EPA TASK ORDER 19 MONTANA TMDL SUPPORT TASK 4b: 2012 TEMPERATURE DATA COLLECTION

Sampling and Analysis Plan and Quality Assurance Project Plan

Prepared by:

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Approvals

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APPENDICES

Appendix A Continuous Temperature Data Logger Field Form

1.0 Distribution List

Name	Title	Organization	Phone	Email
Lisa Kusnierz	Task Order Manager	U.S. EPA	406 457-5001	Kusnierz.Lisa@epamail.epa.gov
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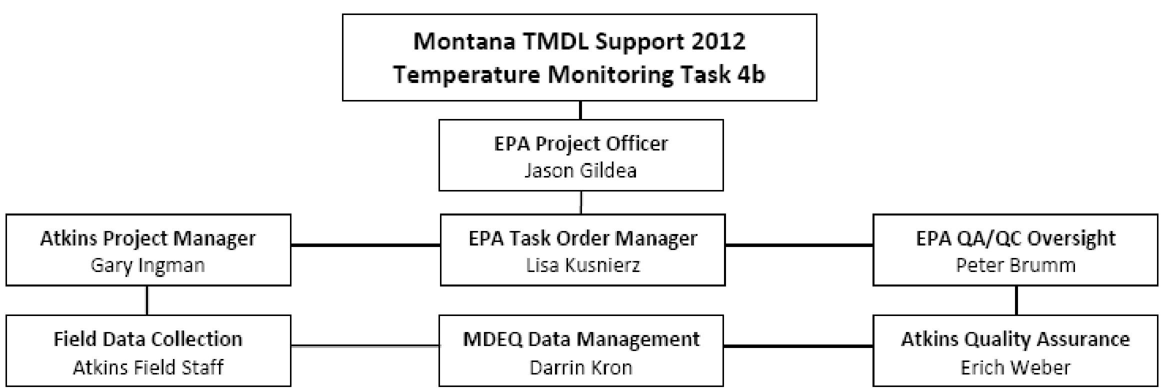
Gary Ingman	Project Manager	Atkins	406 495-1377	gary.ingman@atkinsglobal.com
Jeff Dunn	Project Field Coordinator	Atkins	406 624-3104	Jeff.dunn@atkinsglobal.com
Erich Weber	Project QA Manager	Atkins	406 495-1377	erich.weber@atkinsglobal.com

2.0 Project Task/Organization

Project team members and their respective roles are shown in **Figure 1** below. Atkins field staff will perform the field preparation and water temperature monitoring activities. Erich Weber with Atkins will perform pre- and post-deployment calibration accuracy checks on *HOBO Water Temp Pro v2* temperature loggers and prepare an independent QA review with EPA oversight. Following completion of the temperature logger accuracy check, Atkins will provide the project data and other deliverables in Microsoft Excel spreadsheets to the EPA Task Order Manager and the MDEQ Project Manager. MDEQ will perform QA/QC review of field data and temperature logger data, and upload validated data to the Montana DEQ EQuIS WQX (MT-eWQX) database, as required in the project task order. The Atkins quality assurance manager will be responsible for the original approved QAPP, including making changes and distributing updated copies to managers and field personnel.

Figure 1.



3.0 Project Description

This document constitutes the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for the completion of water temperature assessments and the establishment of reference conditions for selected stream segments in the Fisher, Middle Clark Fork Tributaries and Tobacco TMDL Planning Areas (TPA). Waterbody segments listed as temperature impaired and addressed under Task 4b are included in **Table 1**.

Table 1. ***Waterbody segments listed as temperature-impaired under Task 4b.***

TMDL Planning Area	Segment ID	Waterbody Name
Fisher	MT76C001_020	WOLF CREEK, headwaters to mouth (Fisher River)
Middle Clark Fork Tributaries	MT76M002_130	PETTY CREEK, headwaters to the mouth (Clark Fork River)
	MT76N003_010	LYNCH CREEK, headwaters to mouth (Clark Fork River)
Tobacco	MT76D004_020	FORTINE CREEK, headwaters to mouth (Graves Creek)

Under Montana law, an impaired water body is defined as a water body for which sufficient and credible data indicates non-compliance with applicable water quality standards (MCA 75-5-103). Section 303 of the Federal Clean Water Act requires states to submit a list of impaired water bodies or stream segments to the U.S. Environmental Protection Agency (EPA) every two years. Prior to 2004, this list was referred to as the "303(d) list", but is now named the "Integrated Report". The Montana Water Quality Act further directs states to develop TMDLs for all water bodies appearing on the 303(d) list as impaired or threatened by "pollutants" (MCA 75-5-703).

The purpose of this project is to collect data in selected streams and tributaries to provide sufficient information for TMDL development. Streams requiring additional temperature monitoring at multiple locations include Wolf Creek in the Fisher TPA, Petty Creek and Lynch Creek in the Middle Clark Fork Tributaries TPA, and Fortine Creek in the Tobacco TPA (Table 1).

Possible temperature influences in the basins included in this monitoring may be the result of riparian degradation from land development/subdivision, timber harvest and agriculture, flow alteration during portions of the summer from hydrostructure flow regulation/modification, irrigation diversions, irrigation return flows and/or natural recharge from or infiltration into the alluvium.

4.0 Objectives and Design

The objective of this sampling and analysis plan/quality assurance project plan (SAP/QAPP) is to collect water temperature, flow and solar shading data that will be used to confirm suspected thermal impairments, identify gaining/losing areas for temperature, and to begin to identify areas where the implementation of best management practices would decrease stream temperatures. The results of this study will support the eventual development of temperature TMDLs and allocations for the various TPAs. This SAP/QAPP is specific to the monitoring required under Task 4b. Section 4.1 addresses how the data collected under this QAPP will meet the required inputs for the model. A separate QAPP has been prepared and submitted for the temperature modeling (Task 4c) and TMDL development (Task 4d).

4.1 Study Design

This SAP/QAPP document covers the three listed segments identified under EPA Task Order 19, Task 4b that are in need of additional data to permit TMDL development: Wolf Creek in the Fisher TPA, Petty Creek and Lynch Creek in the Middle Clark Fork Tributaries TPA, and Fortine Creek in the Tobacco TPA. Existing temperature data consist of spot temperature measurements, but no records from temperature loggers or temperature monitoring gauges (USGS, etc.) are available for three of the four stream segments. Temperature data were collected utilizing *HOBO Water Temp Pro v2* temperature loggers from three sites on Wolf Creek during the summer of 2010. Multiple monitoring sites utilizing *HOBO Water Temp Pro v2* temperature loggers will be established in June 2012 on each of the four segments; sites for data logger deployment will be determined based on the following:

- Ability to bracket known sources (e.g., upstream /downstream of tributaries, inputs, etc.)
- Ability to determine a reference/least impacted segment
- Previous monitoring at the site by federal or state agencies.
- Site access and site suitability

Temperature monitoring sites will be established throughout each of the four listed water bodies, as well as on selected major tributary streams to each of the segments. Sites located near the upper end of each segment will serve as a least-impacted reference site for downstream reaches. For QA/QC purposes, a duplicate data logger will be deployed at one randomly-selected monitoring site on each of the four segments, which equates to a 9.3% frequency for quality control samples.

The *HOBO Water Temp Pro v2* temperature data loggers will be programmed to record stream temperature at 30-minute intervals for a period of approximately two months, beginning in late June 2012 and continuing through late-September 2012. Data loggers will be deployed following Standard Operating Procedures (SOPs), with specific deployment and retrieval dates dependent upon task order approval, SAP/QAPP approval, and availability of Atkins personnel to complete the work.

Geospatial data (latitude and longitude in digital degrees, elevation) will determined by GPS (datum: NAD83) for all logger locations at the time of deployment. In-stream water temperature will be measured at the time of data logger deployment and retrieval, and during a mid-deployment visit, using an electronic field meter (YSI 556 or similar) with temperature probe to serve as QC checks. Additional physical parameter measurements, or the collection of water samples for chemical analysis, will not be included in this study design.

Solar shading data will be collected at representative monitoring sites at either the time of temperature logger deployment or retrieval, using a Solar Pathfinder instrument according to SOPs (Shumar and de Varona 2009; Solar Pathfinder, 2008; Platts et al. 1987). The degree of shading provided to each stream reach by riparian vegetation, determined as a percentage of the maximum sunlight available during the month of

August with corrections for magnetic declination from true north, will be recorded mid-stream at three points within each monitoring reach. The first measurement (downstream end) will be made immediately upstream of the logger location, with the second (middle) and third (upstream end) made at intervals of approximately 50 m, for a total reach length of 100 m. The dominant vegetation types present at the three points along each stream reach, estimates of vegetation heights and distances from the channel at bank-full flow, as well as bank-full width, will also be determined for consideration as variables to be factored into the temperature model (see below).

Stream discharge will be measured at each monitoring site at the time of temperature logger deployment and retrieval, and during a mid-deployment visit, using a Marsh-McBirney Flo-Mate model 2000 flow meter according to SOPs. If a stream cannot be waded at a particular monitoring site due to high flow or otherwise unsafe conditions, discharge will be estimated by visual means, or by correlating with values measured at upstream and/or downstream sites.

Data collected from the three listed stream segments under Task 4b, as detailed above, will be utilized to form the basic input for a temperature water quality model (SSTEMP model) as described under Task 4c of the SOW. Data required for the SSTEMP model include continuous temperature measurements through the summer period, flow measurements at temperature logger deployment and retrieval, and shade measurements specific to each stream segment. All information and data identified in this document are critical to the project. The overall strategy in the development of these modeling tools is to evaluate the relative influence of shade and water use on in-stream water temperature.

Potential sources of variability include seasonality of stream flow (i.e., high and low extremes that occur early and late in the monitoring period, respectively) and resultant effects on temperature data loggers deployed in fixed locations. A concerted effort will be made to select prime locations that will remain wetted throughout the data logger deployment period of interest. All temperature data will be carefully evaluated for any evidence indicating a site became dry during the monitoring period, and any discrepancies reconciled to assure data quality objectives are met.

4.2 Sampling Locations

Eight to twelve monitoring sites will be established on each of the three listed stream segments and selected tributaries, based on physical characteristics of the watershed, and available access to each segment (**Table 2; Figures 3, 4, 5 and 6**). Thermograph and streamflow gauging sites were identified by assessment of aerial images and maps, review of DEQ water quality information for each waterbody compiled on the Clean Water Act Information Center (CWAIC) website, and consideration of land ownership and land uses. Reviews of maps and aerial imagery considered areas where stream temperature could be influenced by changes in vegetation cover/land use (e.g. agriculture, silviculture and/or residential subdivision and commercial development) and flow regulation/modification/supplementation (e.g. hydrostructures, irrigation diversions and tributary streams). The rationale for selection of each monitoring site is included in **Table 2**. If during the initial field visit a sampling site is found to be inaccessible due to an ownership issue or physical barrier, or unsuitable because of in-stream conditions, it will be re-located to an alternate location if available. Atkins field personnel will be responsible for making decisions as to the suitability of an identified or alternate site.

5.0 Training Requirements/Certifications

All field monitoring activities will be performed by senior Atkins staff with extensive prior water quality monitoring field experience and training. Field staff will include Gary Ingman and Erich Weber. Field methods described in this project SAP/QAPP document or referenced in other documents will be jointly reviewed in the office by all field staff prior to initiating field monitoring activities.

Training in the deployment and retrieval of the recording thermographs will be provided to field staff by Erich Weber prior initiating that work. Training will address site selection and documentation, completion of site visit forms, and techniques for securely deploying the thermographs in a range of stream types and settings. Training in the use of the Solar Pathfinder instrument for the measurement of sunlight shading will be provided to all field staff involved in thermograph deployment/retrieval, by individual(s) familiar with SOPs through prior field experience with the Solar Pathfinder. The Atkins Project Manager will be responsible for assuring that any training/certification necessary for Atkins field staff to properly conduct monitoring activities is satisfied. Documentation of training/certifications for all Atkins field staff will be maintained in the project file.

Table 2. ***Temperature monitoring locations for 2012 included under task 4b.***

Segment	Site ID	Site Description	Latitude	Longitude	Site Selection Rationale
Wolf Creek	BRSHC	Brush Creek near mouth	48.40220	-114.91380	Major tributary stream
	CALXC	Calx Creek near mouth	48.26960	-115.11750	Major tributary stream
	DRFKC	Dry Fork Creek near mouth	48.35020	-115.04940	Major tributary stream
	LWLFC	Little Wolf Creek near mouth	48.30530	-115.03520	Major tributary stream
	RCHDC	Richards Creek near mouth	48.25840	-115.19970	Major tributary stream
	WLFC-T0.1	Wolf Creek below Weigel Creek	48.47050	-114.97680	Headwaters, upper end of listed reach
	WLFC-T0.2	Wolf Creek above Brush Creek	48.40460	-114.91630	Between tributary streams
	WLFC-T1	Wolf Creek above Wolf Prairie RS	48.35410	-115.03700	Between tributary streams
	WLFC-T1.5	Wolf Creek above Little Wolf Creek	48.30970	-115.03910	Between tributary streams
	WLFC-T2	Wolf Creek above Calx Creek	48.27240	-115.11930	Between tributary streams
	WLFC-T2.5	Wolf Creek above Richards Creek	48.26110	-115.18830	Between tributary streams
	WLFC-T3	Wolf Creek near mouth	48.23333	-115.28446	Lower end of listed reach
Petty Creek	EDSC	Eds Creek near mouth	46.90280	-114.46540	Major tributary stream
	JHNS	Johns Creek near mouth	46.87520	-114.45110	Major tributary stream
	MDSN	Madison Gulch near mouth	46.95520	-114.43350	Major tributary stream
	PRINT	Printers Creek near mouth	46.87360	-114.44940	Major tributary stream
	PTTYC-T1	Petty Creek below confluence of S. Fork Petty Cr. and E. Fork Petty Cr.	46.85270	-114.43840	Upper end of listed reach
	PTTYC-T2	Petty Creek above Johns Creek	46.87300	-114.45070	Between tributary streams
	PTTYC-T3	Petty Creek above West Fork Petty Creek	46.91580	-114.46380	Between tributary streams
	PTTYC-T4	Petty Creek above Spring Gulch	46.93160	-114.44430	Between tributary streams
	PTTYC-T5	Petty Creek 0.25 mile above Madison Gulch	46.95070	-114.43180	Between tributary streams
	PTTYC-T6	Petty Creek above Reservoir Creek	46.98660	-114.44930	Lower end of listed reach
	RSRV	Reservoir Creek near mouth	46.98690	-114.45070	Major tributary stream
	WFPTY	West Fork Petty Creek near mouth	46.91630	-114.46370	Major tributary stream
Lynch Cr.	CEDRC	Cedar Creek near mouth	47.56950	-114.88350	Major tributary stream
	CLRKC	Clark Creek near mouth	47.54430	-114.88080	Major tributary stream
	LYNHC-T1	Lynch Creek 1.3 miles upstream of T2	47.58550	-114.89810	Upper end of listed reach
	LYNHC-T2	Lynch Creek above Cedar Creek	47.56940	-114.88400	Between tributary streams
	LYNHC-T3	Lynch Creek above Clark Creek	47.54620	-114.88340	Between tributary streams
	LYNHC-T5	Lynch Creek 1.25 miles upstream of T6	47.53190	-114.88220	Between tributary streams
	LYNHC-T6	Lynch Creek south of Dump Road	47.51280	-114.88770	Between tributary streams
	LYNHC-T7	Lynch Creek near mouth	47.49420	-114.91690	Lower end of listed reach
Fortine Creek	DEEP	Deep Creek near mouth	48.76120	-114.89150	Major tributary stream
	EDNA	Edna Creek near mouth	48.64540	-114.91340	Major tributary stream
	FRTNC-T1	Fortine Creek above Basin Creek	48.54500	-114.95330	Upper end of listed reach
	FRTNC-T2	Fortine Creek above Swamp Creek	48.59900	-114.95890	Between tributary streams
	FRTNC-T3	Fortine Creek above Edna Creek	48.64420	-114.91110	Between tributary streams
	FRTNC-T4	Fortine Creek below Lime Creek	48.67340	-114.89870	Between tributary streams
	FRTNC-T5	Fortine Creek above Brimstone Creek	48.70220	-114.88100	Between tributary streams
	FRTNC-T6	Fortine Creek above Deep Creek	48.75990	-114.89990	Between tributary streams
	FRTNC-T7	Fortine Creek near mouth	48.79340	-114.95430	Lower end of listed reach
	MDWC	Meadow Creek near mouth	48.77570	-114.93520	Major tributary stream
	SWMP	Swamp Creek near mouth	48.60180	-114.97000	Major tributary stream

**All sites are subject to change based on flow conditions and availability of access.*

Figure 2. *Wolf Creek temperature monitoring locations.*

Figure 3. *Petty Creek temperature monitoring locations.*

Figure 4. *Lynch Creek temperature monitoring locations.*

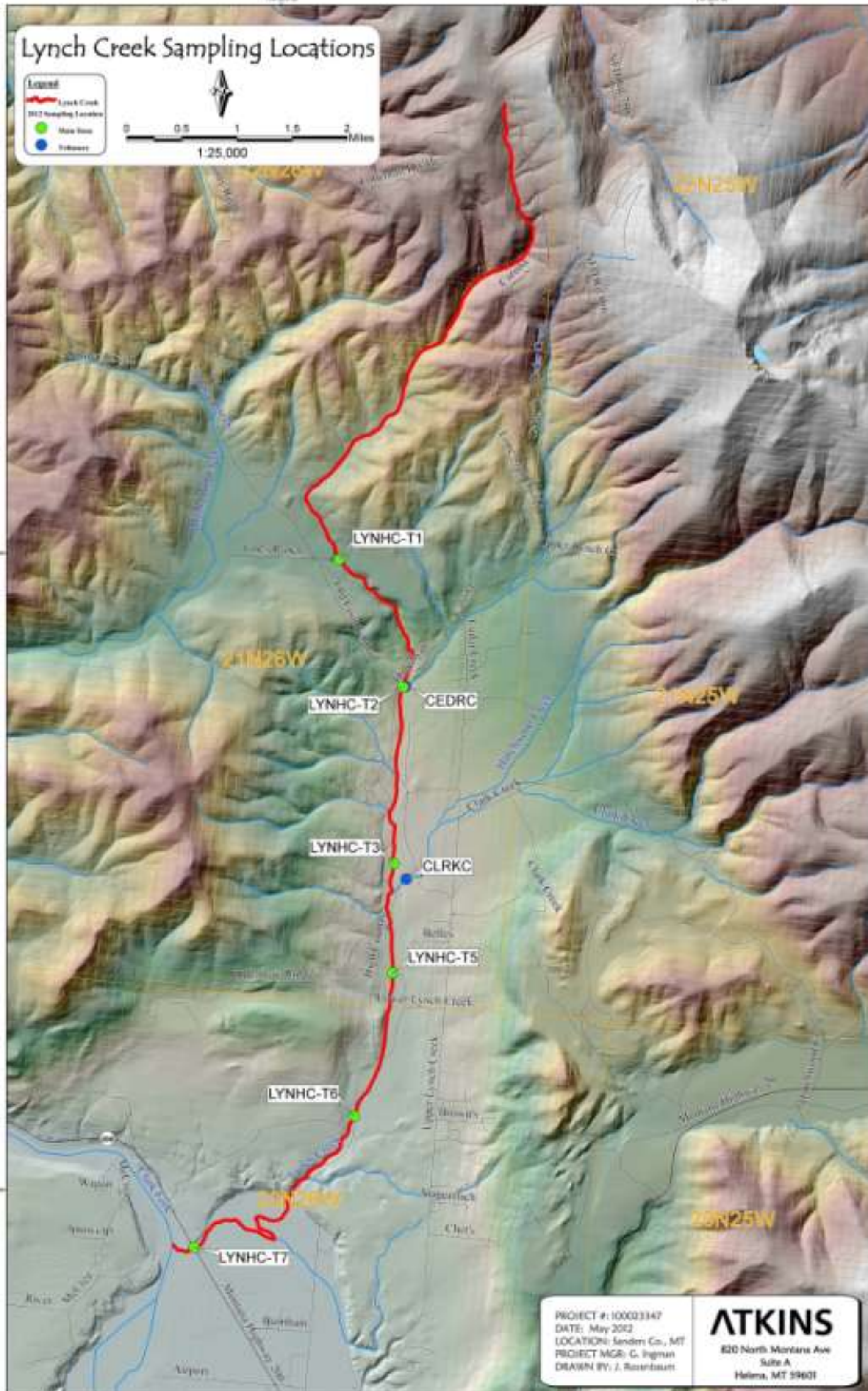


Figure 5. *Fortine Creek temperature monitoring locations.*

6.0 Documentation and Records

Thermograph field deployment forms will be completed on-site by field personnel prior to leaving each field monitoring location. Site visit forms, field photographs and photo logs will be compiled by field personnel and delivered to the Atkins quality assurance officer upon return to the office. The Atkins quality assurance officer will perform the required quality assurance reviews on the field data and prepare the project data deliverables. **Table 3** lists who should receive project data, and in what format. All original site visit forms, field notes, field photos, and photo logs will be provided to the EPA task order manager upon completion of the project. Backup copies of the above will be maintained by the Atkins project manager in Atkins project files for a period of three years, and archived electronically beyond that for an indefinite period of time. Electronic copies of those project data specified in Section 2.0 will be formatted for inputting to the MT-eWQX database, with verification of uploads provided to the EPA task order manager by MDEQ upon completion. Temperature logger data files in Excel spreadsheet (EDD) format will be stored electronically, and copies distributed on DVD and/or other portable electronic media only rather than as hard copies, which are extremely voluminous and of little practical use. Upload of temperature logger EDD files and field data to MT-eWQX will be performed by MDEQ.

Table 3. ***Repository for Project Data Records.***

Data Report	Original (hard copy) to:	Copy or pdf to:	EDD to:
Field Data Sheets	EPA TO Manager	Tetra Tech TO Leader, Atkins PM	EPA, MDEQ
Field Photos and Logs	EPA TO Manager	Tetra Tech TO Leader, Atkins PM	EPA, MDEQ
Field Notes	EPA TO Manager	Tetra Tech TO Leader, Atkins PM	EPA, MDEQ
Thermograph Files	EPA TO Manager	Tetra Tech TO Leader, Atkins PM	EPA, MDEQ
Data QA/QC Review Forms	EPA TO Manager	Tetra Tech TO Leader, Atkins PM	EPA, MDEQ

7.0 Field Sampling Methods

The study will employ the *HOBO Water Temp Pro v2* data logger, with associated hardware and software to permit pre- and post-deployment accuracy checks and data downloads. Monitoring (including instrument accuracy checks) will be done in accordance with the MDEQ's Field Procedures Manual (DEQ, 2005). A site form (Continuous Data Logger Field Form, Appendix A) will be completed for each site that includes GPS coordinates, time, weather, a hand drawn site sketch indicating temperature logger locations and any other observations. The site will be marked with flagging tape, and digital photographs taken and logged on the field form. Instantaneous stream discharge will be measured at the time of data logger deployment and again upon retrieval, using a *Marsh McBirney Flo-Mate 2000*™ electronic current velocity meter and standard USGS area-velocity method. If low flow conditions prevent the use of the velocity meter, discharge will be estimated using the timed float method. Sunlight/shade data will be collected at the time of temperature logger deployment or retrieval using a Solar Pathfinder instrument (**Figure 6**) according to SOPs (Shumar and de Varona 2009; Solar Pathfinder, 2008; Platts et al. 1987). The Solar Pathfinder measures the degree of shading at a particular stream location, in order to estimate the percentage of the total potentially-available solar energy at that latitude that actually reaches the water during a particular month (in this case, August). Solar pathfinder measurements will be performed at representative sites along each study stream. The selection of representative sites for Solar Pathfinder measurements will be based on assessments of riparian vegetation cover types using aerial imagery. If very similar shade characteristics are observed at multiple monitoring locations, Solar Pathfinder measurements will be made at a single representative site and applied to the others.

Figure 6. *Solar Pathfinder instrument.*

Sites for data logger deployment will be located in areas of low public use to reduce the likelihood of theft or vandalism. To the degree possible, data loggers will be placed in a well-mixed portion of the stream, in or near the thalweg, in a shaded location under vegetative cover nearer to the stream bank to minimize positive bias due to solar energy absorption. For streams with cobble or rocky substrates, data loggers will be attached to fired clay bricks or clay pavers using doubled-up heavy-duty plastic zip ties (**Figure 7**). Bricks will not be used in depositional areas or silty streams where accumulated sediment could inhibit the free flow of water around the data logger during deployment. Alternately, for streams with sand, silt or mud substrates, a 2 to 3 foot-long piece of ½" steel rebar will be driven vertically into the stream bed to within 12" of the stream bottom, and the data logger attached using double plastic zip ties. All bricks and rebar will be removed at the end of the deployment period, and the post-retrieval condition of data loggers noted on the field forms.

The Atkins Project Manager will serve as the POC responsible for determining and/or authorizing necessary corrective actions when problems occur with sampling methods.

Figure 7. *HOBO Pro v2 Temperature Data Loggers ready for deployment.*

8.0 Quality Assurance and Quality Control Requirements

All applicable QA/QC requirements detailed in the Field Procedures Manual for Water Quality Assessment Monitoring, the Temperature Data Logger Protocols SOP, and the Quality Assurance Project Plan for Sampling and Water Quality Assessment of Streams and Rivers (Montana DEQ 2005a, 2005b, 2005c) will be instituted for this project. Field QA/QC will consist of deploying duplicate temperature loggers at approximately a 10% frequency (i.e., 4 duplicate instruments for the 43 deployed, one per stream segment) at a randomly-selected sampling site within each segment

8.1 Precision and Accuracy

To measure logger precision over the course of a study, two instruments will be placed side-by-side at randomly-selected sites to create replicate data sets. Replicate measures will be performed at approximately a 10% frequency (4 sites). Paired values obtained from a replicate deployment should not vary more than +/- 0.5^{o}C for readings taken at the same time. The manufacturer of the *HOBO Water Temp Pro v2* water temperature data logger (Onset) claims an effective accuracy of +/- 0.2^{o}C over a wide temperature range.

Duplicate field measurements of degree of sunlight shading (Section 7.0) will not be required due to the nature of intended uses of these data. Every effort will be made to obtain representative data of acceptable precision and accuracy for these parameters through thoughtful selection of monitoring sites and close adherence to SOPs. Duplicate field measurements of stream discharge will be made at a frequency of 10% (4 sites). All temperature data loggers will be checked for accuracy against a NIST-certified thermometer prior to deployment and again post retrieval, following procedures detailed in the Temperature Data Logger Protocols SOP (DEQ 2005b). Pre and post-deployment checks are necessary to understand any bias that may be present in the data. Temperature data loggers that fail to record a value within +/- 0.5ºC of the NIST thermometer reading pre-deployment will be set aside for further checks. The failure of a logger to agree within +/- 0.5ºC during the post-deployment check would necessitate flagging, and possibly rejecting and discarding, of all data recorded by the instrument in question.

8.2 Data Completeness

An overall goal of >90% data completeness will be applied to the field monitoring aspects of Task 4b. Factors affecting completeness of field data include excessively high or low flows, loss of or damage to temperature loggers due to natural conditions or vandalism, and/or instrument malfunction/error. These factors are largely controllable through timing of monitoring events, careful placement and concealment of temperature loggers, adequate maintenance, and thorough review of instrument calibration and programming. Project time constraints do not allow for re-sampling in the event a logger and its associated data are lost. A failure of the post-deployment accuracy test that requires rejection of temperature data from the instrument in question will not count against the completeness goal.

8.3 Data Comparability

Temperature data will be collected following Montana DEQ protocols and will be comparable to other temperature data collected for temperature TMDLs in Montana. Shade data will be collected using the Solar Pathfinder instrument following SOPs (Shumar and de Varona 2009; Solar Pathfinder, 2008; Platts et al. 1987). The Solar Pathfinder is the device most commonly used by MDEQ to measure shading, and will meet the needs of the SSTEMP model.

9.0 Data Analysis, Record Keeping, and Reporting Requirements

Site visit forms (Continuous Data Logger Field Forms) will be properly completed for all samples. Written field notes and forms will be processed by Atkins staff following the internal QA/QC process, and copies kept in project folders. Results from post-deployment accuracy checks and replicate data loggers will be analyzed by Atkins staff, and any excursions outside acceptable limits properly noted. Any failure of the post-deployment accuracy test will be noted in the database under comments, and all temperature data from the logger may be rejected if excursions are sufficient to render the data highly suspect (see Section 8.1). All temperature data will be reviewed for discrepancies that suggest a data logger was not submerged for the entire deployment period, and for a time likely was recording air temperature rather than water temperature; suspect data will be identified under comments in the database. All stream flow and Solar Pathfinder data and associated field forms, digital photographs and field logs, and complete downloads of all temperature logger data files will be provided to EPA in an electronic project folder in Excel spreadsheet format. A QA/QC checklist and summary will be included with the final data deliverables to EPA.

10.0 Schedule for Completion

- June 25-30, 2012: Temperature logger deployment, flow measurement.
- August 1-30, 2012: Mid-deployment inspection, flow measurement.
- September 23-30, 2012: Temperature logger retrieval, flow measurement.
- October 1 – December 30, 2012: Data download, final temperature logger, shade and flow data deliverables.

11.0 References

DEQ. 2005a. Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring. Montana Dept. of Environmental Quality, WQPBWQM-020, revision 2. April 21, 2005. *Available at:* http://www.deq.mt.gov/wqinfo/qaprogram/PDF/SOPs/WQPBWQM-020.pdf

DEQ. 2005b. Temperature Data Logger Protocols Standard Operating Procedure. Montana Dept. of Environmental Quality, WQPBWQM-006, revision 1. April 11, 2005. *Available at:* http://www.deq.mt.gov/wqinfo/qaprogram/PDF/SOPs/WQPBWQM-006.pdf

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Shumar, M. and de Varona, J. 2009. The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual. State Technical Services Office. Idaho Dept. of Environmental Quality. http://www.deq.idaho.gov/media/528731-pnv_temp_tmdl_manual_revised_1009.pdf

Solar Pathfinder. 2008. Instruction Manual for the Solar Pathfinder http://www.solarpathfinder.com/pdf/pathfinder-manual.pdf

APPENDIX A
Continuous Temperature Data Logger Field Form

Continuous Temperature Data Logger Field Form

Waterbody: ____________ Site Description: ____________

Station ID: ____________ Project: ____________ Personnel: ____________

Medium: Water ☐ Air ☐ Comments: ____________

Logger Make/Model: ____________ Serial #: ____________ Accuracy Check OK?: Y ☐ N ☐ Date: ____________

Launch Date: ____________ Launch Time: ____________ Interval: (*hh:mm*) ____________

Programmer: ____________ Comments: ____________

Deployment Date: ____________ Deployment Time: ____________ MST ☐ MDT ☐

Latitude: ____________ Longitude: ____________ Datum: NAD83 ☐ Other: ____________

Geo Method: GPS (NADS 83) ☐ Other: ____________ County: ____________ HUC: ____________

Deployment Location and Additional Information: ____________

Photos: Digital ☐ Photo Number and Description: ____________

Data Logger Deployment Map:

Comments: ____________

Retrieval Date: ____________ Retrieval Time: ____________ MST ☐ MDT ☐

Retrieval Information and Logger Condition: ____________

Photos: Digital ☐ Photo Number and Description: ____________

Logger Data Uploaded?: Y ☐ N ☐ Date: ____________ Uploaded By: ____________

Electronic File Name: ____________ Accuracy Check OK?: Y ☐ N ☐ Date: ____________

Comments: