Lower Gallatin TMDL Planning Area

2009 Nutrient, *E. coli,* and Algae Sampling

Data Submittal and Quality Review Report

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1.0 INTRODUCTION

OASIS Environmental Inc., (OASIS) conducted nutrient, *Escherichia coli* (*E. coli*), and algae sampling within the Lower Gallatin TMDL Planning Area September 14th-25th 2009. This effort was a continuation of the 2008 monitoring effort, with sites selected based on 2008 monitoring results and the 2009 Lower Gallatin Source Assessment, conducted by OASIS in August-September 2009 (see the 2009 Source Assessment Reports for details on the assessment findings).

John Gangemi was the project manager and lead scientist; Levia Shoutis was the field team leader and was responsible for Quality Assurance/Quality Control (QA/QC) during data collection, and for data analysis and reporting. This report describes modifications to the methods, analysis, and sampling sites detailed in the *Lower Gallatin TMDL Planning Area Nutrient, Algae, and E. coli. Monitoring Sampling and Analysis Plan*, August 2008 (2008 SAP) (**Attachment A)**, amended September 2009 (**Attachment B**) and provides a Quality Assurance evaluation of analytical results. It also presents the following project deliverables: site visit forms and discharge measurement documentation (**Attachment C)**, laboratory analytical reports and chain of custody forms (**Attachment D)**, and confirmation data upload to the MT-eWQX database (**Attachment E)**. MT-eWQX data upload was completed on April 5th, 2010 and can be accessed at http://deq.mt.gov/wqinfo/datamgmt/MTEWQX.ASP.

In 2009, nutrients were sampled at 83 sites, algae at 7 sites, and *E. coli* at 38 sites (**Figure 1-1)**. Water quality field measurements (flow, dissolved oxygen, conductivity, temperature and pH) were also recoerded at each site visit. Including duplicate and blank samples, a total of 103 nutrient, 46 *E. coli*, and 8 algae samples were collected during the 2009 field sampling, as detailed in **Table 1-1**. Algae was sampled at 6 of the sample sites, while one site was visually estimated to have less than 50 mg/m^2 of chlorophyll-*a* and was therefore documented with notes and photos only (**Table 1-2).** Duplicate samples were collected at two of the algae sites. Algae was analyzed for both chlorophyll-*a* and ash-free dry weight.

Final sampling site coordinates and parameters sampled at each site are listed in **Table 1-3**. Nutrients were analyzed in samples from all of the sites; *E. coli* samples were analyzed in samples from all sites located on the following five streams (including pipes and tributaries on Sourdough Creek): Camp Cr, Godfrey Cr, Smith Cr, Reese Cr and Sourdough Cr. Streamflow and field parameters (pH, conductivity, air and water temperature, and dissolved oxygen), were sampled concurrently with nutrient and *E. coli* sampling.

Table 1-1. Actual number of samples Collected for nutrients, *E. coli* and algae

Sample Type	Initial Sites Collected	Duplicates Collected	Blanks Collected	Total Number Samples
Nutrients and TSS	83	10	10	103
E. coli	38	4	4	46
Algae	6	2	NA	8

Table 1-2. 2009 Algae sampling details.

Station ID	Waterbody	Photos	Algae Sampling[1]	Duplicate Sample	Algae Documentation
BR01	Bear Creek	X	X		
BR03	Bear Creek	X			X
EG02a	East Gallatin River	X	X		
EG05-M05EGALR04	East Gallatin River	X	X		
EG10	East Gallatin River	X	X	X	
EG13	East Gallatin River	X	X	X	
TH01a	Thompson Creek	X	X		

[1] DEQ 2008 Sample collection and laboratory analysis of chlorophyll-a and ash-free dry weight.

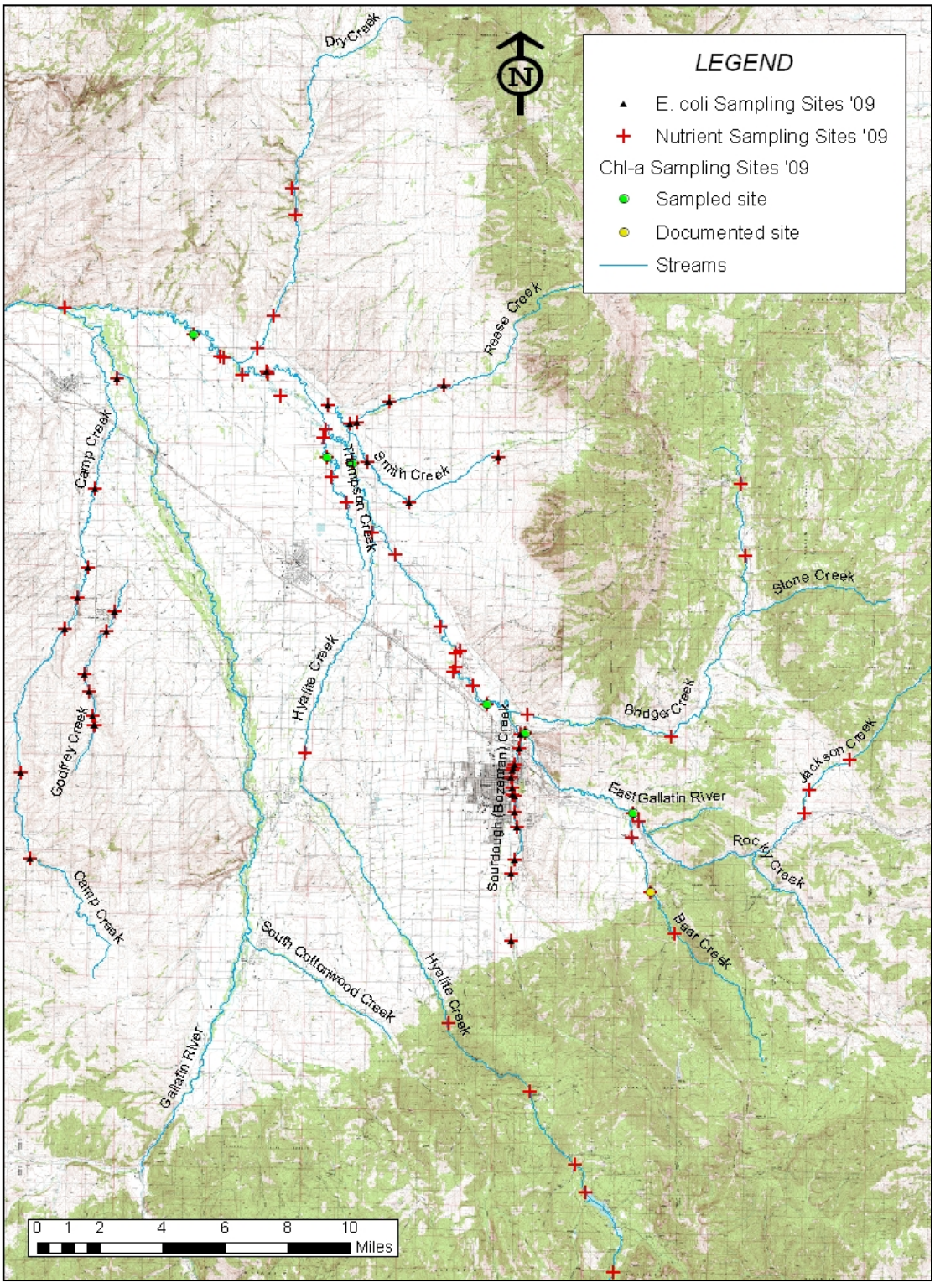

Figure 1-1. Final location of 2009 sample sites

Table 1-3. 2009 Sample site coordinates and parameters* sampled at each site.

Station ID	Stream Name	Field Msmts	Nutrients	E. coli	Algae	Longitude	Latitude
BG01	Bridger Creek	X	X			-111.022756	45.70898
BG02-M05BRIDC03	Bridger Creek	X	X			-110.928081	45.700098
BG04	Bridger Creek	X	X			-110.881074	45.783779
BG05-M05BRIDC04	Bridger Creek	X	X			-110.885197	45.817133
BH01	Ben Hart Creek	X	X			-111.190758	45.853576
BR01	Bear Creek	X	X		X	-110.952182	45.664151
BR02	Bear Creek	X	X			-110.952486	45.652795
BR03	Bear Creek	X	X		X	-110.939916	45.628128
BR04-M05BEARC05	Bear Creek	X	X			-110.923333	45.608645
CP01	Camp Creek	X	X	X		-111.298563	45.86007
CP02-M05CAMPC01	Camp Creek	X	X	X		-111.31143	45.808968
CP02a	Camp Creek	X	X	X		-111.315304	45.772498
CP02b	Camp Creek	X	X	X		-111.321757	45.758333
CP03-M05CAMPC03	Camp Creek	X	X	X		-111.329532	45.743864
CP03a	Camp Creek	X	X	X		-111.35607	45.676817
CP05	Camp Creek	X	X	X		-111.348399	45.637677
DY01	Dry Creek	X	X			-111.206412	45.875344
DY01a	Dry Creek	X	X			-111.19652	45.890475
DY01b	Dry Creek	X	X			-111.183401	45.937292
DY02	Dry Creek	X	X			-111.185538	45.949699
EG01-M05EGALR10	East Gallatin River	X	X			-111.33435	45.891852
EG02a	East Gallatin River	X	X		X	-111.024472	45.699998
EG05-M05EGALR04	East Gallatin River	X	X		X	-111.050223	45.713362
EG05a	East Gallatin River	X	X			-111.059406	45.721485
EG06a	East Gallatin River	X	X			-111.072834	45.728121
EG07-M05EGALR06	East Gallatin River	X	X			-111.071365	45.730101
EG07a	East Gallatin River	X	X			-111.071452	45.73633
EG08	East Gallatin River	X	X			-111.081387	45.748825
EG09-M05EGALR07	East Gallatin River	X	X			-111.112604	45.781427
EG10	East Gallatin River	X	X		X	-111.141965	45.823366
EG11	East Gallatin River	X	X			-111.160426	45.838474
EG12	East Gallatin River	X	X			-111.19898	45.863885
EG13-M05EGALR09	East Gallatin River	X	X		X	-111.24898	45.881088
ET01	Trib to E Gallatin River	X	X			-111.22837	45.87068
ET03	Trib to E Gallatin River	X	X			-111.068467	45.73758
GB01	Gibson Creek	X	X			-111.231061	45.871334
GD01-2738GO01	Godfrey Creek	X	X	X		-111.297033	45.752171
GD02-2738GO05	Godfrey Creek	X	X	X		-111.302051	45.743044
GD02a	Godfrey Creek	X	X	X		-111.315401	45.722911
GD03	Godfrey Creek	X	X	X		-111.311931	45.714934
GD03a	Godfrey Creek	X	X	X		-111.309286	45.704243
GD04-2738GO02	Godfrey Creek	X	X	X		-111.307867	45.699663
GD05	Godfrey Creek	X	X	X		-111.309103	45.69967
HY01	Hyalite Creek	X	X			-111.128354	45.791215
HY02	Hyalite Creek	X	X			-111.169296	45.689188

Table 1-3 Continued. Sample site coordinates and parameters* sampled at each site.

Station ID	Stream Name	Field Msmts	Nutrients	*E. coli*	Algae	Longitude	Latitude
HY03	Hyalite Creek	X	X			-111.016519	45.53497
HY04	Hyalite Creek	X	X			-110.98585	45.501386
HY05	Hyalite Creek	X	X			-111.07121	45.565658
HY06	Hyalite Creek	X	X			-110.979045	45.488764
HY08	Hyalite Creek	X	X			-110.959369	45.452261
JK01a	Jackson Creek	X	X			-110.839641	45.665725
JK01b	Jackson Creek	X	X			-110.836831	45.676564
JK02a	Jackson Creek	X	X			-110.809929	45.69047
RK01a	Rocky Creek	X	X			-110.948633	45.660445
RS01a	Reese Creek	X	X	X		-111.13955	45.842263
RS01b	Reese Creek	X	X	X		-111.118556	45.851841
RS01c	Reese Creek	X	X	X		-111.144371	45.841675
RS02	Reese Creek	X	X	X		-111.082368	45.859819
SD01-M05BOZMC01	Sourdough Creek	X	X	X		-111.027311	45.699595
SD02-M05SOURC02	Sourdough Creek	X	X	X		-111.027846	45.693207
SD02a	Sourdough Creek	X	X	X		-111.031714	45.684022
SD03	Sourdough Creek	X	X	X		-111.032076	45.67495
SD03a	Sourdough Creek	X	X	X		-111.030136	45.671011
SD04	Sourdough Creek	X	X	X		-111.028186	45.656785
SD05-M05SOURC01	Sourdough Creek	X	X	X		-111.029914	45.641731
SD05a	Sourdough Creek	X	X	X		-111.031594	45.635357
SD06	Sourdough Creek	X	X	X		-111.030583	45.604459
SDP01	Pipe to Sourdough Creek	X	X	X		-111.030627	45.66376
SDP02	Pipe to Sourdough Creek	X	X	X		-111.032675	45.679916
SDP03	Pipe to Sourdough Creek	X	X	X		-111.031999	45.683147
SDP04	Pipe to Sourdough Creek	X	X	X		-111.031275	45.68577
SDTR01	Trib to Sourdough Creek	X	X	X		-111.028735	45.656566
SDTR02	Trib to Sourdough Creek	X	X	X		-111.031752	45.671494
SM01	Smith Creek	X	X	X		-111.199695	45.864529
SM02	Smith Creek	X	X	X		-111.159149	45.849616
SM03	Smith Creek	X	X	X		-111.132212	45.823819
SM04a	Smith Creek	X	X	X		-111.045616	45.827275
SM03a	Smith Creek	X	X	X		-111.103597	45.805875
ST01	Story Creek	X	X			-111.216121	45.86275
TH01-M05TMPSC01	Thompson Creek	X	X			-111.161496	45.834857
TH01a	Thompson Creek	X	X			-111.158823	45.825832
TH02-M05TMPSC02	Thompson Creek	X	X			-111.155836	45.816588
TH02a	Thompson Creek	X	X			-111.145355	45.805227

* Field Measurements: flow, dissolved oxygen, pH, conductivity, temperature, photographs
Nutrients: total nitrogen, nitrate+nitrite, total phosphorus, total suspended solids

2.0 ANALYTICAL DATA: QUALITY CONTROL SUMMARY

The following sections provide detailed information for the DEQ's Quality Control Checklist contained in Appendices H and I in the 2008 SAP (**Attachment A)**, and document quality control elements for all water quality samples defined in the SAP.

2.1 Condition of samples upon receipt

All samples met QC requirements for the condition of samples upon receipt at each laboratory. Samples were in the proper containers at the proper storage temperatures, and had been preserved as necessary. Algae samples were delivered cooled and on ice packs.

2.2 All field documentation complete. All field data was correctly completed during each site visit on site visit forms (DEQ site visit forms, versions printed 6/1/2007 and 4/1/2008). Site visit attributes and samples taken (grab or algae) were documented during every site visit. In addition, field parameters were documented when grab samples were collected (nutrients and *E. coli)*, and algae collection information (transect location and method) were documented during algae sampling events. Flow was measured and documented on OASIS' discharge calculation sheet for every grab sampling event. Flow measurements were then entered into an Excel version of the discharge calculation spreadsheet. The calculated flow was entered into the corresponding field on the site visit form for each grab sampling event.

Field photographs documenting overall site conditions and the sampled substrate were taken during each site visit, and during algae sampling. For algae samples, the geographic coordinates of the F transect were provided in the comment field on the site visit form to identify the site.

2.3 Holding times met

Two *E. coli* samples exceeded the six hour hold times (**Table 2-1**). These two samples were coded with "H" values in the Result Qualifier field in the EQuIS spreadsheet. All nutrient, TSS and algae samples met required hold times.

Table 2-1. *E. coli* samples that exceeded holding times

Site ID	Parameter	Collect. Date	Collect. Time	Sample Received by Lab	Holding Time Exceeded
SDP01	*E. coli*	9/15/09	1100	1730	30 min
SD06	*E. coli*	9/15/09	1125	1730	5 min

2.4 Field duplicates collected at the proper frequency (specified in SAP)

Field duplicate samples for nutrients, TSS and *E. coli* were collected at greater than the 10% frequency specified in the SAP (12% frequency for nutrients and TSS, 10.5% frequency for *E.*

coli) (**Table 2-2**). In addition, the DEQ project manager requested that OASIS collect duplicate algae samples at two locations, sites EG10 and EG13-M05EGALR09.

Table 2-2. Frequency of duplicates and blanks collected.

Sample Type	Routine Samples	Duplicate Collected	Dup Frequency	Blanks Collected	Blank Frequency
Nutrients and TSS	83	10	12%	10	12%
E. coli	38	4	10.5%	4	10.5%
Algae	6	2	33%	NA	NA

2.5 Field blanks collected at the proper frequency (specified in SAP)

Field blank samples for nutrients, TSS and *E. coli* were collected at greater than the 10% frequency specified in the SAP (12% frequency for nutrients and TSS, 10.5% frequency for *E. coli)* (**Table 2-2**).

2.6 All sample IDs match those provided in the SAP

Field duplicates were clearly marked on samples and noted as such in lab results. Field duplicates and blanks were identified by adding "DUP" or "BLANK" to the ID, respectively.

Site RS01c was not listed in the SAP. This site replaced site RS01 which was found to be located on Smith Creek rather than Reese Creek due to incorrect stream channel mapping on the MT DEQ 303d GIS stream layer. In 2008, site RS01 was placed just downstream of the confluence with Smith Creek, and was in fact sampled on Smith Creek rather than Reese Creek (see the *Reese Creek 2009 Source Assessment Report* for a detailed description of the correct alignment of Smith and Reese Creeks near their confluence). Therefore, for the 2009 monitoring effort, site RS01 was moved upstream of the Smith-Reese Creek confluence, and re-named RS01c (**Figure 2-1**).

The following discrepancies were identified during the monitoring, all of which were corrected through communication with Energy Labs:

1. The TN-TSS duplicate and blank sample bottles for site EG05 were not labeled as such.
2. Samples from site SDP03 were in the 9/17/09 delivery but were not listed on the COC form.
3. Samples from sites SM03 and SM03a did not have the requested analysis marked on the 9/22/09 COC form.
4. The EG12 Blank samples had a collection time of 1410 on the bottle and 1330 on the 9/22/09 COC form.
5. BG02-M05BRIDC03 bottles listed the short name "BG02" rather than the complete site name on the 9/22/09 COC form.

Figure 2-1. Location of site RS01c at the Smith Cr-Reese Cr confluence

2.7 Analyses carried out as described within the SAP (e.g. analytical methods, photo documentation, field protocols)

All photo documentation, and laboratory analysis methods for nutrients and *E. coli* were carried out as described in the SAP. Lab analysis methods for algae samples differed from those described in the SAP. Algae samples were sent to Energy Labs in Helena, as specified in the SAP. Due to equipment issues at Energy Labs, they sent the algae samples to the DPHHS Lab in Helena for chlorophyll-*a* and ash-free dry weight (AFDW) analysis. Composited hoop samples for AFDW from two sites, EG13-M05EGALR09 routine and TH01a, were destroyed in the oven fire at the DPHHS lab. Weighted mg/m2 for these two sites was calculated using only transects where templates and cores were collected.

Field protocol differed from the SAP in the following ways:

1. pH was measured at all sites, but readings at 50 of the sites were rejected. The readings were rejected based on the following: Two YSI units were used for the monitoring, and one of the units was commonly out of range during calibration. pH values where this unit was used were identified and readings were compared to 2009 sites on the same stream, as well as readings collected at the same sites in 2008. Several readings on certain days were obviously out of range (e.g. readings of 2.5 and 11.5), while on other days readings all appeared to be within range (7.0-9.0). Based on this assessment, it was deemed that all of the readings at the 50 sites where the questionable YSI unit was used should be rejected. Rejected readings were qualified with and "R" and a comment in the comment field in the Equis upload.
2. Flow was not measured at site HY04. Rather, flow was interpolated from 2008 flow measurements at sites HY04 and the downstream site HY03. In 2008, HY04 flow was 88% of HY03 flow. This relationship was used to calculate an estimated flow value at site HY04 in 2009. The resulting estimated flow was confirmed to be between the downstream HY03 site and the upstream HY06 site. The flow measurement at site HY04 was entered as "Estimated" in the "Value Type" field in the EQuIS database.
3. Algae transect spacing was delineated by pacing instead of stringing a tape measure between transects.
4. For algae sampling, OASIS used a square, rubber template with the exact side dimensions of the razor blade. Therefore, the template size used was 16 cm^2 rather than the 12.5 cm^2 PVC ring. The square template was preferred over the round template because field staff were better able to scrape periphyton from rocks.
5. The DEQ project manager requested that OASIS collect duplicate algae samples at two locations, EG10 and EG13-M05EGALR09. This was achieved by collecting both a routine sample, and a separate duplicate sample, at each of the eleven algae transects. Duplicate samples were collected at a different location along the transect than the routine sample location (e.g. if the routine were collected on the left, duplicate was collected from center or right), per the guidance of the DEQ project manager. Routine

and duplicate samples were collected during the same sampling event but were packaged and/or filtered separately, and recorded on separate Site Visit Forms.

6. At 56 of the 83 sites dissolved oxygen was incorrectly reported on the Site Visit Forms as % saturation rather than as mg/l. To correct this problem, mg/l was back calculated from % saturation at those sites using the following method provided by Chris Shirley on 11/12/09 (see communication documentation in **Attachment F**).
   a. Pressure in mm Hg was determined from archived barometric pressure records for the days and times of each sampling event at the Gallatin Field Airport in Belgrade. Pressure was also calculated for each sampling event using the following equation (P= pressure in atm, h= site elevation in km):

$$\ln P = 5.25 \times \ln\left(1 - \frac{h}{44.3}\right)$$

   b. Pressure in atm was converted to mm Hg using: P mm Hg= P atm x 760
   c. Airport pressure in mm Hg was compared with the calculated pressure. It was determined that the two results were well within 10% of each other, thus airport pressure was used for all of the sites rather than the calculated pressure.
   d. Dissolved oxygen in mg/l at 100% saturation was determined using the table at: http://water.usgs.gov/owq/FieldManual/Chapter6/6.2.4.pdf using pressure and water temperature.
   e. Actual mg/l dissolved oxygen was then back calculated from mg/l at saturation, and the measured % saturation, using:

   Measured DO (mg/l)= DO (% saturation) x DO (mg/l at 100% saturation)

   f. The 56 calculated results are designated as “Calculated” rather than “Actual” in the “Value_Type” field in the EQuIS spreadsheet

2.8 Reporting detection limit met the project-required detection limit (“reporting limits”)

All analysis met the project-required reporting limits for analysis of nutrient, TSS and *E. coli* samples. These are referred to as “detection limits” in the Energy Labs electronic data deliverable and in the MT EQuIS database.

2.9 All blanks were less than the project-required detection limit (“reporting limit”)

All four *E. coli* blanks were less than the project-required detection limit (non-detects). Several samples had detectable values of total phosphorus, ammonia and nitrate-nitrites (**Table 2-3**). However, only four of these detects in blank samples were greater than the project-required detection limit. Of these, three of the samples were detected at exactly the detection limit level.

Table 2-3. Blank samples with detected levels of a given parameter.
(samples that exceeded project-required detection limit ("reporting limit" are bolded)

Site ID	Parameter	Result value (mg/l)	Detection limit (mg/l)	Flag
EG05 Blank	**total phosphorus**	**0.006**	**0.005**	**B**
EG07 Blank	total phosphorus	0.004151	0.005	J
SD02a Blank	total phosphorus	0.004007	0.005	J
EG12 Blank	ammonia	0.0354	0.05	J
	total phosphorus	0.004925	0.005	J
RK01a Blank	**ammonia**	**0.05**	**0.05**	**B**
	nitrate-nitrite	**0.01**	**0.01**	**B**
	total phosphorus	0.003144	0.005	J
SM02 Blank	ammonia	0.0463	0.05	J
	nitrate-nitrite	**0.01**	**0.01**	**B**
	total phosphorus	0.004867	0.005	J
TH01a Blank	ammonia	0.0472	0.05	J
CP02a Blank	total phosphorus	0.003541	0.005	J
GD03 Blank	total phosphorus	0.001987	0.005	J

2.10 If any blanks exceeded the project-required detection limit, associated data is flagged

Where blanks exceeded the project-required detection limit associated data were B-flagged according to Appendix I in the 2008 SAP (QA/QC checklist and data qualifiers, **Attachment A)** (**Table 2-3)**. Blanks where a parameter was detected but at levels lower than the project-required detection limit were J flagged (**Table 2-3).**

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

Bridger Analytical Labs does not perform laboratory QC analysis on their *E. coli* samples as the quality control measures are built into the analytical method used. Energy Labs summarized the number of samples analyzed for each of the lab QC procedures which included all of the samples analyzed in a single analysis "run" for each parameter. Thus, the total number of samples and number of QC samples detailed in **Table 2-4** includes samples from other work orders analyzed with the 2009 LGTPA samples at Energy Labs (per conversations with Jonathan Hager, the lab manager at Energy Labs on 12/14/09).

Method blanks, lab fortified blanks, sample matrix spikes, and sample matrix spike duplicates were analyzed at greater than a 10% frequency for total N, ammonia, nitrate-nitrite and total P. Energy Labs runs a lab control sample (LCS) at the beginning of each QC run, as required by the analytical method for each of the parameters mentioned above. The exception is for TSS, where the analytical methods require LCS and method blanks (MB) to be run at a 5% frequency. LCS and MB's were run at less than a 5% frequency for all parameters except total P. Energy

identified this problem during an audit just after these samples were run and has since taken corrective action to run TSS QC samples at a 5% frequency.

Energy does not perform analysis of lab fortified blanks, sample matrix spikes, and sample matrix spike duplicates for TSS. They also do not analyze sample duplicates, and instead analyzes sample matrix spike duplicates. Energy Labs QC analysis documentation can be found in the final electronic deliverable to DEQ.

Table 2-4. Lab Blank/Duplicate Frequency.
Samples analyzed at less than the method-required frequency are bolded

	QAQC Procedure	Lab control sample % (LCS)	Sample duplicate[3] % (D)	Method blank % (MB/PB)	Lab fortified blank % (LFB)	Sample matrix spike % (MS)	Sample matrix spike duplicate % (MSD)
TSS[1]	# QC Samples	6	18	6	NA	NA	NA
	Total # Samples	175	175	175	NA	NA	NA
	Freq. QC Samples %	**3**	10	**3**	NA	NA	NA
Total N	# QC Samples	10	3	36	37	24	24
	Total # Samples	239	239	239	239	239	239
	Freq. QC Samples %	**4**	1	15	15	10	10
Ammonia	# QC Samples	4	NA	40	63	32	32
	Total # Samples	314	NA	314	314	314	314
	Freq. QC Samples %	**1**	NA	13	20	10	10
Nitrate-nitrite	# QC Samples	6	NA	38	44	34	34
	Total # Samples	313	NA	313	313	313	313
	Freq. QC Samples %	**2**	NA	12	14	11	11
Total P	# QC Samples	39	NA	45	69	27	27
	Total # Samples	273	NA	273	273	273	273
	Freq. QC Samples %	14	NA	16	25	10	10

1: For TSS, Energy Labs runs only LCS and MB's

2: LCS and MB's are run at 5% frequency as required by the method. Energy Labs took corrective action for the LCS and MB that were analyzed at <5% frequency.

3: Energy Labs does not perform sample duplicates, rather the sample matrix spike duplicate is used.

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

All method blanks resulted in "non-detect" and the relative percent difference between all matrix spikes and matrix spike duplicates was well below 20%, as required by the Laboratory Quality Assurance Plan (LQAP). According to the LQAP, required percent recovery for laboratory control samples and sample matrix spikes for TSS is 80-120%, and 90-110% for nitrate-nitrite and TPN. The following nutrient lab method spikes (MS) and method spike duplicates (MSD) were not within the required 90-110% recoverable for nutrients:

- 9/18/09 delivery
  - Nitrate-nitrite: MS values= 114%, 112%; MSD values= 111%, 113%, 111%
  - Total P: MS values= 87%, 87%; MSD= 88%, 89%
- 9/23/09 delivery
  - Total N: MS values= 80%, 111%, 84%; MSD values= 82%
  - nitrate-nitrite: MS value= 113%; MSD values= 111%, 111%
- 9/29/09 delivery
  - Nitrate-nitrite: MS value= 83%

2.13 Project DQOs and DQIs were met (as described in SAP)

Specific DQOs and DQIs were not established for this project, though representativeness, comparability, completeness, sensitivity, precision, and bias/accuracy are outlined as DQIs in Appendix H (QAQC Glossary), contained in the 2008 SAP (**Attachment A**) and in *Quality Assurance Project Plan (QAPP) Sampling and Water Quality Assessment of Streams and Rivers in Montana, 2005*, available on the Internet at http://www.deq.state.mt.us/wqinfo/QAProgram/WQPBQAP-02.pdf. **..\SAP\SAP Appendix_final.pdf**. These sections are detailed below.

Representativeness

Representativeness is the degree to which field and lab measurements represent the environmental conditions found across both spatial and temporal gradients within the project area. Timing of data collection was designed to correspond to late summer season low flows and to capture a variety of stream settings. All field and lab data for this project are spatially representative, with sites chosen on streams of interest using both aerial photos and field investigations to represent a range of land uses and physical settings.

Comparability

Comparability is the ability to assess the data in the context of the project's decision rules, which in this case are the acute and chronic aquatic life criteria listed in the Montana Numeric Water Quality Standards, Circular WQB-7. All field data, and lab data for nutrients, *E.coli,* and chlorophyll *a* has sufficient comparability. Lab data for AFDW should be compared with caution due to the missing composited hoop samples at sites EG13-M05EGALR09 routine and TH01a which

were destroyed in the oven fire at the MT DPHHS lab in Helena. Weighted mg/m2 for these two sites was calculated using only transects where templates and cores were collected.

Completeness

Completeness is the percentage of the usable data actually collected during assessment activities for each parameter. The overall completeness goal established by DEQ is 90% (Appendix H of the 2008 SAP (**Attachment A)**). For this project, both field completeness and lab completeness were determined.

Field completeness was 100%. Field parameters and nutrient samples were collected at all 83 nutrient sites, and all 7 algae sites were assessed and/or sampled for algae. Field parameters and *E. coli* was collected at all of the 38 *E. coli* sites. All data was collected prior to September 31st as required by the SAP.

Lab completeness was 100% for all of the 46 *E. coli* samples analyzed at Bridger Analytical, and the 103 samples analyzed at Energy Labs. A total of 18 composited samples were analyzed for chlorophyll *a* and ash-free dry weight (AFDW) from the eight algae samples (6 routine, 2 duplicate). Of these, chlorophyll *a* completeness was 100%. AFDW completeness was 89% because the composited hoop samples from two sites, EG13-M05EGALR09 routine and TH01a, were destroyed in the oven fire at the MT DPHHS lab in Helena.

Sensitivity

Sensitivity is the limit of a measurement to reliably detect a characteristic of a sample. The goal for field method sensitivity was Field Blank<Reporting Limit, while for lab analytical methods, sensitivity is expressed as the method detection limit (MDL). Field method sensitivity was not achieved for four nutrient samples, as listed in **Table 2-3**. All other field blanks were less than the project-required reporting limit, as detailed in Section 2.9. Field sensitivity was not assessed for algae analysis as no field blanks were collected. All laboratory method blanks resulted in a non-detect, as reported in Energy Lab's QAQC reports.

Bias and Accuracy

Bias is directional error from the true value, and can occur either in the field or during lab analysis. None of the field or lab parameters were suspected of bias, based on the range of expected values for each of the field parameters. Accuracy combines high precision (high agreement of repeated measurements of the same characteristic, or a tight grouping) and low bias. Review of the lab analytical method controls and the analytical batch controls revealed that all QC results were within the limits set by Energy Lab's Laboratory Quality Assurance Plan (LQAP).

Precision

Precision refers to the degree of agreement among repeated measurements of the same characteristic. Precision was assessed separately below for *E. coli* and nutrient/TSS samples, using relative percent difference (RPD) and standard deviation (SD) between the sample and its corresponding duplicate. RPD is calculated as:

RPD as % = ((D1 – D2)/((D1 + D2)/2)) x 100

Where:

D1 is first replicate result

D2 is second replicate result

E. coli. Precision

RPD for duplicate *E. coli* counts ranged from 4 to 25%. The mean, relative percent difference and standard deviation of each of the repeated *E. coli* measurements are detailed in **Table 2-5** and the distribution of the *E. coli* sample and duplicate results around the mean value are depicted in **Figure 2-2**.

Table 2-5. *E. coli* Sampling: Relative percent difference, mean and standard deviation.

Site	Date	Original Sample (cfu/100 mL)	Duplicate Sample (cfu/100 mL)	Difference	Mean (cfu/100 mL)	RPD	SD
CP02a	9/23/2009	219	210	9	214.5	4%	6.36
GD03	9/25/2009	186	219	33	202.5	16%	23.33
SD02a	9/15/2009	111	142	31	126.5	25%	21.92
SM02	9/17/2009	291	345	54	318	17%	38.18

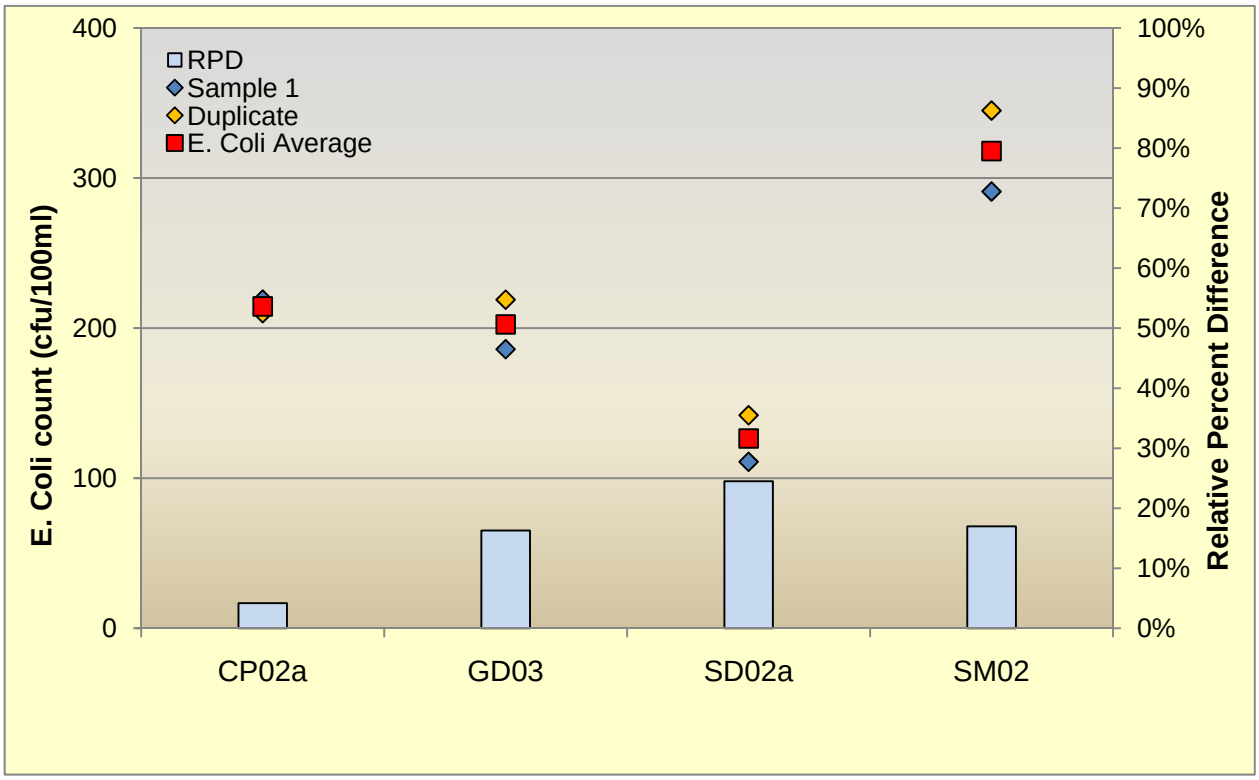

Figure 2-2. Relative % difference between routine and duplicate *E. coli* samples, and distribution of routine and duplicate results around the mean cfu/ml for each sampling event where duplicates were collected.

Nutrient/TSS Precision

The mean, relative percent difference and standard deviation of each of the repeated nitrate-nitrite, TPN, and TSS measurements are presented in **Table 2-6**. The relative percent difference between individual samples and respective duplicate, and the distribution of the sample and duplicate around the mean values, for each of the repeated measurements are presented in **Figures 2-3** through **2-7**. Note the differences in parameter concentration and RPD on each of the graphs. RPD's between nitrate-nitrite, total nitrogen, and ammonia samples were all below 6% difference. RPD's for total phosphorus were less than 30%. All RPD's for TSS were less than 30% with the exception of site EG12.

Table 2-6. Nutrients: Relative percent difference and standard deviation.

	Site	Date	Original Sample (mg/l)	Duplicate Sample (mg/l)	Difference	Mean	RPD	SD
Nitrate+Nitrite	HY01	9/14/2009	0.19	0.20	0.01	0.20	5%	0.01
	SD02a	9/15/2009	0.52	0.53	0.01	0.53	2%	0.01
	EG05-M05EGALR04	9/16/2009	0.25	0.25	0	0.25	0%	0.00
	EG07-M05EGALR06	9/16/2009	1.74	1.74	0	1.74	0%	0.00
	EG12	9/17/2009	0.75	0.76	0.01	0.76	1%	0.01
	RK01a	9/18/2009	0.01	0.01	0	0.01	0%	0.00
	SM02	9/17/2009	1.15	1.17	0.02	1.16	2%	0.01
	TH01a	9/22/2009	1.18	1.16	0.02	1.17	2%	0.01
	CP02a	9/23/2009	0.87	0.87	0	0.87	0%	0.00
	GD03	9/25/2009	1.99	2.00	0.01	2.00	1%	0.01
Total N	HY01	9/14/2009	1.91	1.92	0.01	1.92	1%	0.01
	SD02a	9/15/2009	0.69	0.72	0.03	0.71	4%	0.02
	EG05-M05EGALR04	9/16/2009	0.45	0.44	0.01	0.45	2%	0.01
	EG07-M05EGALR06	9/16/2009	1.99	1.99	0	1.99	0%	0.00
	EG12	9/17/2009	0.87	0.89	0.02	0.88	2%	0.01
	RK01a	9/18/2009	0.19	0.19	0	0.19	0%	0.00
	SM02	9/17/2009	1.25	1.24	0.01	1.25	1%	0.01
	TH01a	9/22/2009	1.19	1.21	0.02	1.20	2%	0.01
	CP02a	9/23/2009	1.05	1.03	0.02	1.04	2%	0.01
	GD03	9/25/2009	2.10	2.10	0	2.10	0%	0.00

Table 2-6 Continued. Nutrients: Relative percent difference and standard deviation.								
	Site	Date	Original Sample (mg/l)	Duplicate Sample (mg/l)	Difference	Mean	RPD	SD
Ammonia	HY01	9/14/2009	0.00	0.00	0	0.00	0%	0.00
	SD02a	9/15/2009	0.00	0.00	0	0.00	0%	0.00
	EG05-M05EGALR04	9/16/2009	0.00	0.00	0	0.00	0%	0.00
	EG07-M05EGALR06	9/16/2009	0.00	0.00	0	0.00	0%	0.00
	EG12	9/17/2009	0.06	0.06	0	0.06	0%	0.00
	RK01a	9/18/2009	0.05	0.05	0	0.05	0%	0.00
	SM02	9/17/2009	0.06	0.06	0	0.06	0%	0.00
	TH01a	9/22/2009	0.049	0.05	0.001	0.05	2%	0.00
	CP02a	9/23/2009	0.00	0.00	0	0.00	0%	0.00
	GD03	9/25/2009	0.00	0.00	0	0.00	0%	0.00
Total P	HY01	9/14/2009	0.084	0.084	0	0.08	0%	0.00
	SD02a	9/15/2009	0.048	0.050	0.002	0.05	4%	0.00
	EG05-M05EGALR04	9/16/2009	0.023	0.023	0	0.02	0%	0.00
	EG07-M05EGALR06	9/16/2009	0.559	0.606	0.047	0.58	8%	0.03
	EG12	9/17/2009	0.045	0.05	0.005	0.05	11%	0.00
	RK01a	9/18/2009	0.012	0.016	0.004	0.01	29%	0.00
	SM02	9/17/2009	0.052	0.052	0	0.05	0%	0.00
	TH01a	9/22/2009	0.025	0.024	0.001	0.02	4%	0.00
	CP02a	9/23/2009	0.050	0.059	0.009	0.05	17%	0.01
	GD03	9/25/2009	0.041	0.044	0.003	0.04	7%	0.00
TSS	HY01	9/14/2009	19	19	0	19.00	0%	0.00
	SD02a	9/15/2009	12	11	1	11.50	9%	0.71
	EG05-M05EGALR04	9/16/2009	3	4	1	3.50	29%	0.71
	EG07-M05EGALR06	9/16/2009	5	5	0	5.00	0%	0.00
	EG12	9/17/2009	1	3	2	2.00	100%	1.41
	RK01a	9/18/2009	3	3	0	3.00	0%	0.00
	SM02	9/17/2009	17	17	0	17.00	0%	0.00
	TH01a	9/22/2009	28	25	3	26.50	11%	2.12
	CP02a	9/23/2009	24	24	0	24.00	0%	0.00
	GD03	9/25/2009	6	5	1	5.50	18%	0.71

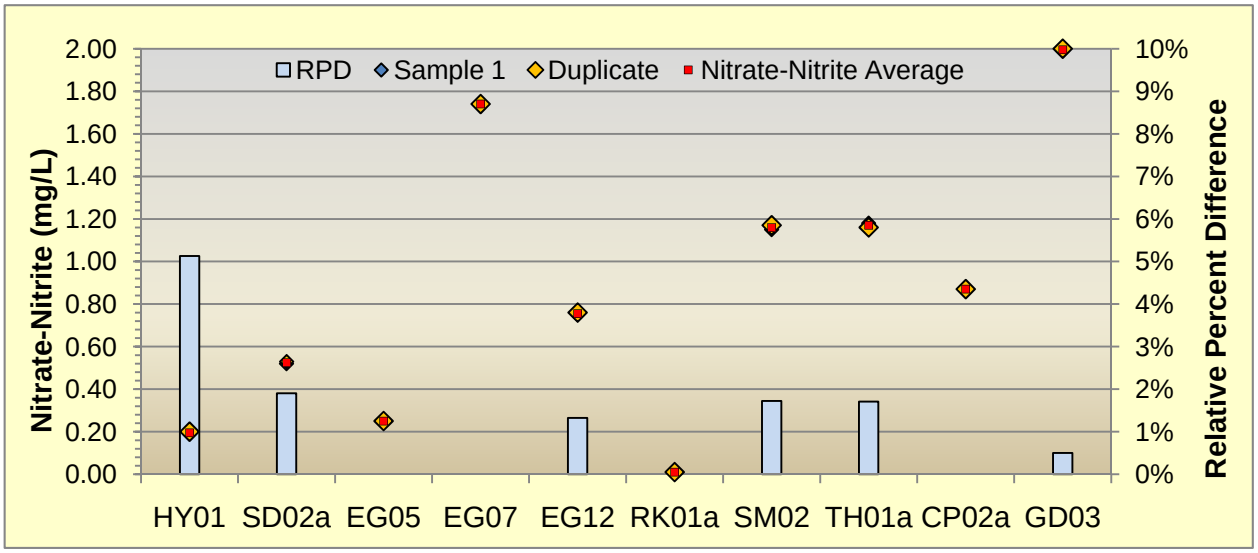

Figure 2-3. Nitrate-nitrite relative percent difference, and sample and duplicate results.

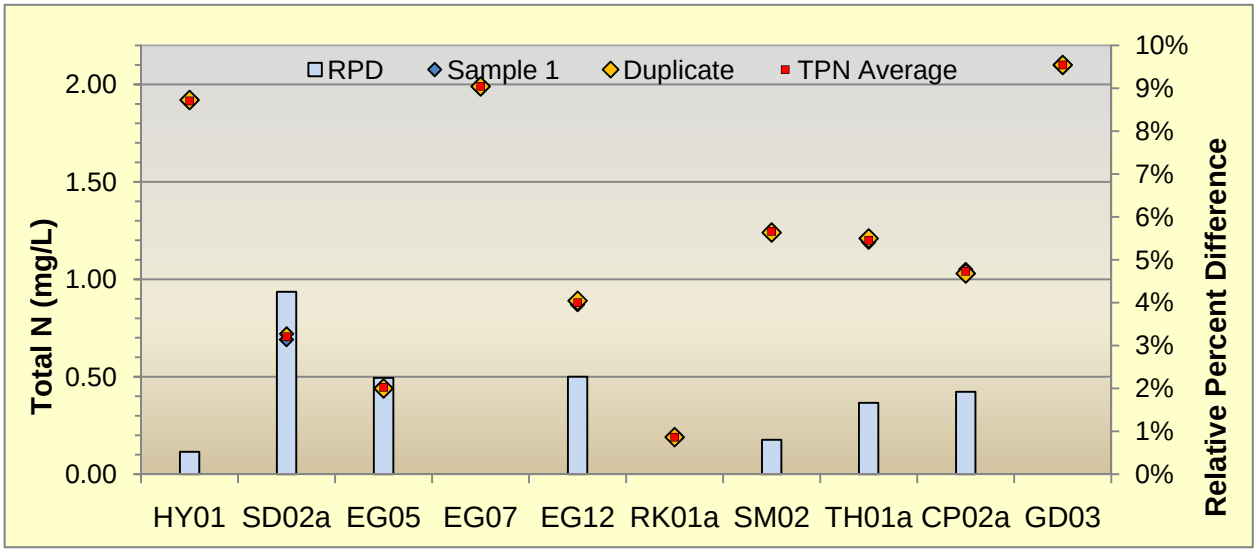

Figure 2-4. Total nitrogen relative percent difference, and sample and duplicate results.

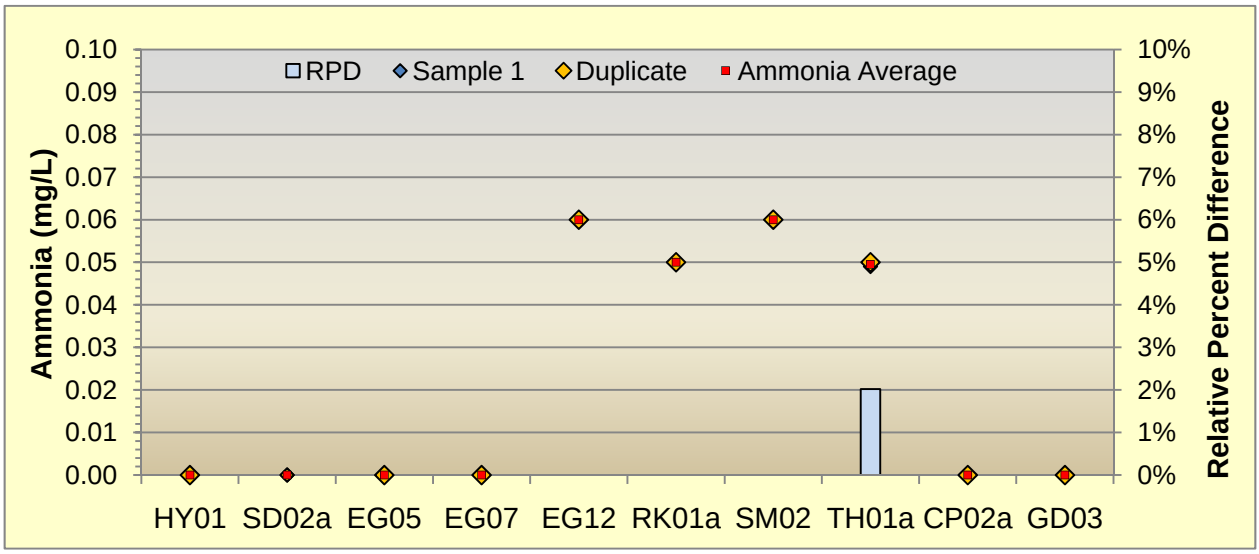

Figure 2-5. Ammonia relative percent difference, and sample and duplicate results.

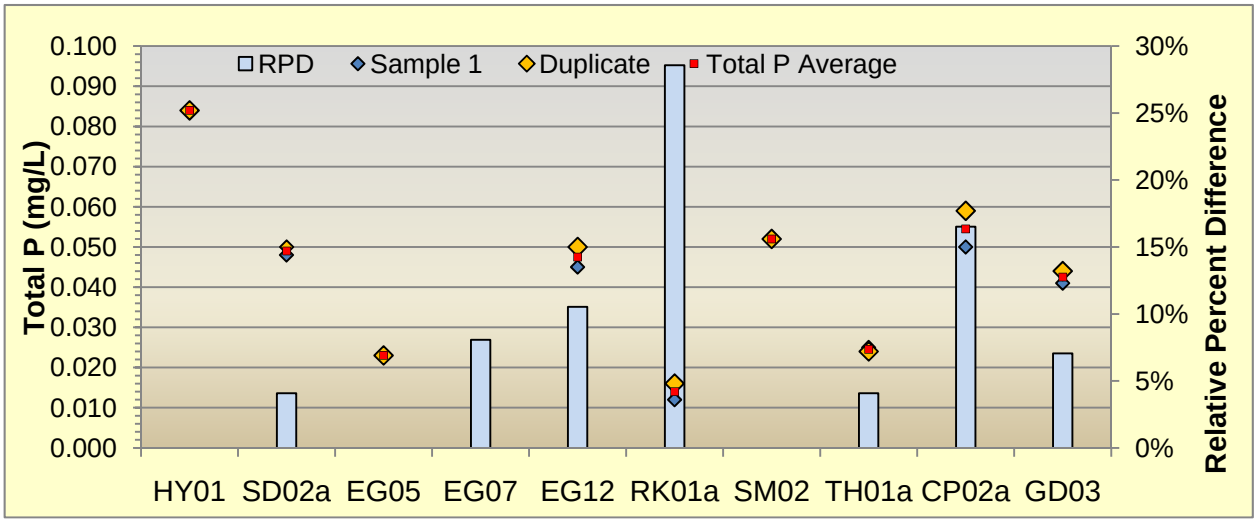

Figure 2-6. Total phosphorus relative percent difference, and sample and duplicate results.

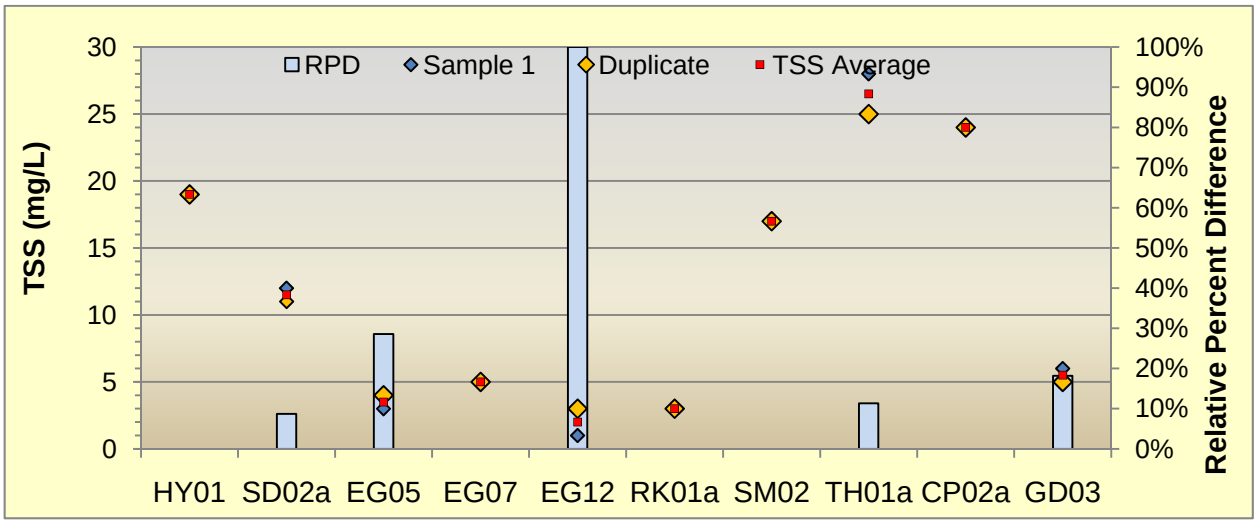

Figure 2-7. Total suspended solids relative percent difference, and sample and duplicate results.

Algae Precision

Duplicate algae samples were collected at sites EG10 and EG13-M05EGALR09. While the chlorophyll-a concentration between duplicate samples was very similar at site EG10, the routine and duplicate concentrations at site EG13-M05EGALR09 were quite disparate. AFDW for duplicate samples were quite similar at each of the sites where duplicates were sampled. AFDW hoop samples for site EG13-M05EGALR09 routine, and TH01a were destroyed in the oven fire at the MT DPHHS lab in Helena. Weighted mg/m2 AFDW for these two sites was calculated using only transects where templates and cores were collected.

Table 2-7. Chlorophyll *a*: results for each method and weighted mg/m2

Site ID	Waterbody	Core mg/m2	# Cores	Temp mg/m2	# Temps	Hoop mg/m2	# Hoops	Weighted mg/m2
BR01	Bear Creek	1.26	2	33.5	9			27.64
EG02a	East Gallatin River	33.5	1	110	10			103.05
EG05-M05EGALR04	East Gallatin River	31.7	2	85.6	9			75.80
EG10	East Gallatin River	36.1	4	193	7			135.95
EG10 Duplicate	East Gallatin River	60.8	5	188	6			130.18
EG13	East Gallatin River	24.9	4	15.3	4	146	3	54.44
EG13 Duplicate	East Gallatin River	6.94	4	395	4	54.3	3	160.97
TH01a	Thompson Creek	28.7	4			124	7	89.35

Table 2-8. Ash-free dry weight (AFDW): results for each method and weighted mg/m2

Site ID	Waterbody	Core mg/m2	# Cores	Temp mg/m2	# Temps	Hoop mg/m2	# Hoops	Weighted mg/m2
BR01	Bear Creek	240	2	17.2	9			57.71
EG02a	East Gallatin River	302	1	66.8	10			88.18
EG05-M05EGALR04	East Gallatin River	238	2	87.4	9			114.78
EG10	East Gallatin River	216	4	82.3	7			130.92
EG10 Duplicate	East Gallatin River	170	5	75.8	6			118.62
EG13	East Gallatin River	339	4	147	4	missing*	3	243.00
EG13 Duplicate	East Gallatin River	252	4	202	4	351	3	260.82
TH01a	Thompson Creek	113	4			missing*	7	113.00

*"missing" AFDW hoop samples were lost in the oven explosion at the MT DPHHS lab in fall 2009. Weighted mg/m2 are adjusted to account for the actual number of transects sampled without the hoop sample transects.

2.14 Summary of results of QC analysis, issues encountered, and how issues were addressed (corrective action). The following is a summary of QC issues and how issues were addressed.

- *Holding Time.* Two *E. coli* samples were processed past hold time. Due to the short amount of time these samples were past hold (5 minutes and 30 minutes), Bob Ingram at Bridger Analytical Lab indicated that this was not a concern for data quality.
- *COC-Bottle Disagreement.* The disagreements between the COC sheet and information written on submitted sample bottles for sites EG05, SM03, SM03a, EG12, and BG02-M05BRIDC03 were resolved directly with personnel at Energy Labs within 24 hours of sample delivery. Each of the ID's was correct on the final lab EDD.
- *Field Methods.* The use of pacing rather than stringing a tape, and a 16 cm^2 template rather than a 12 cm^2, for chlorophyll-*a* field protocol was approved by DEQ prior to field sampling.

2.15 Completed QC checklist before MT-eWQX upload

MT-eWQX upload was completed on April 5th, 2010. One file with three spreadsheets was uploaded to MT EQuIS:

1. Projects: Data on the LGTPA project.
2. Stations: Data on the 72 site locations.
3. Chemistry and Field Measurement Results: Chemistry- data collected in the field and analyzed at a laboratory: *E. coli*, nutrient, TSS, and chlorophyll *a*; Field Measurements- data collected and analyzed in the field e.g. flow, dissolved oxygen and temperature.

3.0 SUMMARY OF ADDITIONAL ISSUES AND PROBLEMS ENCOUNTERED

Overall, few problems were encountered during the 2010 sampling effort. As detailed in Section 2.7, all of the pH measurements collected with one of the two YSI field meters were rejected in Equis due to problems with calibration of this unit. It was assumed that cleaning the pH probe would solve the problem, and by the time it was recognized that field readings were still periodically out of range even with cleaning, the field effort was nearly complete. All of the probes including the pH probe have since been replaced on this unit and we do not anticipate further issues with this YSI meter. OASIS recognizes that probes should have been replaced during the sampling effort, and if calibration problems are encountered in the future we will address them immediately.

At 56 of the 83 sites dissolved oxygen (DO) was incorrectly measured as % saturation rather than mg/l, as one of the field teams mistakenly understood the reporting units. To correct this problem, mg/l was back calculated from % saturation at those sites using the method provided by DEQ QAQC personnel Chris Shirley, as detailed in Section 2.7. Every effort will be made to ensure that collection units are clear to all field teams during future sampling events.

One problem encountered in 2010 was that we were pressed for time to complete the monitoring within the official low flow sampling season which ends in late September. DEQ project managers are very busy during the summer season, and thus we did not receive the final sampling sites from the DEQ project manager until later than expected, and were not able to begin sampling until September 14th. Recognizing that the sampling is intended to be semi-synoptic and ideally sampled in a relatively short timeframe, the 2010 sampling was compressed into too short of a timeframe and did not allow for any leeway to accommodate potential problems such as bad weather or equipment failure. However, we understand that the delay was unavoidable and we were able to complete the sampling within the low-flow sampling period. We have discussed this issue with the DEQ project manager and DEQ will make every effort to ensure that we are able to begin sampling in a timely manner on future DEQ projects.

On a positive note, obtaining landowner permissions to access sampling sites went significantly smoother in 2010 compared to 2009. Prior to initiating the 2010 sampling effort OASIS informed DEQ that due to the compressed timeframe, DEQ would need to assist with obtaining landowner permissions. OASIS compiled the landowner names and phone numbers using GIS, and made several initial contacts. The DEQ project manager then took the initiative to drive to several of the proposed sampling sites to obtain the more difficult landowner permissions, allowing us to focus on the sampling effort. This effort by the DEQ project manager was greatly appreciated.

4.0 REFERENCES

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

DEQ. 2008. Sample Collection and Laboratory Analysis of Chlorophyll-*a.* Montana Department of Environmental Quality. WQPBWQM-011. Revision June 5, 2008.

OASIS Environmental, Inc. 2008. Lower Gallatin TMDL Planning Area Nutrient, *E. coli,* and Algae Sampling and Analysis Plan. August 18, 2008.

Attachments

Attachment A: Sampling and Analysis Plan and Appendices, August 2008

Attachment B: Addendum 3 to August 2008 Sampling and Analysis Plan, September 2009

Attachment C: Site Visit Forms and Discharge Measurement Documentation

Attachment D: Laboratory Analytical Reports and Chain of Custody Forms

Attachment E: MT-eWQX Data Upload and Confirmation Documentation

Attachment F: Dissolved Oxygen Calculation Documentation

Attachment G: Algae Site Photos