

PPL Montana, 45 Basin Creek Road, Butte, Montana 59701



PPLM-2301-2001

Magalie R. Salas  
Secretary  
Federal Energy Regulatory Commission  
888 First Street, NE  
Washington, DC 20426

Re: Filing of Mystic Lake Project 2301 Study No. 18 Addendum from Evaluation of Current Fish Population and Habitat in West Rosebud Creek Downstream from Emerald Lake Study

May 30, 2006

Dear Secretary Salas:

PPL Montana herein files a Study No. 18 Addendum (macroinvertebrate and sediment data) from the Evaluation of Current Fish Population and Habitat in West Rosebud Creek Downstream from Emerald Lake Study per the Commission's Integrated Licensing Process (ILP).

Sincerely,

A handwritten signature in blue ink, appearing to read "Jon H. Jourdonnais", is written over a faint, larger version of the same signature.

Jon H. Jourdonnais,  
Director Hydro Licensing and Compliance

Cc: PPL Montana will send Mystic stakeholders an email with directions to access this filing at website [www.mysticlakeproject.com](http://www.mysticlakeproject.com)

## **Study No. 18 Addendum**

### **Evaluation of the Current Fish Population and Habitat in West Rosebud Creek Downstream from Emerald Lake: Results from the Macroinvertebrate and Sediment Study**

### **Mystic Lake Hydroelectric Project FERC No. 2301**

Mystic Lake, Montana

#### **PPL Montana**

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Butte, Montana 59701

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May 30, 2006

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## Executive Summary

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PPL Montana (PPLM) owns and operates the Mystic Lake Hydroelectric Facility on West Rosebud Creek, Stillwater County, Montana. Environmental and biological monitoring efforts on this stream system are ongoing. During August of 2005, PPLM collected streambed sediments and aquatic macroinvertebrates from trout spawning habitat in West Rosebud Creek near the Pine Grove Campground (PGC) and Allen Grade Bridge (AGB). The 2005 macroinvertebrate and substrate data are presented and evaluated in this report. Data on macroinvertebrates obtained from these sites in 2004 is also incorporated into this presentation.

The two sites on lower West Rosebud Creek supported generally healthy assemblages of aquatic macroinvertebrates. There were no indications of significant environmental stress at PGC. Similarly, unembedded cobbles at AGB supported benthic assemblages indicative of excellent water quality.

However, biological integrity at AGB may be slightly impaired by imbalances in the sediment budget (recruitment, transport, and storage). Community composition and most macroinvertebrate metrics indicated altered benthic assemblages in some habitats at AGB. While cobble habitats supported a fairly diverse community, large quantities of sand (up to 40 %) appeared to reduce macroinvertebrate abundance and species richness in potential spawning habitats. In addition, accumulations of detritus and fine sediment in areas of low water velocity created microhabitats supporting atypical macroinvertebrate assemblages. Based on these assessments, a large hillside slump between AGB and PGC may be a significant sediment source.

Substrate samples in West Rosebud Creek had low fine sediment levels, high Fredle Indices, and low to moderate embeddedness. Sediment levels increase in a downstream direction, with the metrics at the Allen Grade Bridge consistently indicating higher amounts of fine sediment than at the Pine Grove Campground. Both sites provide substrate that is suitable for salmonid reproduction.

If the Mystic Hydroelectric Project was a source of fine sediment, it would be expected that there would be larger amounts of fine sediment close to the project, with decreasing amounts downstream. In fact, the opposite trend is apparent. This indicates that the Mystic Project is not causing sediment impacts to West Rosebud Creek.

# Section 1 - Aquatic Macroinvertebrate Survey

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## 1.1 Introduction

PPL Montana (PPLM) owns and operates the Mystic Lake Hydroelectric Facility on West Rosebud Creek, Stillwater County, Montana. Environmental and biological monitoring efforts on this stream system are ongoing. During August of 2005, PPLM collected streambed sediments and aquatic macroinvertebrates from trout spawning habitat in West Rosebud Creek near the Pine Grove Campground (PGC) and Allen Grade Bridge (AGB). The 2005 macroinvertebrate data are presented and evaluated in this report. Data obtained from these sites in 2004 (McGuire 2004) is incorporated into this presentation.

## 1.2 Methods

Macroinvertebrates were collected with a Hess sampler enclosing 0.1 m<sup>2</sup> (390 micron mesh). A scrub brush was used to dislodge macroinvertebrates from stones in the sampler. The number of cobbles, large gravels and medium gravels removed from the sampler was recorded. The remaining substrate was stirred and sifted by hand to transport organisms into the collection net. Water depth and velocity were measured at each sample location. Samples were collected, preserved, and analyzed by Dan McGuire, McGuire Consulting.

The composition of surface substrates enclosed by the sampler was estimated. Particle sizes were based on the modified Wentworth scale (Platts et al. 1983). Size distribution estimates was standardized among samples by counting each cobble as 10%, each large gravel as 5%, and each medium gravel as 2.5% of the total. The remainder was portioned among small gravel, sand and silt/clay based on visual and tactile estimates while processing the sample.

Samples were collected 1 to 2 m upstream from sediment cores in areas suitable for trout spawning. Five samples were collected from nearshore gravel bars at each site. The majority of these samples clearly contained fewer macroinvertebrates than expected and provide a skewed characterization of the benthic fauna. Consequently, four additional macroinvertebrate samples (3 at PGC and 1 at AGB) were collected from predominantly cobble substrates in riffle habitats.

The 2005 data are presented separately for each habitat (spawning gravel and riffle cobble). The 2004 data were stratified among habitats based on water velocity and depth (e.g. shallow-fast, shallow-slow, deep-fast, deep-slow) and presented as a composite for each site.

### 1.2.1 Sample Sites

Two sites on lower West Rosebud Creek were sampled during 2004 and 2005 (Figure 1).

PGC Pine Grove Campground (lower) ~ N45° 16.8' - W109° 38.2'  
AGB Allen Grade Bridge ~ N45° 20.2' - W109° 36.3'

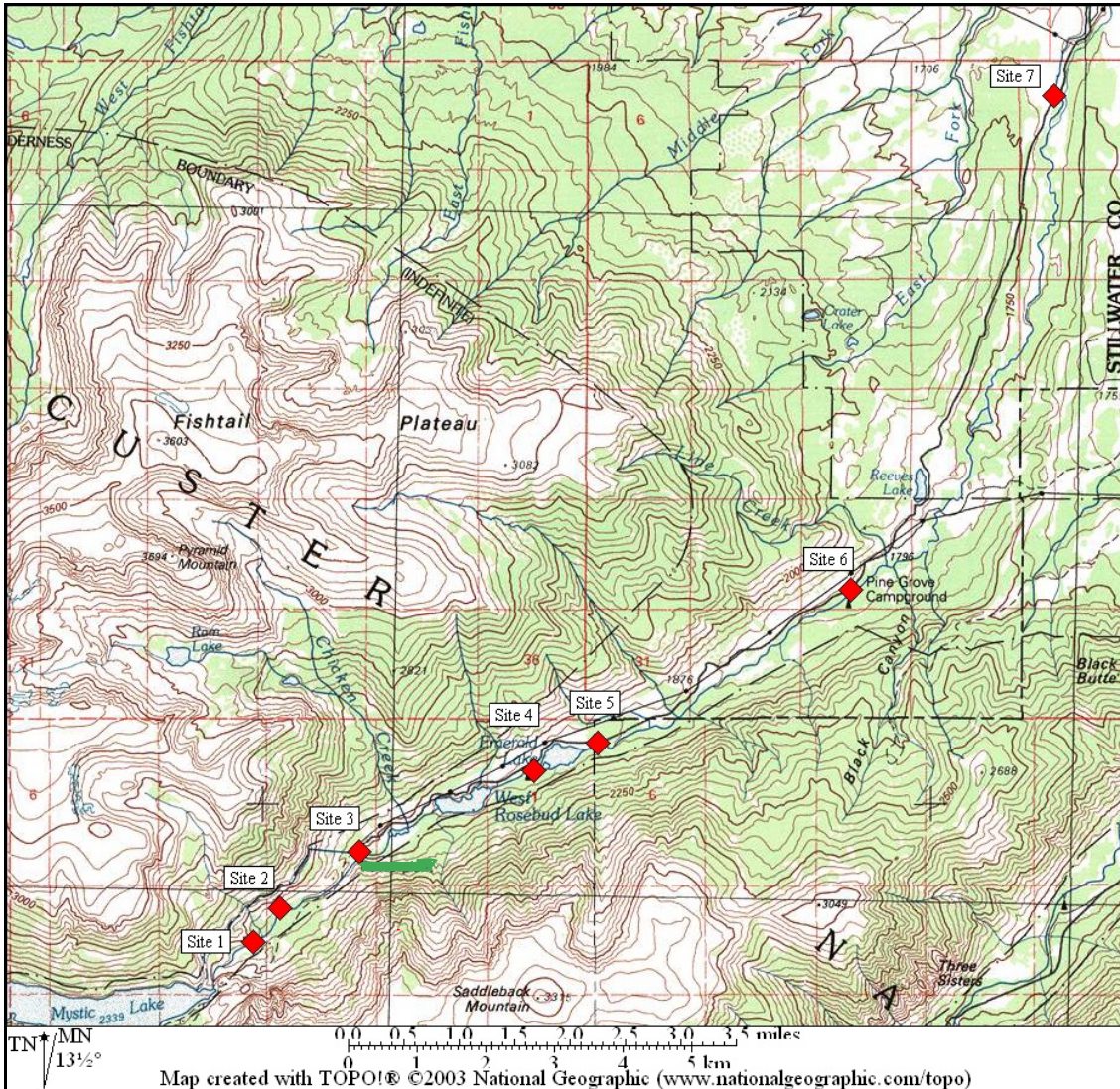


Figure 1. Locations (red diamonds) of aquatic macroinvertebrate sampling sites in West Rosebud Creek, 2004 and 2005. Sites 6 and 7 (PGC and AGB, respectively) were sampled in August, 2005.

## 1.3 Results

Identifications, enumerations, metric values, and substrate estimates for each sample collected in 2005, along with summary statistics for each site, are presented in Appendix A.

### 1.3.1 Macroinvertebrate taxa

West Rosebud Creek supports a diverse macroinvertebrate fauna typical of mountain streams in the region. A total of 103 macroinvertebrate taxa were identified from West Rosebud Creek in 2004 and 2005 (Table 1). Insects accounted for 92 taxa while 11 non-insect taxa were identified. Dipterans were the most diverse group with 41 taxa, including 28 genera of midges. Mayflies, stoneflies, and caddisflies were each represented by 15 to 17 species. Five species of beetles were collected from the stream. Non-insect taxa included segmented worms, leeches, flatworms, crustaceans, fingernail clams and freshwater sponge.

Greater sampling effort in 2004 resulted in more taxa being collected (7 sites, 96 taxa) than in 2005 (2 sites, 68 taxa). However, seven taxa (generally represented by one or two individuals) were added to the species list in 2005 (Table 1).

Table 1. A checklist of aquatic macroinvertebrates collected from West Rosebud Creek, Stillwater County, Montana during August, 2004 and 2005.

Order	Family	genus/species	Distribution		
			upper 2004	lower 2004	lower 2005
DIPTERA (two-winged flies)			2004	2004	2005
	Athericidae	<i>Atherix sp.</i>	x		
	Blephariceridae	<i>Agathon sp.</i>		x	
	Ceratopgonidae	Ceratopogoninae		x	x
	Chironomidae (Podonominae)	<i>Boreochlus sp.</i>	x		
	(Tanypodinae)	<i>Macropelopia sp.</i>			
		<i>Thienemannimyia gp.</i>	x	x	x
	(Diamesinae)	<i>Diamesa sp.</i>			x
		<i>Pagastia sp.</i>	x	x	x
		<i>Pseudodiamesa sp.</i>	x		
	(Prodiamsinae)	<i>Prodiamesia sp.</i>		x	
	(Orthocladinae)	<i>Brillia sp.</i>	x	x	x
		<i>Corynoneura sp.</i>	x	x	x
		<i>Cricotopus spp.</i>		x	
		<i>Eukiefferiella spp.</i>	x	x	x
		<i>Hydrobaenus sp.</i>	x	x	
		<i>Krenosmittia sp.</i>	x	x	
		<i>Orthocladus sp.</i>	x	x	x

Order	Family	genus/species	Distribution		
			upper	lower	lower
		<i>Nanocladius sp.</i>		X	
		<i>Parametrioctenus sp.</i>		X	X
		<i>Paraphaenocladius sp.</i>			X
		<i>Rheocricotopus sp.</i>	X	X	X
		<i>Synorthocladius sp.</i>	X	X	
		<i>Tvetenia sp.</i>	X	X	X
	(Chironomini)	<i>Microtendipes sp.</i>		X	
		<i>Paracladopelma sp.</i>		X	X
		<i>Polypedilum sp.</i>	X	X	X
	(Tanytasini)	<i>Cladotanytarsus sp.</i>		X	X
		<i>Sublettia sp.</i>		X	
		<i>Stempellinella sp.</i>	X		
		<i>Krenopsectra sp.</i>	X	X	X
		<i>Micropsectra sp. (poss. early instar Krenopsectra)</i>			X
		<i>Tanytarsus sp.</i>		X	
	Deuterophlebiidae	<i>Deuterophlebia sp.</i>	X	X	X
	Empididae	<i>Chelifera sp.</i>	X	X	X
		<i>Clinocera sp.</i>	X	X	X
	Tipulidae	<i>Antocha sp.</i>		X	X
		<i>Dicranota sp.</i>	X	X	
		<i>Hexatoma sp.</i>	X	X	X
		<i>Hesperoconopa sp.</i>	X		X
		<i>Limnophila sp.</i>		X	X
	Simuliidae	<i>Simulium sp. (Eusimulium)</i>	X	X	X
EPHEMEROPTERA					
	Ameletidae	<i>Ameletus sp.</i>	X	X	X
	Baetidae	<i>Acentrella sp.</i>	X	X	X
		<i>Baetis tricaudatus</i>	X	X	X
		<i>Dipheter hageni</i>	X	X	X
	Ephemerellidae	<i>Caudatella hystrix</i>		X	
		<i>Drunella coloradensis</i>		X	
		<i>Drunella doddsi</i>	X	X	X
		<i>Drunella grandis</i>	X	X	X
		<i>Ephemerella sp.</i>	X		X
		<i>Seratella tibialis</i>	X	X	X
	Heptageniidae	<i>Cinygmula sp.</i>	X	X	X
		<i>Epeoris grandis</i>		X	X
		<i>Epeorus longimanus</i>	X	X	X
		<i>Rhithrogena sp.</i>	X	X	X
	Leptophlebiidae	<i>Paraleptophlebia sp.</i>	X	X	X

Order	Family	genus/species	Distribution		
			upper	lower	lower
PLECOPTERA					
	Capniidae		x		
	Leuctridae		x		x
	Nemouridae	<i>Malenka sp.</i>		x	x
		<i>Podmosta sp.</i>	x		
		<i>Visoka cataractae</i>	x		
		<i>Zapada oregonensis gp.</i>		x	
		<i>Zapada cinctipes</i>	x	x	x
	Chloroperlidae	Chloroperlinae*	x	x	x
		<i>Kathroperla sp.</i>	x	x	x
	Perlodidae	<i>Skwala sp.</i>		x	x
		<i>Cultus sp.</i>			x
	Perlidae	Unident. early instar	x	x	
		<i>Claassina sabulosa</i>		x	x
		<i>Doroneuria theodora</i>	x		
		<i>Hesperoperla pacifica</i>	x	x	x
TRICHOPTERA					
	Hydropsychidae	<i>Arctopsyche sp.</i>	x	x	x
		<i>Hydropsyche (C) oslari</i>		x	x
	Philopotamidae	<i>Dolophilodes sp.</i>		x	x
	Limnephilidae	<i>Ecclisomyia sp.</i>	x		
		<i>Psychoglypha sp.</i>		x	
	Hydroptilidae	<i>Agraylea sp.</i>		x	
	Brachycentridae	<i>Brachycentrus americanus</i>	x		x
		<i>Micrasema sp.</i>		x	x
	Lepidostomatidae	<i>Lepidostoma sp.</i>		x	x
	Glossosomatidae	<i>Glossosoma sp.</i>		x	x
	Uenoidae	<i>Neophylax sp.</i>		x	
	Rhyacophilidae	<i>Rhyacophila betteni gp.</i>	x		
		<i>Rhyacophila brunnea gp.</i>		x	x
		<i>Rhyacophila hyalinata gp.</i>			x
		<i>Rhyacophila coloradensis gp.</i>			x
		<i>Rhyacophila sibirica gp.</i>		x	
COLEOPTERA (beetles)					
	Dytiscidae	<i>Stictotarsus sp.</i>		x	
	Elmidae	<i>Heterlimnius corpulentus</i>	x	x	x
		<i>Narpus concolor</i>		x	x

Order	Family	genus/species	Distribution		
			upper	lower	lower
ANNELIDA		<i>Optioservus sp.</i>	x	x	x
		<i>Ziatzevia parvula</i>			x
	Enchytraeidae		x	x	x
	Megadrilli		x	x	x
	<i>Naididae</i>	<i>Nais sp.</i>		x	
	Tubificidae				
		immature wo/capilliform chaetae (prob Limnodrilus)		X	X
		immature w/capilliform chaetae (prob Rhyacodrilus)		X	X
	Glossophoniidae	<i>Helobdella stagnalis</i>		x	
	CRUSTACEA				
	Isopoda	<i>Caecidotea sp.</i>		x	
	Ostracoda		x	x	
MOLLUSCA					
	Sphaeriidae	<i>Pisidium sp.</i>	x	x	x
TURBELLARIA			x	x	x
PORIFERA				x	x

### 1.3.2 Community composition

Community composition was constant between years and substrates at PGC (Figure 2). Mayflies and stoneflies were numerically dominant at this site during August. Early instar *Baetis tricaudatus*, *Paraleptophlebia sp.* and Chloroperlinae (mostly *Sweltsa sp.*) were the most abundant taxa in each group of samples.

In contrast, community composition varied between years and substrate types at AGB. The riffle beetle, *Optioservus sp.*, was the most numerous taxon in samples from AGB during 2005 and was particularly abundant (37%) in the samples from gravel substrates. Mayflies and caddisflies were more abundant in predominantly cobble substrate than in gravel substrates. Non-insects were the most abundant macroinvertebrates collected at AGB in 2004. These data were skewed by the predominance of isopods, fingernail clams and segmented worms in one sample (deep-slow) containing a large volume of detritus and fine sediment (McGuire 2004).

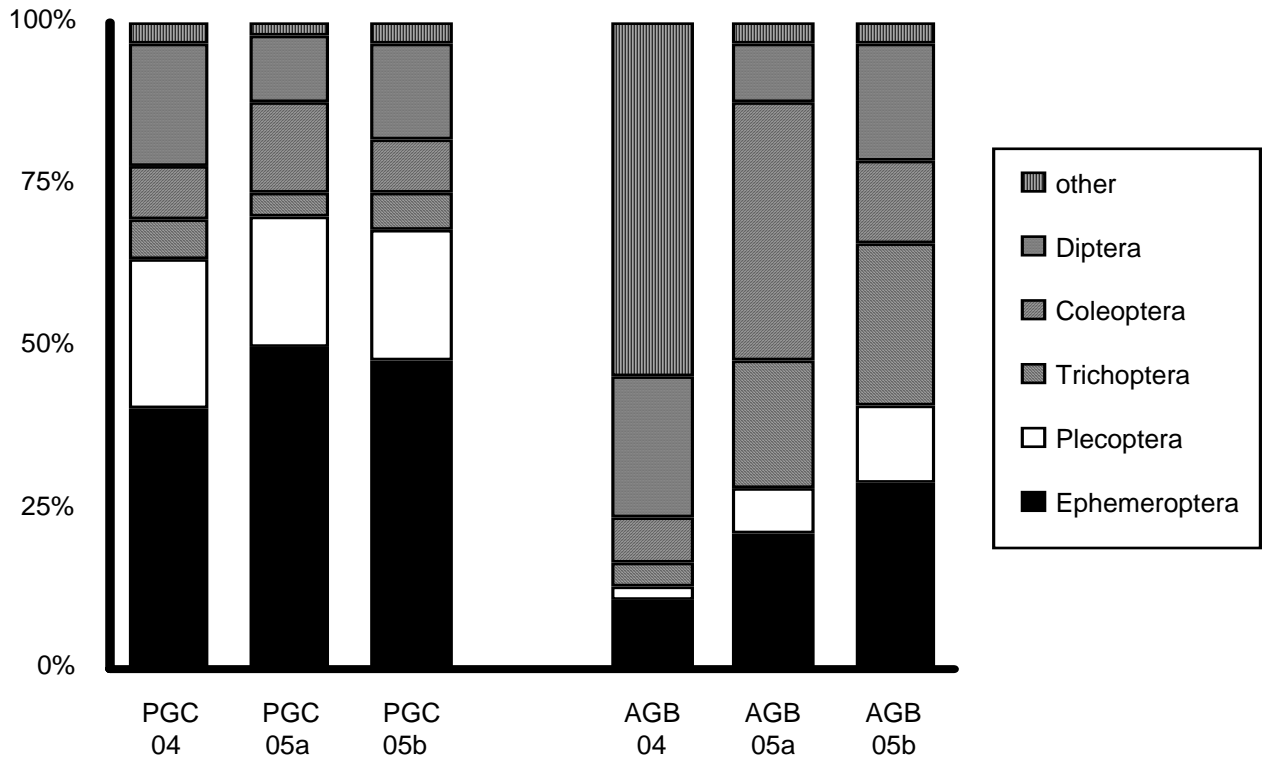


Figure 2. Percent relative abundance of major macroinvertebrate groups at 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravel; 05b = riffle cobble.

### 1.3.3 Percent EPT

Mayflies, stoneflies, and caddisflies (Ephemeroptera, Plecoptera, and Trichoptera, respectively) typically dominate macroinvertebrate faunas in mountain streams. The combined relative abundance of these 3 groups (percent EPT) is a standard community composition metric used to evaluate water and habitat quality (Bukantis 1997). Environmental stress may be indicated when EPT comprise less than about 50% of the fauna.

Mean EPT relative abundance was consistently high at PGC but varied among years and habitats at AGB (Figure 3). Mean %EPT values ranged from 71 to 74% at PGC and from 24 to 67% at AGB. At AGB, the riffle cobble sample contained 67% EPT while EPT relative abundance averaged 47% within spawning gravels. On average, the 2004 samples at AGB contained only 24% EPT. These data may reflect localized environmental stresses associated with patches of suboptimal habitat. EPT relative abundance was negatively influenced at AGB by a few samples collected from areas with accumulations of detritus and excessive fine sediments.

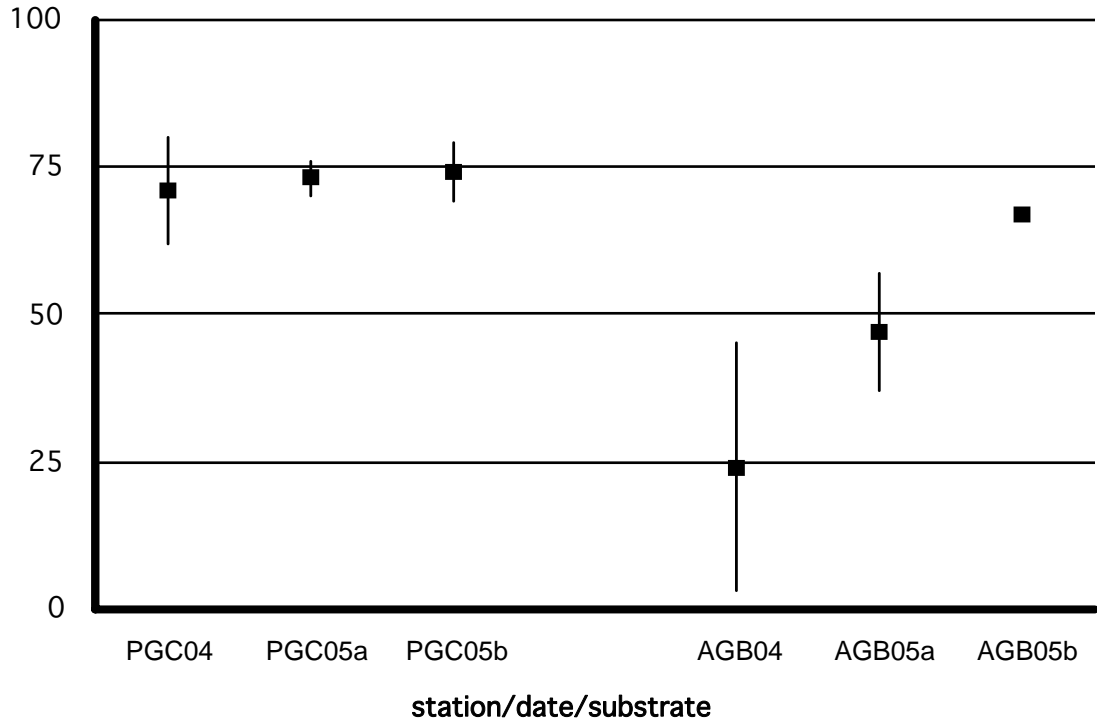


Figure 3. Mean percentage (+ 1 SD) of EPT (mayflies, stoneflies, and caddisflies) in Hess samples from 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravel; 05b = riffle cobble.

### 1.3.4 Community Density

Macroinvertebrate community density estimates ranged from 108 to 524 organism per 0.1m<sup>2</sup> (Figure 4). Total density was significantly higher at PGC than at AGB in 2005 but not in 2004. In 2005, community density averaged 401 organisms per Hess samples at PGC and 141 organisms per sample at AGB. Densities were higher in predominantly cobble substrates (mean 470) than in substrates comprised primarily of small gravels (mean 218). The strongest relationship between substrate characteristics and macroinvertebrate densities was a negative correlation with percent sand on the substrate surface (Figure 5).

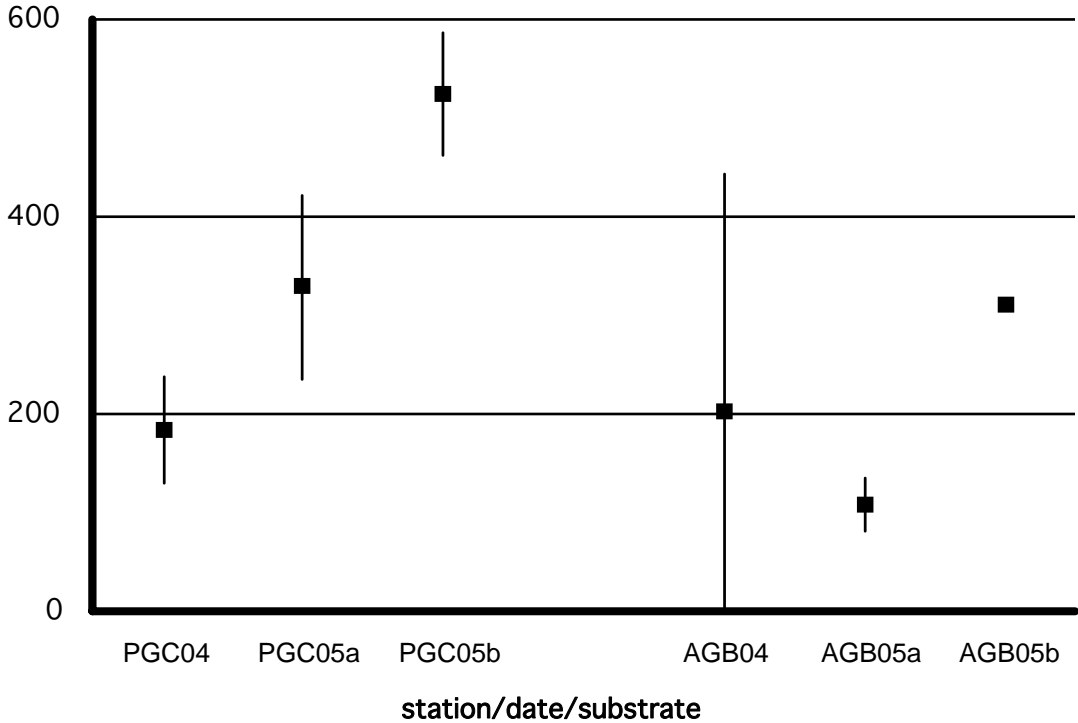


Figure 4. Mean macroinvertebrate densities ( $\#/0.1\text{m}^2 \pm 1\text{ SD}$ ) in Hess samples from 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravels; 05b = riffle cobbles.

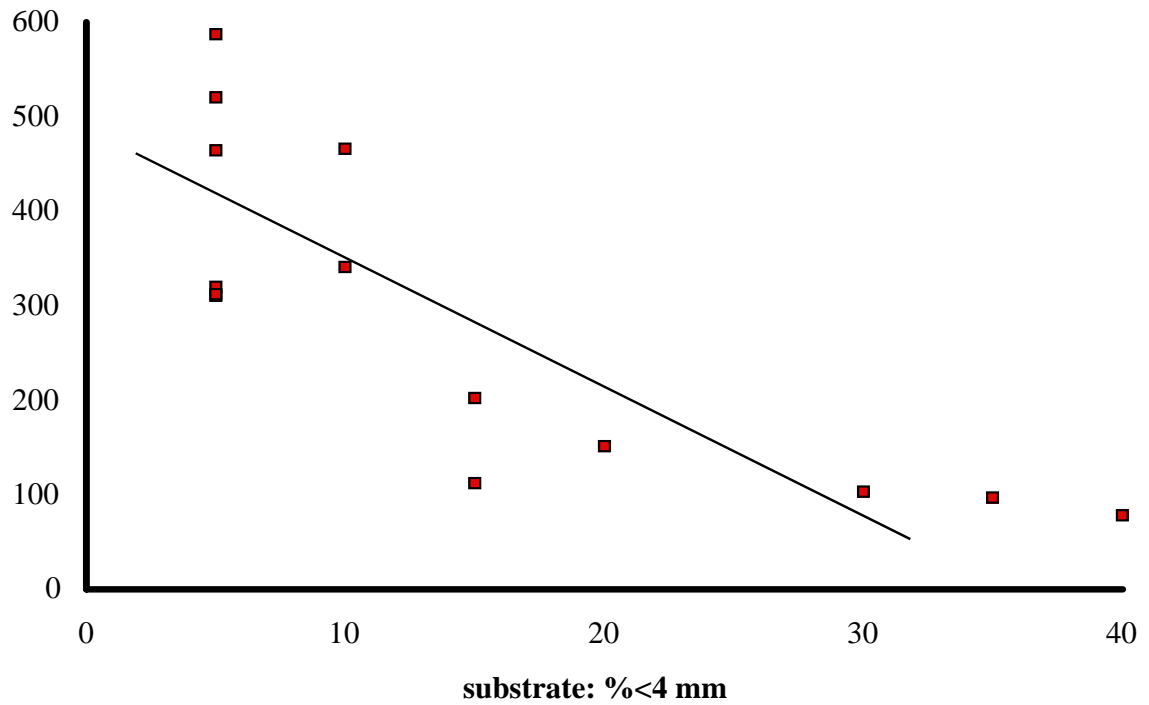


Figure 5. Macroinvertebrate density ( $\#/0.1\text{m}^2$ ) as a function of percent surface sand and fines in West Rosebud Creek during August 2005 ( $r^2 = 0.63$ ,  $p = 0.001$ ,  $n = 14$ ).

### 1.3.5 Taxa Richness

Mean taxa richness ranged from 20 to 34 taxa per sample (Figure 6). Taxa richness tended to be higher at PGC than at AGB. Taxa richness was higher in predominately cobble substrates than in small gravel. The strongest correlation between substrate components and taxa richness was a negative relationship with percent sand and fines (Figure 7).

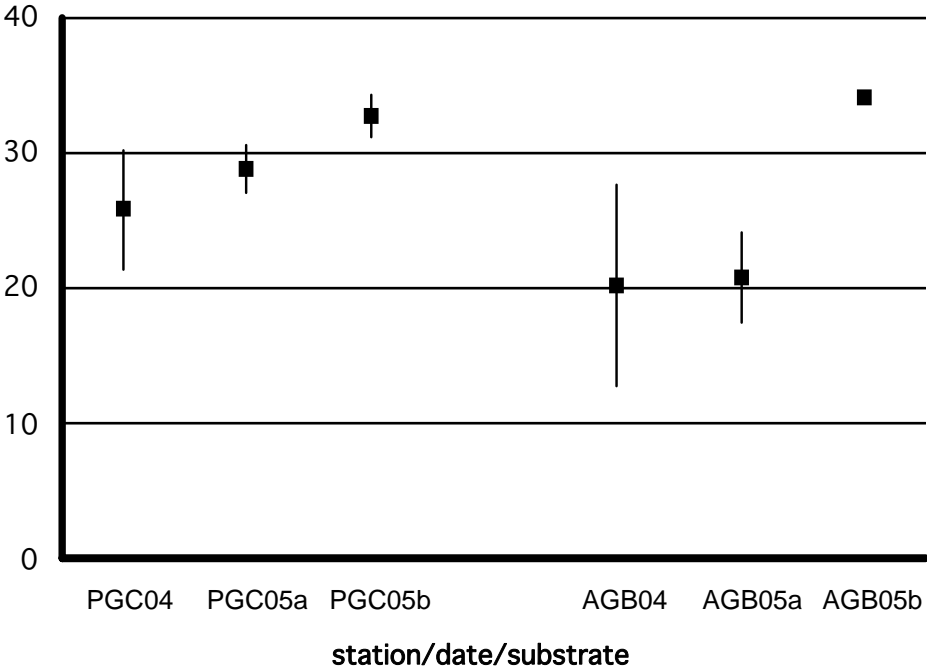


Figure 6. Mean macroinvertebrate taxa richness ( $\#/0.1\text{m}^2 \pm 1 \text{SD}$ ) in Hess samples from 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravels; 05b = riffle cobbles.

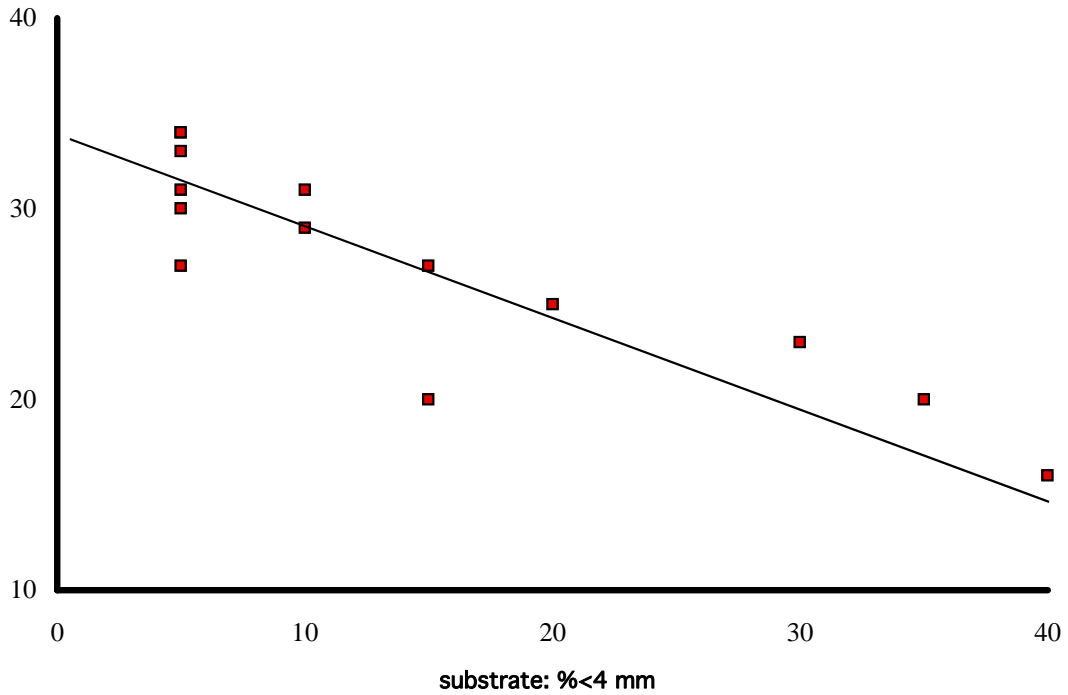


Figure 7. Macroinvertebrate taxa richness (#taxa/sample) as a function of percent surface fines in West Rosebud Creek during August 2005 ( $r^2 = 0.77$ ,  $p = 0.000$ ,  $n = 14$ ).

### 1.3.6 EPT Richness

The mean number of mayfly, stonefly and caddisfly taxa per sample ranged from 8 to 18 (Figure 8). EPT richness was lowest at AGB during 2004. EPT richness tended to be slightly higher in cobble substrates than in gravel substrates in 2005.

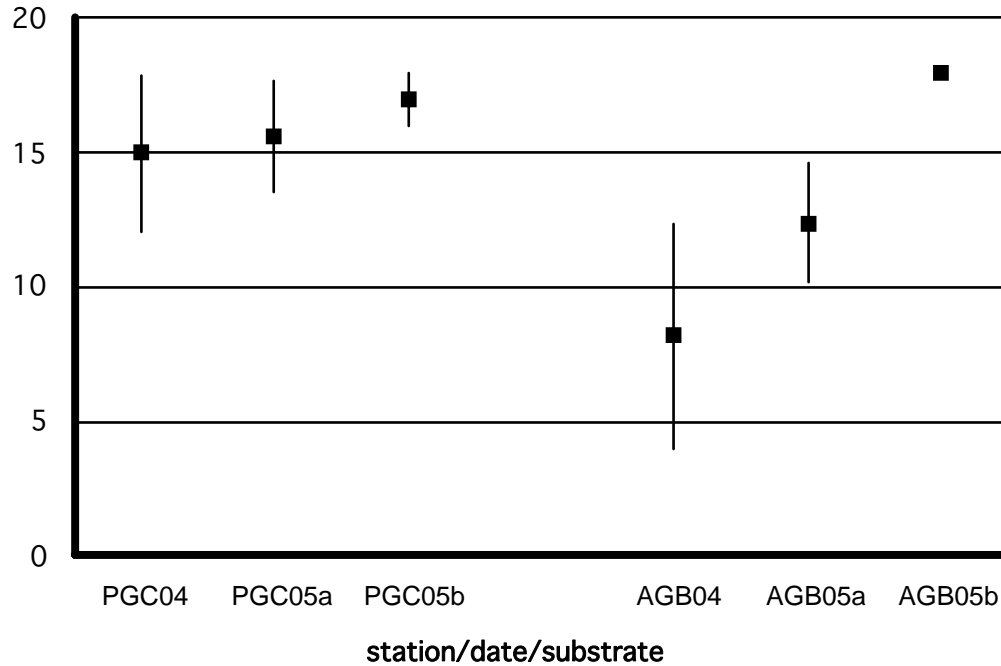


Figure 8. Mean EPT taxa richness (+- 1 SD) per 0.1 m<sup>2</sup> Hess sample from 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravels; 05b = riffle cobbles.

### 1.3.7 Biotic Index

The biotic index was developed as a measure of organic pollution (Hilsenhoff 1987). The Montana version of this index (Bukantis 1997) is an excellent indicator of a streams trophic status and also tends to be correlated with water temperature, substrate embeddedness, and the percentage of fine sediments (Bollman 1998). On a scale of 0 to 10, with higher values indicating increasingly eutrophic conditions, healthy mountain streams in Montana typically have biotic index values of 4 or less (McGuire 1992).

Biotic index values were generally low and indicative of good to excellent water quality in lower West Rosebud Creek (Figure 9). Mean values were highly variable and somewhat elevated at AGB during 2004.

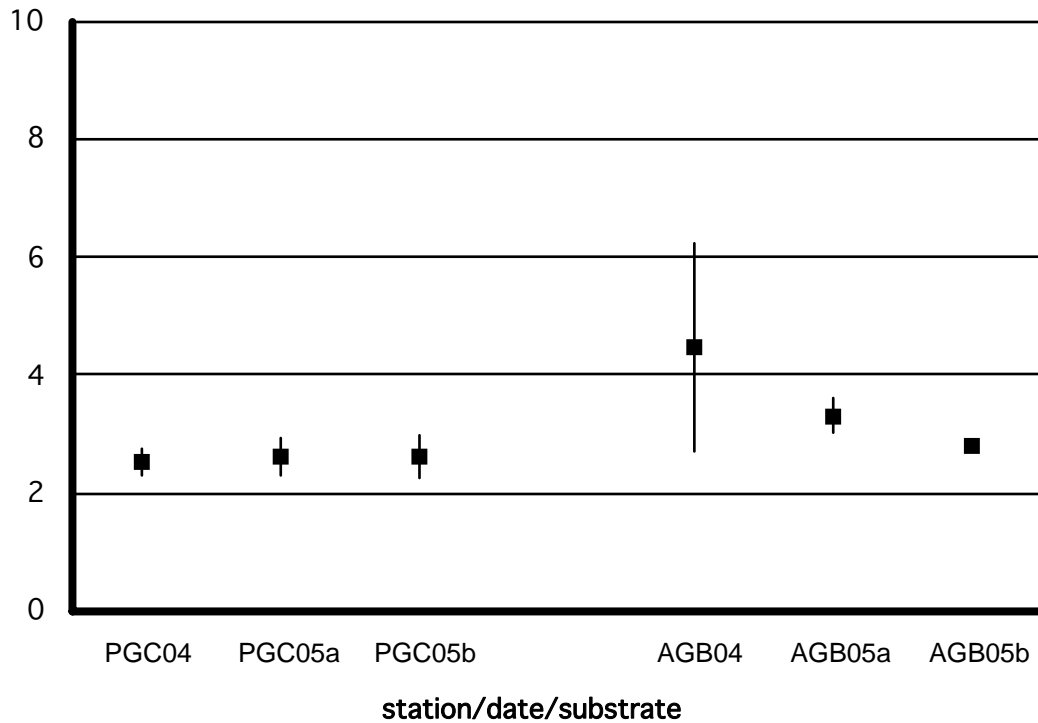


Figure 9. Mean biotic index values (+ 1 SD) per 0.1 m<sup>2</sup> Hess sample from 2 sites on West Rosebud Creek, August, 2004 and 2005. 2004 samples: composite of available habitats; 2005 samples: 05a = spawning gravels; 05b = riffle cobbles.

## 1.4 Conclusion

The two sites on lower West Rosebud Creek supported generally healthy assemblages of aquatic macroinvertebrates. There were no indications of significant environmental stress at PGC. Similarly, unembedded cobbles at AGB supported benthic assemblages indicative of excellent water quality.

However, biological integrity at AGB may be slightly impaired by imbalances in the sediment budget (recruitment, transport, and storage). Community composition and most macroinvertebrate metrics indicated altered benthic assemblages in some habitats at AGB. While cobble habitats supported a fairly diverse community, large quantities of sand (up to 40 %) appeared to reduce macroinvertebrate abundance and species richness in potential spawning habitats. In addition, accumulations of detritus and fine sediment in areas of low water velocity created microhabitats supporting atypical macroinvertebrate assemblages. Based on these assessments, a large hillside slump between AGB and PGC may be a significant sediment source.

These data illustrate the sensitivity of macroinvertebrate monitoring and the importance of sample site selection. Results varied between years because different habitats were sampled each year. Future monitoring should include samples from the full range of habitats present at each site. Samples should be stratified among habitats (as in 2004) with at least three samples from optimal habitat. Samples from unembedded cobbles will provide the best assessment of water quality and establish a site-specific baseline for evaluating other habitats. Three additional samples should be obtained from habitats with greater embeddedness and/or finer sediments. Data from each habitat type should be analyzed and presented separately.

## **1.5 Literature Cited**

- Bollman, W. 1998. Improving stream bioassessment methods for the Montana Valleys and Foothills Ecoregion. Masters Thesis. University of Montana. Missoula, MT.
- Bukantis, R. 1997. Rapid bioassessment macroinvertebrate protocols: Sampling and sample analysis SOP's. Montana Dept. of Health & Environmental Sciences. Helena, Montana.
- McGuire, D.L. 2004. Aquatic macroinvertebrates in West Rosebud Creek, Montana. Prepared for PPL-Montana. Butte, MT.
- McGuire, D.L. 1992. Montana Reference Streams Project: 1991 Aquatic macroinvertebrate surveys. Prepared for the Montana Water Quality Bureau. Helena, Montana.
- Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. General Technical Report INT-138, Intermountain Forest and Range Experimental Station, USDA Forest Service, Ogden, UT 70 pp.

## 1.6 Appendix A

West Rosebud Creek, PPL-MT:		Stillwater County, MT Site: Pine Grove Camp Ground								
30-Aug-05		Corresponding to Sediment Samples (Spawning Gravel)								
Hess sample (0.1m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA	
Taxon										
<b>COLEOPTERA</b>						<b>47</b>		<b>235</b>	<b>14%</b>	
<i>Heterlimnius</i> <i>corpulentus</i>	24	29	16	29	14	22.4	7.1	112	6.8%	
<i>Narpus concolor</i>	0	0	1	0	3	0.8	1.3	4	0.2%	
<i>Optioservus sp.</i>	34	19	8	12	46	23.8	15.9	119	7.3%	
<b>DIPTERA</b>						<b>31</b>		<b>157</b>	<b>10%</b>	
<i>Thienemannimyia</i> <i>gp.</i>	2	1	2	0	0	1.0	1.0	5	0.3%	
<i>Diamesa sp.</i>	2	0	0	0	0	0.4	0.9	2	0.1%	
<i>Pagastia sp.</i>	1	0	1	0	1	0.6	0.5	3	0.2%	
<i>Corynoneura sp.</i>	0	1	0	1	1	0.6	0.5	3	0.2%	
<i>Eukiefferiella spp.</i>	2	3	0	1	1	1.4	1.1	7	0.4%	
<i>Orthocladius sp.</i>	3	0	0	0	3	1.2	1.6	6	0.4%	
<i>Parametriocnemus</i> <i>sp.</i>	0	0	0	1	1	0.4	0.5	2	0.1%	
<i>Rheocricotopus sp.</i>	0	2	0	2	1	1.0	1.0	5	0.3%	
<i>Tvetenia sp.</i>	4	9	0	2	0	3.0	3.7	15	0.9%	
<i>Polypedilum sp.</i>	0	0	0	3	0	0.6	1.3	3	0.2%	
<i>Micropsectra sp.</i>	17	33	8	23	4	17.0	11.6	85	5.2%	
<i>Hexatoma sp.</i>	4	1	1	4	5	3.0	1.9	15	0.9%	
<i>Chelifera sp.</i>	2	0	0	0	0	0.4	0.9	2	0.1%	
<i>Deuterophlebia sp.</i>	0	0	1	0	0	0.2	0.4	1	0.1%	
Ceratopogoninae <i>Simulium spp.</i> ( <i>Eusimulium</i> )	0	0	2	0	0	0.4	0.9	2	0.1%	
<b>EPHEMEROPTERA</b>						<b>163</b>		<b>816</b>	<b>50%</b>	
<i>Acentrella sp.</i>	0	0	0	0	1	0.2	0.4	1	0.1%	
<i>Baetis tricaudatus</i>	68	95	39	88	107	79.4	26.7	397	24.2%	
<i>Drunella doddsi</i>	0	2	0	0	0	0.4	0.9	2	0.1%	
<i>Drunella grandis</i>	1	1	3	0	0	1.0	1.2	5	0.3%	
<i>Ephemerella sp.</i>	1	0	0	0	3	0.8	1.3	4	0.2%	

West Rosebud Creek, PPL-MT:		Stillwater County, MT Site: Pine Grove Camp Ground									
30-Aug-05		Corresponding to Sediment Samples (Spawning Gravel)									
Hess sample (0.1m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA		
Taxon											
<i>Seratella tibialis</i>	3	4	3	1	2	2.6	1.1	13	0.8%		
<i>Cinygmula spp.</i>	1	1	0	0	0	0.4	0.5	2	0.1%		
<i>Rhithrogena sp.</i>	5	11	6	5	1	5.6	3.6	28	1.7%		
<i>Paraleptophlebia sp.</i>	71	103	44	76	47	68.2	24.1	341	20.8%		
<i>Ameletus sp.</i>	8	2	5	3	5	4.6	2.3	23	1.4%		
<b>PLECOPTERA</b>						<b>64</b>		<b>320</b>	<b>20%</b>		
Leuctridae	1	0	0	0	0	0.2	0.4	1	0.1%		
<i>Zapada cinctipes</i>	4	7	4	8	22	9.0	7.5	45	2.7%		
Chloroperlinae*	48	97	35	30	37	49.4	27.4	247	15.1%		
<i>Kathroperla sp.</i>	0	0	0	0	1	0.2	0.4	1	0.1%		
<i>Skwala sp.</i>	0	0	2	1	0	0.6	0.9	3	0.2%		
<i>Cultus sp.</i>	1	0	0	0	0	0.2	0.4	1	0.1%		
<i>Claassina sabulosa</i>	0	1	0	3	0	0.8	1.3	4	0.2%		
<i>Hesperoperla pacifica</i>	1	10	1	4	2	3.6	3.8	18	1.1%		
<b>TRICHOPTERA</b>						<b>12</b>		<b>61</b>	<b>4%</b>		
<i>Arctopsyche sp.</i>	0	6	0	1	1	1.6	2.5	8	0.5%		
<i>Dolophilodes sp.</i>	0	2	3	1	2	1.6	1.1	8	0.5%		
<i>Brachycentrus americanus</i>	0	3	2	2	15	4.4	6.0	22	1.3%		
<i>Micrasema sp.</i>	1	1	0	0	0	0.4	0.5	2	0.1%		
<i>Lepidostoma sp.</i>	1	6	4	0	4	3.0	2.4	15	0.9%		
<i>Glossosoma sp.</i>	1	0	1	0	2	0.8	0.8	4	0.2%		
<i>Rhyacophila brunnea gp.</i>	0	1	0	0	0	0.2	0.4	1	0.1%		
<i>Rhyacophila hyalinata gp.</i>	1	0	0	0	0	0.2	0.4	1	0.1%		
<b>ANNELIDA</b>						<b>5</b>		<b>23</b>	<b>2%</b>		
Enchytraeidae	7	5	6	2	3	4.6	2.1	23	1.4%		
Megadrilli	0	1	1	1	0	0.6	0.5	3	0.2%		
Tubificidae (w/cap)	0	0	0	7	0	1.4	3.1	7	0.4%		

West Rosebud Creek, PPL-MT: Stillwater County, MT Site: Pine Grove Camp Ground											
30-Aug-05 Corresponding to Sediment Samples (Spawning Gravel)											
Hess sample (0.1m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA		
Taxon											
OTHER						4		19	1%		
Turbellaria	0	2	0	1	0	0.6	0.9	3	0.2%		
<i>Pisidium sp.</i>	1	7	2	0	6	3.2	3.1	16	1.0%		
IDs by D. McGuire											
TOTAL ORGANISMS	320	466	202	312	341	328	94.1	1641			
TAXA RICHNESS	30	31	27	27	29	28.8	1.8	50			
EPT RICHNESS	17	18	14	13	16	15.6	2.1	26			
BIOTIC INDEX	2.66	2.40	2.24	2.86	2.94	2.62	0.30	2.63			
% DOMINANT TAXON	22%	22%	22%	28%	31%	25%	4%				
% COLLECTORS (g+f)	54%	47%	46%	57%	63%	53%	7%	53%			
% SCRAPER+SHREDDER	28%	29%	32%	29%	24%	28%	3%	28%			
%EPT	68%	76%	75%	71%	74%	73%	3%	73%			
SHANNON DIVERSITY	3.42	3.39	3.60	3.25	3.37	3.40	0.13	3.58			
EPT/(EPT + Chironomidae)	0.88	0.88	0.93	0.87	0.95	0.90	0.04	0.92			
% COLLECTOR-GATHERERS	53%	43%	42%	56%	56%	50%	7%	50%			
% SHREDDERS	2%	3%	4%	3%	9%	4%	3%	4%			
% SCRAPERS	25%	26%	27%	26%	15%	24%	5%	24%			
% FILTERERS	0%	4%	4%	1%	7%	3%	3%	3%			
% PREDATORS	19%	24%	22%	14%	13%	18%	5%	19%			
% CHIRONOMIDAE	10%	11%	5%	11%	4%	8%	3%	8%			
% TANYTARSINI	5%	7%	4%	7%	1%	5%	3%	5%			
Baetidae/EPHEMEROPTERA	43%	43%	39%	51%	65%	48%	10%	49%			
METALS TOLERANCE INDEX	2.88	2.63	2.50	2.96	3.45	2.89	0.37	2.90			
notes: Chloroperlinae mostly early instar- both Sweltsa and Suwallia present.											

<b>West Rosebud</b>											
<b>Creek, Stillwater County, MT</b>											
<b>PPL-MT: Site: Pine Grove Camp Ground</b>											
<b>30-Aug-05 Corresponding to Sediment Samples (Spawning Gravel)</b>											
Hess sample (0.1m2):	1	2	3	4	5		MEAN	ST. DEV.	TOT #	%RA	
Taxon											
Water depth (ft):	0.1	0.9	0.9	0.6	0.8		0.7	0.4			
Water velocity (ft/sec)	0.73	2.49	1.09	1.80	1.81		1.58	0.69			
Streambed % composition (visual estimate of substrate surface)											
Cobble	20	0	10	10	20		12	8			
Gravel	75	90	75	85	70		79	8			
Sand	5	10	15	5	10		9	4			
gravel size											
(large gravel)	40	55	10	20	20		29	18			
(medium gravel)	20	25	50	40	40		35	12			
(small gravel)	15	10	15	25	10		15	6			

AQUATIC MACROINVERTEBRATE DATA								
West Rosebud Creek, Stillwater County, MT								
PPL-MT: site: Pine Grove Campground								
8/29/2005 riffle cobbles								
Hess sample (0.1 m2):	1	2	3	MEAN	ST. DEV.	TOT #	%RA	
Taxon								
<b>COLEOPTERA</b>				42		126	8%	
<i>Heterlimnius corpulentus</i>	35	10	10	18.3	14.4	55	3.5%	
<i>Narpus concolor</i>	3	1	0	1.3	1.5	4	0.3%	
<i>Optioservus sp.</i>	45	11	11	22.3	19.6	67	4.3%	
<b>DIPTERA</b>				78		234	15%	
<i>Thienemannimyia gp.</i>	0	3	0	1.0	1.7	3	0.2%	
<i>Pagastia sp.</i>	2	0	2	1.3	1.2	4	0.3%	
<i>Eukiefferiella spp.</i>	4	1	1	2.0	1.7	6	0.4%	
<i>Orthocladius sp.</i>	7	3	17	9.0	7.2	27	1.7%	
<i>Rheocricotopus sp.</i>	0	0	1	0.3	0.6	1	0.1%	
<i>Tvetenia sp.</i>	11	3	1	5.0	5.3	15	1.0%	
<i>Polypedilum sp.</i>	0	1	0	0.3	0.6	1	0.1%	
<i>Krenopsectra sp.</i>	26	54	50	43.3	15.1	130	8.3%	
<i>Antocha sp.</i>	0	1	0	0.3	0.6	1	0.1%	
<i>Hexatoma sp.</i>	5	0	4	3.0	2.6	9	0.6%	
<i>Hesperoconopa sp.</i>	0	0	1	0.3	0.6	1	0.1%	
<i>Limnophila sp.</i>	1	0	0	0.3	0.6	1	0.1%	
<i>Chelifera sp.</i>	0	0	1	0.3	0.6	1	0.1%	
<i>Clinocera sp.</i>	1	0	0	0.3	0.6	1	0.1%	
<i>Deuterophlebia sp.</i>	2	0	1	1.0	1.0	3	0.2%	
Ceratopogoninae	4	0	0	1.3	2.3	4	0.3%	
<i>Simulium spp. (Eusimulium)</i>	23	0	3	8.7	12.5	26	1.7%	
<b>EPHEMEROPTERA</b>				249		747	48%	
<i>Acentrella sp.</i>	0	7	0	2.3	4.0	7	0.4%	
<i>Baetis tricaudatus</i>	151	59	123	111	47.2	333	21.2%	
<i>Dipheter hageni</i>	0	2	0	0.7	1.2	2	0.1%	
<i>Drunella doddsi</i>	4	4	0	2.7	2.3	8	0.5%	
<i>Seratella sp.</i>	5	5	9	6.3	2.3	19	1.2%	
<i>Epeorus longimanus</i>	4	0	2	2.0	2.0	6	0.4%	
<i>Rhithrogena sp.</i>	4	1	6	3.7	2.5	11	0.7%	
<i>Paraleptophlebia sp.</i>	44	196	120	120	76.0	360	22.9%	
<i>Ameletus sp.</i>	0	0	1	0.3	0.6	1	0.1%	

AQUATIC MACROINVERTEBRATE DATA								
West Rosebud Creek, Stillwater County, MT								
PPL-MT: site: Pine Grove Campground								
8/29/2005 riffle cobbles								
Hess sample (0.1m2):	1	2	3	MEAN	ST. DEV.	TOT #	%RA	
Taxon								
<b>PLECOPTERA</b>				<b>105</b>		<b>315</b>	<b>20%</b>	
<i>Malenka sp.</i>	0	1	0	0.3	0.6	1	0.1%	
<i>Zapada cinctipes</i>	17	15	51	27.7	20.2	83	5.3%	
Chloroperlinae*	120	33	44	65.7	47.4	197	12.5%	
<i>Skwala sp.</i>	0	1	0	0.3	0.6	1	0.1%	
<i>Claassina sabulosa</i>	1	1	3	1.7	1.2	5	0.3%	
<i>Hesperoperla pacifica</i>	10	7	11	9.3	2.1	28	1.8%	
<b>TRICHOPTERA</b>				<b>33</b>		<b>98</b>	<b>6%</b>	
<i>Arctopsyche sp.</i>	8	7	12	9.0	2.6	27	1.7%	
<i>Hydropsyche (C) oslari</i>	0	1	1	0.7	0.6	2	0.1%	
<i>Dolophilodes sp.</i>	10	9	5	8.0	2.6	24	1.5%	
<i>Brachycentrus americanus</i>	9	6	7	7.3	1.5	22	1.4%	
<i>Micrasema sp.</i>	3	0	0	1.0	1.7	3	0.2%	
<i>Lepidostoma sp.</i>	4	5	3	4.0	1.0	12	0.8%	
<i>Glossosoma sp.</i>	3	0	0	1.0	1.7	3	0.2%	
<i>Rhyacophila brunnea gp.</i>	3	0	2	1.7	1.5	5	0.3%	
<b>ANNELIDA</b>				<b>6</b>		<b>18</b>	<b>1%</b>	
Enchytraeidae	5	0	13	6.0	6.6	18	1.1%	
Megadrilli	0	5	0	1.7	2.9	5	0.3%	
Tubificidae (wo/cap)	5	0	0	1.7	2.9	5	0.3%	
<b>OTHER</b>				<b>8</b>		<b>23</b>	<b>1%</b>	
Turbellaria	0	1	2	1.0	1.0	3	0.2%	
<i>Pisidium sp.</i>	8	10	1	6.3	4.7	19	1.2%	
Porifera	0	0	1	0.3	0.6	1	0.1%	
IDs by D. McGuire								
TOTAL ORGANISMS	587	464	520	524	61.6	1571		
TAXA RICHNESS	34	31	33	32.7	1.5	49		
EPT RICHNESS	17	18	16	17.0	1.0	23		
BIOTIC INDEX	2.94	2.25	2.68	2.62	0.35	2.65		
% DOMINANT TAXON	26%	42%	24%	31%	10%	23%		
% COLLECTORS (g+f)	59%	41%	50%	50%	9%	51%		
% SCRAPER+SHREDDER	16%	49%	37%	34%	17%	33%		

AQUATIC MACROINVERTEBRATE DATA							
West Rosebud Creek, Stillwater County, MT							
PPL-MT: site: Pine Grove Campground							
8/29/2005 riffle cobbles							
Hess sample (0.1 m2):	1	2	3	MEAN	ST. DEV.	TOT #	%RA
Taxon							
%EPT	68%	78%	77%	74%	5%	74%	
SHANNON DIVERSITY	3.74	3.16	3.50	3.47	0.29	3.73	
EPT/(EPT + Chironomidae)	0.89	0.85	0.85	0.86	0.02	0.89	
% COLLECTOR-GATHERERS	50%	34%	44%	43%	8%	43%	
% SHREDDERS	5%	5%	10%	7%	3%	7%	
% SCRAPERS	11%	44%	27%	27%	17%	26%	
% FILTERERS	10%	7%	6%	8%	2%	8%	
% PREDATORS	25%	10%	13%	16%	8%	16%	
% CHIRONOMIDAE	9%	14%	14%	12%	3%	12%	
% TANYTARSINI	4%	12%	10%	9%	4%	8%	
Baetidae/EPHEMEROPTERA	71%	25%	47%	48%	23%	46%	
METALS TOLERANCE INDEX	3.28	2.08	2.75	2.70	0.60	2.75	
notes: Chloroperlinae mostly early instar- both Sweltsa and Suwallia present.							
Water depth (ft):	0.8	0.8	0.7	0.8	0.1		
Water velocity (ft/sec)	3.59	2.92	2.00	2.84	0.80		
Streambed % composition (visual estimate of substrate surface)							
Cobble	40	40	40	40	0		
Gravel	55	55	55	55	0		
Sand	5	5	5	5	0		
gravel sizes							
(large gravel)	40	30	20	30	10		
(medium gravel)	10	15	30	18	10		
(small gravel)	5	10	5	7	3		

AQUATIC MACROINVERTEBRATE DATA										
West Rosebud Creek, Stillwater County, MT										
PPL-MT: site: Allen Grade Bridge (lower site)										
8/29/2005 corresponding to sediment samples (spawning gravel)										
Hess sample (0.1 m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA	
Taxon										
<b>COLEOPTERA</b>						<b>44</b>		<b>218</b>	<b>40%</b>	
<i>Heterlimnius corpulentus</i>	1	1	1	0	2	1.0	0.7	5	0.9%	
<i>Narpus concolor</i>	0	7	0	1	1	1.8	2.9	9	1.7%	
<i>Optioservus sp.</i>	28	45	44	43	41	40.2	7.0	201	37.2%	
<i>Zaitzevia sp.</i>	0	0	2	1	0	0.6	0.9	3	0.6%	
<b>DIPTERA</b>						<b>10</b>		<b>51</b>	<b>9%</b>	
<i>Pagastia sp.</i>	0	0	0	0	1	0.2	0.4	1	0.2%	
<i>Eukiefferiella spp.</i>	1	0	1	0	4	1.2	1.6	6	1.1%	
<i>Orthocladus spp.</i>	3	3	4	2	1	2.6	1.1	13	2.4%	
<i>Paraphaenocladus sp.</i>	0	0	1	0	0	0.2	0.4	1	0.2%	
<i>Tvetenia sp.</i>	2	0	1	0	0	0.6	0.9	3	0.6%	
<i>Paracladopelma sp.</i>	0	1	0	0	0	0.2	0.4	1	0.2%	
<i>Cladotanytarsus sp.</i>	1	0	0	0	0	0.2	0.4	1	0.2%	
<i>Micropsectra sp.</i>	0	2	2	1	0	1.0	1.0	5	0.9%	
<i>Hexatoma sp.</i>	1	2	1	0	6	2.0	2.3	10	1.8%	
<i>Chelifera sp.</i>	2	5	0	1	0	1.6	2.1	8	1.5%	
<i>Deuterophlebia sp.</i>	0	0	0	0	1	0.2	0.4	1	0.2%	
<i>Simulium spp. (Eusimulium)</i>	0	0	1	0	0	0.2	0.4	1	0.2%	
<b>EPHEMEROPTERA</b>						<b>23</b>		<b>113</b>	<b>21%</b>	
<i>Acentrella sp.</i>	4	0	1	0	4	1.8	2.0	9	1.7%	
<i>Baetis tricaudatus</i>	6	16	3	2	25	10.4	9.9	52	9.6%	
<i>Drunella doddsi</i>	0	0	0	0	1	0.2	0.4	1	0.2%	
<i>Seratella tibialis</i>	1	0	0	0	1	0.4	0.5	2	0.4%	
<i>Rhithrogena sp.</i>	10	4	11	2	9	7.2	4.0	36	6.7%	
<i>Paraleptophlebia sp.</i>	1	3	4	1	2	2.2	1.3	11	2.0%	
<i>Ameletus sp.</i>	0	2	0	0	0	0.4	0.9	2	0.4%	
<b>PLECOPTERA</b>						<b>7</b>		<b>37</b>	<b>7%</b>	
<i>Zapada cinctipes</i>	4	0	0	0	1	1.0	1.7	5	0.9%	
Chloroperlinae*	2	1	7	1	8	3.8	3.4	19	3.5%	
<i>Claassina sabulosa</i>	0	1	6	1	2	2.0	2.3	10	1.8%	
<i>Hesperoperla pacifica</i>	0	3	0	0	0	0.6	1.3	3	0.6%	

AQUATIC MACROINVERTEBRATE DATA									
West Rosebud Creek, Stillwater County, MT									
PPL-MT: site: Allen Grade Bridge (lower site)									
8/29/2005 corresponding to sediment samples (spawning gravel)									
Hess sample (0.1m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA
Taxon									
<b>TRICHOPTERA</b>						21		107	20%
<i>Arctopsyche sp.</i>	11	1	1	2	5	4.0	4.2	20	3.7%
<i>Dolophilodes sp.</i>	0	0	2	0	1	0.6	0.9	3	0.6%
<i>Brachycentrus americanus</i>	0	12	2	17	0	6.2	7.8	31	5.7%
<i>Micrasema sp.</i>	1	1	0	0	1	0.6	0.5	3	0.6%
<i>Lepidostoma sp.</i>	2	1	2	1	4	2.0	1.2	10	1.8%
<i>Glossosoma sp.</i>	15	1	2	1	16	7.0	7.8	35	6.5%
<i>Rhyacophila brunnea gp.</i>	1	0	1	1	1	0.8	0.4	4	0.7%
<i>Rhyacophila coloradensis gp.</i>	0	0	0	0	1	0.2	0.4	1	0.2%
<b>ANNELIDA</b>						3		15	3%
Enchytraeidae	0	0	3	0	12	3.0	5.2	15	2.8%
IDs by D. McGuire									
TOTAL ORGANISMS	97	112	103	78	151	108	27.0	541	
TAXA RICHNESS	20	20	23	16	25	20.8	3.4	36	
EPT RICHNESS	12	12	12	10	16	12.4	2.2	19	
BIOTIC INDEX	2.91	3.52	3.43	3.58	3.09	3.30	0.29	3.28	
% DOMINANT TAXON	29%	40%	43%	55%	27%	39%	11%		
% COLLECTORS (g+f)	59%	74%	67%	87%	64%	70%	11%	69%	
% SCRAPER+SHREDDER	35%	15%	18%	8%	25%	20%	10%	21%	
%EPT	60%	41%	41%	37%	54%	47%	10%	48%	
SHANNON DIVERSITY	3.42	3.11	3.28	2.30	3.58	3.14	0.50	3.66	
EPT/(EPT + Chironomidae)	0.89	0.88	0.82	0.91	0.93	0.89	0.04	0.93	
% COLLECTOR-GATHERERS	47%	63%	61%	63%	60%	59%	6%	59%	
% SHREDDERS	7%	8%	2%	3%	5%	5%	3%	5%	
% SCRAPERS	28%	7%	17%	5%	20%	15%	9%	16%	
% FILTERERS	11%	12%	6%	24%	4%	11%	8%	10%	
% PREDATORS	6%	11%	15%	5%	12%	10%	4%	10%	
% CHIRONOMIDAE	7%	5%	9%	4%	4%	6%	2%	6%	
% TANYTARSINI	1%	2%	2%	1%	0%	1%	1%	1%	
Baetidae/EPHEMEROPTERA	45%	64%	21%	40%	69%	48%	19%	54%	
METALS TOLERANCE INDEX	3.54	4.04	3.64	4.28	3.50	3.80	0.34	3.76	

notes: Chloroperlinae mostly early instar- both Sweltsa and Suwallia present.

AQUATIC MACROINVERTEBRATE DATA										
West Rosebud Creek, Stillwater County, MT										
PPL-MT: site: Allen Grade Bridge (lower site)										
8/29/2005 corresponding to sediment samples (spawning gravel)										
Hess sample (0.1m2):	1	2	3	4	5	MEAN	ST. DEV.	TOT #	%RA	
Taxon										
Acentrella turbida present, most nymphs identifiable only to genus.										
Water depth (ft):	1.0	0.9	1.1	2.2	1.0	1.2	0.5			
Water velocity (ft/sec)	2.77	1.18	4.01	2.23	2.53	2.54	1.02			
Streambed % composition (visual estimate of substrate surface)										
Cobble	0	20	0	10	10	8	8			
Gravel	65	65	70	50	70	64	8			
Sand	35	15	30	40	20	28	10			
gravel size										
(large gravel)	0	20	10	30	20	16	11			
(medium gravel)	30	30	30	10	30	26	9			
(small gravel)	35	15	30	10	20	22	10			

AQUATIC MACROINVERTEBRATE DATA			
West Rosebud Creek, Stillwater County, MT			
PPL-MT: site: Allen Grade Bridge (lower site)			
8/29/2005 riffle cobble sample			
Hess sample (0.1m2):	1	TOT #	%RA
Taxon			
<b>COLEOPTERA</b>		<b>41</b>	<b>13%</b>
<i>Narpus concolor</i>	1	1	0.3%
<i>Optioservus sp.</i>	40	40	12.9%
<b>DIPTERA</b>		<b>56</b>	<b>18%</b>
<i>Pagastia sp.</i>	2	2	0.6%
<i>Brillia sp.</i>	1	1	0.3%
<i>Eukiefferiella spp.</i>	5	5	1.6%
<i>Orthocladius sp.</i>	5	5	1.6%
<i>Paraphaenocladius sp.</i>	1	1	0.3%
<i>Rheocricotopus sp.</i>	1	1	0.3%
<i>Tvetenia sp.</i>	10	10	3.2%
<i>Micropsectra sp.</i>	18	18	5.8%
<i>Hexatoma sp.</i>	2	2	0.6%
<i>Chelifera sp.</i>	1	1	0.3%
Ceratopogoninae	1	1	0.3%
<i>Simulium spp. (Eusimulium)</i>	9	9	2.9%
<b>EPHEMEROPTERA</b>		<b>91</b>	<b>29%</b>
<i>Acentrella sp.</i>	13	13	4.2%
<i>Baetis tricaudatus</i>	32	32	10.3%
<i>Ephemerella sp.</i>	1	1	0.3%
<i>Seratella sp.</i>	11	11	3.5%
<i>Epeorus grandis</i>	1	1	0.3%
<i>Rhithrogena sp.</i>	15	15	4.8%
<i>Paraleptophlebia sp.</i>	18	18	5.8%
<b>PLECOPTERA</b>		<b>38</b>	<b>12%</b>
<i>Zapada cinctipes</i>	16	16	5.2%
Chloroperlinae*	11	11	3.5%
<i>Claassina sabulosa</i>	6	6	1.9%
<i>Hesperoperla pacifica</i>	5	5	1.6%
<b>TRICHOPTERA</b>		<b>79</b>	<b>25%</b>

AQUATIC MACROINVERTEBRATE DATA			
West Rosebud Creek, Stillwater County, MT			
PPL-MT: site: Allen Grade Bridge (lower site)			
8/29/2005 riffle cobble sample			
Hess sample (0.1m2):	1	TOT #	%RA
Taxon			
<i>Arctopsyche sp.</i>	30	30	9.7%
<i>Hydropsyche (C) oslari</i>	1	1	0.3%
<i>Dolophilodes sp.</i>	28	28	9.0%
<i>Brachycentrus americanus</i>	12	12	3.9%
<i>Micrasema sp.</i>	1	1	0.3%
<i>Lepidostoma sp.</i>	4	4	1.3%
<i>Glossosoma sp.</i>	3	3	1.0%
ANNELIDA		1	0%
Enchytraeidae	1	1	0.3%
Megadrilli	4	4	1.3%
IDs by D. McGuire			
TOTAL ORGANISMS	310	310	
TAXA RICHNESS	34	34	
EPT RICHNESS	18	18	
BIOTIC INDEX	2.81	2.81	
% DOMINANT TAXON	13%	13%	
% COLLECTORS (g+f)	69%	69%	
% SCRAPER+SHREDDER	23%	23%	
%EPT	67%	67%	
SHANNON DIVERSITY	4.30	4.30	
EPT/(EPT + Chironomidae)	0.83	0.88	
% COLLECTOR-GATHERERS	43%	43%	
% SHREDDERS	7%	7%	
% SCRAPERS	15%	15%	
% FILTERERS	26%	26%	
% PREDATORS	8%	8%	
% CHIRONOMIDAE	14%	14%	
% TANYTARSINI	6%	6%	
Baetidae/EPHEMEROPTERA	49%	49%	
METALS TOLERANCE INDEX	3.17	3.17	
notes: Chloroperlinae mostly early instar- both Sweltsa and Suwallia present.			
Water depth (ft):	0.5		

AQUATIC MACROINVERTEBRATE DATA			
West Rosebud Creek, Stillwater County, MT			
PPL-MT: site: Allen Grade Bridge (lower site)			
8/29/2005 riffle cobble sample			
Hess sample (0.1m2):	1	TOT #	%RA
Taxon			
Water velocity (ft/sec)	1.30		
Streambed % composition (visual estimate of substrate surface)			
Cobble	40		
Gravel	55		
Sand	5		
gravel size			
(large gravel)	25		
(medium gravel)	15		
(small gravel)	15		

## Section 2 – Stream Substrate in West Rosebud Creek

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### 2.1 Introduction

Substrate sampling was undertaken in two reaches of West Rosebud Creek in 2005 in order to evaluate the quality of fish habitat available under the current flow regime in West Rosebud Creek, and to determine areas that might benefit from habitat improvements or alternative land use practices (e.g. conservation easements, grazing strategies, etc.). The substrate sampling was one component of a larger study of the fisheries and aquatic habitat of West Rosebud Creek downstream of Emerald Lake. Results for other components of the study were reported in a report filed with the Commission on October 3, 2005 titled: Study No. 18, Evaluation of the Current Fish Population and Habitat in West Rosebud Creek Downstream from Emerald Lake.

### 2.2 Methods

PPL Montana, in field collaboration with MFWP, selected appropriate study locations in West Rosebud Creek below Emerald Lake. The two study sites selected were 1) above Forest Service boundary near Pine Grove Campground (FS land), and, 2) above Allen Grade Bridge (on Lazy EL property).

The composition of substrates within each monitoring location were sampled using a 12” McNeil core sampler, with a design based on a 6-inch version developed by McNeil and Ahnell (1964). At each site, samples were collected from five locations (for a total of ten samples), representative of salmonid spawning gravel areas. Particle Size analysis was conducted by Piedmont Engineering, Belgrade, MT

An estimate of embeddedness, as defined by Platts, Megahan, and Minshall (1983), was performed at regularly spaced intervals across each of three transects. Embeddedness was visually estimated (0, 25, 50, 75, or 100% embeddedness) as the percentage of the surface of the dominant particle size covered by fine sediment within one meter of the sample location. The average and modal rating for each transect and site were calculated.

## 2.3 Results

### 2.3.1 Embeddedness

Embeddedness on the three transects measured at each study site is summarized in Table 2. The modal embeddedness rating at both sites was 25%. The Pine Grove Campground site had an average embeddedness rating of 22% and the Allen Grade Bridge site had an average embeddedness of 32%. Embeddedness between 5-25% is considered low, and between 25-50% is considered moderate (Bain 1999). In general, embeddedness appeared to be slightly higher along transects in the downstream study site (Allen Grade Bridge) than in the upstream study site (Pine Grove Campground).

Table 2. Estimates of embeddedness based on visual estimates on three transects at each study site, West Rosebud Creek, 2005.

Site	Transect #	Date	GPS Coordinates (Right bank)	Average Embeddedness (%)	Modal Embeddedness Rating (%)
Upper – near Pine Grove CG	1	8/30/2005	N 45° 16.742’ W 109° 38.275’	20.0	25
Upper – near Pine Grove CG	2	8/30/2005	N 45° 16.769’ W 109° 38.237’	23.9	25
Upper – near Pine Grove CG	3	8/30/2005	N 45° 16.742’ W 109° 38.275’	20.9	0
<i>Upper site</i>				22.2	25
Lower – Above Allen Grade Bridge	1	8/29/2005	N 45° 20.164’ W 109° 36.294’	28.4	25
Lower – Above Allen Grade Bridge	2	8/29/2005	N 45° 20.178’ W 109° 36.294’	30.0	0
Lower – Above Allen Grade	3	8/29/2005	N 45° 20.197’ W 109° 36.271’	34.2	25

Site	Transect #	Date	GPS Coordinates (Right bank)	Average Embeddedness (%)	Modal Embeddedness Rating (%)
Bridge					
Lower site				31.7	25

**2.3.2 Core samples**

Results of the laboratory analysis of the core samples were plotted logarithmically for each sample site (Figures 10 and 11). It is apparent from these plots that gravel sizes at the upper sampling site were more variable than at the lower sampling site. The average of the two site is displayed on Figure 12. The upper site clearly has larger particle sizes and a lower percentage of fine sediment than the lower site.

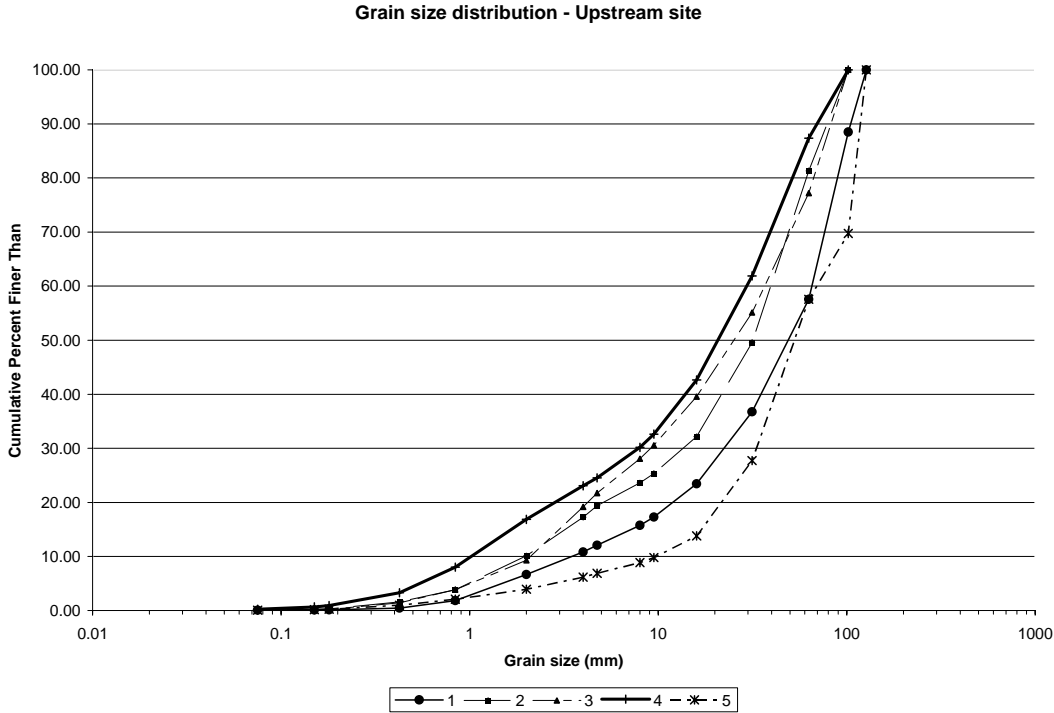


Figure 10. Distribution of gravel sizes in five core samples collected near Pine Grove Campground in West Rosebud Creek.

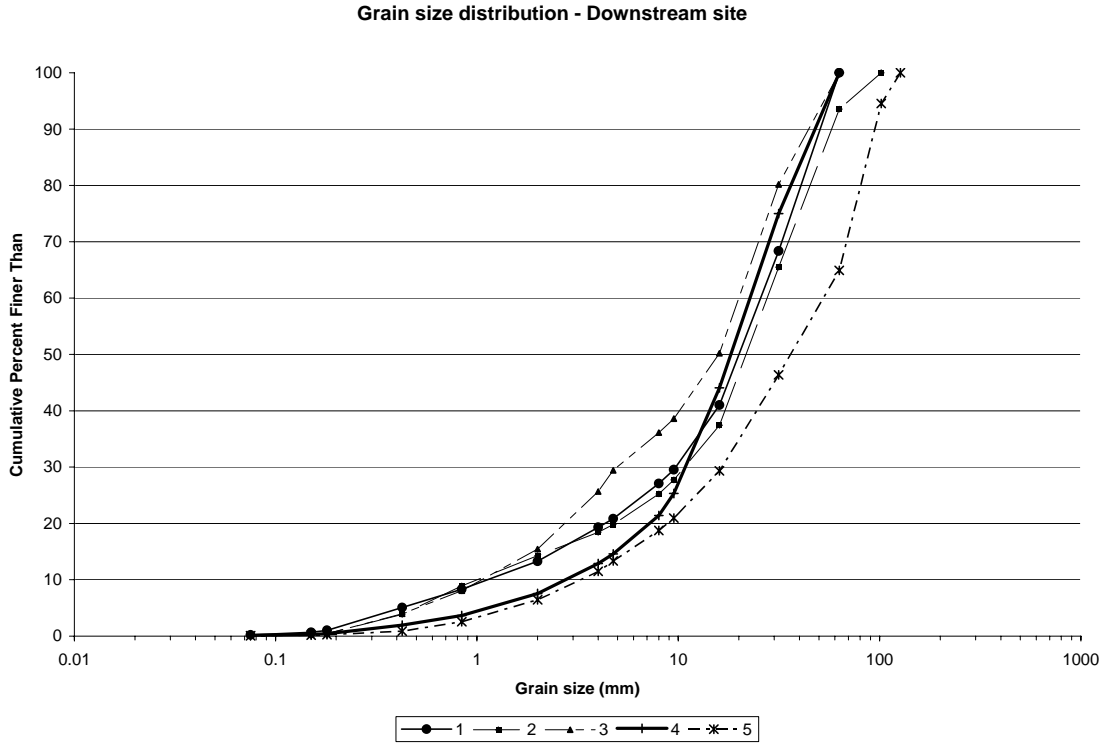


Figure 11. Distribution of gravel sizes in five core samples collected near Allen Grade Bridge in West Rosebud Creek.

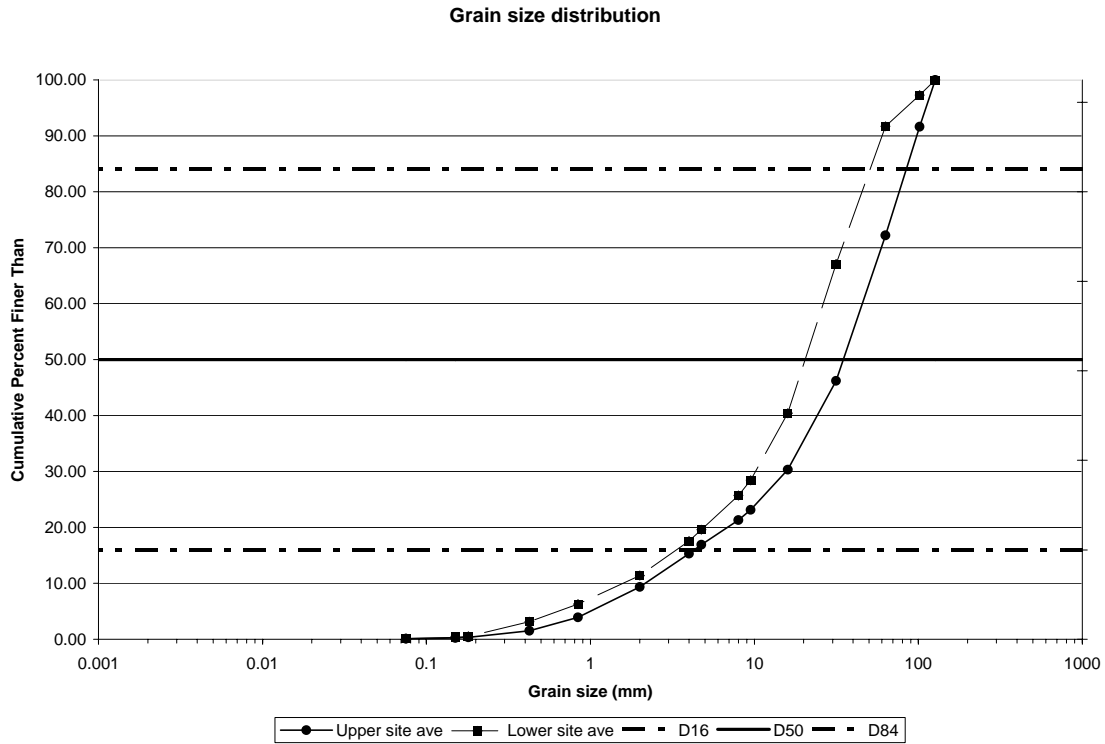


Figure 12. Average distribution of grain size at the two study sites on West Rosebud Creek in 2005.

To compare size distributions of gravel samples, the median particle diameter ( $d_{50}$ ) was estimated for each core sample, and for the two samples sites on average. In addition, the  $d_{16}$  and  $d_{84}$  of each sample was also estimated. These are the gravel sizes at which 16% and 84% of the sample, respectively, are finer (Table 3). Higher numbers indicate larger particle sizes. Based on these data, the upper site (Pine Grove Campground) has larger particle sizes than the lower site (Allen Grade Bridge).

Table 3. Summary of substrate characteristics from the upper site (Pine Grove Campground) and the lower site (Allen Grade Bridge), West Rosebud Creek, 2005.

Site	Core #	$d_{16}$ (mm)	$d_{50}$ (mm)	$d_{84}$ (mm)	$F_i$
Upper	1	8.0	50.0	95.0	59.2
	2	3.5	30.5	63.0	36.7
	3	3.0	25.0	73.0	46.8
	4	1.8	20.0	58.0	30.7
	5	18.0	52.0	120.0	92.1
Lower	1	2.7	20.0	45.0	25.7
	2	2.5	22.0	50.0	25.0
	3	2.0	18.0	35.0	22.1

Site	Core #	d <sub>16</sub> (mm)	d <sub>50</sub> (mm)	d <sub>84</sub> (mm)	F <sub>i</sub>
	4	5.1	19.0	40.0	26.9
	5	6.0	35.0	85.0	52.3
<i>Ave upper</i>		<b>4.5</b>	<b>35.0</b>	<b>85.0</b>	<b>45.4</b>
<i>Ave lower</i>		<b>3.5</b>	<b>20.0</b>	<b>50.0</b>	<b>29.6</b>

The Fredle Index (Lotspeich and Everest 1981) is a ratio of the quality of salmonid spawning gravel obtained by dividing geometric mean diameter particle size by the sorting coefficient as shown in Equation (1)

$$(1) \quad f_i = \frac{d_g}{S_o}$$

where

d<sub>g</sub> = geometric mean particle size (measure of mean particle size of substrate materials)

S<sub>o</sub> = sorting coefficient, (d<sub>75</sub>/d<sub>25</sub>)<sup>1/2</sup>; d<sub>75</sub> is the particle diameter at the 75<sup>th</sup> percentile of cumulative particle weight and d<sub>25</sub> is the diameter at the 25<sup>th</sup> weight percentile (Armantrout 1998).

The relationship between the Fredle Index and survival-to-emergence of salmonids has not been documented experimentally. However, using existing data, Lotspeich and Everest (1981) estimated that a Fredle Index of 4 corresponds to a survival-to-emergence of 60% for coho salmon (*Oncorhynchus kisutch*) and 75% for steelhead (*Oncorhynchus mykiss*). Larger Fredle Indices indicate better conditions for salmonid survival (Lotspeich and Everest 1981).

The Fredle Index for West Rosebud Creek averaged 45.4 at the Pine Grove Campground site, and 29.6 at the Allen Grade Bridge site (Table 3). These numbers indicate substrate composition that should be compatible with high salmonid survival-to-emergence.

## 2.4 Discussion

Kondolf (2000) reviewed the literature of laboratory and field experiments of incubation and emergence success as related to substrate size. He found a wide variation in the literature in the definition of “fine sediment” ranging from 0.83 mm to 9.5 mm. Table 4 lists the mean fine sediment percentages corresponding to 50% emergence of salmonids in various studies, as summarized by Kondolf (2000) in comparison to the fine sediment in West Rosebud Creek. Kondolf (2000) selected the 50% emergence somewhat arbitrarily, but with the justification that redds with at least 50% emergence success would probably be considered productive by most biologists. In addition, some streams with successful natural reproduction have less than 50% emergence success.

Table 4. Fine sediment percentages corresponding to 50% emergence of salmonids in various studies, from Kondolf (2000). Comparison to fine sediment levels in West Rosebud Creek, 2005.

Site	Maximum percentage of grains finer than:				
	0.83 mm	2.0 mm	3.35 mm	6.35 mm	9.5 mm
Mean*	13.7	10.0	29.5	30.3	28.0
Upper Site WRC	3.94	9.38	15.31**	20.0**	23.14
Lower Site WRC	6.30	<i>11.4</i>	17.56**	24.0**	<i>28.44</i>

\* Based on literature review. \*\*Data for West Rosebud Creek is estimated from Figure 12. Italics indicate values for West Rosebud Creek higher than the mean from the literature.

It is apparent from Table 4 that West Rosebud Creek has fine sediment levels low enough to support at least 50% emergence success based on most criteria at both sites. Only the lower site on West Rosebud Creek may have higher than desirable fine sediment levels for fines less than 2.0 mm and less than 9.5 mm.

In the Madison River, Montana, PPL Montana has been monitoring substrate composition periodically at four sites since 1994. On that river, conditions are considered impaired when the percentage of sediment <0.84 mm is in excess of 10% (Beck et al. 2004). Neither site on West Rosebud Creek had fine sediment <0.84 mm in excess of 10%.

## 2.5 Conclusions

Substrate in West Rosebud Creek has low fine sediment levels, high Fredle Indices, and low to moderate embeddedness. Sediment levels increase in a downstream direction, with the metrics at the Allen Grade Bridge consistently indicating higher amounts of fine sediment than at the Pine Grove Campground. Both sites provide substrate that is suitable for salmonid reproduction.

If the Mystic Hydroelectric Project was a source of fine sediment, it would be expected that there would be larger amounts of fine sediment close to the project, with decreasing amounts downstream. In fact, the opposite trend is apparent. This indicates that the Mystic Project is

not causing sediment impacts to West Rosebud Creek. Overall, the substrate of West Rosebud Creek provides excellent spawning habitat in the two sites sampled in this study.

## 2.6 Literature Cited

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