on ice

B.2 Field Preparation – YSI Calibration & Care Instructions

(Adapted from a QAPP for the Gallatin Volunteer Monitoring Program written by Tammy Crone)



Figure 3.1 Probe Module

Figure 1: Probe Module from the YSI 556 Manual

YSI 556 Care

- Before calibrating the YSI, check the condition of all of the probes
 - The pH glass bulb at the end of the probe should be clear. If it is starting to get cloudy or if you notice the pH taking a long time (> 5min) to calibrate then consider replacing the pH probe
 - Inspect the membrane on the dissolved oxygen probe. The membrane should be clear and not cloudy/dirty or scratched. There should not be bubbles under the membrane.
 - Check all probes to make sure they are free of sediment or buildup that may have accumulated since the last time it was used.

Calibration Hints and Tips

- Calibration solutions should ideally be stored at room temperature and calibration should be performed at room temperature.
- The transport/calibration cup that comes with the probe serves as a calibration chamber for all calibrations and minimizes the volume of calibration solutions required.
- Ensure all sensors are immersed in the calibration solution. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.
- Make sure to loosen the seal of the transport/calibration cup prior to the DO calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe (Figure 1).
- Put some deionized (DI) water at ambient temperature to rinse the probe between calibration solutions.
- Have several clean, absorbent paper towels or Kim-wipes available to dry the probe between rinses and calibration solutions. Shake excess rinse water off the probe. Dry off the outside of the probe and sensor guard. (Making sure the probe module is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.

Probe Inpection

- Ensure the o-ring is installed in the o-ring groove of the transport/calibration cup and that the bottom cap is securely tightened. NOTE: Do not overtighten!
- Remove the probe sensor guard, if installed.
- Remove the o-ring, if installed, from the probe and inspect for defects. Replace with extra o-ring if defects found.

Probe Storage

• Store the probe with about half an inch of tap water in the storage cup.

Accessing the Calibration Screen

- 1. Press the **On/Off** key to display the **Run** screen.
- 2. Press the Escape key to display the main menu screen (figure 2).
- 3. Use the arrow keys to highlight **Calibrate** (figure 3).
- 4. Press **Enter** key. **Calibrate** screen is displayed. Conductivity will automatically be highlighted on this screen.



Figure 1. Bottles of solution for each calibration solution for rinsing.

Main 1	Menu
Run	
Report	
Sensor	
Calibrate	
File	
Logging setup	
System setup	
01/20/2001 13:41:42	736.4mmHg ⊉∎
Figure 2. Main N	Aenu Screen



Conductivity Calibration

- 1. Go to Calibrate screen as described above.
- 2. Highlight **Conductivity** and press **Enter**. The Conductivity Calibration Screen is displayed.
- 3. Specific Conductance parameter will automatically be highlighted. Press Enter
- 4. Remove the clear plastic transport/calibration cup (picture 1).
- 5. Pre-rinse the conductivity sensor with a little bit of the **1413 standard conductivity calibration solution** and then discard into a waste jar.
- 6. Pour enough new 1413 standard into the transport/calibration cup to entirely cover all 3 sensors including the vent hole on the conductivity sensor (~55ml). Tap the probe gently to remove air bubbles. (picture 2)
- 7. Use the keypad to enter the **calibration value** of the standard that is being used. The
- **1413 uS/cm Standard Solution** should be entered as: **1.413** (the 1.413 value may automatically be displayed)
- 8. Press Enter. The Cond Calibration Menu Screen will be displayed.
- *Note:* the YSI is set-up for "temperature compensation". Always use the value for the calibration standard at **25°C**.
- 9. Allow at least one minute for **instrument temperature** to stabilize. The current values of enabled sensors will appear on the screen and will change with time as they stabilize.
- 10. Observe the reading under Specific Conductivity (uS/cm^C). When the reading shows no significant change for ~30 seconds, then record the "Temp of Standard" and record the Specific Conductivity (uS/cm^C) value on the calibration log sheet under "Reading Before Cal" then press Enter key.

If the meter displays a warning similar to "Value out of range, accept anyway?" Do **NOT** accept the value. Recalibrate and try again

- 11. Record the "Set to" values in the YSI Calibration Log (which should be 1413 uS/cm^C)
- 12. Remember to record the **"Expiration Date"** of the solution too
- 13. Press Enter key again, screen will indicate calibration has been accepted.
- 14. Record the new Specific Conductivity (uS/cm^C) value under **"Reading After Cal"** on the calibration log sheet
- 14. Press Enter key again, to return to the Conductivity Calibration Selection Screen.
- 15. Press **Escape** to return to the **Calibrate Menu Screen**.
- 16. Rinse the probe and sensors with DI water



Picture 2

Dissolved Oxygen Calibration in % Saturation

- 1. In the Calibration Screen, use the arrow keys to highlight DO 2 mil PE (Blue).
- 2. Press Enter key. The DO % will automatically be highlighted.
- 3. Press **Enter** key again. The **Enter Baro mmHG screen** will be displayed and the BP will automatically appear because the meter has an internal barometer
- 4. Record the **Barometric Pressure** on the calibration log sheet
- 5. Pour approximately 1/8 inch of water (indicated by arrow 2) in bottom of **transport/calibration cup**.
- * **Do Not** immerse any of the sensors in the water.
- 6. Screw the **transport/calibration cup** onto the probe using only 1 or 2 threads, so it is just hanging on (arrow 1).
- 7. Press Enter key. The DOsat Calibration Menu Screen will be displayed.
- 8. Allow 10 minutes for the **DO probe** to stabilize (and for the temperature to stabilize).
- 9. When the **DO %** reading is stable for 30 seconds, record the **DO%** and **DO mg/L** values in the calibration log.
- 10. Press Enter key to accept the reading.
- ***If the meter displays a warning "Value out of range, accept anyway?" Do NOT accept the value, recalibrate and try again***
- 11. Record the new DO% and DO mg/L values in the YSI Calibration Log
- 12. Press Enter key again. This returns you to the DO Calibration Menu Screen.
- 13. Press Escape key, to return to the Calibrate Menu Screen.

pH Calibration

- 1. In the **Calibration Screen**, use the **arrow keys** to highlight **pH**.
- 2. Press Enter key. The pH Calibration Screen will be displayed.
- 3. Use **arrow keys** to highlight **2-point** option to calibrate the pH sensor.
- 4. Press the Enter key, the pH Entry Screen will be displayed.
- 5. Enter value of pH standard being used ____ NOTE: Always calibrate in 7 buffer first.
- 7. Rinse the pH sensor with little bit of the 7.00 buffer and discard.
- 8. Pour ~35 ml 7.00 buffer into the transport/calibration cup make sure there are no air bubbles in the solution (picture 4).
- 9. Use the keypad to enter the **calibration value** of the **pH standard** being used.
- 10. Press Enter. The pH Calibration Screen will be displayed.
- 11. Allow **1 minute** for temperature to stabilize. **Observe pH reading**. If **no significant change** in **30 seconds**, the record the current pH value under "Reading Before Cal" and the Temperature of the standard under "Temp of Standard"
- 12. Press Enter key. The screen will indicate calibration accepted.
- ***If the meter displays a warning similar to "Value out of range, accept anyway?"
- Do **NOT** accept the value. Recalibrate and try again***
- 13. Record the "Set to" value on the Calibration Log and record the new pH reading under "Reading After Cal"
- 14. Pour used solution into a waste container and rinse the probes with DI water.
- 15. Press Enter key to return to pH Calibration Screen, continue with the second point of calibration for pH 10.00 (repeat steps 5-13).
- 16. Press Enter to return to the pH Calibration Screen. Press Escape twice to return to the data logging menu.



Picture 4

B.3 Field Preparation – Marsh McBirney Zero Check

Marsh McBirney Zero Check

(Instructions from the Marsh McBirney manual)

Once a week, a zero check should be performed on the Marsh McBirney to ensure that the meter is reading accurately

- 1. First gently clean the sensor with soapy water because oil film buildup on the sensor bulb can cause noisy readings
- 2. Fill a 5 gallon bucket with water
- 3. Attach the bulb to a top setting rod and place the bulb 3 inches from the bottom of the top setting rod.
- 4. Place the sensor in the bucket of water making sure to keep the sensor at least 3 inches away from all sides of the bucket.
- 5. Wait 10-15 minutes and make sure the water is not moving. If the meter reads zero, it is in good shape. If it does not read zero, continue to step 6.
- 6. To start the zeroing sequence, press the STO and RCL keys at the same time. You will see a number 3 on the display.



7. Push the down arrow key until the number reaches zero



8. The number 32 should be displayed



9. The unit will decrement itself to zero and turn off. The unit is now zeroed

Note:

Once a year or at least every few years the Marsh McBirney should be checked against a known velocity. This can be done by using the meter in a flume where you know the exact velocity (i.e. hydrology lab at MSU), sending the meter into Marsh McBirney to be calibrated, or comparing the readings against a different meter that you know is accurately recording velocity.

B.4 Discharge (Flow)

Concept

Discharge (flow) is the volume of water moving past a point in a stream in a given amount of time. The most common unit for discharge is cubic feet per second (CFS) or cubic meters per second. If you know the discharge in a stream and the concentration of a pollutant in the stream, you can calculate the total amount of the pollutant moving downstream. Discharge is also important for understanding behavior of parameters like temperature in a stream.

Discharge readings are usually taken after chemistry samples are taken because the bottom of the channel is disturbed when measuring discharge which can affect water quality.

Procedure

Select a good cross section by looking for the following:

- A relatively straight portion of channel (not on a bend)
- Water is as smooth as possible (not turbulent)
- Water is moving downstream across the entire width (no backwater areas)
- Avoid undercut banks or section with obstacles (such as large rocks or debris)
- Make sure you are capturing all of the flow (there are no side channels)
- It is ideal to select a location with no islands. However, a discharge can be taken where an island exists, if the tape is stretched over the island and measurements are taken on both sides of the island.

Finding a good cross section may require altering the stream by removing debris, rocks, or algae. If you do alter the channel, make sure you do it before starting the measurement.

- Stretch a measuring tape across channel perpendicular to the flow with the zero end of the tape at the left bank. The left bank is on the left side when looking downstream.
 - Secure the tape with stakes or objects on the bank. Make sure the tape is taut and does not sag in the middle.
 - Record the measurement on the tape at the left and right edges of water. Use these
 numbers to determine the wetted width of the channel.
- Based on the wetted width of the channel, determine the distance between measurement increments.
 - Select a length that will give you at least 20 measurements across the width. An easy way to
 do this is to divide the wetted width by 20 and round down to a convenient number.
 - Start at the left wetted edge of the channel and record zero depth and zero velocity on the discharge datasheet for that location.
 - Move over with the top setting rod one length increment away from the left bank to make the first measurement. Make sure you are standing downstream and away from the rod to avoid your legs altering the flow and affecting the measurement.
 - Measure and record the depth. The increments on the rod are in tenths of feet.

- Adjust the top setting rod so the measurement bulb is at the correct depth and is facing upstream. If the stream is less than 2 feet deep the measurement is taken at 60% depth (60% of the way down from the surface). If the water is more than 2 feet deep, two measurements are taken and averaged, one at 20% and one at 80% depth.
 - Depth less than 2 ft example: if the water is 1.8 feet deep, align the 1 on the sliding rod with the 8 on the handle of the rod. This will place the bulb at 60% of the 1.8 ft depth.
 - Depth more than 2 ft example: if the water is 2.6 ft deep, the rod is set at half and then twice the depth for the two readings. Two times 2.6 is 5.2 so you align the 5 on the slider with the 2 on the handle which places the bulb at 20% of the depth. Half of 2.6 is 1.3 so you align the 1 on the slider with the 3 on the handle which puts the bulb at 80% of the depth.
- Once you have positioned the bulb, press the "On/c" button to start the velocity measurement and hold the rod stationary for 30 seconds. You should see a bar move across the screen as the meter averages the velocity over the 30 second period. Record the velocity on the datasheet.
- Repeat the depth and velocity measurement for each increment across the channel.
- The final measurement should be on the right bank with zero velocity and zero depth.



B.5 Field Parameter Measurements, Grab Water Samples, Stream Sediment Samples

Do not wade at a sample site if it does not seem safe. Always wear a life jacket and work in pairs.

Field Measurements (YSI)

Gently place the YSI probe far enough into the stream that it is in actively moving water. The probe is delicate and should never be thrown into the water. The probe should be left to equilibrate for at least 5 minutes. Once numbers have stabilized, record Temperature, pH, Specific Conductance, Conductivity, Dissolved Oxygen mg/l, Dissolved oxygen percent saturation, and barometric pressure on the field visit form.

	Log of	Run Menu ne sample	
Temperat	<u>Start</u> UIC	-9.99°c	28.70 _₽ H
Specific C	ond	0.003	
Raw Co	ond	-1,µ\$⁄tm	
DO % 9	Sat	6.5 _{00%}	
DO mg	ı/L	4.66 0 5	
	02/06	/2000 01:41:33	735.9mmHg 1

After measurements are completed, rinse the probe and replace the storage cup with half an inch of tap water to keep the probes moist.

Place a handheld thermometer in the shade to determine air temperature and record this value on the field visit form.

Water Sample Collection and Bottle Labeling

- 1. All samples (including quality control samples) should be labeled with a permanent marker before being filled and then covered with clear packing tape so that the labeled information does not smear. Labels should include:
 - a. Date and time (military time)
 - b. Sample ID (includes year, month, day, site ID, QC sample type, and sample type)

Sample ID = Year-Month-Day-SiteID-Sample QC Type Letter – Sample Type Letter

QC Type Letter

- A = Regular Sample
- B = Duplicate Sample
- C = Blank Sample
- Sample Type Letter
 - W = Water
 - S = Sediment
- Company Name (Client): Apsaalooke Water and Wastewater Authority (AWW)) will be added to sample ID before being uploaded to the database. This will be exempt from the bottle labels due to the limited space to write the sample IDs
- 3. Samples will be collected in a well-mixed portion of each stream.
- 4. Bottles and lids shall be rinsed three times with stream water prior to sampling. During sampling, the sample bottle opening should face upstream and should be drawn through the water column once, carefully avoiding disturbance of bottom sediments.
- 5. One set of quality control (QC) samples consisting of blanks and duplicates will be collected for each sampling event

- a. A field blank is prepared by transporting laboratory-grade deionized (DI) water to the field and pouring it into sample containers provided by the lab. The blank will be prepared at the same time that the samples are collected from the stream. The bottle for the blank should be triple rinsed with DI water before being filled with DI water.
- b. A duplicate sample is a second stream sample collected at the same time in the same way that the regular stream sample is collected.
- c. Duplicate and blank samples will be collected at the same location for each event but the site they are collected at will rotate through the sample sites for subsequent sample events.
- 6. Blank and duplicate samples are handled and delivered to the lab in the same manner that regular samples are handled.

Sample ID Examples at a QC site where water and sediment samples are collected: A regular water sample collected at the Upper Bear Creek site on June 15th, 2011 would be labeled:

20110615- BCUPBC-A-W

A **duplicate** at the same place and time as above: 20110615- BCUPBC-B-W

A **blank** at the same place and time as above: 20110615- BCUPBC-C-W

A **regular sediment sample** collected at the Upper Bear Creek site on June 15th, 2011 would be labeled:

20110615- BCUPBC-A-S

A **duplicate** at the same place and time as above:

20110615- BCUPBC-B-S

A water sample for sieving collected at the same place and time as above: 20110615- BCUPBC-SIEVING

Stream Sediment Collection for Metals Parameters

(modified from MTDEQ sediment samples for metals protocol 2012)

Sediment samples are collected to measure the potential for heavy metals to become suspended in the waterbody during high flows. They are a better representation of cumulated impacts of metals.

- 1. Appropriately label one 1-L glass jar and one 1-L plastic bottle
- 2. Identify at least 5 wadeable deposition zones of VERY fine bed sediment that are representative of the stream reach; identify additional zones as necessary.
- 3. Scoop sediment from the streambed with a non-metallic spoon or turkey baster and place it in the 1L glass jar.
- 4. Rinse the equipment with ambient stream water between each depositional zone.
- 5. Scoop enough sediment from your depositional zones at each site to fill the jar 3/4th full. (Try to minimize the amount of water that gets into this jar)
- 6. Collect a 1L bottle of stream water (this will be used by the lab in the wet sieving process)

- 7. After you are finished collecting the sediment at each site, rinse all equipment with dilute nitric acid (5%). Rinse equipment again with DI water after acid wash is complete
- 8. Ensure all lids are tight; bottles are labeled, and store them on ice in a cooler until delivery to the laboratory for analysis.
- 9. For duplicate samples, scoop a sediment sample that is next to each original sediment sample for each of your depositional zones at your QC site. It will be easiest to collect your sample and duplicate at the same time to ensure you are collecting duplicate samples that are as close to your original samples as possible.

Packaging Samples for Shipment

- 1. Samples need to be kept on ice or in a refrigerator until shipping. The holding time for the samples is 7 days. This means that the lab needs to process these samples within 7 days.
- Samples should be shipped as quickly after collection as possible but need to be shipped on a Monday or Tuesday and not later than Wednesday. Next day delivery is ideal, but if outside temperatures aren't too high, two day delivery would work too. Samples need to be shipped so they do not arrive on a weekend.
- 3. Samples should be packaged immediately before shipping to avoid unnecessary loss of ice before shipping.
- 4. Organize all samples on a table, grouped by site, in the order they were collected.
- 5. Check that all sample labels are completely filled out.
- 6. Fill out the chain of custody for the testing laboratory (in pen not pencil). This includes listing all of the sample IDs and sampling times. See the completed example on the following page.
- 7. Place a large trash bag inside the cooler. This bag will hold all of the samples and be tied off at the end to prevent any liquids from leaking from the cooler.
- 8. Place all the glass bottles back in the bubble wrap protectors and send them in one cooler. Fill the other coolers with the water samples.
- 9. Fill a minimum of 2 gallon ziplock bags with ice purchased from a store or ice from your freezer (whichever is more convenient) to include with the samples. The volume of ice should be at least equal to that of the samples.
- 10. Place all of the samples and the bagged ice inside the trash bag, inside the cooler and tie off the top of the trash bag.
- 11. Place the COC inside a ziplock bag and tape it to the top of the cooler.
- 12. Close the cooler and tape it closed. Sign and stick the custody seal on the cooler. Peel the tracking sticker on the UPS prepaid sticker and place it on the pink sheet. Deliver the cooler to the shipping center immediately.
- 13. Timely delivery of samples is critical so the ice doesn't melt. Especially if temperatures are hot, samples need to reach the lab quickly to avoid overheating.

Appendix C: Sampling Schedule and Parameters

Site ID	Site Name	Sampling Event	Parameters
AWW_LB_TRPT	Treatment Plant	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle
AWW_OC_MSTM	Mainstem Owl	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle
	Sioux Pass	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle

Site ID	Site Name	Sampling Event	Parameters
AWW_OC_SOLO	Southern Little Owl	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle
AWW_LB_SPSD	Spear Siding Site	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle
AWW_BC_UPBC	Upper Bear Creek	Base flow (March or April)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL bottle Stream Sediment 1000 mL HPDE bottle for water 1000 mL wide mouth glass jar for stream sediment
		High flow (May or June)	 Water: Dissolved, Total Recoverable, & Supporting Analysis 1000 mL HPDE bottle

Appendix D: Site Visit and Discharge Forms

Crow Metals Sampling Site Visit Form

Date:	Time:	Team Men	nber(s):				Station ID: AWW		Visit #:		
Waterbody:			Site De	scription:				County: Big H	lorn, MT		
HUC:	Latitu	ide:				Longitude:		(Record in d	ecimal degrees)		
Way Point Number	•	GP:	S Datum:	NAD83		Lat/Long Verified?	Ву:				
# SAMPLES COLL Grab Sample Collect	ECTED: tion Method			Dissolved ,	1 L HDPE Total Recov	Bottle — Water erable, & Supporting Analysis	1 Liter Wide Mouth Stream Sed	1 Liter Wide Mouth Glass Bottle Stream Sediment			
SAMPLE ID: (Year Example: 2012061	AonthDay-SitelD-Samp 5-BCUPBC-A	ole Type Letter	t	Aluminum, Magnesium, Soli	Arsenic, Cadr Sodium, Bror ids (TSS), Tota	nium, Lead. Uranium, Calcium, nide , Fluoride, Total Suspended l Dissolved Solids (TDS)	Arsenic, Barium, Beryll Chromium, Copper, Iror Selenium, Thallium,	lium, Cadmium, n, Lead, Mercury, Uranium, Zinc	To accompany sediment sample for wet sieving		
Regular Sample II):										
Duplicate Sample	1D:										
Blank Sample ID:											
Stream Field Mea	asurements:				Current \	Weather (Circle One):					
Water Temperatu	ire:°C	Air Temp	erature:	°C	Cloud Co	ver: <5% 5 - 2	5% 25-75%	75 - 10	0%		
рН: І	3P:mmHg	La Avia			Precipitation: None Light Moderate Heavy						
Specific Conductivi	ty:µS ^c /cm	Turbidity	(Visual):): Past Precipitation (last 24 hour			: None Light Moderate Heavy				
Electrical Conductiv	vity:µS/cm	- C	ear [ight [Flow Method:							
Dissolved Oxygen mg/L	: %sat		urbid [paque [Float Gage Global Flow Meter Flow Mate2000 Dischargecfs						
Site Visit Comment	is:										
Camera Used	Jpeg # (on o	camera)				Photo Desc	ription				
			Lookin	ing Upstream							
			Lookin	g Downstrear	n						
2 m			Lookin	g Across Strea	am						
Chemistry Lab Int	formation:		C. M. Bar			and the second					
Lab Samples Sub	mitted to: Energy	Labs	Acco	unt#: N/A		Date Submitted:	Analytic	al Services Quo	te ID #:		
Invoice Address:							EDD	Format: M	T EQUIS		
Contact Name &	Phone:										
Relinquished By: Date/Time:		Shi Da	pped By (ci te/Time:	rcle one): FEI	DEX UPS	FORM REVIEWED & CH	ECKED BY:				

			Discharge Da	ta Sheet		
Strea	am Name:			Sample Site ID:		
Tean	n Members:					
Date	.:			Time Measureme	nt Started:	
Left	Wetted*		Right Wetted*			
Edge	Measurement:		Edge Measurement:		Wetted Width:	
#	Measurement on Tape	Depth	Velocity	Velocity 2 (for depths over 2ft)	Average Velocity	Section Discharge
1	Left Wetted Edge	0	0			
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
	* Note: left and righ	nt side of channel	are determined when	looking down stre	am.	
R	iver ttle <u>Bighorn Sar</u>	Sampling and Apa	e Site	· · · · · · · · · · · · · · · · · · ·	Date	10.55
					1 48	<u>c</u>

Appendix E: Special Instructions for Energy Labs to Include with Chain of Custody

- o Fill out COC with a pen
- Before the samples are sent out, call Energy Labs to let them know the samples are in transit and that they will need to split the samples. Energy Labs in Helena: 406-442-0711

1. There are two 1 L plastic bottles filled with water. One should stay with the glass jar filled with sediment. Make sure to match up the appropriate water and sediment bottles corresponding to site. There are six (6) sites.

2.. The other 1000mL bottle should be split accordingly to be processed for dissolved and total recoverable metals as well as supporting analyses. See table below:

Water	Parameter	Preferred Method	Alternate Method
Dissolved (D) & Total Recoverable (TR)*	Aluminum** ^D	EPA 200.7	EPA 200.8
	Arsenic ^{D, TR}	EPA 200.8	-
	Cadmium ^{D, TR}	EPA 200.8	-
	Lead ^{D, TR}	EPA 200.8	-
	Uranium ^{D, TR}	EPA 200.8	-
Supporting Analysis*	Calcium	EPA 200.7	EPA 200.8
	Magnesium	EPA 200.7	-
	Sodium	EPA 200.7	EPA 200.8
	Bromide	E300.0	
	Fluoride	A 4500 F-C / Technicon 380-7WE	
	Sulfate	EPA 300.0	-
	Total Suspended Solids (TSS)	EPA 160.2	A2540 D
	Total Dissolved Solids (TDS)	EPA 160.1	A2540 C

* The lab will split samples for dissolved, total recoverable, & supporting analyses. This will include the filtering and preservation

** Aluminum should only be run for dissolved analysis

Continued on other side...

3. The other water bottle should be used for wet sieving. The sediment is to be sieved through a 60 micron sieve

	Parameter	Method
Stream Sediment	Arsenic	EPA 200.7
	Barium	EPA 200.7
	Beryllium	EPA 200.8
	Cadmium	EPA 200.8
	Chromium	EPA 200.8
	Copper	EPA 200.8
	Iron	EPA 200.7
	Lead	EPA 200.8
	Mercury	EPA 7471B
	Selenium	EPA 200.8
	Thallium	EPA 200.8
	Uranium	EPA 200.8
	Zinc	EPA 200.7

4. The sediment samples should be analyzed for the following: