Rapid Lightning Creek Stressor Identification

Task Order 26
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Prepared for:

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Region X
Seattle, WA

and

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SUMMARY

TerraGraphics Environmental Engineering, Inc. (TerraGraphics) identified seven potential stressors or causes for fish, macroinvertebrate, or habitat scores to be significantly different from established reference sites. The stressors include:

- Low nutrients resulting in low fish and macroinvertebrate abundance;
- Increased flood frequency and maximum stream flows with a concomitant decrease in base flows;
- Increased sediment delivery and percent fines;
- Reduction in riparian cover, shift in riparian plant species, lower quality shade;
- Increased metal concentrations;
- Increased nutrients; and
- Ineffective sampling or inappropriate reference stream reaches for comparison.

Increased nutrients and low nutrient levels were eliminated as potential stressors based on available information from investigation of current and historic land use practices. We determined that the likely stressor was excessive coarse to fine grained sediment within the stream channel but that sufficient data do not exist to recommend a Total Maximum Daily Load (TMDL). We recommend that the watershed be modeled to determine if the amount of sediment being delivered to the system is significantly higher than background.

We also recommend the collection of instream metal data from both Flume and Rapid Lightning Creeks to determine if metal loadings are an issue. Thermal modification is also likely to be stressing the aquatic community and additional information should be collected to confirm this supposition.

SECTION 1.0 SCOPE OF THE INVESTIGATION

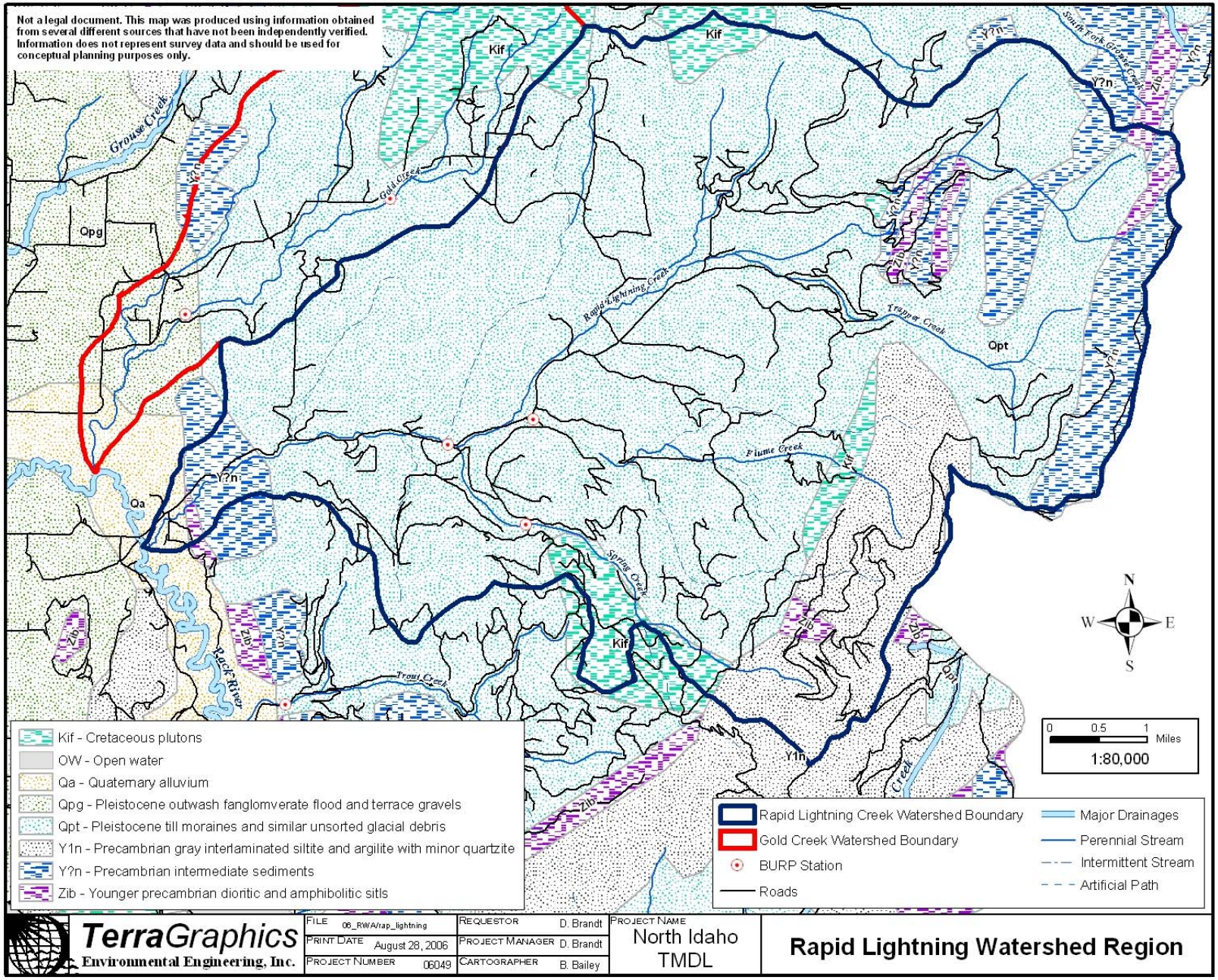
Rapid Lightning Creek is a tributary stream to the Pack River. The following was taken from the Idaho Department of Lands (IDL) Cumulative Watershed Effects (CWE) investigation.

> "Upper Rapid Lightning Creek is a 13,006 acre forested watershed in northern Idaho managed for agriculture, rural development, and timber production. For the purposes of this assessment, Upper Rapid Lightning Creek, along with major and minor tributaries, are referred to as Upper Rapid Lightning Creek. Upper Rapid Lightning Creek flows into the Pack River approximately 7 miles north of Trestle Creek, Id. The lower end of the watershed is generally accessed from Trestle Creek by heading north on State highway 200 approximately four miles to the Pack River Flats Refuge Frontage Road and continue on approximately 2 miles into the drainage area. The middle and upper reaches can be accessed from Forest Route Road # 629, and 66b. The forested portions of the watershed are primarily Forest Service and Idaho Department of Lands ownership, with the valley and meadow portions under private ownership. The watershed is located in Bonner County, Idaho.
>
> Upper Rapid Lightning Creek is a third order tributary, with a dendritic stream feeder pattern to Pack River. The drainage is oriented in a southwesterly direction with side tributaries entering mostly from the southwest and northeast. Elevation in the watershed ranges from 2,480 feet above sea level where Upper Rapid Lightning Creek empties into Pack River to 6,755 feet above sea level in the headwaters on Pend Oreille Mt.
>
> The Upper Rapid Lightning Creek drainage is predominantly underlain by Metasediments (highly and weakly weathered), basalt (Columbia River Basalt Flow), granitic rocks (highly and weakly weathered), and glacial drift/till. These geologic types are typically divided, with the highly weathered material occurring along the lower elevations and dominating the main stem flood plain and lower tributary flood plains. The weakly weathered material occupies the uplands and ridgelines.
>
> The area is characterized by warm dry summers and cold wet winters, with an average annual precipitation ranging from 30 inches at the lower elevations to 50 inches at the higher elevations. The majority of precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events.
>
> Vegetation varies with elevation and aspect. Strong south to west facing slopes at lower elevations support forbs, grasses, and ponderosa pine savannah. On north slopes, and with increasing elevation, forest stands become denser with a greater number of coniferous species. The presence of Douglas-fir, grand fir, western hemlock, western larch, lodgepole pine, western red cedar and western white pine increases with increasing elevation and effective precipitation" (IDL 2005).

The Stressor Identification was completed using existing biological data, water chemistry data, aerial photos, field notes from previous investigations, Idaho Department of Environmental Quality (IDEQ) BURP database and Pend Oreille Sub-basin TMDL, U.S. Forest Service (USFS) reports, interviews, and Geographic Information Systems (GIS) coverages (land use, geology).

A map of the drainage with some distinguishing features can be found in Figure 1.

Figure 1 Rapid Lightning Creek Site Location Map



SECTION 2.0 DESCRIPTION OF THE IMPAIRMENT

In 1997, the Coeur d'Alene office of IDEQ conducted rapid bioassessment surveys of Rapid Lightning Creek and Flume Creek. The data were analyzed according to the Ecological Assessment Framework (Grafe 2002a) and the Water Body Assessment Guidance (WBAG) document (Grafe et al. 2002b). A status report was created in 2002. The Index Scores for Rapid Lightning Creek and Flume Creek are located in Table 1. IDEQ determined that the Stream Macroinvertebrate Index (SMI) was significantly lower than expected for a stream within the Northern Rockies Ecoregion when compared to reference or least impacted streams (Table 2). Electrofishing was not conducted for these sites; therefore, a Stream Fish Index (SFI) is not available. The stream habitat condition rating was 2 which is considered somewhat degraded but supportive of the beneficial uses. The result of the assessment was the determination that Rapid Lightning Creek was not supporting its beneficial uses of cold water aquatic life and salmonid spawning. The pollutants identified as causing the impairment were "thermal modifications" and "unknown." This stressor identification process will address the "unknown" pollutant but will not attempt to verify the validity of the "thermal modification" determination.

Table 1 Index Scores for the Rapid Lightning Watershed

Assessment Unit	Stream	BURP ID	Stream Macroinvertebrate Index (SMI)	Steam Fish Index (SFI)	Stream Habitat Index (SHI)
ID17010214PN033_02	Flume Creek	1997SCDAA012	41.860	N/A	61
ID17010214PN033_03	Rapid Lightning Creek	1997SCDAA013	47.750	N/A	60

Table 2 Index Scoring Criteria

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above 25th percentile of reference condition	≥65	≥81	≥66	3
10th to 25th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34	N/A	Minimum threshold

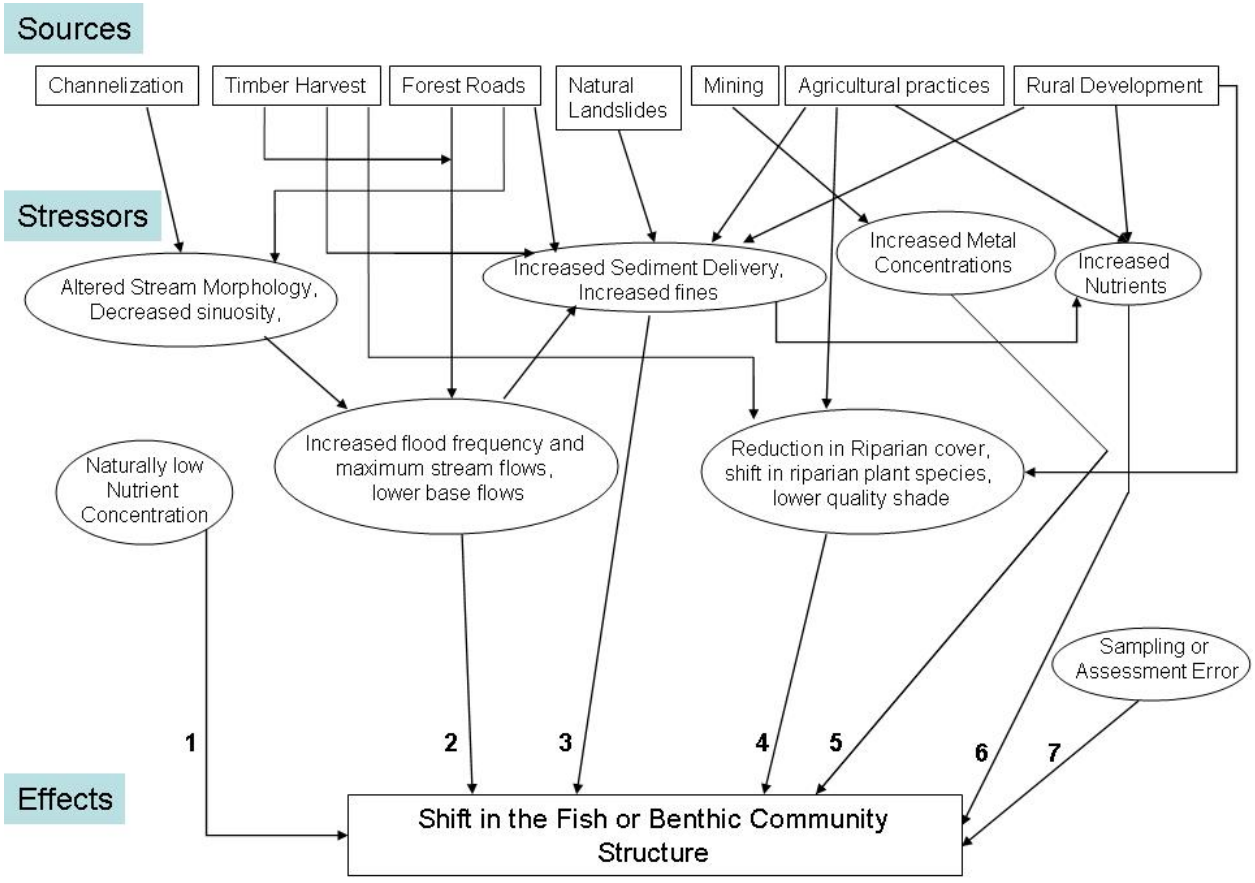
Note: N/A – Not available. SHI does not have a minimum threshold condition rating.

SECTION 3.0 CANDIDATE CAUSES

A conceptual model of candidate causes has been created for the Rapid Lightning Creek Watershed (Figure 2). The conceptual model indicates seven potential causes for the low SMI score for Rapid Lightning Creek. These seven causes include:

1. **Low nutrients resulting in low fish and macroinvertebrate abundance**. If low nutrients are the cause, one would expect low macroinvertebrate abundance and low species diversity due to limited periphyton biomass for the grazer and scraper guilds, low levels of detritus for shredders guilds and insufficient biomass to support macroinvertebrate predators. The low biomass of macroinvertebrates would result in low food for the fish community, resulting in low fish abundance.
2. **Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.** If these were the causes, the stream flows during the time in which the Beneficial Use Reconnaissance Program (BURP) data were collected would be too low to support a viable aquatic community.
3. **Increased sediment delivery and percent fines.** Increased percent fines decreases the amount of interstitial space for emerging fish fry, as well as decreased intergravel dissolved oxygen. This would result in a decreased survival rate of young of the year fish and a resultant reduction in the total fish abundance within the system. The higher percent fines would also result in a shift in the taxa of macroinvertebrates present in the stream. The sediment intolerant species would be suppressed and the sediment tolerant taxa would have higher abundance.
4. **Reduction in riparian cover, shift in riparian plant species, lower quality shade.** The loss of riparian cover and/or a shift to a lower shade canopy will result in increased stream temperatures. This will cause a shift in the aquatic macroinvertebrate community and the fish community. Fish species that require cold water, particularly for spawning and rearing areas, will have increased year class mortality and lower biomass than areas with more or higher quality shade.
5. **Increased metal concentrations.** Increased metal concentrations would result in a reduction in biomass and taxa richness.
6. **Increased nutrients.** Excessive nutrients would result in nuisance levels of periphyton, and lower scores on the Hillsenhoff Biotic Index.
7. **Ineffective sampling or inappropriate reference stream reaches for comparison.** The BURP protocol and the WBAG II were developed to assess beneficial use support conditions for a wide variety of streams. There is a sub-set of streams that are outside of the range of conditions used to develop the field protocols and the assessment model. These conditions could include things such as too little water, too large of stream, too large of substrate, or too steep of gradient. The result of applying the field techniques and assessment protocol to those streams outside the range of experience of the model would result in an erroneous assessment of not full support.

Figure 2 Rapid Lightning Creek Conceptual Model of Candidate Causes



SECTION 4.0 EXISTING DATA

4.1 Physical Habitat Data

Table 3 summarizes the habitat data collected during the BURP sampling. The habitat data collected for Rapid Lightning Creek indicate that the habitat within Rapid Lightning and Flume Creeks is slightly degraded when compared to reference sites for the Northern Rockies. Notes from the BURP event indicate that there were no pools present with some impact from roads.

Table 3 Summary of Selected BURP Habitat Data for Rapid Lightning Creek

BURP ID	Bank Cover Percentage	Bank Stability Percentage	Percent Canopy	Percent Fines	Embedded Score	Channel Shape Score	Pool/Riffle Ratio	Average Wet Depth (m)	Average Wet Width (m)	Width/Depth Ratio (wetted)	Discharge (cfs)
1997SCDAA012 (Flume Creek)	97.5	100	40	11.8	13	8	N/A	0.31	4.37	42.26	14.6
1997SCDAA013 (Rapid Lightning Creek)	97.5	90	36.5	32	12	9	N/A	0.48	10.63	66.46	79.3

Note: Percent Fines for 1997SCDAA013 was calculated from BURP field forms. Values in the database were not consistent with the field forms. TerraGraphics was unable to verify the Percent Fines value for 1997SCDAA012, but based on previous inconsistencies, we suspect this value is in error.

IDL conducted a CWE survey on the Rapid Lightning Watershed. Tables 4 and 5 contain the index scores and summary evaluations of the watershed. The CWE survey indicates that there are low risks of mass failure and total sediment delivery. The primary contributors to this determination are the mean watershed gradient and the soil type.

Table 4 Rapid Lightning Creek CWE Assessment Results

CWE Watersheds	Results	Channel Stability	Canopy Removal	Roads	Mass Failure	Total Sediment Delivery	Hydrologic Risk
Rapid Lightning Creek	*Score*	42	0.4	11.6	9	22.6	
Acres: 13,006 FPA Acres: N/A	*Rating*	Moderate		Low	Low	Low	Moderate

Notes: FPA – Forest Practices Act
Canopy Removal is expressed only as a score.
Hydrologic Risk is expressed only as a rating.

Table 5 Rapid Lightning Creek Adverse Conditions

CWE Watersheds	Temperature Adverse Condition	Nutrient Adverse Condition	Fine Sediment Adverse Condition	Hydrologic Adverse Condition
Rapid Lightning Creek	Yes	N/A	No	No

4.2 Biological Data

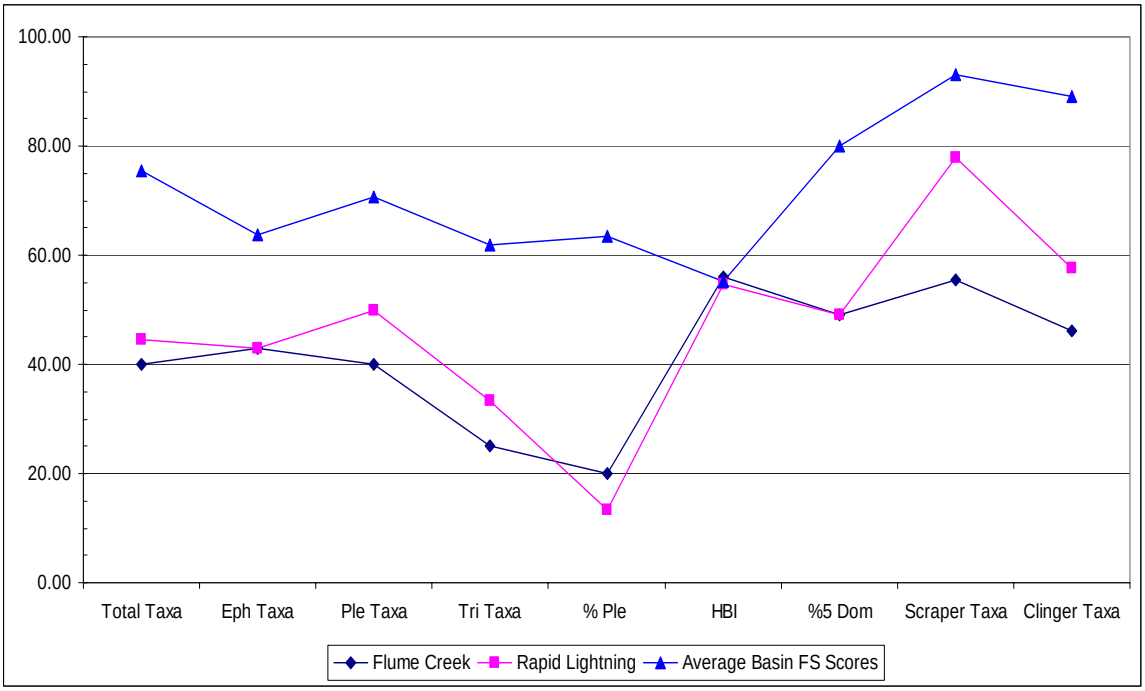
Table 6 summarizes the individual metric scores that are components to the SMI used in the WBAG process. Figure 3 is a graphical representation of the individual metric scores plotted with the average metric scores of streams assessed to be full-support within the Pend Oreille Sub-basin. The scores presented are not the raw metric scores but a conversion of the raw scores to a similar scale and scoring for this ecoregion. The full explanation of how these scores are derived can be found in the WBAG II document (Grafe et al. 2002b). For most metrics, Rapid Lightning Creek and Flume Creek scores are significantly lower than the full support streams within the Pend Oreille Sub-basin. The only exception is HBI. Most of these metrics within the SMI are abundance related; therefore, low abundance of macroinvertebrates is the defining characteristic for the low SMI score of Rapid Lightning Creek and Flume Creek. The most pronounced metric reduction from reference is in the percent Plecoptera taxa. The basin average for full support streams is 63 whereas Rapid Lightning Creek scores 13 and Flume Creek scores 20.

Table 6 Summary of Individual Metric Scores for Rapid Lightning Creek

BURP ID	Total Taxa	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	% Plecoptera	HBI	% Dominance of top 5 taxa	Scraper Taxa	Clinger Taxa	SMI
1997SCDAA012 (Flume Creek)	40.00	42.86	40.00	25.00	19.98	55.87	49.10	55.56	46.15	41.61
1997SCDAA013 (Rapid Lightning Creek)	44.44	42.86	50.00	33.33	13.20	54.62	49.15	77.78	57.69	47.01
Average Basin Scores for Full Support Sites	75.4	63.8	70.6	62.0	63.4	55.1	79.9	93.1	89.2	72.5

Note: The scores range from 0 to 100 and are compared to reference streams within the Bioregion. They are not the raw metric scores.

Figure 3 Individual Metric Scores of Rapid Lightning Creek Compared to the Average Score of BURP sites with SMI scores >2 for the Pend Oreille Sub-basin



4.3 Water Chemistry

Total Phosphorus and Total Nitrogen concentrations were measured from Rapid Lightning Creek in August 2006. The water chemistry and field data from this monitoring effort can be found in Table 7. The water chemistry data do not indicate that excessive nutrients are a problem within Rapid Lightning Creek. The nutrient levels are near the basin mean for Rapid Lightning Creek. Total Phosphorus concentrations were found to be 8 µg/L and Total Nitrogen less than 0.1 mg/L. Specific conductance, another measure of anthropogenic impacts to a watershed, was higher than values typically found higher in the watershed, but within the range expected in this sub-basin.

Table 7 Water Chemistry and Field Parameter Results from August 2006

Date	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Specific Conductance (µs)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
8/9/2006	22.33	7.20	7.47	93.3	46	<0.1	0.008
8/22/2006	18.79	7.43	8.27	98.0	49	<0.1	0.008

A review of the mine inventory for Rapid Lightning Creek and Flume Creek shows that there are three very small lead and silver mines within the Flume Creek drainage.

SECTION 5.0 ANALYSIS

This section investigates each potential cause to determine which ones are supported by the evidence found within the watershed and the current understanding of aquatic ecosystem function.

5.1 Stressor Refinement

Of the seven candidate stressors identified in Section 3.0, we have found sufficient evidence to remove excessive nutrients and low nutrients from the list of potential stressors. This decision was based on the nutrient concentrations found during the 2006 sampling events.

5.2 Candidate Cause Elimination

Increased flood frequency and maximum stream flows with a concomitant decrease in base flows.

There is insufficient data on these watersheds to determine if there have been significant hydrological changes in the Rapid Lightning Creek and Flume Creek watersheds. The stability of the channel, the percent of the bank that is covered and stable, and the flows adequate to support aquatic life during the low flow period suggest that this is an unlikely cause of the impairment within the Rapid Lightning Creek Watershed.

Increased sediment delivery and percent fines.

The majority of the substrate was small to large cobble with a significant proportion of fines. The percent fines found within the flood prone zone is 32%. Many researchers have concluded that a value in excess of 25% is the point where the aquatic community becomes impaired (Relyea, personal communication, 2004). Additionally, the lack of pools within the BURP site and the large percentage of small to large cobbles may indicate that there is excessive loading of coarse grained sediment to the system.

The CWE process indicates that the upper Rapid Lightning Creek watershed has low road erosion potential, low mass failure risk, low total sediment delivery and that it does not have a fine sediment adverse condition.

With the available information, we cannot determine if sediment is a significant stressor to the aquatic system. We recommend that the watershed be modeled to allow comparison of natural load to current load. If the model indicates a large increase in sediment delivery, then a sediment TMDL should be developed.

Reduction in riparian cover, shift in riparian plant species, lower quality shade.

TerraGraphics was unable to locate historical information regarding the riparian shade within the Rapid Lightning Creek watershed. The BURP crew measured canopy closure between 36% and

40% based on concave spherical densiometer readings. Temperature is a likely stressor to the system; however, we do not believe that it is the primary cause of the atypical aquatic community.

Increased metal concentrations.

We did not find any instream metal data for Rapid Lightning Creek or Flume Creek. The mines located within the Flume Creek drainage are very small and are unlikely to be contributing large metal loadings to Flume Creek or Rapid Lightning Creek; however, we cannot rule it out as a stressor at this time. We recommend that total metal data be collected in Flume Creek and in Rapid Lightning Creek downstream from the Flume Creek confluence.

Ineffective sampling or inappropriate reference stream reaches for comparison.

The BURP protocol and the WBAG scoring systems were derived to deal with the most common stream types in Idaho. These are typically streams with gradients of 1-4% and a gravel/cobble substrate. Rapid Lightning and Flume Creeks are characteristic of the types of streams that BURP and WBAG were developed to assess.

Based on the conditions within Rapid Lightning Creek, we have determined that the application of the BURP sampling protocol and the WBAG process was appropriate.

SECTION 6.0 CONCLUSIONS

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, we have determined that excessive fine sediment is the likely stressor of the macroinvertebrate community in Rapid Lightning Creek. Potential stressors that we did not have sufficient data to fully evaluate include metals and temperature.

Based on our analysis, we believe that a sediment model needs to be developed for Rapid Lighting Creek and if the loading is significantly higher than background then a TMDL should be developed.

SECTION 7.0 REFERENCES

Grafe, C.S. (editor), D. Brandt. 2002a. *Idaho river ecological assessment framework: an integrated approach.* Idaho Department of Environmental Quality. Boise, Idaho. 210 pp.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002b. *The Idaho Department of Environmental Quality Water Body Assessment Guidance, Second Edition-Final.* Idaho Department of Environmental Quality. Boise, Idaho.

Idaho Department of Lands (IDL). 2005. Upper Rapid Lightning Creek Cumulative Watershed Effects Assessment.