McCormick Creek Stressor Identification

Task Order 26
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Prepared for:

U.S. Environmental Protection Agency
Region X
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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 high metal concentrations were eliminated as potential stressors based on available information from investigation of current and historic land use practices. It was determined that the most likely causes for the poor macroinvertebrate and fish scores were low nutrients and sampling/assessment problems.

We do not recommend the development of a Total Maximum Daily Load (TMDL) at this time.

SECTION 1.0 SCOPE OF THE INVESTIGATION

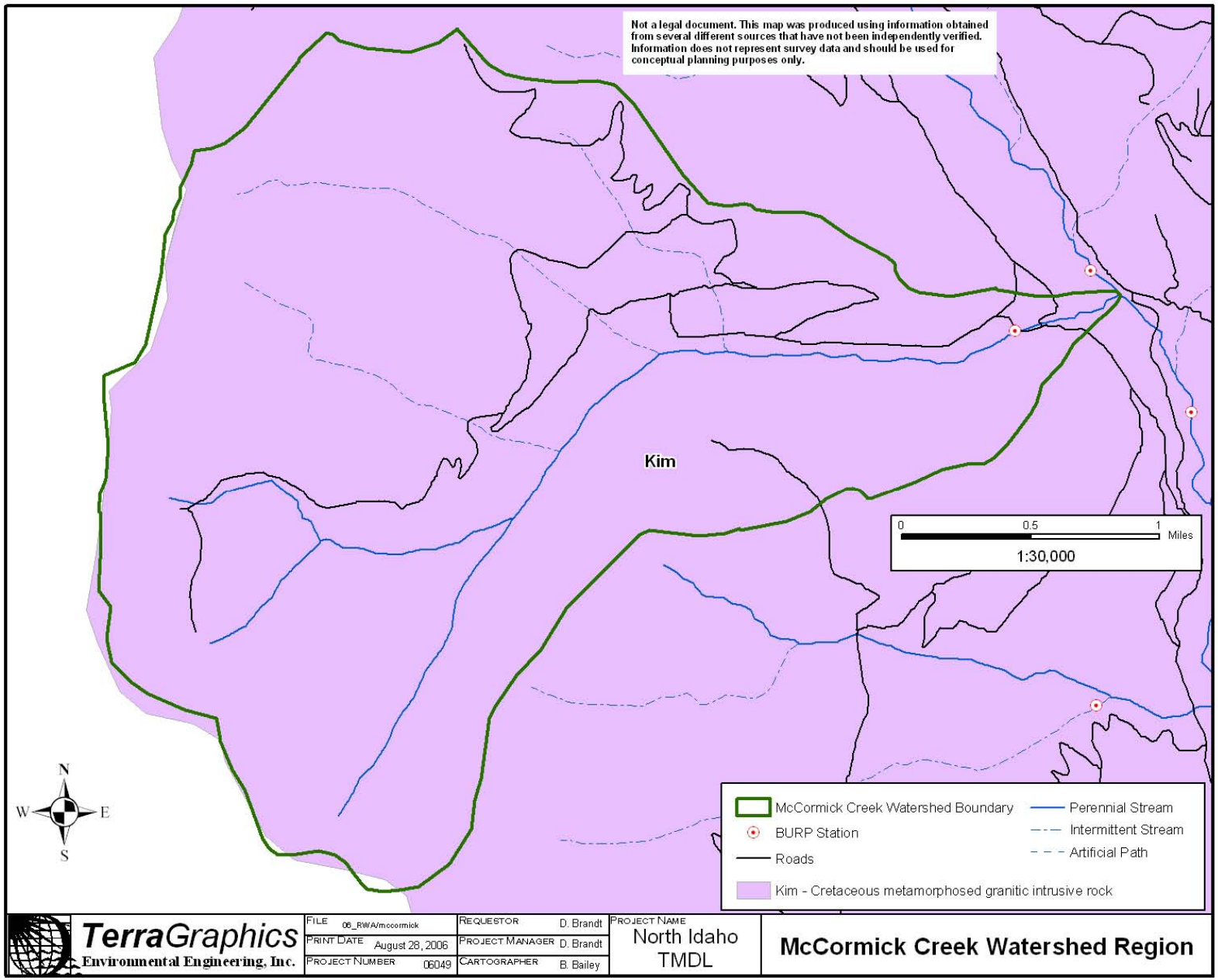
McCormick Creek is a tributary stream to the Pack River. The McCormick Creek catchment is approximately 1,760 hectares. The following was taken from the Idaho Department of Lands (IDL) Cumulative Watershed Effects (CWE) investigation.

> "McCormick Creek flows into the Pack River about 12 1/2 miles upstream from junction County Road 47 and U.S. Highway 2/95 at Colburn, Idaho (Figure 1). McCormick Creek is in Boundary County. The McCormick Creek drainage contains 4,355 acres of which 4,346 acres are used primarily for forestry with a small area of rural residential in the lower drainage. Land ownership is primarily Panhandle National Forest (Kaniksu Nat'l Forest) at the higher elevations and industrial forestry companies at the lower elevations.
>
> McCormick Creek is a third order tributary to the Pack River. The drainage is oriented in a northeasterly direction in the headwaters and then turns east to the confluence with the Pack River. The drainage has a dendritic feeder stream pattern. Elevation ranges from 2990 feet at the confluence with the Pack River to 7359 feet at the headwaters on unsight Peak. McCormick Creek is predominantly underlain by Cretaceous granitic bedrock formations of the Kaniksu Batholith.
>
> Cool, dry summers and moderately cold winters characterize the area. Average annual precipitation ranges from 40 inches at the lower elevations to 50 inches in the headwaters. 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. Lower elevations generally support cedar/hemlock habitat types. Uplands support a mixed conifer forest of Douglas fir, grand fir, western red cedar, larch, hemlock, ponderosa pine, lodgepole pine and western white pine, with more xeric species dominating south to west facing aspects. Higher elevations include subalpine fir, spruce, alder, alpine meadows and brush fields. Very wet areas especially along riparian zones support alder, willow, and other water loving species" (IDL 2003).

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 McCormick Creek Site Location Map



SECTION 2.0 DESCRIPTION OF THE IMPAIRMENT

In 1998, the Coeur d'Alene office of IDEQ conducted a rapid bioassessment survey of McCormick 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 McCormick 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). The Stream Fish Index (SFI) was also lower than expected. The SFI score was in a range that resulted in an automatic determination of impairment (Grafe et al. 2002). The stream habitat score (SHI) was consistent with habitat conditions found in reference streams. The result of the assessment was the determination that McCormick 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 thermal 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 McCormick Watershed

Assessment Unit	Stream	BURP ID	Stream Macroinvertebrate Index (SMI)	Steam Fish Index (SFI)	Stream Habitat Index (SHI)
ID17010214PN042_02	McCormick Creek	1998SCDAB024	40.768	24.192	79

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

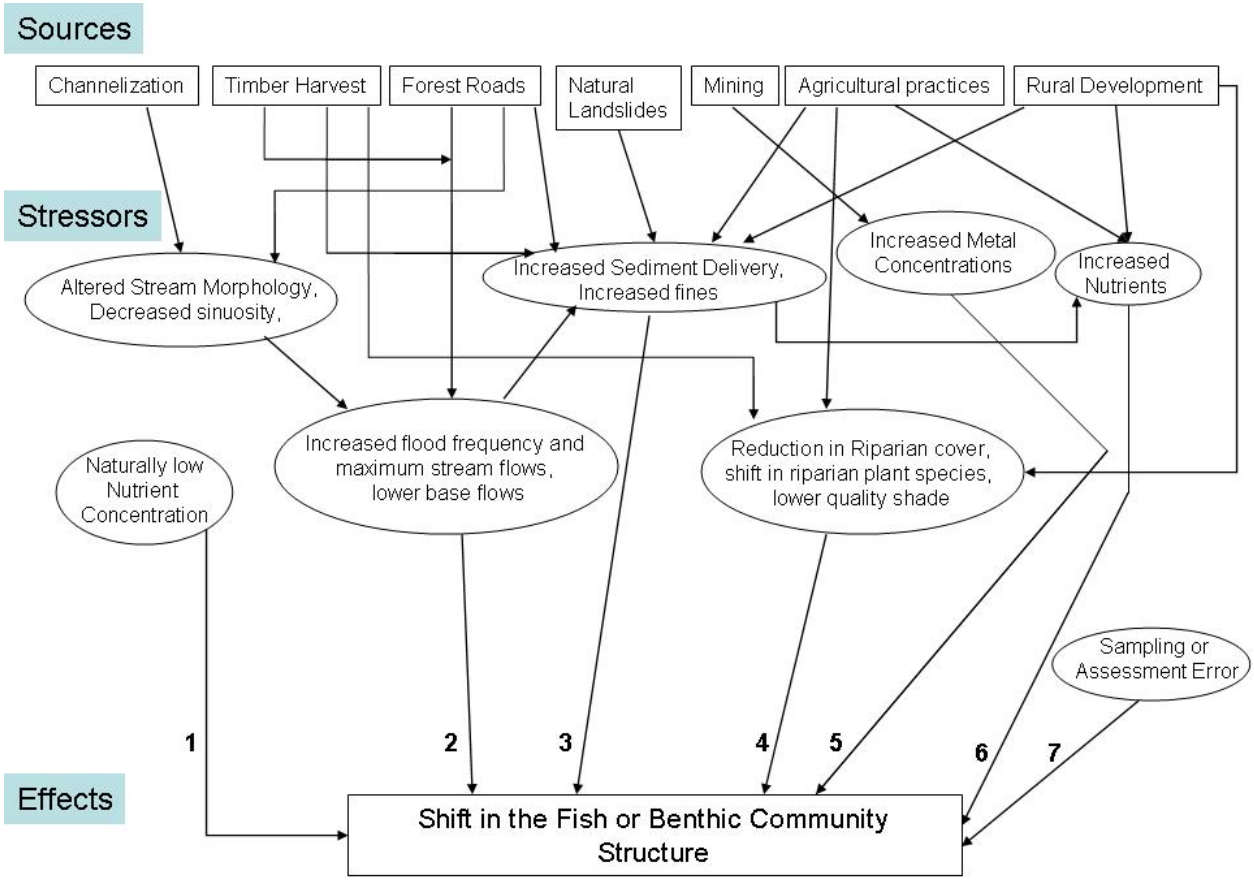
Note: N/A – Not available. SHI does not have a minimum threshold condition rating.

SECTION 3.0 CANDIDATE CAUSES

A conceptual model of candidate causes has been created for the McCormick Creek Watershed (Figure 2). The conceptual model indicates seven potential causes for the low SMI and SFI scores for McCormick 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 shredder 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 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 both the amount of interstitial space for emerging fish fry as well as 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 would result in increased stream temperatures. This would cause a shift in the aquatic macroinvertebrate community and the fish community. Fish species that require cold water, particularly for spawning and rearing areas, would 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 (HBI).
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 McCormick 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 Beneficial Use Reconnaissance Program (BURP) sampling event. The habitat data collected for McCormick Creek indicates that the creek exhibits similar characteristics as reference sites for the Northern Rockies. Notes from the BURP event indicate that the stream gradient was 9% with a number of large cobble present in the system. They also noted evidence of historical forest fires.

Table 3 Summary of Selected BURP Habitat Data for McCormick 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)
1998SCDAB024	100	98.5	19.5	2.1	19	7	0.217	0.51	7.15	41.65	15.9

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

Table 4 McCormick Creek CWE Assessment Results

CWE Watersheds	Results	Channel Stability	Canopy Removal	Roads	Mass Failure	Total Sediment Delivery	Hydrologic Risk
McCormick Creek	*Score*	39	0.46	28.9	88.5	119.5	
Acres: 4355 FPA Acres: 4346	*Rating*	Moderate		Low	High	High	Moderate

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

Table 5 McCormick Creek Adverse Conditions

CWE Watersheds	Temperature Adverse Condition	Nutrient Adverse Condition	Fine Sediment Adverse Condition	Hydrologic Adverse Condition
McCormick Creek	Yes	N/A	Yes	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, McCormick 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 McCormick Creek. The most pronounced metric reduction from reference is in the number of Trichoptera taxa. The basin average for full support streams is 62 whereas McCormick Creek scores 8.3. The only Trichoptera taxa found within the sample was Limnephilidae which is classified as a detritus shredder.

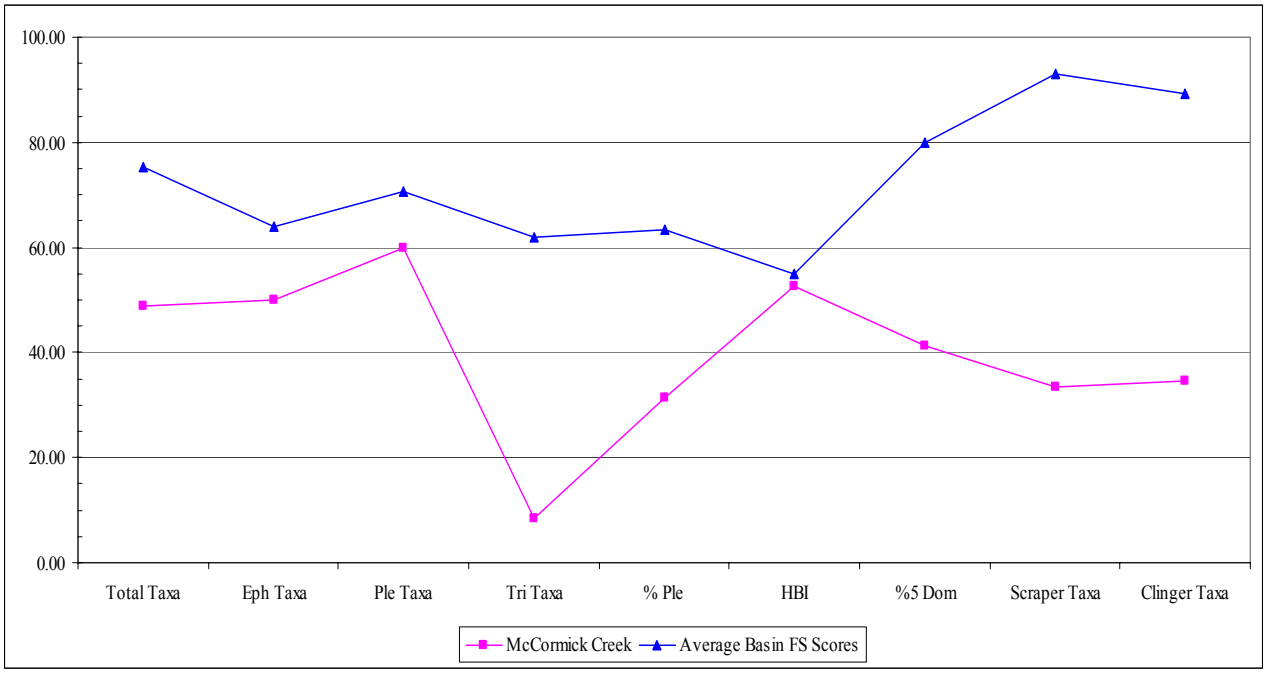
The BURP crew indicated that they saw several fish but were not able to collect them using electrofishing techniques.

Table 6 Summary of Individual Metric Scores for McCormick Creek

BURPID	Total Taxa	Ephemeroptera Taxa	Plecoptera Taxa	Trichoptera Taxa	% Plecoptera	HBI	% Dominance of top 5 taxa	Scraper Taxa	Clinger Taxa	SMI
1998SCDAB024	48.9	50.0	60.0	8.3	31.3	52.6	41.2	33.3	34.6	40.0
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 McCormick 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 McCormick 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 McCormick Creek. The nutrient levels are extremely low for McCormick Creek. Phosphorus concentrations were found to be 2-3 µg/L and total nitrogen less than 0.1 mg/L. Specific conductance, another measure of anthropogenic impacts to a watershed, is extremely low and indicative of an unimpacted system. The low specific conductance could also account for the lack of success at collecting fish using electrofishing gear due to the inability of the water to conduct electricity.

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	18.65	6.40	7.53	87.6	14	<0.1	0.002
8/23/2006	16.89	6.67	8.06	91.0	16	<0.1	0.003

A review of the mine inventory for McCormick Creek does not indicate a history of mining activity within the watershed; therefore, it is unlikely that metal loading is a concern.

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 high metal concentrations from the list of potential stressors. This decision was based on the extremely low nutrient concentrations found during the 2006 sample events as well as the lack of evidence of historical mining operations within the watershed.

5.2 Candidate Cause Elimination

Low nutrients resulting in low fish and macroinvertebrate abundance.

The nutrient values found in McCormick Creek are extremely low. The phosphorus concentrations would classify this stream as ultra-oligotrophic. It is likely that the nutrient levels found within McCormick Creek are limiting primary production and subsequent secondary production which results in low macroinvertebrate and fish densities. Since the SMI is very sensitive to changes in abundance and taxa richness, McCormick Creek would have a very poor score and would result in it being determined to be impaired. The evidence suggests that low nutrient values could be a significant stressor for the McCormick Creek aquatic community.

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

There is not sufficient data to determine if there have been significant hydrological changes in the McCormick Creek watershed. The stability of the channel 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 McCormick Watershed.

Increased sediment delivery and percent fines.

The large cobble substrate and low percent fines found during the BURP survey and observed by TerraGraphics during the nutrient sampling does not support the premise that sediment delivery is a significant contributing factor to the poor SMI scores. The CWE process indicates that the McCormick Creek watershed is susceptible to having high sediment delivery and mass failures; however that is based on the geology and topography of the watershed, not on existing conditions. In other words, it has the potential to have significant sediment delivered to the stream and this would argue for additional management controls for any activities occurring within the watershed.

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 McCormick Creek watershed. The channel gradient and large cobble substrate would suggest that the stream would not have a well developed riparian community. The floodplain is very narrow resulting in little hyporheic water for riparian plants to survive. The large boulders in the stream and cascading water most likely results in stream temperatures higher than one would expect for streams of similar elevations within this ecoregion. Temperature is a likely stressor to the system; however, it is a result of factors not easily influenced by anthropogenic activities (natural conditions) and not the primary cause of the atypical aquatic community.

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 within Idaho. These are typically streams with gradients of 1-4% and with a gravel/cobble substrate. McCormick Creek is very different from the streams used to develop IDEQ's assessment protocols. The gradient is at 9% and the primary substrate are very large boulders (>1 M) in diameter. This type of stream is very difficult to sample with the protocols used by IDEQ and would result in an inability to get a representative macroinvertebrate sample.

The low specific conductance values would make electrofishing a very inefficient way to sample the fish community. The size of the stun zone would be very small resulting in the fish being able to easily swim out of the field and an inability to penetrate into the prime habitat of small salmonids.

Based on the conditions within McCormick Creek, we have determined that ineffective and inappropriate reference streams were used within McCormick Creek and that this is a potential cause for the poor fish and macroinvertebrate scores.

SECTION 6.0 CONCLUSIONS

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, we have identified several potential causes that resulted in the listing of McCormick Creek. The most likely causes are 1) low nutrients, and 2) ineffective sampling and inappropriate reference streams. A secondary cause is increased stream temperature due to natural conditions within the watershed.

Based on our analysis, we do not believe that the development of a TMDL is appropriate at this time. Additional data collection will allow for a refinement of the candidate causes. The characteristics of the watershed make it very susceptible to adverse changes caused by changes within the watershed; therefore we suggest that care be taken by the land managers when contemplating activities within the McCormick Creek Watershed.

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). 2003. McCormick Creek Cumulative Watershed Effects Assessment.