ATTACHMENT A – KOOTENAI-FISHER TMDL PROJECT AREA: SEDIMENT AND HABITAT ASSESSMENT

Kootenai-Fisher TMDL Project Area: Sediment and Habitat Assessment

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1.0 INTRODUCTION

A detailed sediment and habitat assessment of streams in the Kootenai-Fisher TMDL Project Area (Project Area) was conducted to facilitate development of sediment TMDLs. The Kootenai-Fisher Project Area encompasses an area of approximately 2,511 square miles in Lincoln and Flathead counties in northwestern Montana. The Kootenai-Fisher Project Area includes both the Kootenai TMDL Planning Area (TPA) (1,667 square miles) and the Fisher TPA (844 square miles). The Kootenai TPA encompasses the majority of the Upper Kootenai River HUC8 (17010104), while the Fisher TPA aligns with the Fisher River HUC8 (17010101). Within the Kootenai-Fisher Project Area, there are six water body segments listed on the 2012 303(d) List for sediment-related impairments (**Table 1-1**). Bristow Creek, Libby Creek, Lake Creek and Quartz Creek are listed as impaired due to sediment in the Kootenai TPA, while Wolf Creek and Raven Creek are listed as impaired due to sediment in the Fisher TPA. In addition, Granite Creek, which is a tributary to Libby Creek, was included to provide reference data.

Table 1-1. Waterbody Segments Addressed during the Sediment and Habitat Assessment

TPA	List ID	Waterbody Description
Kootenai/Fisher	MT76C001_020	WOLF CREEK, headwaters to mouth (Fisher River)
Kootenai/Fisher	MT76C001_030	RAVEN CREEK, headwaters to mouth (Pleasant Valley Fisher River)
Kootenai/Fisher	MT76D002_110	BRISTOW CREEK, the headwaters to mouth at Lake Koocanusa
Kootenai/Fisher	MT76D002_062	LIBBY CREEK, from the highway 2 bridge to mouth (Kootenai River)
Kootenai/Fisher	MT76D002_070	LAKE CREEK, Bull Lake outlet to mouth (Kootenai River)
Kootenai/Fisher	MT76D002_090	QUARTZ CREEK, headwaters to confluence with the Kootenai River

The goal of this assessment is to collect data to evaluate the existing condition of sediment impaired streams and to estimate the relative existing sediment load from eroding streambanks and the sediment load reductions that will occur with the application of all appropriate riparian best management practices (BMPs). Sediment from eroding streambanks is commonly a major contributing sediment source to streams throughout western Montana. Estimated sediment loads from eroding streambanks will be used to assist Montana DEQ and EPA with development of sediment TMDLs, which are expressed as a percent reduction in annual loading. Estimated sediment loads should not be considered absolute loads, but instead are used to indicate the relative amount of loading from streambank erosion, as well as the percent reduction in loading that could be achieved via the improvement of riparian management practices. In addition to estimating sediment loads from eroding streambanks, stream channel morphology, in-stream habitat, and riparian vegetation assessments were also performed to further examine sediment dynamics within the streams of interest. The Kootenai-Fisher Project Area sediment and habitat assessment included three main components, which are presented in the following sections: aerial assessment reach stratification, sediment and habitat assessment, and streambank erosion assessment.

2.0 Aerial Assessment Reach Stratification

Prior to field data collection, an aerial assessment of streams in the Kootenai-Fisher Project Area was conducted in GIS to stratify streams into distinct reaches based on landscape and land-use factors following procedures described in the document *Watershed Stratification Methodology for TMDL Sediment and Habitat Investigations* (DEQ 2008). The reach stratification process involved dividing each stream segment into distinct reaches based on four landscape factors: ecoregion, valley gradient, Strahler stream order, and valley confinement resulting in a series of "reach types" specific to the streams within the Kootenai-Fisher Project Area.

2.1 Methods

An aerial assessment of streams in the Kootenai-Fisher Project Area was conducted using National Agricultural Imagery Program (NAIP) color imagery from 2009 in GIS along with other relevant data layers, including the National Hydrography Dataset (NHD) 1:100,000 stream layer and United States Geological Survey 1:24,000 Topographic Quadrangle Digital Raster Graphics. GIS data layers were used to stratify streams into distinct reaches based on landscape and land-use factors. The reach stratification methodology involves breaking a water body **stream segment** into **stream reaches** and **sub-reaches**. Each of the stream segments in the Kootenai-Fisher Project Area was initially divided into distinct stream reaches based on four landscape factors: ecoregion, valley gradient, Strahler stream order, and valley confinement. Stream reaches classified by these four criteria were then further divided into sub-reaches based on the surrounding vegetation and land-use characteristics, including predominant vegetation type, riparian health, adjacent land-use, level of development, and potential anthropogenic influences on streambank erosion. This resulted in a series of stream reaches and sub-reaches delineated based on landscape and land-use factors which were compiled into an Aerial Assessment Database for the Kootenai-Fisher Project Area.

2.1.1 Reach Types

The aerial assessment reach stratification process involved dividing each stream segment into distinct reaches based on four landscape factors: ecoregion, valley gradient, Strahler stream order, and valley confinement. Each individual combination of the four landscape factors is referred to as a **reach type** in this report based on the following definition:

Reach Type - *Unique combination of ecoregion, gradient, Strahler stream order and confinement*

Reach types were described using the following naming convention based on the reach type identifiers presented in **Table 2-1**:

Level III Ecoregion – Valley Gradient – Strahler Stream Order – Confinement

Table 2-1. Reach Type Identifiers

Landscape Factor	Stratification Category	Reach Type Identifier
Level III Ecoregion	Northern Rockies	NR
Valley Gradient	0-<2%	0
	2-<4%	2
	4-<10%	4
	>10%	10
Strahler Stream Order	first order	1
	second order	2
	third order	3
	fourth order	4
	fifth order	5
Confinement	unconfined	U
	confined	C

Thus, a stream reach identified as NR-0-3-U is a low gradient (0-<2%), 3rd order, unconfined stream in the Northern Rockies Level III ecoregion.

2.2 RESULTS

A total of 84 reaches were delineated during the aerial assessment reach stratification process covering 103.1 miles of stream, excluding Granite Creek, which was assessed for potential reference conditions (**Table 2-2**). This assessment includes the entire mainstem of Libby Creek, though only the lower segment, which extends 14.8 miles from the highway 2 bridge crossing to the confluence with the Kootenai River is listed as impaired for sediment. Based on the level III ecoregion, there were a total of 19 distinct reach types delineated in the Kootenai-Fisher Project Area. The complete Aerial Assessment Database is provided in **Attachment A**.

Table 2-2. Aerial Assessment Stream Segments

Stream Segment	Number of Reaches	Number of Reaches and Sub-Reaches	Length (Miles)
Bristow Creek	5	8	6.4
Lake Creek	8	11	17.6
Libby Creek	10	21	26.0
Quartz Creek	10	11	11.3
Raven Creek	6	7	2.6
Wolf Creek	11	26	39.3
Total	**50**	**84**	**103.1**

3.0 Sediment and Habitat Assessment

Substrate character and stream habitat conditions were evaluated by performing a stream channel assessment in the listed tributaries within the Kootenai-Fisher Project Area. Longitudinal surveys including pebble counts, grid toss, cross sections, pool data collection, riparian greenline surveys, and eroding streambank measurements were performed at each of the selected monitoring sites during July and August of 2011 following methods presented in *Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments* (DEQ 2011).

Field assessment reaches were selected in relatively low-gradient portions of the listed streams to facilitate the evaluation of sediment loading impacts. At least two monitoring reaches were selected per listed stream. The monitoring locations were chosen to represent various reach characteristics, land-use categories, and human-caused influences, but their representativeness relative to other reaches of the same slope, order, confinement and ecoregion, as well as ease of access, were also considered. There was a preference toward sampling those reaches where human influences would most likely lead to impairment conditions, since it is a primary goal of sediment TMDL development to further characterize sediment impairment conditions. Thus, it is not a random sampling design intended to sample stream reaches representing all potential impairment and non-impairment conditions. Instead, it is a targeted sampling design that aims to assess a representative subset of reach types, while ensuring that reaches within each 303(d) listed waterbody with potential sediment impairment conditions are incorporated into the overall evaluation.

3.1 Methods

Sediment and habitat assessments were performed at 15 field monitoring sites, which were selected based on the aerial assessment in GIS and on-the-ground reconnaissance using the factors discussed above. Sediment and habitat data was collected within six reach types, with the complete sediment and habitat assessment performed at 13 monitoring sites and only the streambank erosion portion of the assessment performed at two sites (**Table 3-1**, **Figures 3-1** and **3-2**). Field monitoring sites were assessed progressing in an upstream direction and the length of the monitoring site was based on the bankfull channel width. A monitoring site length of 500 feet was used at three sites in which the bankfull width was less than 10 feet, a monitoring site length of 1,000 feet was used at nine sites in which the bankfull width was between 10 feet and 50 feet, and a monitoring site length of 2,000 feet was used at three sites in which the bankfull width exceeded 50 feet. Each monitoring site was divided into five equally sized study cells in which a series of sediment and habitat measurements were performed. Study cells were numbered 1 through 5 progressing in an upstream direction. The following sections provide brief descriptions of the various field methodologies employed during the sediment and habitat assessment. A more in-depth description of the methods is available in *Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments* (DEQ 2011).

Table 3-1. Reach Types and Monitoring Sites

Reach Type	Number of Reaches	Number of Monitoring Sites	Monitoring Sites
NR-0-3-C	4		
NR-0-3-U	12	1	QRTZ10-01
NR-0-4-U	29	8	GRNT13-01, LAKE02-01, LAKE03-03, LIBY09-03, LIBY09-05, WOLF08-03*, WOLF09-02, WOLF11-03
NR-0-5-U	1		
NR-10-1-C	1		
NR-10-1-U	3		
NR-10-2-C	1		
NR-2-1-C	1		
NR-2-1-U	2		
NR-2-2-C	1	1	QRTZ03-01
NR-2-2-U	7	1	RAVN07-01
NR-2-3-C	1		
NR-2-3-U	9	2	BRST04-02, BRST04-04
NR-2-4-C	1		
NR-2-4-U	2		
NR-4-1-U	1	1	RAVN04-01*
NR-4-2-C	2		
NR-4-2-U	4	1	RAVN06-01
NR-4-3-U	2		

*Streambank erosion assessment only

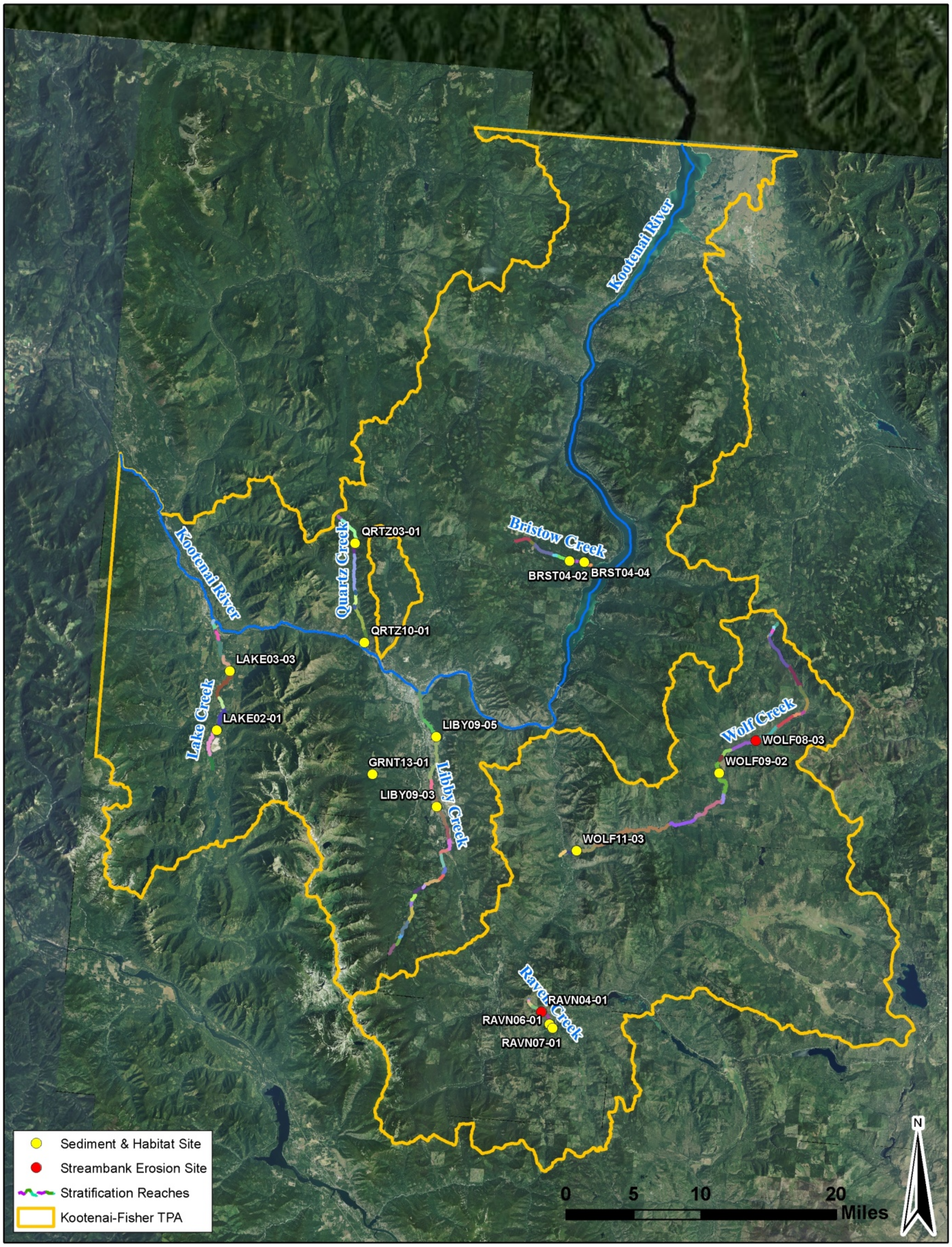


Figure 3-1. Aerial Assessment Reach Stratification

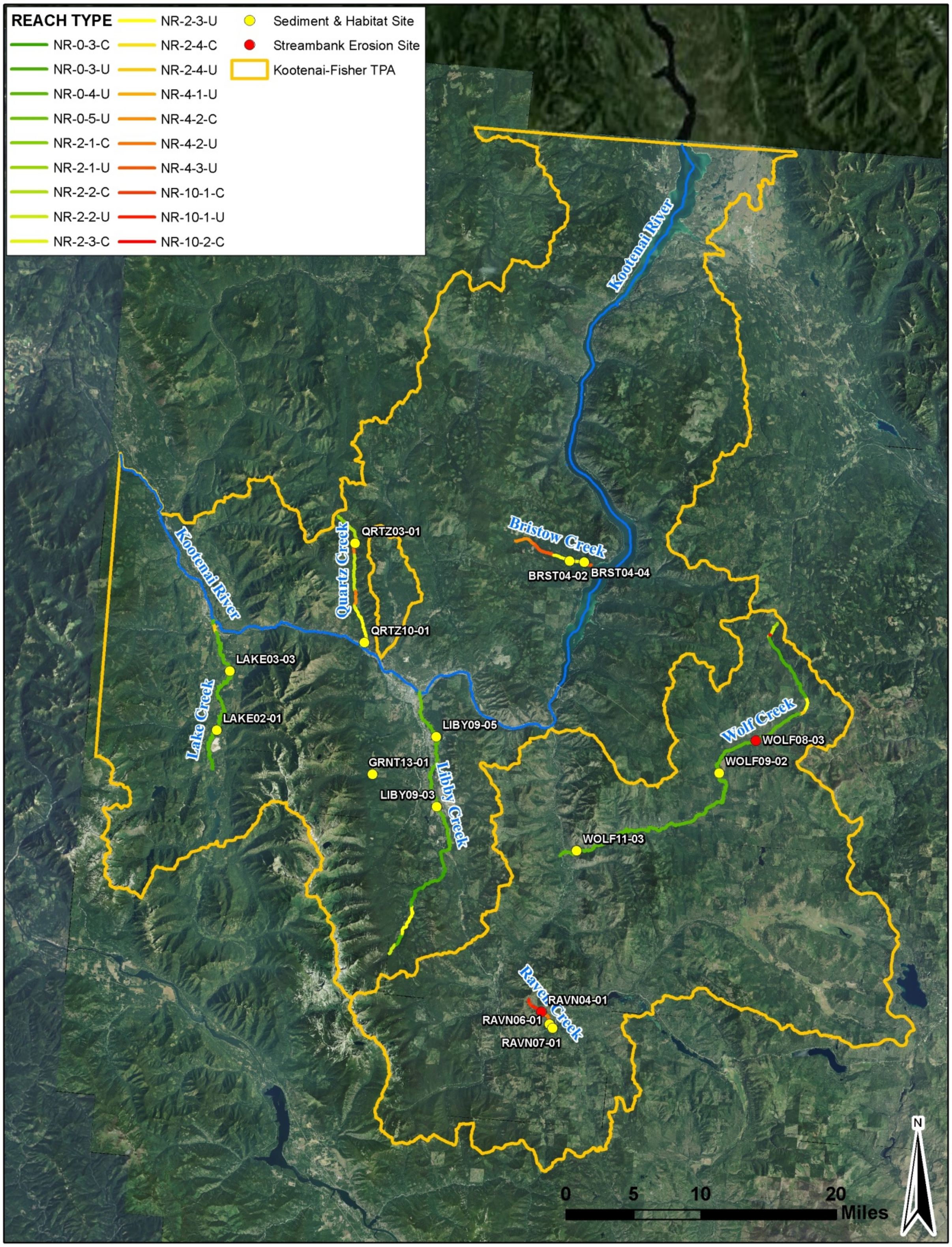


Figure 3-2. Aerial Assessment Reach Types

Field measurements conducted during the sediment and habitat assessment include channel form and stability measurements, fine sediment measurements, in-stream habitat measurements, and riparian health measurements, as summarized below:

Channel Form and Stability Measurements
- Field Determination of Bankfull
- Channel Cross-sections
- Floodprone Width Measurements
- Water Surface Slope

Fine Sediment Measurements
- Riffle Pebble Count
- Riffle Grid Toss
- Pool Tail-out Grid Toss
- Riffle Stability Index

In-stream Habitat Measurements
- Channel Bed Morphology
- Residual Pool Depth
- Pool Habitat Quality
- Woody Debris Quantification

Riparian Health Measurements
- Riparian Greenline Assessment

3.1.1 Channel Form and Stability Measurements

Channel form and stability measurements include the field determination of bankfull, channel cross-sections, floodprone width, and surface water slope.

3.1.1.1 Field Determination of Bankfull

The bankfull elevation was determined for each monitoring site. Bankfull is a concept used by hydrologists to define a regularly occurring channel-forming high flow. One of the first generally accepted definitions of bankfull was provided by Dunne and Leopold (1978):

> "The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."

Indicators that were used to estimate the bankfull elevation included scour lines, changes in vegetation types, tops of point bars, changes in slope, changes in particle size and distribution, staining of rocks, and inundation features. Multiple locations and bankfull indicators were examined at each site to determine the bankfull elevation, which was then applied during channel cross-section measurements.

3.1.1.2 Channel Cross-sections

Channel cross-section measurements were performed at the first riffle in each cell using a line level and a measuring rod. At each cross-section, depth measurements at bankfull were performed across the channel at regular intervals, which varied depending on channel width. These measurements allowed for the calculation of the cross sectional area, the average bankfull depth, and the [bankfull] width/depth ratio. The thalweg depth (i.e., maximum depth) was recorded at the deepest point of the channel independent of the regularly spaced intervals.

3.1.1.3 Floodprone Width Measurements

The floodprone elevation was determined by multiplying the maximum depth value by two (Rosgen 1996). The floodprone width was then measured by stringing a tape from the bankfull channel margin on both the right and left banks until the tape (pulled tight and “flat”) touched the ground at the floodprone elevation. When dense vegetation or other features prevented a direct line of tape from being strung, the floodprone width was estimated by pacing or making a visual estimate. The floodprone width divided by the bankfull width of the channel is the entrenchment ratio, which is typically within a certain range by stream type and is an indicator of a stream’s ability to access it floodplain.

3.1.1.4 Water Surface Slope

Water surface slope measurements were performed using a transit level and stadia rod. This measurement was used to evaluate the slope assigned in GIS based on the aerial assessment. The field measured slope was used when evaluating the Rosgen stream type at each monitoring site.

3.1.2 Fine Sediment Measurements

Fine sediment measurements include the riffle pebble count, riffle grid toss, pool tail-out grid toss, and the riffle stability index. The pebble count and grid toss measurements were used to identify if excess fine sediment was accumulating in areas important for the reproduction and survival of aquatic life. The riffle stability index measures the dominant size of mobile particles in a riffle and is an indicator of excess sediment supply.

3.1.2.1 Riffle Pebble Count

One Wolman pebble count (Wolman 1954) was performed at the first riffle encountered in cells 1, 2, 3 and 5, providing a minimum of 400 particles measured within each assessment reach. Particle sizes were measured along their intermediate length axis (b-axis) and results were grouped into size categories. The pebble count was performed from bankfull to bankfull using the “heel to toe” method.

3.1.2.2 Riffle Grid Toss

The riffle grid toss was performed at the same location as the pebble count measurement. The riffle grid toss measures fine sediment accumulation on the surface of the streambed. Riffle grid tosses were performed prior to the pebble count to avoid disturbances to surface fine sediments.

3.1.2.3 Pool Tail-out Grid Toss

A measurement of the percent of fine sediment in pool tail-outs was taken using the grid toss method at each pool in which potential spawning gravels were identified. Three measurements were taken in each pool with appropriate sized spawning gravels using a 49-point grid. The spawning potential was recorded as “Yes” (Y) or “Questionable” (Q). No grid toss measurements were made when the substrate was observed to be too large to support spawning. Pool tail-out grid toss measurements were performed when the substrate was observed to be too fine to support spawning since the goal of this assessment is to quantify fine sediment accumulation in spawning areas.

3.1.2.4 Riffle Stability Index

In streams that had well-developed point bars, a Riffle Stability Index (RSI) evaluation was performed. For streams in which well-developed point bars were present, a total of three RSI measurements were conducted, which consisted of intermediate axis (b-axis) measurements of 15 particles determined to be among the largest size group of recently deposited particles that occur on over 10% of the point bar (Kappesser 2002). During post-field data processing, the riffle stability index was determined by calculating the geometric mean of the dominant bar particle size measurements and comparing the result to the cumulative particle distribution from the riffle pebble count in an adjacent or nearby riffle.

3.1.3 Instream Habitat Measurements

Instream habitat measurements include channel bed morphology, residual pool depth, pool habitat quality and woody debris quantification.

3.1.3.1 Channel Bed Morphology

The length of each monitoring site occupied by pools and riffles was recorded progressing in an upstream direction. The upstream and downstream stations of “dominant” riffle and pool features were recorded. Features were considered “dominant” when occupying over 50% of the bankfull channel width.

3.1.3.2 Residual Pool Depth

At each pool encountered, the maximum depth and the depth of the pool tail crest at its deepest point was measured. The difference between the maximum depth and the tail crest depth is considered the residual pool depth. It is basically a measure of the water depth that will remain in a pool if the channel is drained. No pool tail crest depth was recorded for dammed pools.

3.1.3.3 Pool Habitat Quality

Qualitative assessments of each pool feature were undertaken, including pool type (i.e., scour or dammed), size (i.e., small or large), formative feature (i.e., lateral scour, plunge, boulder, woody debris), and cover type (i.e., overhanging vegetation, depth, undercut, boulder, woody debris, none). The total number of pools was also quantified.

3.1.3.4 Woody Debris Quantification

The amount of large woody debris (LWD) within each monitoring site was recorded. Large pieces of woody debris located within the bankfull channel that were relatively stable so as to influence the channel form were counted as either single, aggregate or "willow bunch". A single piece of large woody debris was counted when it was greater than 9 feet long or spanned two-thirds of the wetted stream width, and 4 inches in diameter at the small end (Overton et al. 1997). Two or more single pieces that are touching each other and collectively influencing channel morphology were considered an aggregate, and the number of pieces per aggregate was recorded. A "willow bunch" could be a dead or living willow, or other riparian shrub, that was in the channel and influencing channel morphology.

3.1.4 Riparian Health Measurements

Riparian health measurements include the riparian greenline assessment.

3.1.4.1 Riparian Greenline Assessment

An assessment of riparian vegetation cover was performed along both streambanks at each monitoring site. Vegetation types were recorded at 10 to 20-foot intervals, depending on the bankfull channel width. The riparian greenline assessment described the general vegetation community type of the groundcover, understory and overstory. The vegetation options on the field forms for groundcover were wetland, grasses/rose/snowberry, disturbed/bare ground, rock, and riprap; the options for understory and overstory were coniferous, deciduous, and mixed coniferous/deciduous. At 50-foot intervals, the riparian buffer width was estimated on either side of the channel. The riparian buffer width corresponds to the belt of vegetation buffering the stream from adjacent land uses.

3.2 Results

In the Kootenai-Fisher Project Area, sediment and habitat parameters were assessed at 13 monitoring sites. Out of the 19 reach types delineated on the sediment impaired stream segments in GIS, sediment and habitat assessments were performed in six reach types, with a focus on low gradient reach types. A statistical analysis of the sediment and habitat data is presented by reach type and for individual monitoring sites in the following sections. The complete sediment and habitat dataset is presented in **Attachment B**.

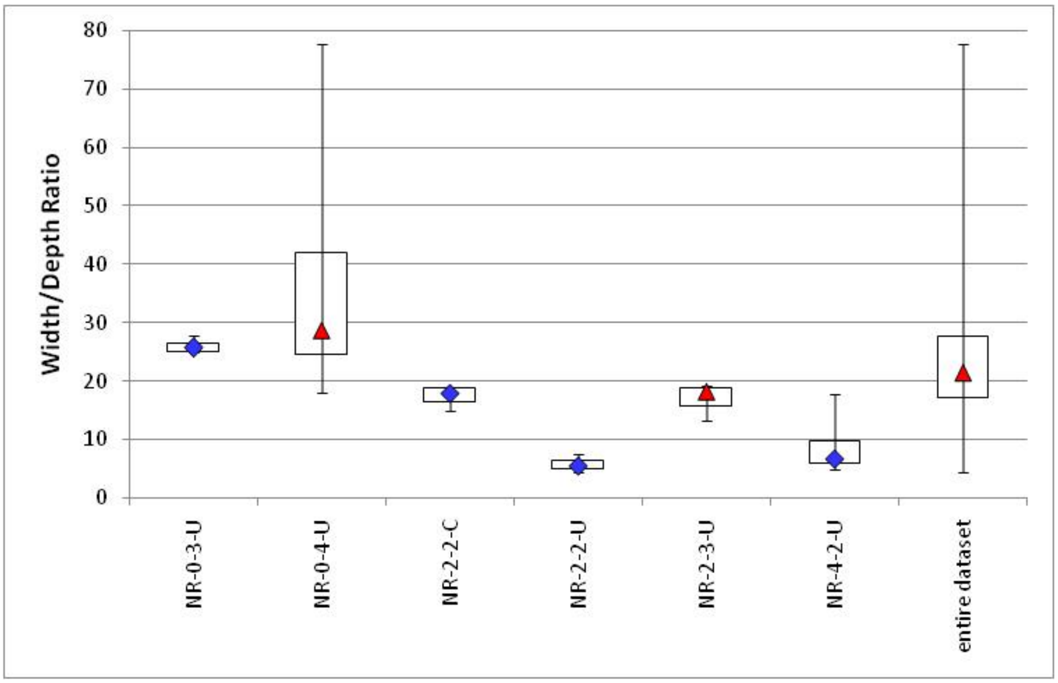
3.2.1 Reach Type Analysis

This section presents a statistical analysis of sediment and habitat base parameters for each of the reach types assessed in the Kootenai-Fisher Project Area. Reach type discussions are based on median values, while summary statistics for the minimum, 25th percentile, 75th percentile, and maximum values are also provided since these may be more applicable for developing sediment TMDL criteria. Sediment and habitat base parameter analysis is provided by reach type for the following parameters:

- width/depth ratio
- entrenchment ratio
- riffle pebble count <2mm
- riffle pebble count <6mm
- riffle grid-toss <6mm
- pool tail-out grid toss <6mm
- residual pool depth
- pool frequency
- LWD frequency
- greenline understory shrub cover
- greenline bare ground

3.2.1.1 Width/Depth Ratio

The channel width/depth ratio is defined as the channel width at bankfull divided by the mean bankfull depth (Rosgen 1996). The channel width/depth ratio is one of several standard measurements used to classify stream channels, making it a useful variable for comparing conditions between reaches with the same stream type (Rosgen 1996). A comparison of observed and expected width/depth ratios is also an indicator of channel over-widening and aggradation, which are often linked to excess streambank erosion and/or sediment inputs from sources upstream of the study reach. Channels that are over-widened are often associated with excess sediment deposition and streambank erosion, contain shallower and warmer water, and provide fewer deepwater refugia for fish. Median width/depth ratios for assessed reach types ranged from 5.5 in NR-2-2-U to 28.6 in NR-0-4-U (**Figure 3-3** and **Table 3-2**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.
Figure 3-3. Width/Depth Ratio

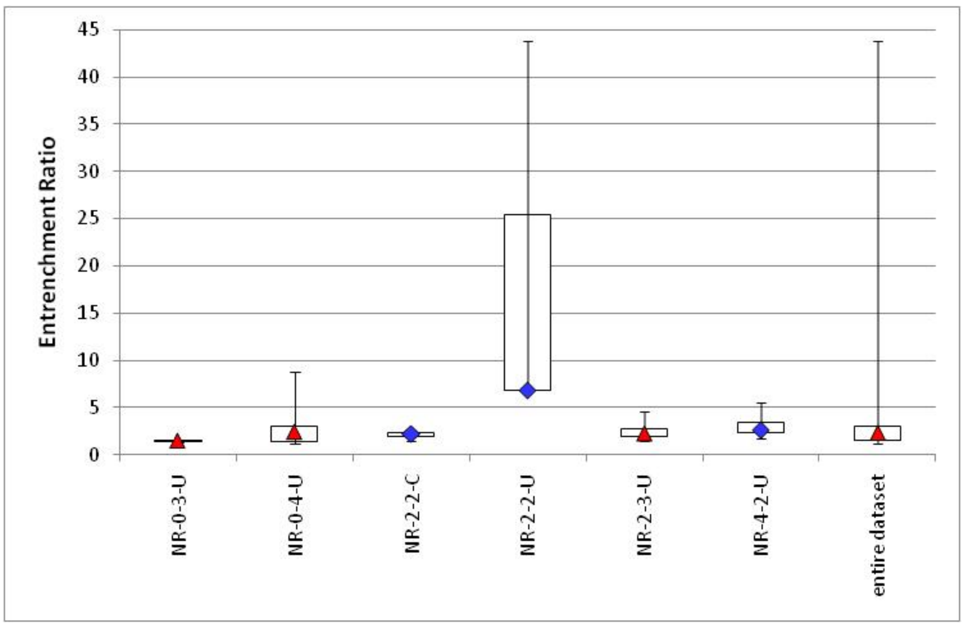
Table 3-2. Width/Depth Ratio

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	1	6	1	1	2	1	12
Sample Size	4	17	4	3	6	4	38
Minimum	24.9	18.0	14.8	4.5	13.2	5.0	4.5
25th Percentile	25.1	24.6	16.4	5.0	15.8	5.9	17.1
Median	25.7	28.6	17.9	5.5	18.2	6.7	21.4
75th Percentile	26.5	41.9	18.8	6.5	18.8	9.8	27.7
Maximum	27.8	77.8	18.9	7.4	19.2	17.8	77.8
Monitoring Sites	QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.2 Entrenchment Ratio

A stream's entrenchment ratio is equal to the floodprone width divided by the bankfull width (Rosgen 1996). The entrenchment ratio is used to help determine if a stream shows departure from its natural stream type and is an indicator of stream incision that describes how easily a stream can access its floodplain. Streams can become incised due to detrimental land management activities or may be naturally incised due to landscape characteristics. A stream that is entrenched is more prone to streambank erosion due to greater energy exerted on the streambanks during flood events, which results in higher sediment loads. The entrenchment ratio is an important measure of channel conditions since it relates to sediment loading and habitat condition. Rosgen (1996) defines an entrenched channel as having a ratio less than 1.4, a moderately entrenched channel having a ratio between 1.4 and 2.2, and a slightly entrenched channel as having a ratio greater than 2.2. Therefore, as the entrenchment ratio increases, floodplain access increases. The median entrenchment ratio for assessed reach types ranged from 1.5 in NR-0-3-U to 6.9 in NR-2-2-U (**Figure 3-4** and **Table 3-3**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.
Figure 3-4. Entrenchment Ratio

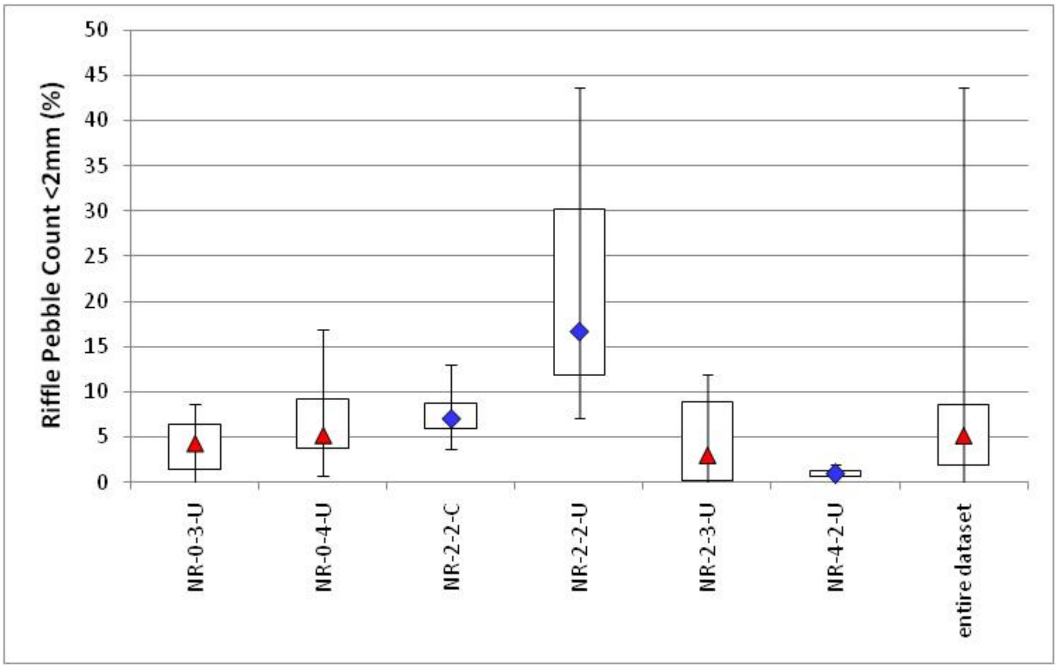
Table 3-3. Entrenchment Ratio

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	1	6	1	1	2	1	12
Sample Size	4	17	4	3	6	4	38
Minimum	1.3	1.2	1.4	6.9	1.4	1.7	1.2
25th Percentile	1.4	1.4	2.0	6.9	1.9	2.4	1.5
Median	1.5	2.4	2.2	6.9	2.2	2.6	2.3
75th Percentile	1.5	3.0	2.3	25.4	2.8	3.4	3.0
Maximum	1.6	8.7	2.4	43.9	4.6	5.5	43.9
Monitoring Sites	QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.3 Riffle Pebble Count <2mm

Percent surface fine sediment measures the amount of siltation occurring in a river system. Surface fine sediment measured using the Wolman (1954) pebble count method is one indicator of aquatic habitat condition and higher values can signify excessive sediment loading. The Wolman pebble count provides a survey of the particle distribution of the entire channel width, allowing investigators to calculate a percentage of the surface substrate (as frequency of occurrence) composed of fine sediment. Median values for the percent of fine sediment <2mm based on riffle pebble counts ranged from 1% in NR-4-2-U to 17% in NR-2-2-U (**Figure 3-5** and **Table 3-4**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-5. Riffle Pebble Count <2mm

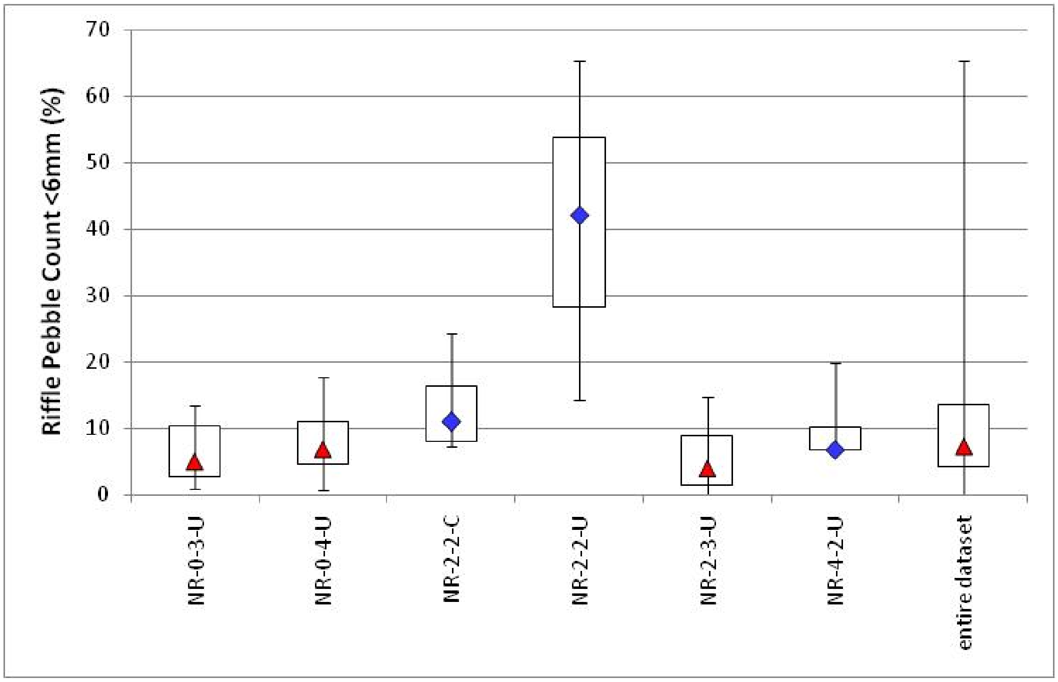
Table 3-4. Riffle Pebble Count <2mm

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	1	1	2	1	13
Sample Size	8	20	4	3	6	4	45
Minimum	0	1	4	7	0	0	0
25th Percentile	1	4	6	12	0	1	2
Median	4	5	7	17	3	1	5
75th Percentile	6	9	9	30	9	1	9
Maximum	9	17	13	44	12	2	44
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.4 Riffle Pebble Count <6mm

As with surface fine sediment <2mm, an accumulation of surface fine sediment <6mm may indicate excess sedimentation. Median values for the percent of fine sediment <6mm based on pebble counts conducted in riffles ranged from 4% in NR-2-3-U to 42% in NR-2-2-U (**Figure 3-6** and **Table 3-5**). The percent of fine sediment <6mm followed the same general trend as the percent of fine sediment <2mm.



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.
Figure 3-6. Riffle Pebble Count <6mm

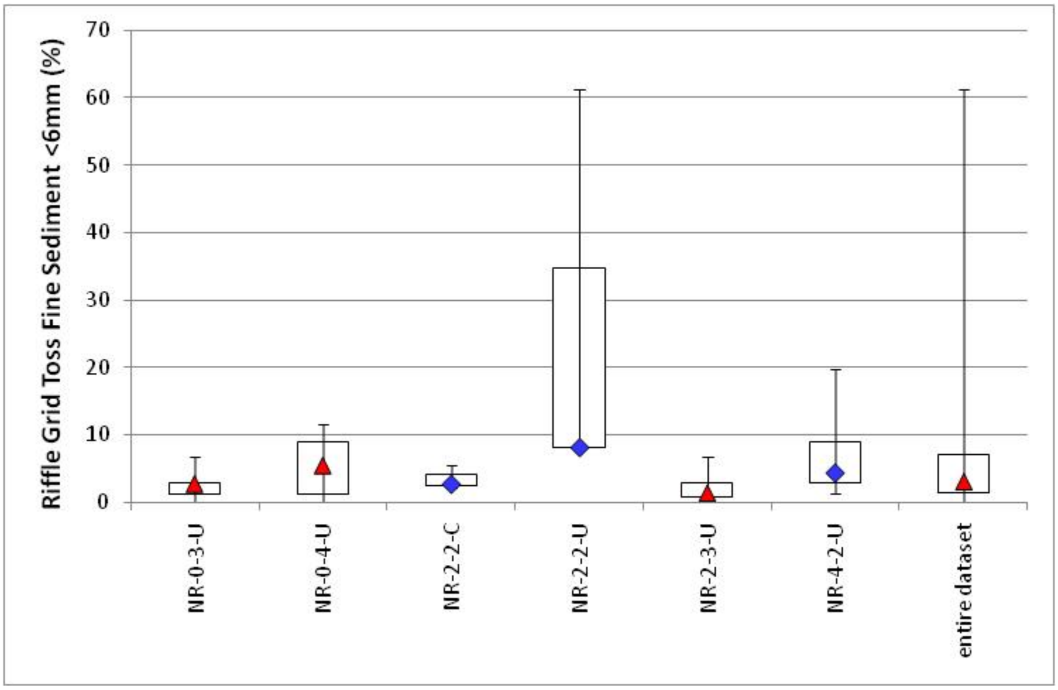
Table 3-5. Riffle Pebble Count <6mm

Statistical Parameter	Reach Type						
	NR-0-3-U	**NR-0-4-U**	**NR-2-2-C**	**NR-2-2-U**	**NR-2-3-U**	**NR-4-2-U**	**Entire Dataset**
# of Monitoring Sites	2	6	1	1	2	1	13
Sample Size	8	20	4	3	6	4	45
Minimum	1	1	7	14	0	6	0
25th Percentile	3	5	8	28	1	7	4
Median	5	7	11	42	4	7	7
75th Percentile	10	11	16	54	9	10	13
Maximum	13	18	24	65	15	20	65
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.5 Riffle Grid Toss <6mm

The riffle grid toss is a standard procedure frequently used in aquatic habitat assessments that provides complimentary information to the Wolman pebble count. Median values for riffle grid toss fine sediment <6mm in the Kootenai-Fisher Project Area range from 1% in NR-2-3-U to 8% in NR-2-2-U (**Figure 3-7** and **Table 3-6**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-7. Riffle Grid Toss Fine Sediment <6mm

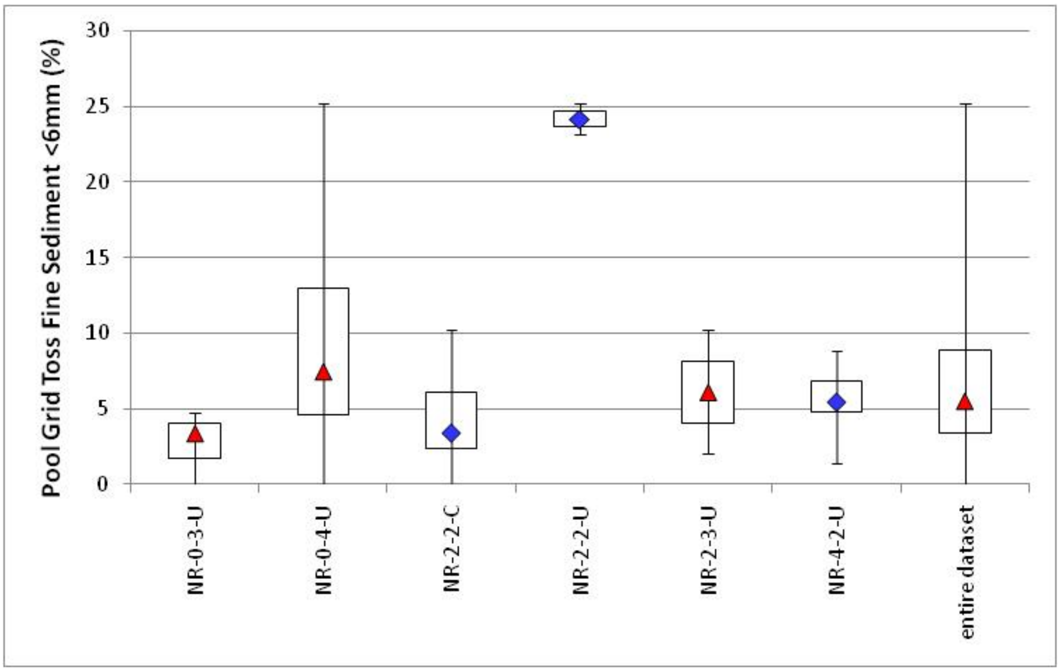
Table 3-6. Riffle Grid Toss Fine Sediment <6mm

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	1	1	2	1	13
Sample Size	8	20	3	3	6	4	44
Minimum	0	0	2	8	0	1	0
25th Percentile	1	1	2	8	1	3	1
Median	3	5	3	8	1	4	3
75th Percentile	3	9	4	35	3	9	7
Maximum	7	12	5	61	7	20	61
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.6 Pool Tail-out Grid Toss <6mm

Grid toss measurements in pool tail-outs provide a measure of fine sediment accumulation in potential fish spawning sites, which may have detrimental impacts on aquatic habitat by cementing spawning gravels, preventing flushing of toxins in egg beds, reducing oxygen and nutrient delivery to eggs and embryos, and impairing emergence of fry (Meehan 1991). Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35mm and the emergence success of westslope cutthroat trout and bull trout, both of which are present in the Kootenai-Fisher Project Area. Median values for pool tail-out grid toss fine sediment <6mm range from 3% in NR-0-3-U and NR-2-2-C to 24% in NR-2-2-U (**Figure 3-8** and **Table 3-7**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-8. Pool Tail-out Grid Toss <6mm

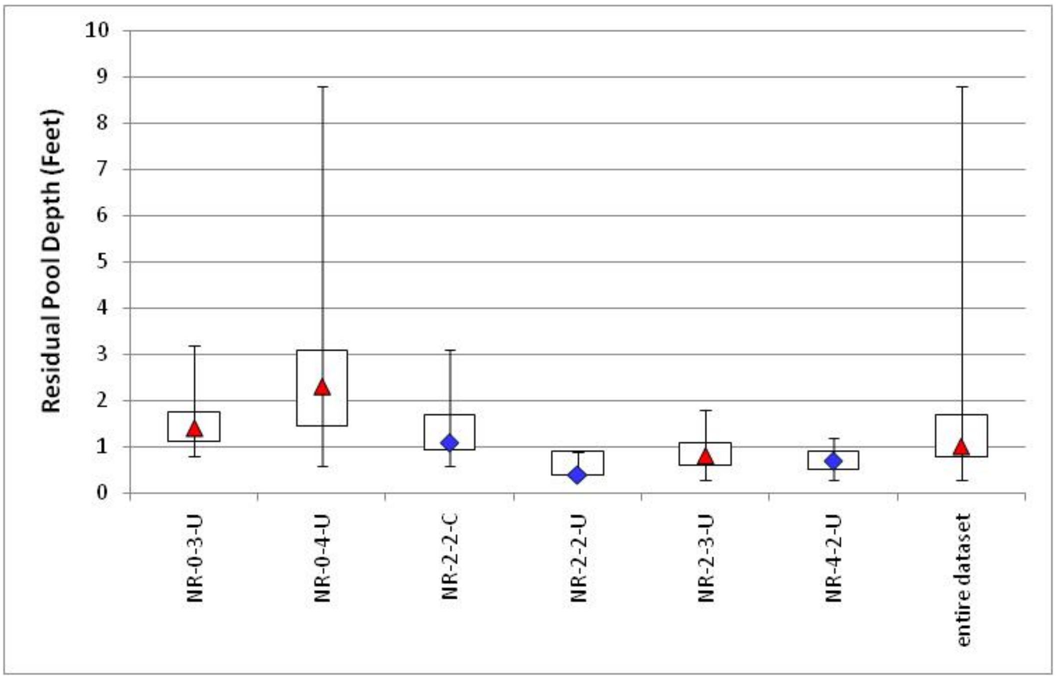
Table 3-7. Pool Tail-out Grid Toss <6mm

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	1	1	2	1	13
Sample Size	3	28	15	2	2	7	57
Minimum	0	0	0	23	2	1	0
25th Percentile	2	5	2	24	4	5	3
Median	3	7	3	24	6	5	6
75th Percentile	4	13	6	25	8	7	9
Maximum	5	25	10	25	10	9	25
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.7 Residual Pool Depth

Residual pool depth, defined as the difference between the maximum depth and the tail crest depth, is a discharge-independent measure of pool depth and an indicator of the quality of pool habitat. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes. Residual pool depth is also an indirect measurement of sediment inputs to streams since an increase in sediment loading can cause pools to fill, thus decreasing residual pool depth over time. Median residual pool depths ranged from 0.4 feet in NR-2-2-U to 2.3 feet in NR-0-4-U (**Figure 3-9** and **Table 3-8**). This analysis indicates that the deepest pools are found in low gradient 4th order streams and that residual pool depth tends to increase as stream order increases in the Kootenai-Fisher Project Area.



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-9. Residual Pool Depth

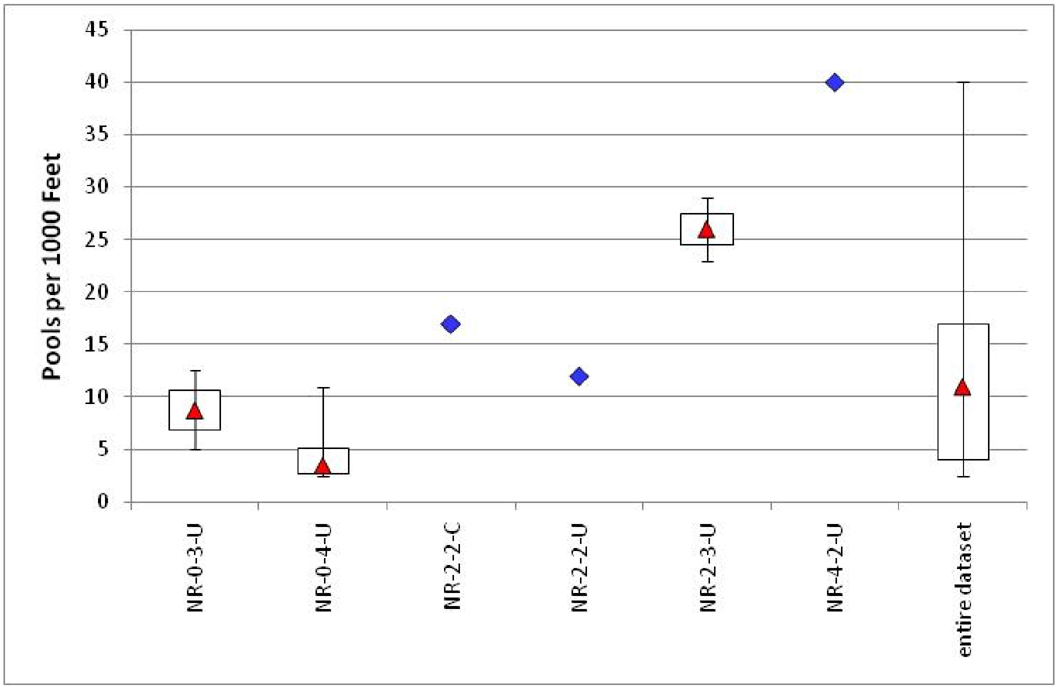
Table 3-8. Residual Pool Depth

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	1	1	2	1	13
Sample Size	14	39	15	5	52	16	141
Minimum	0.8	0.6	0.6	0.4	0.3	0.3	0.3
25th Percentile	1.1	1.5	1.0	0.4	0.6	0.5	0.8
Median	1.4	2.3	1.1	0.4	0.8	0.7	1.0
75th Percentile	1.8	3.1	1.7	0.9	1.1	0.9	1.7
Maximum	3.2	8.8	3.1	0.9	1.8	1.2	8.8
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions.

3.2.1.8 Pool Frequency

Pool frequency is a measure of the availability of pools to provide rearing habitat, cover, and refugia for salmonids. Pool frequency is related to channel complexity, availability of stable obstacles, and sediment supply. Excessive erosion and sediment deposition can reduce pool frequency by filling in smaller pools. Pool frequency can also be adversely affected by riparian habitat degradation resulting in a reduced supply of large woody debris or scouring from stable root masses in streambanks. Excluding reach types with only one monitoring site, the median value for the number of pools per 1,000 feet ranged from four (NR-0-4-U) to 26 (NR-2-3-U) (**Figure 3-10** and **Table 3-9**). Pool frequency tends to decrease as gradient decreases and stream order increases in the Kootenai-Fisher Project Area.



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-10. Pools per 1000 Feet

Table 3-9. Pools per 1000 feet

Statistical Parameter	Reach Type					
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	*1*	*1*	2	*1*	13
Sample Size	2	6	*1*	*1*	2	*1*	13
Minimum	5	3	*17*	*12*	23	*40*	3
25th Percentile	7	3	*17*	*12*	25	*40*	4
Median	9	4	*17*	*12*	26	*40*	11
75th Percentile	11	5	*17*	*12*	28	*40*	17
Maximum	13	11	*17*	*12*	29	*40*	40
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 2-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

Pool frequency data is also provided as pools per mile in **Table 3-10** for future TMDL applications.

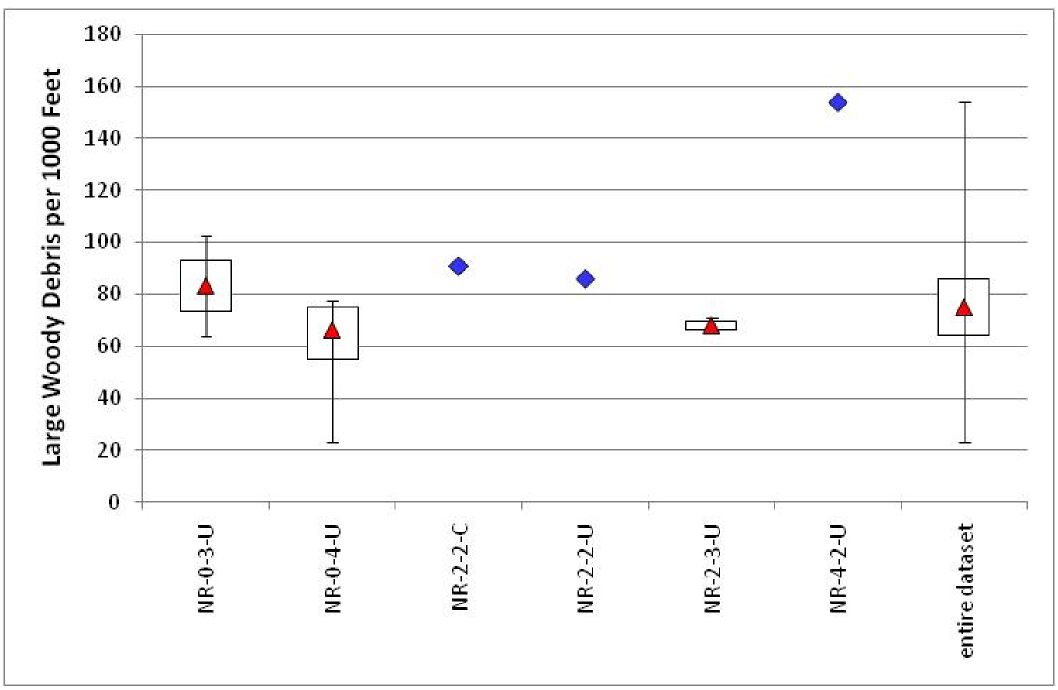
Table 3-10. Pools per Mile

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
Minimum	26	13	*90*	*63*	121	*211*	13
25th Percentile	36	14	*90*	*63*	129	*211*	21
Median	46	18	*90*	*63*	137	*211*	58
75th Percentile	56	27	*90*	*63*	145	*211*	90
Maximum	66	58	*90*	*63*	153	*211*	211

Note: See Table 2-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

3.2.1.9 Large Woody Debris Frequency

Large woody debris (LWD) is a critical component of high-quality salmonid habitat, providing habitat complexity, quality pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward 1989). LWD frequency can be measured and compared to reference reaches or literature values to determine if more or less LWD is present than would be expected under optimal conditions. Excluding reach types with only one monitoring site, the median value for the amount of large woody debris (LWD) per 1,000 feet ranged from 66 in NR-0-4-U to 83 in NR-0-3-U (**Figure 3-11** and **Table 3-11**). Note that "willow bunches" assigned in the field were tallied as large woody debris. Thus, this analysis makes no distinction as to the size of the woody material.



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site.

Figure 3-11. Large Woody Debris per 1000 Feet

Table 3-11. Large Woody Debris per 1000 Feet

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	2	6	*1*	*1*	2	*1*	13
Sample Size	2	6	*1*	*1*	2	*1*	13
Minimum	64	23	*91*	*86*	65	*154*	23
25th Percentile	74	55	*91*	*86*	67	*154*	64
Median	83	66	*91*	*86*	68	*154*	75
75th Percentile	93	75	*91*	*86*	70	*154*	86
Maximum	103	78	*91*	*86*	71	*154*	154
Monitoring Sites	GRNT13-01, QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01	BRST04-02, BRST04-04	RAVN06-01	

Note: See Table 1-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

Data is also provided as large woody debris per mile in **Table 3-12** for future TMDL applications.

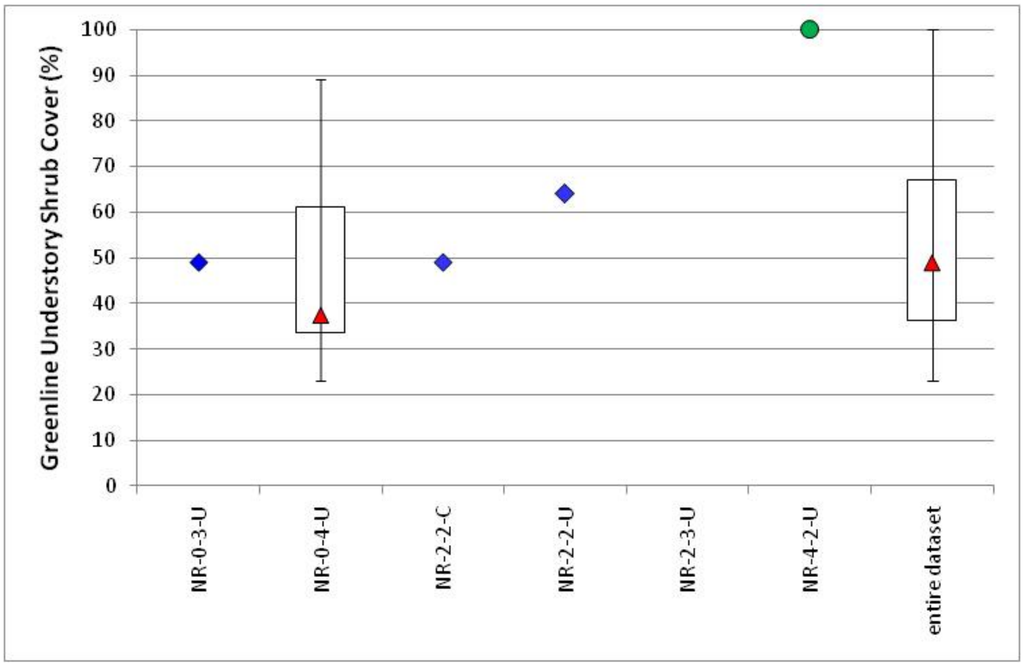
Table 3-12. Large Woody Debris per Mile

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
Minimum	338	121	*480*	*454*	343	*813*	121
25th Percentile	389	290	*480*	*454*	351	*813*	338
Median	440	350	*480*	*454*	359	*813*	396
75th Percentile	490	396	*480*	*454*	367	*813*	454
Maximum	541	409	*480*	*454*	375	*813*	813

Note: See Table 2-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

3.3.1.10 Greenline Understory Shrub Cover

Riparian shrub cover is an important influence on streambank stability. Removal of riparian shrub cover can dramatically increase streambank erosion and increase channel width/depth ratios. Shrubs stabilize streambanks by holding soil and armoring lower banks with their roots, and reduce scouring energy of water by slowing flows with their branches. Good riparian shrub cover is also important for fish habitat. Riparian shrubs provide shade, reducing solar inputs and increases in water temperature. The dense network of fibrous roots of riparian shrubs allows streambanks to remain intact while water scours the lowest portion of streambanks, creating important fish habitat in the form of overhanging banks and lateral scour pools. Excluding reach types with only one monitoring site, the median value for greenline understory shrub cover was 38% in NR-0-4-U (**Figure 3-12** and **Table 3-13**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site; and the green circle indicates the results of a qualitative visual estimate.

Figure 3-12. Greenline Understory Shrub Cover

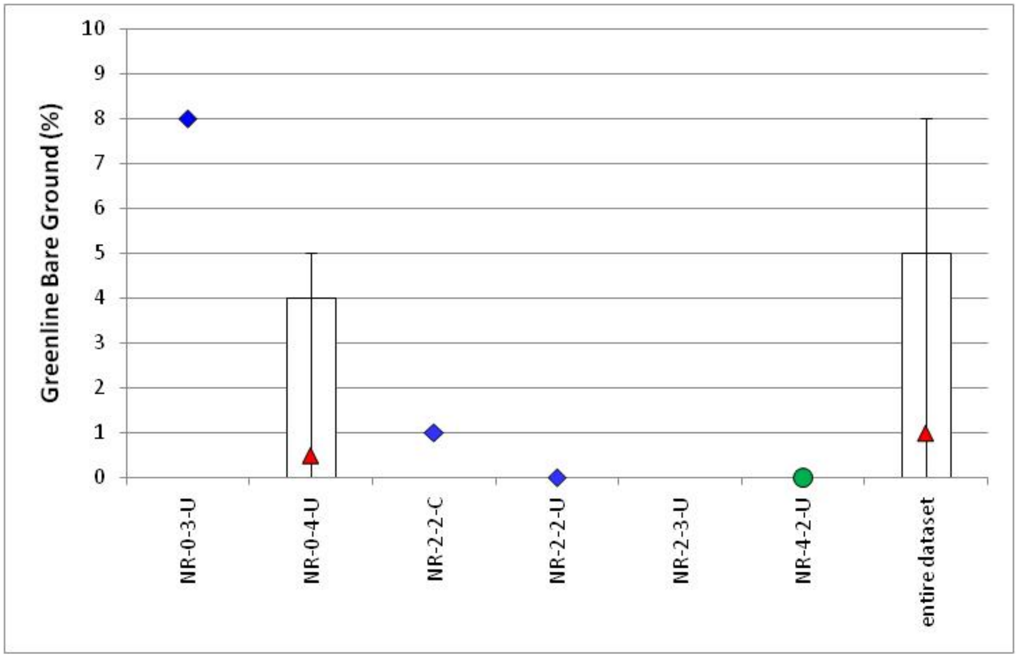
Table 3-13. Greenline Understory Shrub Cover

Statistical Parameter	Reach Type						
	NR-0-3-U	NR-0-4-U	NR-2-2-C	NR-2-2-U	NR-2-3-U	NR-4-2-U	Entire Dataset
# of Monitoring Sites	*1*	6	*1*	*1*	0	*1*	10
Sample Size	*1*	6	*1*	*1*	0	*1*	10
Minimum	*49*	23	*49*	*64*		*100*	23
25th Percentile	*49*	34	*49*	*64*		*100*	36
Median	*49*	38	*49*	*64*		*100*	49
75th Percentile	*49*	61	*49*	*64*		*100*	67
Maximum	*49*	89	*49*	*64*		*100*	100
Monitoring Sites	QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01		RAVN06-01	

Note: See Table 2-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

3.2.1.11 Greenline Bare Ground

Percent bare ground is an important indicator of erosion potential, as well as an indicator of land management influences on riparian habitat. Bare ground was noted in the greenline inventory where recent disturbance has resulted in exposed bare soil. Bare ground is often caused by trampling from livestock or wildlife, fallen trees, recent bank failure, new sediment deposits from overland or overbank flow, or severe disturbance in the riparian area, such as from past mining, road-building, or fire. Ground cover on streambanks is important to prevent sediment recruitment to stream channels since sediment can wash in from unprotected areas during snowmelt, storm runoff and flooding. Bare areas are also more susceptible to erosion from hoof shear. Excluding reach types with only one monitoring site, the median value for greenline bare ground was 1% in NR-0-4-U (**Figure 3-13** and **Table 3-14**).



Blue diamonds denote reach types with one monitoring site; red triangles denote more than one monitoring site; and the green circle indicates the results of a qualitative visual estimate.

Figure 3-13. Greenline Bare Ground

Table 3-14. Greenline Bare Ground

Statistical Parameter	Reach Type						
	NR-0-3-U	**NR-0-4-U**	**NR-2-2-C**	**NR-2-2-U**	**NR-2-3-U**	**NR-4-2-U**	**Entire Dataset**
# of Monitoring Sites	*1*	6	*1*	*1*	0	*1*	10
Sample Size	*1*	6	*1*	*1*	0	*1*	10
Minimum	*8*	0	*1*	*0*		*0*	0
25th Percentile	*8*	0	*1*	*0*		*0*	0
Median	*8*	1	*1*	*0*		*0*	1
75th Percentile	*8*	4	*1*	*0*		*0*	5
Maximum	*8*	5	*1*	*0*		*0*	8
Monitoring Sites	QRTZ10-01	WOLF09-02, WOLF11-03, LIBY09-03, LIBY09-05, LAKE02-01, LAKE03-03	QRTZ03-01	RAVN07-01		RAVN06-01	

Note: See Table 2-1 for reach type descriptions. Reach types with only one monitoring site denoted in blue italics.

3.2.2 Monitoring Site Analysis

Sediment and habitat data collected at each monitoring site was reviewed individually in the following sections. Monitoring site discussions are based on median values. Summary statistics for the minimum, 25th percentile, 75th percentile and maximum values are presented graphically, since these may be more applicable for developing sediment TMDL criteria.

3.2.2.1 Width/Depth Ratio

The highest median width/depth ratio was observed in LIBY09-05 (**Figure 3-14**). Extensive mid-channel gravel bar deposits indicate Libby Creek is aggrading in this reach, while a review of color aerial imagery in GIS indicates this condition extends along the entire lower segment of Libby Creek. It appears that the mobile bedload is the primary source of sediment to Libby Creek, along with additional inputs from streambank erosion as the stream actively meanders across the floodplain.

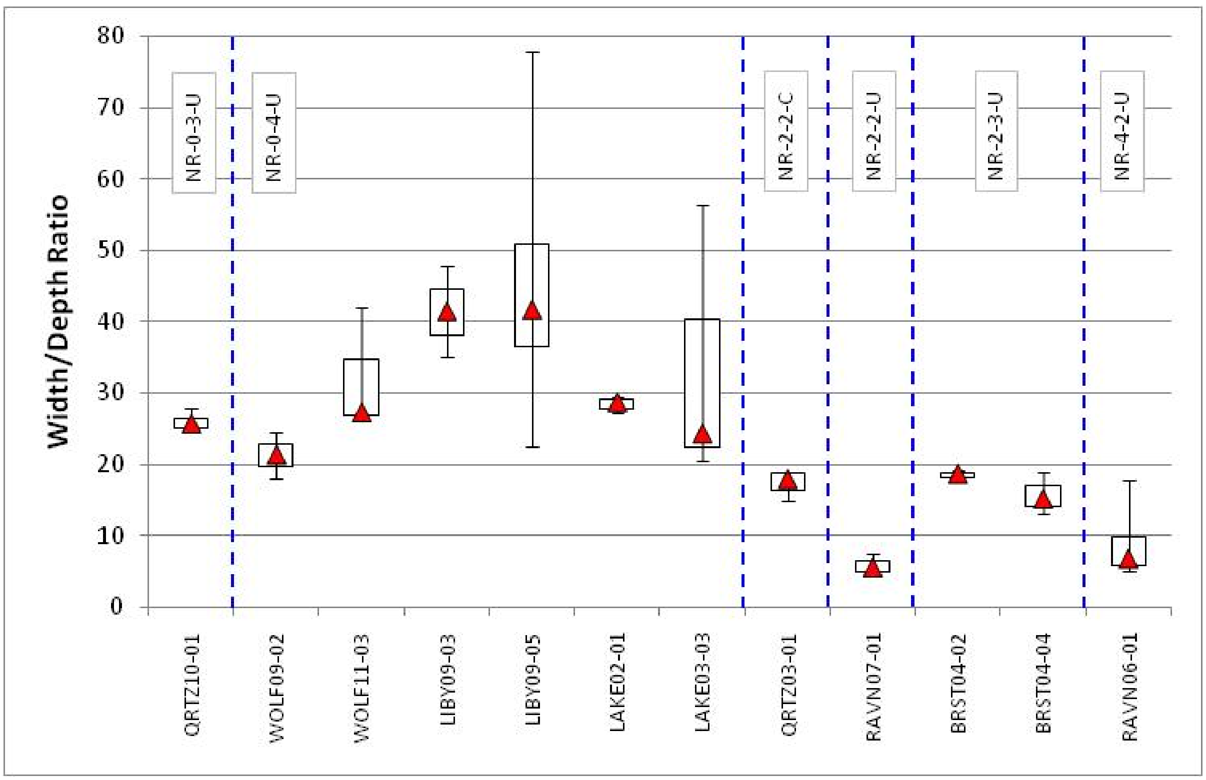


Figure 3-14. Width/Depth Ratio

3.2.2.2 Entrenchment Ratio

Entrenchment ratio data collected within the Kootenai-Fisher Project Area indicates the following (**Figure 3-15**):

1. RAVN07-01 on Raven Creek has the greatest amount of floodplain access out of the sites assessed. This site was located near the confluence of Raven Creek and the Fisher River on the Fisher River floodplain.
2. Entrenched conditions (entrenchment ratio <1.4) were documented in WOLF11-03 as a result of historic channelization due to road and railroad construction.
3. Moderately entrenched conditions (entrenchment ratio 1.4-2.2) were documented in QRTZ10-01 and LIBY09-03 as the result of channelization due to road construction, while moderately entrenched conditions in WOLF09-02 appear to be the result of historic grazing and timber harvest throughout the upper watershed.

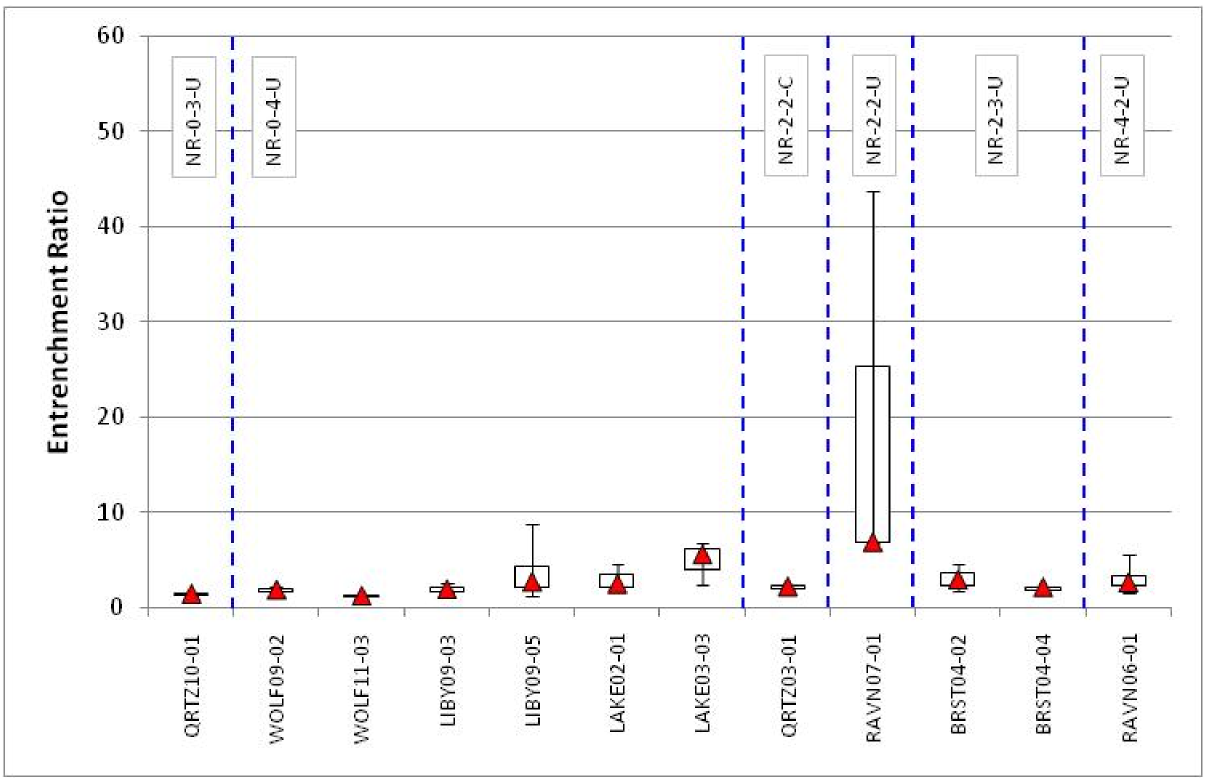


Figure 3-15. Entrenchment Ratio

3.2.2.3 Riffle Pebble Count <2mm

The median percent of fine sediment in riffles <2mm as measured by a pebble count was highest in RAVN07-01, followed by WOLF09-02 (**Figure 3-16**).

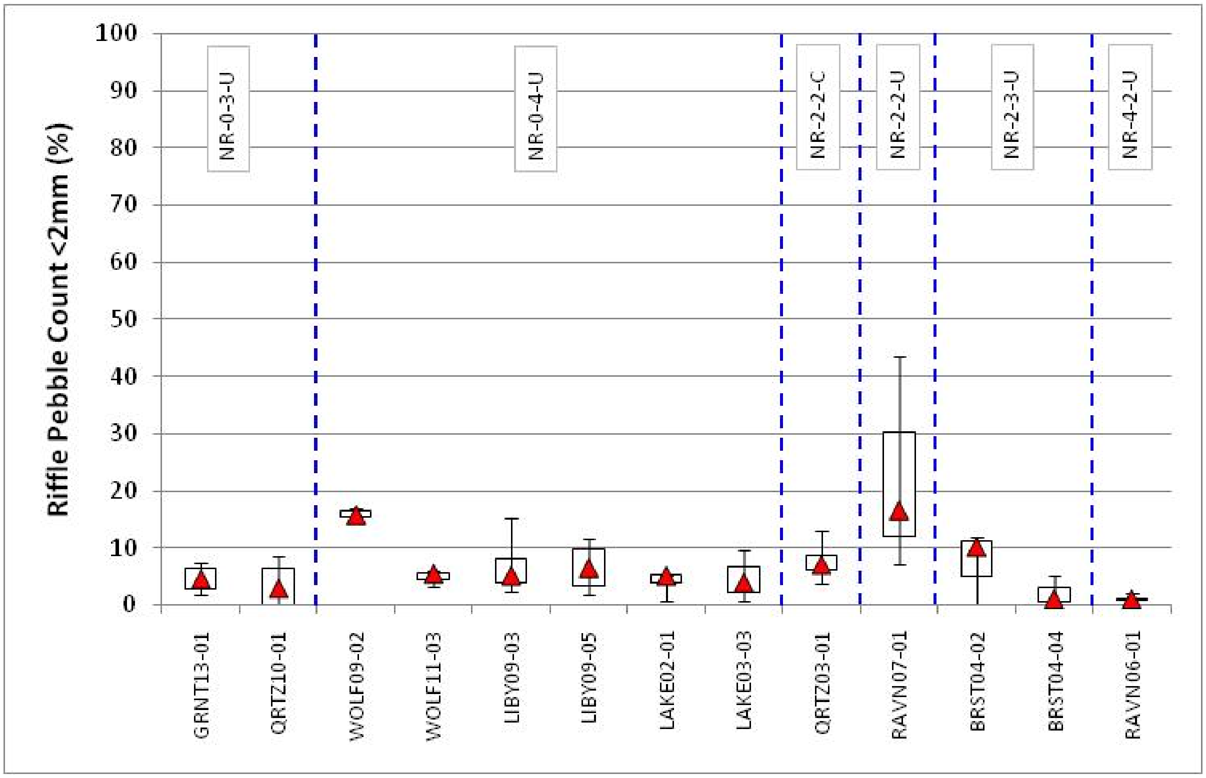


Figure 3-16. Riffle Pebble Count <2mm

3.2.2.4 Riffle Pebble Count <6mm

The percent of fine sediment in riffles <6mm as measured by a pebble count followed a similar trend as the percent of fine sediment <2mm, with the highest median values in RAVN07-01, followed by WOLF09-02 (**Figure 3-17**).

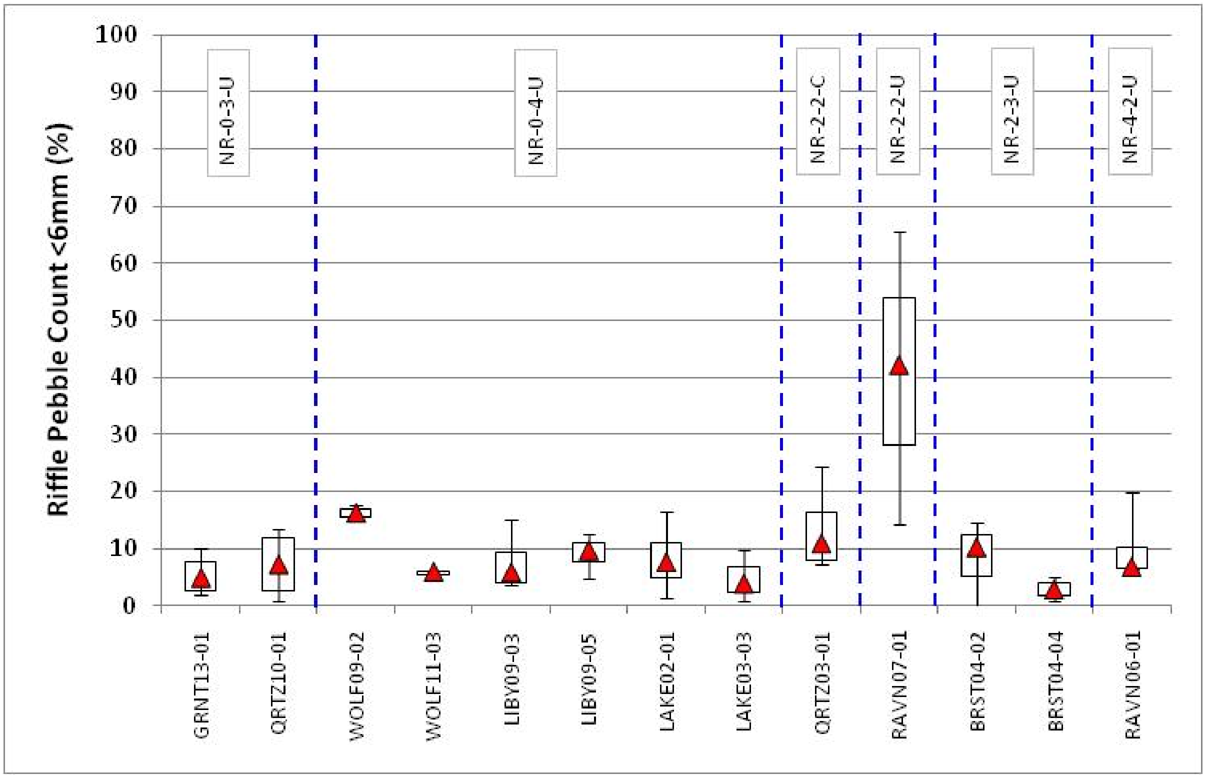


Figure 3-17. Riffle Pebble Count <6mm

3.2.2.5 Riffle Grid Toss <6mm

The median percent of fine sediment in riffles <6mm as measured by a grid toss was highest in LAKE03-03, followed by LIBY09-03 and RAVN07-01 (**Figure 3-18**).

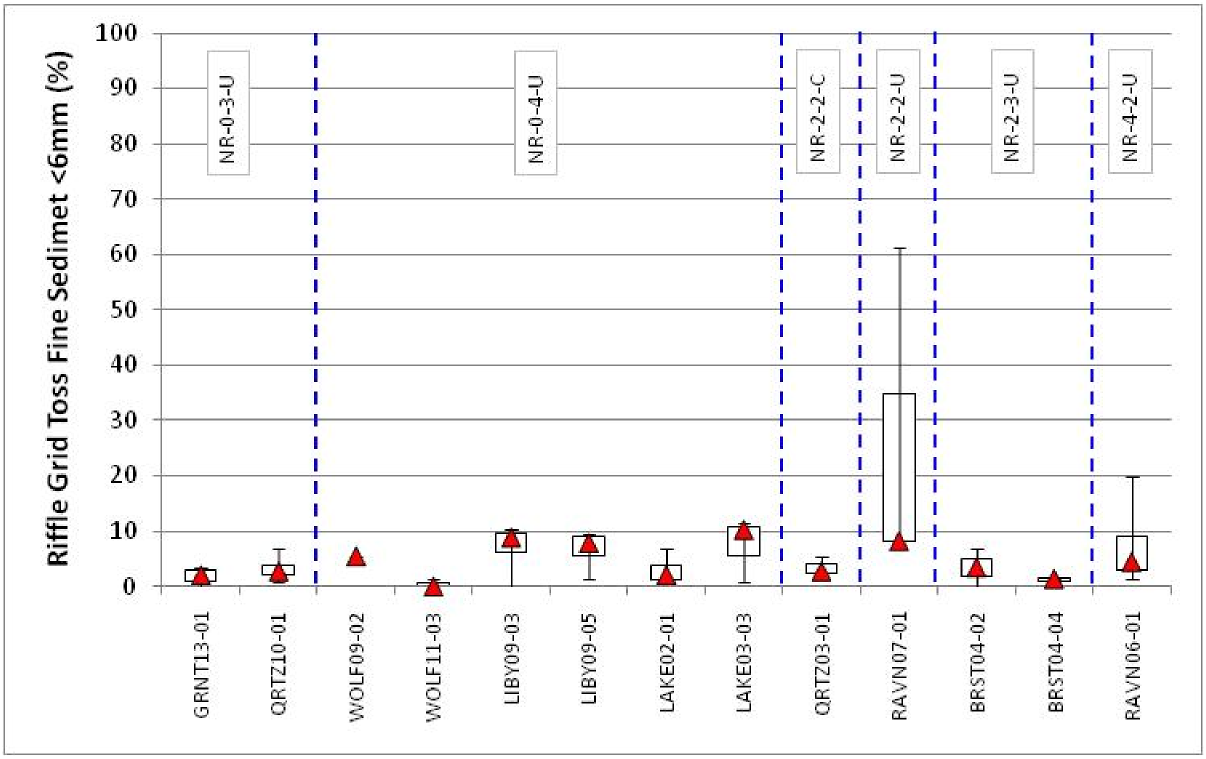


Figure 3-18. Riffle Grid Toss <6mm

3.2.2.6 Riffle Stability Index

The mobile percentile of particles on the riffle is termed "Riffle Stability Index" (RSI) and provides a useful estimate of the degree of increased sediment supply to riffles. The RSI addresses situations in which increases in gravel bedload from headwater activities is depositing material on riffles and filling pools, and it reflects qualitative differences between reference and managed watersheds. Although the expected range varies some by stream type, increasing RSI values above 40-70 generally indicate increased sediment supply to riffles (Kappesser 2002). In the Kootenai-Fisher Project Area, RSI evaluations were performed in BRST04-02, BRST04-04, LIBY09-03, LIBY09-05, and LAKE03-03. (**Table 3-15**).

Table 3-15. Riffle Stability Index Summary

	Mobile Particle Analysis		Pebble Count Analysis		RSI
Site	Cell	Geometric Mean (mm)	Cell	D50 (mm)	
BRST04-02	1	112	1	93	58
BRST04-04	1	114	1	114	50
LIBY09-03	1	182	1	64	95
LIBY09-03	4	166	4	55	90
LIBY09-05	1	185	1	44	97
LAKE03-03	1	166	1	62	94
LAKE03-03	4	155	4	59	96

3.2.2.7 Pool Tail-out Grid Toss <6mm

Fine sediment in pool tail-outs as measured by the grid toss followed a similar pattern as the riffle grid toss. The median percent of fine sediment in pool tail-outs as measured with the grid toss was highest in LAKE03-03, followed by RAVN07-01 (**Figure 3-19**).

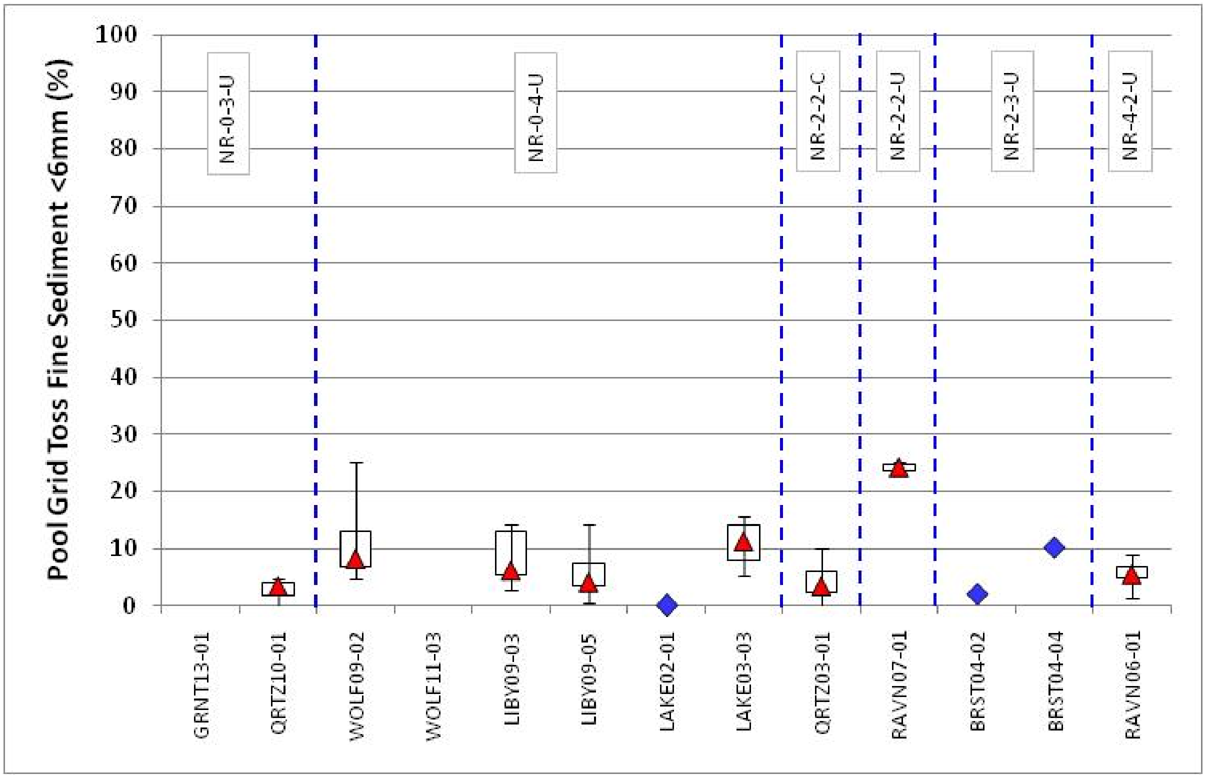


Figure 3-19. Pool Tail-out Grid Toss <6mm

3.2.2.8 Residual Pool Depth

The greatest median residual pool depth was measured in LAKE03-03, followed by LAKE02-01, both of which contained very deep pools in which the maximum depth was estimated (**Figure 3-20**). Maximum depths were also estimated in a portion of the pools in both Libby Creek monitoring sites. The lowest residual pool depth was found in RAVN07-01, which is a small stream flowing across the Fisher River floodplain. In general, residual pool depths increase in the downstream direction within the assessed streams.

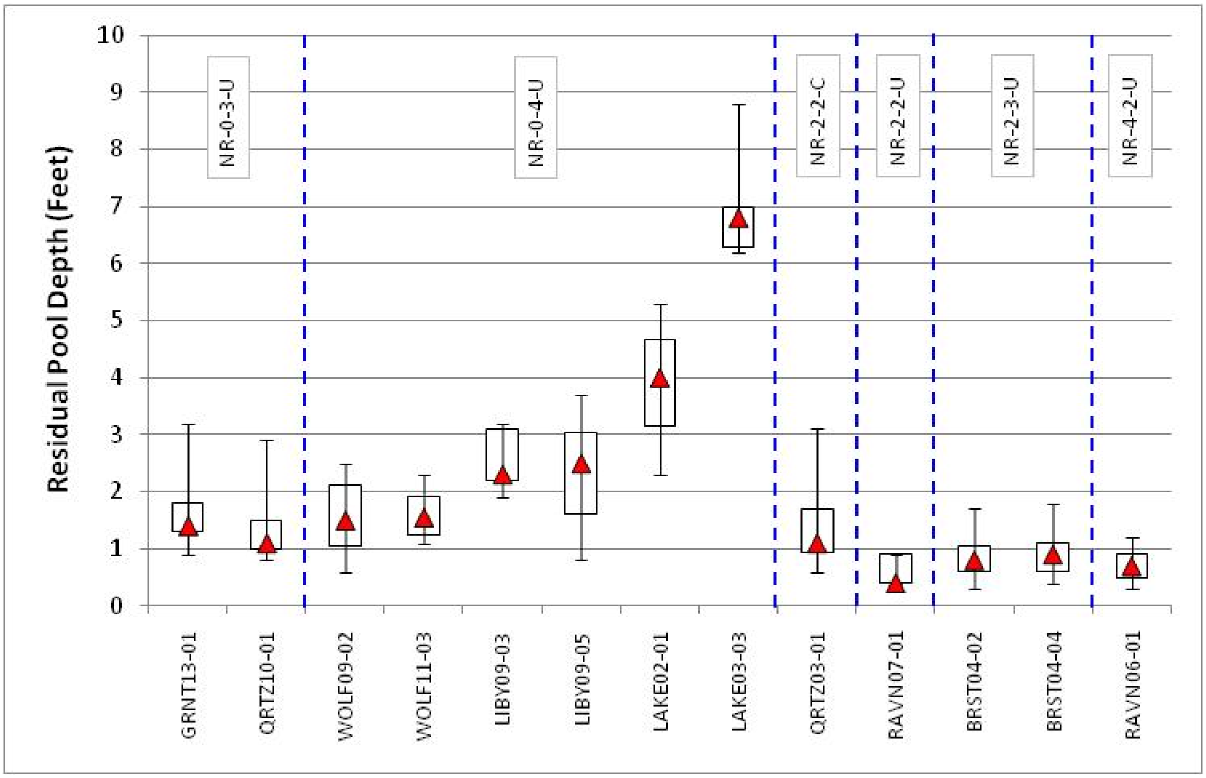


Figure 3-20. Residual Pool Depth

3.2.2.9 Pool Frequency

RAVN06-01 had the greatest number of pools per 1000 feet, followed by BRST04-04 (**Figure 3-21**). Numerous small pools in RAVN06-01 on Raven Creek were formed by interactions with coarse woody debris inputs along this narrow alder-lined stream channel. Pools in BRST04-04 were typical of a cobble and boulder dominated step-pool mountain stream with frequent small pools and large substrate.

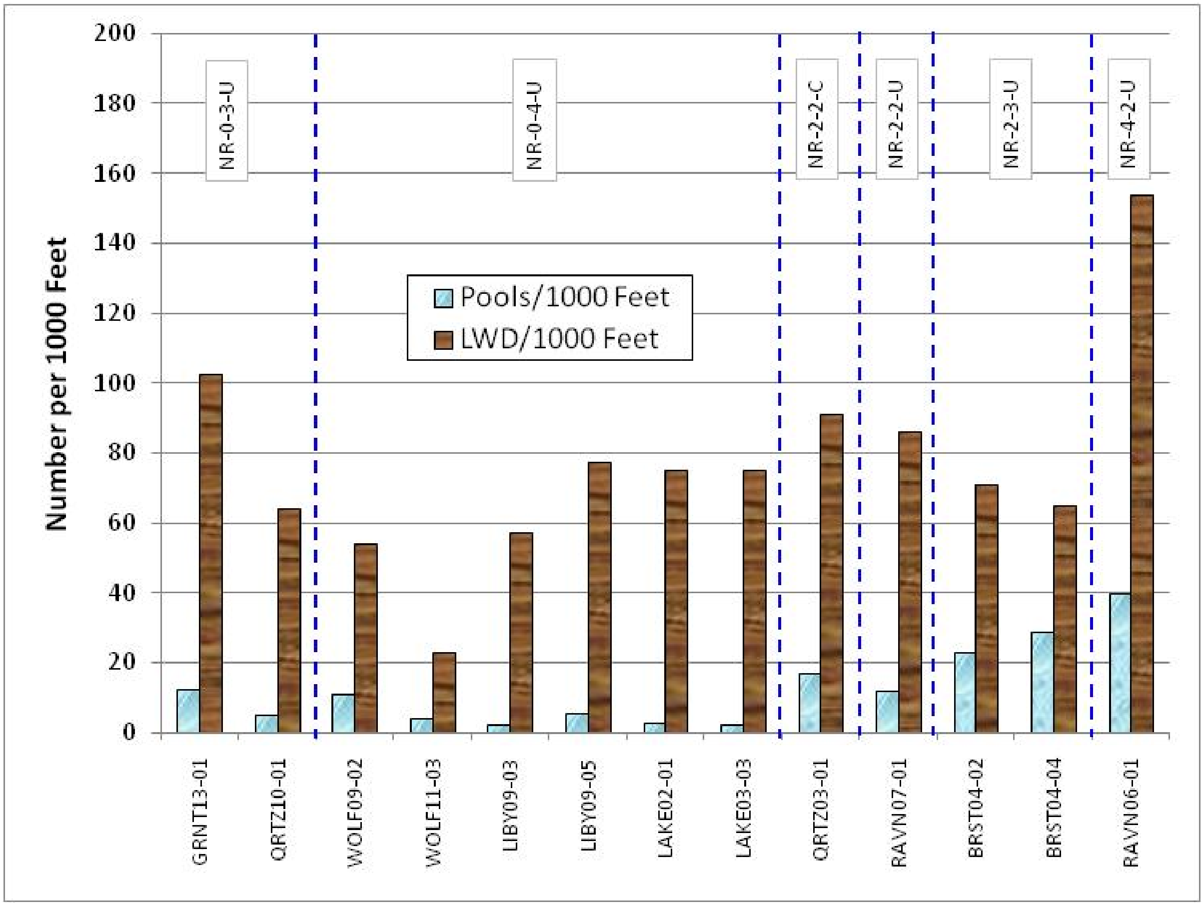


Figure 3-21. Pool and Large Woody Debris Frequency

3.2.2.10 Large Woody Debris Frequency

RAVN06-01 had the greatest amount of large woody debris per 1000 feet, followed by GRNT13-01, which was assessed for potential reference conditions (**Figure 3-21**). Small woody debris inputs from the alder-lined streambanks along Raven Creek comprised the majority of the large woody debris total at RAVN06-01. In GRNT13-01, the channel was lined by large cedar trees with pools formed primarily by large woody debris, which occurred both individually and in several large woody debris aggregates.

3.2.2.11 Greenline Understory Shrub Cover

Mean understory shrub cover exceeded 50% in WOLF11-03, LAKE02-01, and RAVN07-01, while mean shrub density was less than 50% in QRTZ10-01, WOLF09-01, LIBY09-03, LIBY09-05, and LAKE03-03, and QRTZ03-01 (**Figure 3-22**). No greenline measurements were performed in GRNT13-01, BRST04-02, or BRST04-04 since these monitoring sites were located in dense coniferous forests in which dense understory shrub cover was not an expected component of the riparian ecosystem. The greenline understory shrub cover was visually estimated as 100% along RAVN06-01 since the entire reach was lined with dense alders.

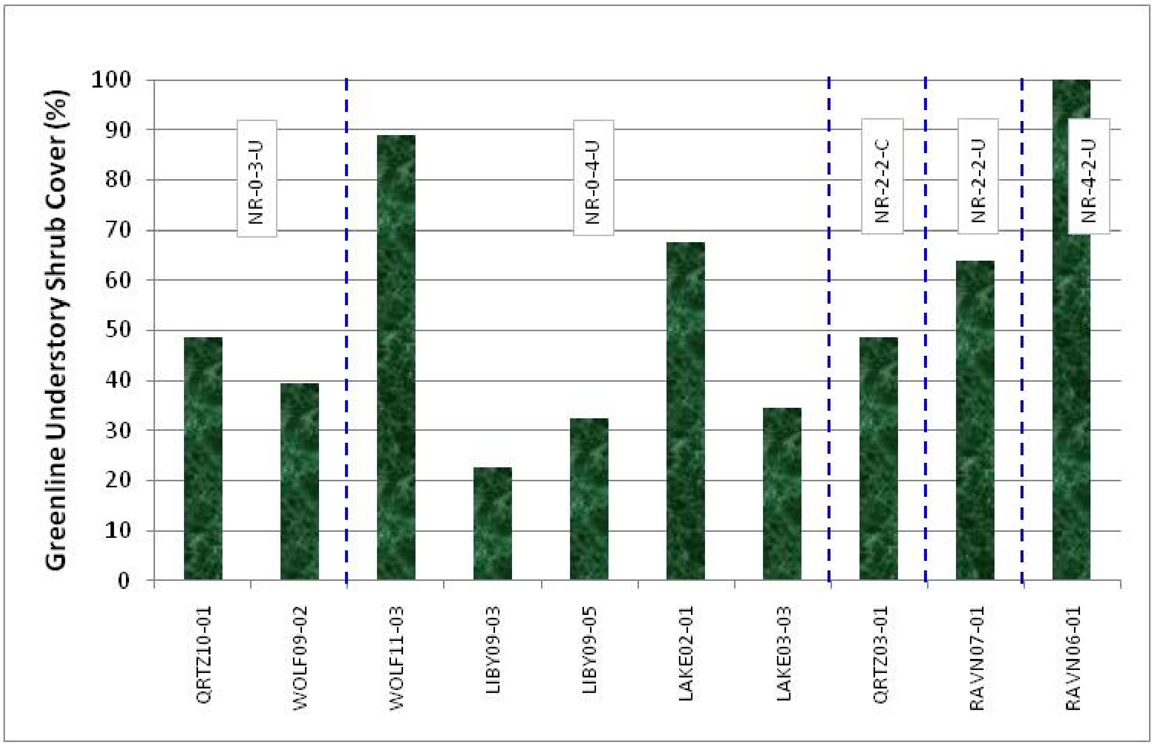


Figure 3-22. Greenline Understory Shrub Cover

3.2.2.12 Greenline Bare Ground

Mean bare ground values equaled or exceeded 5% in QRTZ10-01, LIBY09-03, and LIBY09-05, with all other monitoring sites remaining below 5%, including RAVN06-01 in which bare ground was visually estimated (**Figure 3-23**).

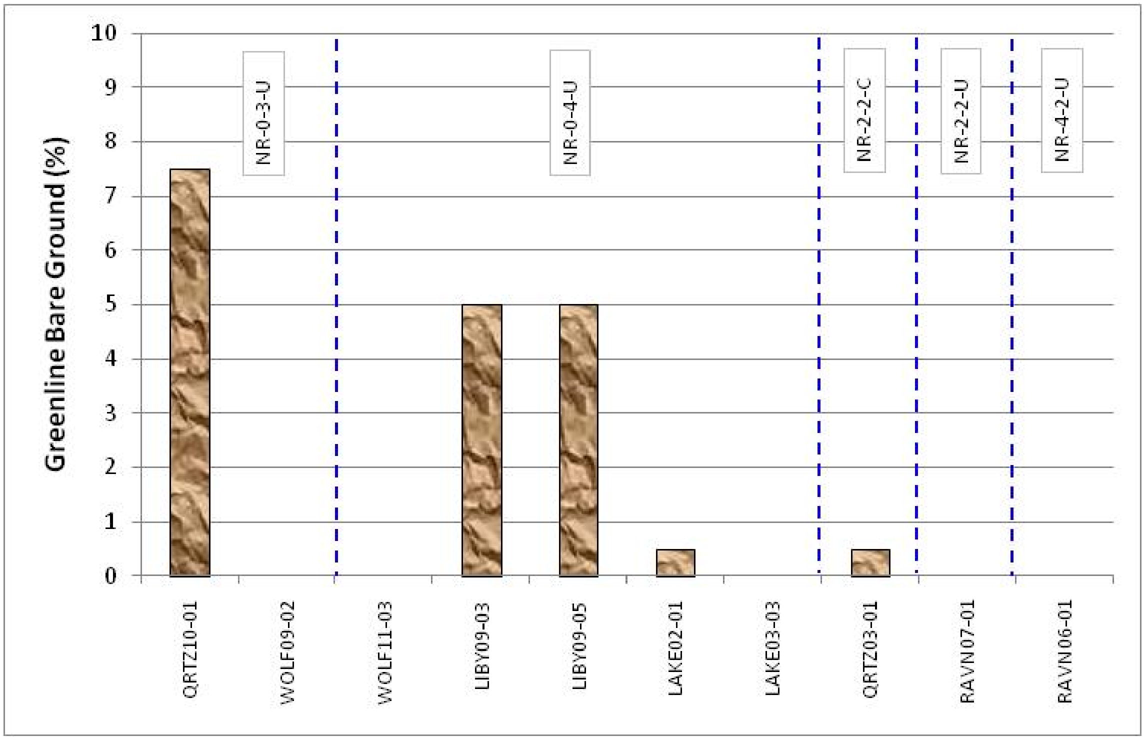


Figure 3-23. Greenline Bare Ground

3.2.3 Site Visit Notes

Following field data collection, field notes were recorded describing conditions observed in the field. Field notes were recorded for four categories and are summarized in the following sections:

- Description of human impacts and their severity
- Description of stream channel conditions
- Description of streambank erosion conditions
- Description of riparian vegetation conditions

3.2.3.1 Bristow Creek – BRST04-02

BRST04-02 was located along a forested reach of Bristow Creek that did not appear to have been logged historically, though logging has occurred in the watershed upstream of the monitoring site and along the stream channel corridor downstream of the monitoring site. The riparian corridor along the monitoring site contained large old cedar trees, though streamside management zone (SMZ) flagging was observed on several streamside trees. Ferns covered the forest floor and large conifers in the overstory limited the amount of understory shrub cover in this reach. Channel conditions were typical of a lower gradient mountain stream with LWD aggregates forming pools and relatively large substrate limiting potential spawning sites. Streambanks were comprised of coarse material and limited erosion was occurring where the flow was directed toward the streambank. The potential for this reach is a B3 stream type, while conditions at the monitoring site ranged from B3 to C3b. The restoration potential for this reach is low as it is in a natural condition.

3.2.3.2 Bristow Creek – BRST04-04

BRST04-04 was located along a forested reach of Bristow Creek downstream of the Koocanusa West Side road crossing. The riparian corridor did not appear to have been logged historically, though logging has occurred in the watershed upstream of the monitoring site. Ferns covered the forest floor and large conifers in the overstory limited the amount of understory shrub cover in this reach, though some alders were present along the channel margin at the upstream end of the reach. Channel conditions were typical of a cobble and boulder dominated step-pool mountain stream with frequent small pools and large substrate limiting potential spawning sites. Streambanks were comprised of coarse material and streambank erosion was limited. The potential for this reach is a B3 stream type, while conditions at the monitoring site ranged from B3a to C3a. The restoration potential for this reach is low as it is in a natural condition.

3.2.3.3 Granite Creek – GRNT13-01

GRNT13-01 was located near the trailhead leading up Granite Creek and the end of the Granite Creek road. This monitoring site was selected to document potential reference conditions and no land use activities beyond the trailhead parking area were observed during a review of 2009 color aerial imagery in GIS. Timber harvest was observed downstream of the monitoring site. This channel was lined by large cedar trees with infrequent alder in the understory. There was very little streambank erosion. The substrate was comprised of large cobbles and small boulders, with pools formed primarily by large woody debris. This reach is at its potential stream type, which is estimated as a B3.

3.2.3.4 Lake Creek – LAKE02-01

LAKE02-01 was located in an area of limited rural residential development along Lake Creek. This reach contained one very deep pool formed by large woody debris at a meander bend. The channel transitioned from a meandering channel to more of a riffle dominated channel progressing upstream through the monitoring site. Naturally eroding streambanks occurred at the outsides of meander bends, with alders along the channel margin and conifers on the floodplain. The potential for this reach is a C4 stream type, with conditions at the monitoring site ranging from C3 to C4 to B3c. The restoration potential for this reach is low as the majority of the reach is in a natural condition.

3.2.3.5 Lake Creek – LAKE03-03

LAKE03-03 was located upstream of the Lake Creek/Spar Lake road crossing. The road encroached the river left bank at the downstream end of the reach and the streambank was lined with riprap. Immediately upstream of the riprap, this streambank has not been stabilized and is actively eroding. The landowner along this streambank estimated it has retreated 10 feet over the past 7 years. Continued erosion is threatening a structure on the property. The opposite streambank progressing upstream is also riprapped along a field, likely leading to the accelerated rate of erosion at the next meander bend downstream. Lake Creek is a meandering channel with a well defined riffle-pool sequence and gravel bars at the insides of meander bends. Fine sediment was observed in the interstitial spaces of the coarse gravel substrate. This reach contained several very deep pools, which were estimated at 8-10 feet deep. These pools were typically formed by large woody debris accumulating at meander bends. Riparian vegetation removal for agricultural activities has occurred and the channel margin was noted to generally lack overstory vegetation at the downstream end of the reach. Progressing upstream, conifer forests occur at the outside of meander bends, with cottonwood galleries at the inside of meander bends. This reach is a C4 stream type, which is the potential stream type. The restoration potential for this reach is moderate and could include revegetation of the stream channel margin along the field and stabilization of the eroding streambank upstream of where the road abuts the channel.

3.2.3.6 Libby Creek – LIBY09-03

LIBY09-03 was located downstream of the Farm to Market – Hammer Cutoff road. The Stimson Haul Road was situated along the river left bank at the upstream end of the reach, including a stretch of riprap lined streambank. Extensive mid-channel gravel bar deposits indicate Libby Creek is aggrading in this reach, while a review of 2009 color aerial imagery in GIS indicates this condition extends along the entire sediment impaired segment of Libby Creek (which extends from the Highway 2 crossing to the mouth). It appears that the mobile bedload is the primary source of sediment to Libby Creek, along with additional inputs from streambank erosion as the stream actively meanders across the floodplain. The large gravel bars contained numerous pieces of large woody debris. Streambanks were primarily comprised of coarse gravel and small cobbles of similar size to the stream substrate. A layer of fine sediment, likely of lacustrine origin, overlay the gravel layer in some of the eroding banks. Fine sediment was observed in the interstitial spaces of the coarse gravel substrate found in the long glides downstream of pools, which typically formed at the outsides of meander bends and in association with large woody debris. Relatively large substrate in the pool tail-outs likely limits spawning potential for all but the largest fish. Even-aged mid-seral cottonwood stands along the river suggest riparian clearing at one point in time. One local resident indicated that Libby Creek was historically lined with large cedar trees, which were logged. Since that time, the stream has been actively meandering, becoming over-widened, and transporting large quantities of bedload sediment. Understory shrub cover was sparse and extensive patches of knapweed were observed. The potential for this reach given the historic disturbances is a C3/4 stream type, with existing conditions ranging from C3 to C4 to B3c. The restoration potential for this reach is moderate given the constraints of the extreme channel over-widening and the large mobile bedload stored in gravel bars.

3.2.3.7 Libby Creek – LIBY09-05

LIBY09-05 was located downstream of LIBY09-03 and shared many of the same characteristics of the upstream reach, though the substrate was slightly finer. The Stimson Haul Road was situated along the river right bank and encroached upon the stream channel upstream of the reach, including a stretch of riprap lined streambank and a flow deflection feature extending into the channel. Extensive mid-channel gravel bar deposits indicate Libby Creek is aggrading in this reach, while a review of 2009 color aerial imagery in GIS indicates this condition extends along the entire lower segment of Libby Creek (which extends from the Highway 2 crossing to the mouth). It appears that the mobile bedload is the primary source of sediment to Libby Creek, along with additional inputs from streambank erosion as the stream actively meanders across the floodplain. The large gravel bars contained numerous pieces of large woody debris. Streambanks were primarily comprised of coarse gravel and small cobbles of similar size to the stream substrate, though one large eroding streambank along the river left side of the channel where Libby Creek was eroding into the terrace was a source of finer material, as well as large woody debris. A small side channel along this eroding terrace had a dynamic series of pools formed by recent large woody debris inputs. Even aged mid-seral cottonwood stands along much of this reach suggest riparian clearing at one point in time. Understory shrub cover was sparse and extensive patches of knapweed were observed. The potential for this reach given the historic disturbances is a C4 stream type, with existing conditions ranging from C4 to F4. The restoration potential for this reach is moderate given the constraints of the extreme channel over-widening and the large mobile bedload stored in gravel bars.

3.2.3.8 Quartz Creek – QRTZ03-01

QRTZ03-01 was located along the upper portion of Quartz Creek approximately five miles upstream of the West Fork Quartz Creek confluence. While a road parallels this portion of Quartz Creek, it is situated high up on the hillslope and does not appear to influence the stream channel. Timber harvest has occurred in the watershed upstream of this reach. The QRTZ03-01 monitoring site was lined by large cedar trees, with infrequent alder in the understory. The streambed was comprised of gravel and small cobble substrate, with pools formed by large woody debris. It appeared that the substrate size, pool frequency, and pool quality would provide ideal spawning conditions. Streambank erosion was limited. Excluding potentially elevated sediment inputs from the upper watershed, conditions within this reach likely approximate reference conditions. The potential for this reach is a B4c stream type, with conditions at the monitoring site ranging from B4c to C4. The restoration potential for this reach is low as it is at a natural condition.

In addition to the assessment conducted on QRTZ03-01, the field crew also examined Quartz Creek above (QRTZ07-01) and below (QRTZ08-01) the confluence with the West Fork Quartz Creek accompanied by the Kootenai National Forest Libby Ranger District hydrologist. An erosive hillslope along river left was observed just downstream of the confluence and upstream of a small bedrock canyon. While anthropogenic disturbances appeared absent along the stream channel in this area, timber harvest has occurred on the adjacent hillslopes and may be leading to increased sediment inputs from hillslope erosion.

3.2.3.9 Quartz Creek – QRTZ10-01

QRTZ10-01 was located near the mouth of Quartz Creek. Anthropogenic disturbances that have influenced this site include timber harvest in the upper watershed, riparian harvest along the monitoring site, road encroachment, and large woody debris aggregate removal. This monitoring site was essentially comprised of one long riffle, with a couple of pools at the upper end of the monitoring site formed by large woody debris aggregates. One large eroding streambank was observed where the stream channel abuts a hillslope. Riparian vegetation along the channel margin includes conifers, cottonwoods, and alder. It appears that a large woody debris aggregate at the upstream end of the reach was partially removed as evidenced by saw marks in the logs on both sides of the channel margin. Quartz Creek is one of the primary bull trout spawning tributaries to the Kootenai River between the Libby Dam and Kootenai Falls, particularly West Fork Quartz Creek (Jim Dunnigan, personal communication). A fish counter was observed just upstream of the QRTZ10-01 monitoring site. The potential for this reach is a B3 stream type, with conditions at the monitoring site ranging from B3 to F3. The restoration potential for this reach is moderate and could include the addition of large woody debris jams to enhance channel complexity.

3.2.3.10 Raven Creek – RAVN04-01

A streambank erosion assessment was performed at RAVN04-01, which was located on a dry ephemeral reach of Raven Creek upstream of a road crossing. Logging and fire appear to be the primary landscape scale disturbances along this site. The low streambanks were generally comprised of cobble and streambank erosion was likely limited by the relatively straight cascading stream channel. Grass, small shrubs, and knapweed lined the channel margin of this ephemeral reach. **Figure 3-24** shows Raven Creek in May 1994 following the fire compared to July 2011 looking downstream from the road crossing that the monitoring site was located upstream of.

Figure 3-24. Raven Creek in May 1994 (left) and July 2011 (right), photos courtesy of Plum Creek

3.2.3.11 Raven Creek – RAVN06-01

The RAVN06-01 monitoring site was located in the lower portion of a heavily logged and roaded watershed. Raven Creek contains surface flow in RAVN03-01 before going subsurface in RAVN04-01; arising from springs in RAVN05-01 upstream of the monitoring site in RAVN06-01. The channel is entrenched with numerous small pools formed by small woody debris inputs. Streambank erosion was limited by the small channel size, the degree of entrenchment, and dense woody vegetation along the stream channel margin. The substrate was comprised of gravel and small cobbles and free of fine sediment accumulations due to the high transport capacity of this reach. Alders formed a narrow band of vegetation along the channel margin, while the uplands were comprised of weeds and small conifers. The potential for this reach is a B4 stream type, with an existing condition of B4a/C4a along the monitoring site. The restoration potential for this reach is low due to channel entrenchment.

3.2.3.12 Raven Creek – RAVN07-01

RAVN07-01 was located near the mouth of Raven Creek, where it joins the Pleasant Valley Fisher River. Historic logging has occurred along this transitional reach where Raven Creek flows across the Fisher River floodplain. Stream substrate became finer in a downstream direction toward the mouth. The channel was small with grass lined streambanks that limited streambank erosion. Alders were also present along the channel margin. The potential for this reach is an E4 stream type, which is the existing condition. The restoration potential for this reach is low since it is in a relatively natural condition.

3.2.3.13 Wolf Creek – WOLF08-03

A streambank erosion assessment was performed at WOLF08-03. Extensive logging has occurred in the Wolf Creek watershed upstream of this monitoring site. Grazing appears to be the primary land-use activity along the monitoring site, though overall grazing pressure appears relatively light. Streambanks were comprised primarily of clay and silt and most streambank erosion appeared to be due to historic grazing activity and the loss of riparian vegetation, though historic logging and changes in water yield may also play a role. A fine layer of silt was observed on the streambed. The channel was slightly entrenched at this site and streambanks were lined with grass and alders in the understory along the channel margin.

3.2.3.14 Wolf Creek – WOLF09-02

WOLF09-02 was located in a meadow area that has been grazed historically, though a recently constructed fence appears to exclude grazing. In addition, extensive logging has occurred in the Wolf Creek watershed upstream of this monitoring site. Historic land use activities upstream and along the site appear to be the source of the current channel entrenchment, though the channel is still relatively sinuous and comprised of long runs and slow moving pools, punctuated by an occasional short riffle. The streambed is comprised of relatively fine material with a layer of fine silt noted on the substrate. Streambanks were comprised primarily of clay and silt and most streambank erosion appeared to be due to historic grazing activity and the loss of riparian vegetation, though historic logging and changes in water yield may also play a role. Streambanks were lined with wetland sedges and grasses, with alders in the understory along the channel margin and very little overstory. The riparian vegetation appeared to be in a state of recovery. The potential for this reach is a C4 stream type, with an existing condition of B4c due to the slight channel entrenchment. The restoration potential for this reach is moderate due to slight channel entrenchment. The riparian vegetation is currently in a state of recovery and beaver activity was observed, though sediment contributions from eroding streambanks remain significant.

3.2.3.15 Wolf Creek – WOLF11-03

WOLF11-03 was located along the main road heading up the valley. The monitoring site was situated so that the lower portion was located in a channelized area, while the upper portion was along a meander bend situated away from the road. Extensive channelization has occurred along Wolf Creek due to the construction of the road and railroad. It appears that several grade control structures were added to Wolf Creek as well. During a review of 2009 color aerial imagery using GIS, 31 bridge crossings of Wolf Creek were identified, most of which were associated with the railroad. The streambed at the monitoring site was comprised of large cobbles and small boulders, with riprap lining a portion of the reach, while natural streambanks generally contained large cobbles. Pools were relatively shallow and lacked spawning sized gravels. Alder and red osier dogwood lined the channel margin with conifers and a few cottonwoods in the overstory. The potential for this reach is a C3 stream type, with an existing condition of F3 due to channel entrenchment. The restoration potential for this reach is low due to the large channel material and extensive channelization along the Wolf Creek mainstem. Habitat enhancement projects utilizing large woody debris jams may be beneficial.

4.0 STREAMBANK EROSION ASSESSMENT

4.1 METHODS

In the Kootenai-Fisher Project Area, streambank erosion data was collected at 13 monitoring sites in which the complete sediment and habitat assessment was performed. An additional assessment of streambank erosion was conducted at two sites to increase the representativeness of the assessment. At each of the 15 monitoring sites, eroding streambanks were assessed for erosion severity and categorized as either “actively/visually eroding” or “slowly eroding/vegetated/undercut”. At each eroding streambank, **Bank Erosion Hazard Index (BEHI)** measurements were performed and the **Near Bank Stress (NBS)** was evaluated (Rosgen 1996, 2006). Bank erosion severity was rated from “very low” to “extreme” based on the BEHI score, which was determined based on the following six parameters: bank height, bankfull height, root depth, root density, bank angle, and surface protection. Near Bank Stress was also rated from “very low” to “extreme” depending on the shape of the channel at the toe of the bank and the force of the water (i.e. “stream power”) along the bank. In addition, the source, or underlying cause, of streambank erosion was evaluated at each eroding streambank based on observed anthropogenic disturbances within the riparian corridor, as well as current and historic land-use practices observed within the surrounding landscape. The source of streambank instability was identified based on the following near-stream source categories: transportation, riparian grazing, cropland, mining, silviculture, irrigation, natural, and “historic or other”. Naturally eroding streambanks were considered the result of “natural sources” while “historic or other” sources in the Kootenai-Fisher Project Area include dam operations on Lake Creek, rural residential development along Libby Creek, and railroad development along Wolf Creek. Historic removal of riparian vegetation also likely plays a significant role in the existing rate of streambank erosion along streams in the Kootenai-Fisher Project Area, particularly along Libby Creek. If multiple sources were observed, then a percent was noted for each source.

For each eroding streambank, the average annual sediment load was estimated based on the streambank length, mean height, and annual retreat rate. The length and mean height were measured in the field, while the annual retreat rate was determined based on the relationship between the BEHI and NBS ratings. Annual retreat rates were estimated based on retreat rates developed using Colorado USDA Forest Service (1989) data for sedimentary and metamorphic geologies (Rosgen 2006) (**Table 4-1**). The annual sediment load in cubic feet was then calculated from the field data (annual retreat rate x mean bank height x bank length), converted into cubic yards, and finally converted into tons per year based on the bulk density of streambank material, which was assumed to average 1.3 tons/yard^3 as identified in *Watershed Assessment of River Stability and Sediment Supply* (WARSSS) (EPA 2006, Rosgen 2006). This process resulted in a sediment load for each eroding streambank expressed in tons per year.

Table 4-1. Annual Streambank Retreat Rates (Feet/Year), Colorado USDA Forest Service (adapted from Rosgen 2006)

BEHI	Near Bank Stress					
	very low	low	moderate	high	very high	extreme
very Low	NA	NA	NA	NA	NA	NA
low	0.02	0.04	0.07	0.16	0.32	0.67
moderate	0.09	0.15	0.25	0.42	0.70	1.16
high - very high	0.17	0.25	0.38	0.58	0.87	1.32
extreme	0.16	0.42	1.07	2.75	7.03	17.97

4.1.1 Monitoring Site Sediment Loads

During field data collection, streambank erosion was assessed at a total of 15 monitoring sites in seven different reach types. For each monitoring site, the streambank erosion sediment load was normalized to 1000 feet. Streambank erosion data was then grouped into two categories for the purpose of analysis and extrapolation, with low gradient (<2% slope) 3rd and 4th order reach types (NR-0-3-U, NR-0-4-U) grouped together and moderate or greater gradient (2-10% slope) 1st, 2nd, and 3rd order reach types (NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, and NR-4-2-U) grouped together. These reach type data groupings result in a total of nine monitoring sites in low gradient 3rd and 4th order reach types and six monitoring sites in moderate gradient 1st, 2nd, and 3rd order reach types (**Table 4-2**).

Table 4-2. Reach Type Data Groupings

Reach Type	Number of Monitoring Sites	Monitoring Sites
NR-0-3-U	2	QRTZ 10-01, GRNT13-01
NR-0-4-U	7	LAKE 02-01, LAKE03-03, LIBY09-03, LIBY09-05, WOLF08-03*, WOLF09-02, WOLF11-03
NR-2-2-C	1	QRTZ 03-01
NR-2-2-U	1	RAVN 06-01
NR-2-3-U	2	BRST 04-02, BRST04-04
NR-4-1-U	1	RAVN 04-01*
NR-4-2-U	1	RAVN 05-01

*Streambank erosion assessment only

4.1.2 Streambank Erosion Sediment Loads for Existing Conditions

Streambank erosion was estimated as predominantly due to natural sources at nine of the 15 assessed monitoring sites, while streambank erosion was estimated as predominately due to anthropogenic sources at six monitoring sites. Erosion from predominantly natural sources is defined as reaches where 75% or more of the causes of streambank erosion influence are attributed to natural sources, whereas anthropogenically influenced reaches attribute streambank erosion to human caused sources for greater than 25% of the reach. For the six monitoring sites with streambank erosion predominately due to anthropogenic sources, five monitoring sites were in reaches of low gradient (<2% slope) and one monitoring site was of moderate or greater gradient (2-10% slope). The average sediment load per year for reaches with erosion predominantly influenced by human sources from these groupings was then used to represent existing conditions for these reach types. For low gradient reach types, the sediment load averaged 22.00 tons/year/1000 feet, while the sediment load at the one site in a moderate or greater gradient reach type was 6.32 tons/year/1000 feet (**Table 4-3**).

Table 4-3. Sediment Loads by Reach Type for Existing Conditions

Field Assessed Reach Type Group	Number of Monitoring Sites	Average Sediment Load per 1000 Feet (Tons/Year)	Standard Error (Tons/Year)	Minimum (Tons)	Maximum (Tons)
NR-0-3-U, NR-0-4-U	5	22.00	3.74	12.67	34.73
NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, NR-4-2-U	1	6.32	n/a	n/a	n/a

Since only one data point was available for moderate or greater gradient reach types, additional analysis was conducted based on streams within the vicinity of the Kootenai-Fisher Project Area, including both the Tobacco TPA streambank erosion assessment from 2008 and the 2011 Thompson Project Area streambank erosion assessment. For the Tobacco TPA, four monitoring sites located in moderate or greater gradient reach types with predominately anthropogenic sources averaged 7.70 tons/year/1000 feet, while for the Thompson Project Area, five monitoring sites located in moderate or greater gradient reach types with predominately anthropogenic sources averaged 6.90 tons/year/1000 feet. This analysis indicates that streambank erosion sediment loads applied to moderate gradient reach types in the Kootenai-Fisher Project Area are similar to those applied in adjacent watersheds.

4.1.3 Reducing Streambank Erosion Sediment Loads through Best Management Practices

The ability to reduce streambank erosion through the application of Best Management Practices (BMPs) was evaluated by comparing the existing conditions sediment load for monitoring sites with predominately human influenced erosion to the sediment load at the nine monitoring sites in which streambank erosion was due to predominately natural sources. Of the nine low gradient monitoring sites, streambank erosion was predominately due to natural sources at four of the sites, while five out of the six moderate or greater gradient monitoring sites had predominately natural sources. The average sediment load per year from these groupings was then used to represent potential bank erosion loading under best management practices. For low gradient reach types, the four monitoring sites with a predominately natural sediment load averaged 9.43 tons/year/1000 feet, while the five monitoring sites in moderate or greater gradient reach types with predominately natural sediment load averaged 2.81 tons/year/1000 feet (**Table 4-4**).

Table 4-4. Sediment Loads by Reach Type with BMPs

Field Assessed Reach Type Group	Number of Monitoring Sites	Average Sediment Load per 1000 Feet with BMPs (Tons/Year)	Standard Error (Tons/Year)	Minimum (Tons)	Maximum (Tons)
NR-0-3-U, NR-0-4-U	4	9.43	4.28	3.64	22.14
NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, NR-4-2-U	5	2.81	1.26	0.12	5.82

4.1.4 Streambank Erosion Sediment Load Extrapolation for Existing Conditions

Streambank erosion data collected at **monitoring sites** were extrapolated to the **stream reach**, **stream segment**, and **sub-watershed** scales based on similar reach type characteristics as identified in the Aerial Assessment Database. Sediment load calculations were performed for monitoring sites, stream reaches, stream segments, and sub-watersheds, which are distinguished as follows:

Monitoring Site - *A 500, 1000, or 2000 foot section of a stream reach where field monitoring was conducted*

Stream Reach -*Subdivision of the stream segment based on ecoregion, stream order, gradient and confinement as evaluated in GIS*

Stream Segment *-303(d) listed segment*

Sub-watershed *-303(d) listed segment and tributary streams based on 1:100,000 NHD data layer*

Streambank erosion sediment loads for the 303(d) listed stream segments were estimated based on the following criteria:

1. Monitoring site sediment loads were extrapolated directly to the stream reach in which the monitoring site was located and the percent contribution from different source categories was based on field observations.

2. Existing conditions data from low gradient (<2% slope) 3rd and 4th order reach types (NR-0-3-U, NR-0-4-U) was applied to all low gradient 3rd, 4th and 5th order reach types in the Kootenai-Fisher Project Area with predominately anthropogenic sources (>25%, based on the aerial assessment) (**Table 4-5**).

3. Existing conditions data from moderate or greater gradient (2-10% slope) 1st, 2nd, and 3rd order reach types (NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, and NR-4-2-U) was applied to all moderate gradient 1st, 2nd, 3rd, and 4th order reach types in the Kootenai-Fisher Project Area with predominately anthropogenic sources (>25%, based on the aerial assessment) (**Table 4-5**).

4. BMP condition sediment loads were assigned to reaches with predominately natural sediment loads (>75%, based on the aerial assessment). One loading rate was applied to low gradient and a different rate was applied to moderate gradient reaches.

5. No streambank erosion sediment load was applied to 1st and 2nd order high gradient (>10%) reach types as these channels tend to be small and well armored and have a very low streambank erosion rate.

6. While a portion of the sediment derived from the Upper Lake Creek watershed is likely retained in Bull Lake, no adjustment was made to sediment loading estimates since this assessment is focused on identifying areas where human sources of sediment loading can be reduced.

Table 4-5. Reach Type Groupings for Extrapolation

Field Assessed Reach Type Group	Un-Assessed Reach Types
NR-0-3-U, NR-0-4-U	NR-0-3-C, NR-0-5-U
NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, NR-4-2-U	NR-2-1-C, NR-2-1-U, NR-2-3-C, NR-2-4-C, NR-2-4-U, NR-4-2-C, NR-4-3-U

At the sub-watershed scale, streambank erosion data from the five monitoring sites in the moderate or greater gradient reach type group with a predominately natural sediment load was used to estimate the streambank erosion sediment load for un-assessed tributaries that were not included in the aerial assessment database. For un-assessed tributaries to the 303(d) listed stream segments, a sediment load of 1.41 tons/year/1000 feet was applied. This value is 50% of the average sediment load from the five monitoring sites in the moderate or greater gradient reach type group with a predominately natural sediment load, which averaged 2.81 tons/year/1000 feet. This value was selected because many of the un-assessed tributaries to the sediment listed streams are 1st and 2nd order streams with high gradients (> 10%) (**Figure 4-1**), and they are assumed to have well-armored streambanks with a low erosion rate.

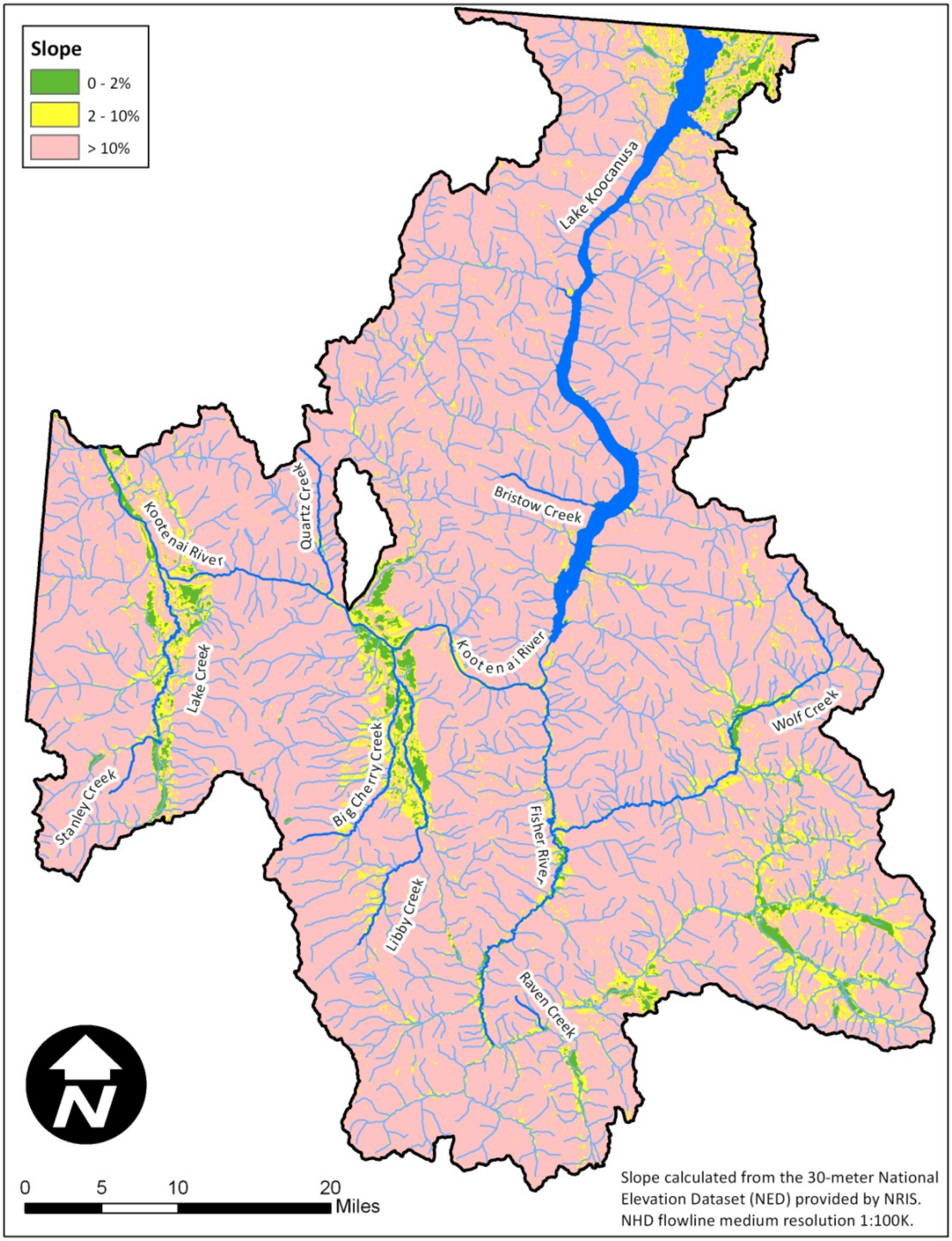


Figure 4-1. Percent Slope in the Kootenai-Fisher Project Area

4.1.5 Streambank Erosion Sediment Load Extrapolation with Best Management Practices

Montana's narrative water quality standards that apply to sediment relate to the naturally occurring condition, which is typically associated with either reference conditions or those that occur if all reasonable land, soil, and water conservation practices are applied. Anthropogenic activities that remove streamside vegetation tend to de-stabilize streambanks and increase the amount streambank erosion. Through the implementation of riparian and streambank BMPs, streambanks can be stabilized and sediment loads can be reduced. The reduction in streambank erosion sediment loads due to anthropogenic sources achievable via the implementation of BMPs was approximated using the estimated streambank erosion rate for monitoring sites in which the sediment load was due to predominately natural sources as discussed in **Section 4.1.3**, along with the following criteria:

1. Because they are assumed to be achieving the naturally occurring condition, no sediment load reductions were applied to reaches with predominately natural sources of erosion (>75%, based on the aerial assessment and observations at monitoring sites). In addition, no load reduction was applied to the natural portion of the sediment load in reaches with <75% natural sources.

2. Percent reductions for monitoring sites with predominately (>25%) anthropogenic sources were based on the difference between the existing conditions streambank erosion sediment load and the BMP sediment load as depicted in **Table 4-6**.

3. BMP sediment loads presented discussed in **Section 4.1.3** were applied to un-assessed reaches on the 303(3) listed stream segments by reach type grouping as shown in **Table 4-6**.

4. No reductions were applied to the un-assessed tributaries to the sediment listed streams (i.e., those not included in the aerial assessment database.

Table 4-6. Percent Reduction in Streambank Erosion Sediment Loads

Field Assessed Reach Type Group	Number of Monitoring Sites	Average Sediment Load per 1000 Feet (Tons/Year)	Average Sediment Load per 1000 Feet with BMPs (Tons/Year)	Percent Reduction
NR-0-3-U, NR-0-4-U	9	22.00	9.43	57%
NR-2-2-C, NR-2-2-U, NR-2-3-U, NR-4-1-U, NR-4-2-U	6	6.32	2.81	56%

4.2 RESULTS

4.2.1 Streambank Erosion Sediment Load Extrapolation

A total average annual sediment load of 246 tons/year was attributed to the 96 assessed eroding streambanks within the 15 monitoring sites. Average annual sediment loads for each monitoring site were normalized to a length of 1,000 feet for the purpose of comparison and extrapolation. Monitoring site sediment loads per 1,000 feet ranged from 0.1 tons/year in RAVN06-01 and RAVN07-01 on Raven Creek to 34.7 tons/year at LIBY09-05 on Libby Creek (**Table 4-7**).

Table 4-7. Monitoring Site Estimated Average Annual Sediment Loads due to Streambank Erosion

Stream Segment	Reach ID	Reach Type	Length of Eroding Bank (Feet)	Monitoring Site Length (Feet)	Percent of Reach with Eroding Streambank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
Bristow Creek	BRST04-02	NR-2-3-U	263	1,000	13%	5.8	5.8
	BRST04-04	NR-2-3-U	154	1,000	8%	2.3	2.3
Granite Creek	GRNT13-01	NR-0-3-U	159	800	10%	2.9	3.6
Lake Creek	LAKE02-01	NR-0-4-U	217	1,000	11%	5.5	5.5
	LAKE03-03	NR-0-4-U	838	2,000	21%	44.3	22.1
Libby Creek	LIBY09-03	NR-0-4-U	1,088	2,000	27%	50.1	25.0
	LIBY09-05	NR-0-4-U	1,789	2,000	45%	69.5	34.7
Quartz Creek	QRTZ03-01	NR-2-2-C	323	1,000	16%	5.6	5.6
	QRTZ10-01	NR-0-3-U	323	1,000	16%	12.7	12.7
Raven Creek	RAVN04-01	NR-4-1-U	216	500	22%	3.2	6.3
	RAVN06-01	NR-4-2-U	6	500	1%	0.1	0.1
	RAVN07-01	NR-2-2-U	4	500	<1%	0.1	0.1
Wolf Creek	WOLF08-03	NR-0-4-U	485	1,000	24%	19.2	19.2
	WOLF09-02	NR-0-4-U	277	1,000	14%	18.4	18.4
	WOLF11-03	NR-0-4-U	219	1,000	11%	6.4	6.4

Monitoring site sediment loads were extrapolated to each 303(d) listed stream segment based on the reach type groups discussed in **Section 4.1.4**. Stream segment sediment loads were estimated for all 103.1 miles of stream included in the Aerial Assessment Database (**Attachment C**). An average annual sediment load of 8,908 tons/year was attributed to eroding streambanks at the stream segment scale (**Table 4-8**). In the Kootenai-Fisher Project Area, streambank erosion sediment loads ranged from 28.8 tons/year in Raven Creek to 3,843.2 tons/year in Wolf Creek (**Attachment C**). Wolf Creek has highest sediment load due to streambank erosion per mile of stream, followed by Libby Creek, while Raven Creek has the lowest streambank erosion sediment load per mile of stream. At the stream segment scale, this assessment indicates that transportation and timber harvest are the greatest anthropogenic contributors of sediment loads due to streambank erosion in the Kootenai-Fisher Project Area, along with removal of riparian vegetation as highlighted in the “other” category (**Figure 4-2**).

Average annual streambank erosion sediment loads at the sub-watershed scale were estimated for the assessed stream segments in the Kootenai-Fisher Project Area based on the total length of stream within each sub-watershed. These sub-watershed sediment loads were estimated from the sum of the average annual streambank erosion sediment loads at the stream segment scale combined with an estimate of streambank erosion sediment loads from un-assessed streams. A total of 103.1 miles of stream were included in the Aerial Assessment Database and there are a total of 877.6 miles of stream in the assessed sub-watersheds based on a modified version of the 1:100,000 NHD stream layer in which ditches were removed (**Table 4-8**). For the purposes of estimating an annual average sub-watershed streambank erosion sediment load, streambank erosion sediment inputs from un-assessed streams was assumed to be 1.41 tons/year/1000 feet. A total sediment load of 14,655 tons per year is estimated at the sub-watershed scale for the Kootenai-Fisher Project Area (**Table 4-8**).

Table 4-8. Sub-watershed Streambank Erosion Sediment Loads

Stream Segment	Stream Length (Miles)	Stream Segment Sediment Load (Tons/Year)	Sub-watershed Stream Length (Miles)	Un-assessed Stream Length (Miles)	Sediment Load Applied to Un-assessed Stream Length (7.42 Tons/Year/Mile)	Sub-watershed Sediment Load (Tons/Year)	Total Load per Mile (Tons/Year)
Bristow Creek	6.4	133.6	22.60	16.2	120.2	253.8	11.2
Lake Creek	17.6	1,625.9	232.15	214.6	1,592.2	3,218.1	13.9
Libby Creek	26.0	3,026.2	283.73	257.7	1,912.1	4,938.3	17.4
Quartz Creek	11.3	250.5	48.24	37.0	274.5	524.9	10.9
Raven Creek	2.6	28.8	6.90	4.3	32.1	60.9	8.8
Wolf Creek	39.3	3,843.2	284.00	244.7	1,816.0	5,659.2	19.9
TOTAL	**103.1**	**8,908**	**877.6**	**774.5**	**5,747**	**14,655**	**16.7**

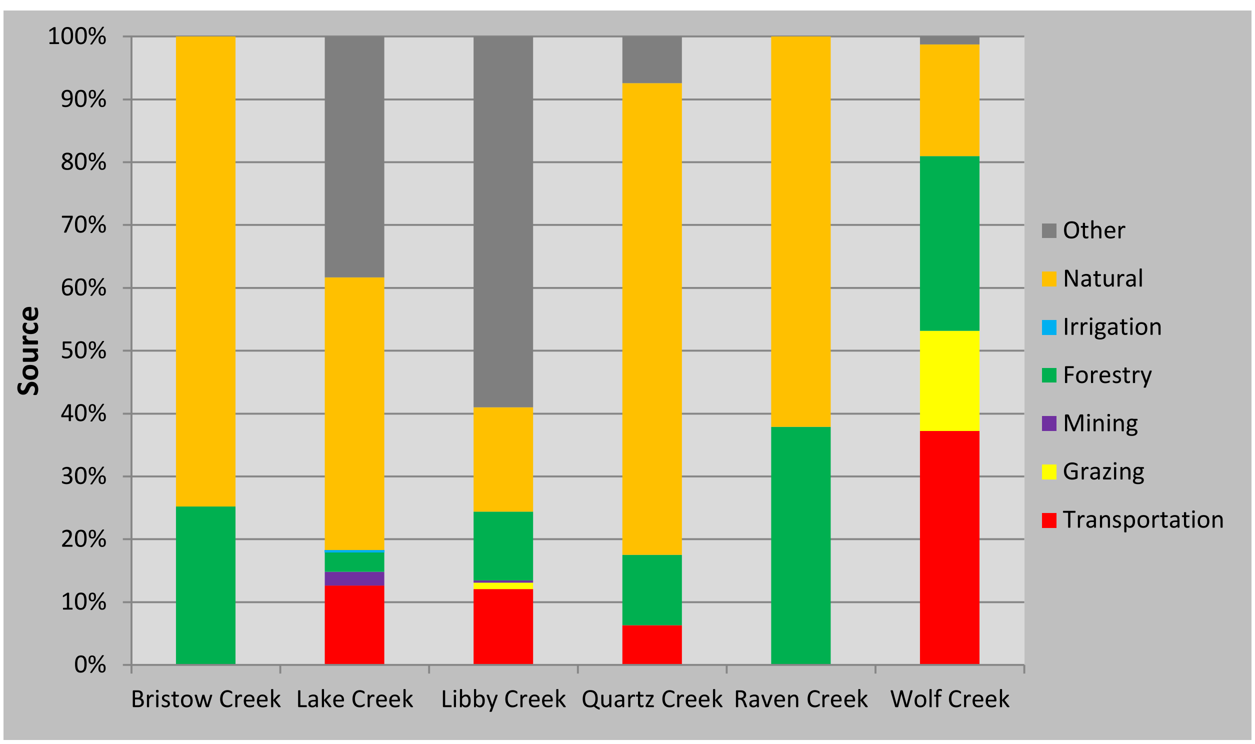


Figure 4-2. Stream Segment and Sub-watershed Streambank Erosion Sources

4.2.1.1 Streambank Composition

The percent of eroding streambank within each particle size category was evaluated for each monitoring site based on the sediment load from each eroding streambank relative to the total sediment load for the monitoring site. Then, the loads per particle size category from the monitoring sites within each impaired stream segment were summed to provide the streambank particle size breakdown for each stream segment (**Table 4-9**). Thus, it is assumed that streambank composition assessed at the field monitoring sites is representative of the overall stream segment. This analysis will help guide implementation activities geared toward reducing sediment loads for specific particle size categories. In the Kootenai-Fisher Project Area, sand/silt generally comprised the greatest portion of the streambank sediment load, comprising greater than 50% of the sediment load in all of the assessed streams except for Libby Creek where coarse gravel comprised the greatest portion of the streambank erosion sediment load.

Table 4-9. Stream Segment Streambank Composition

Stream Segment	Coarse Gravel >6mm (Percent)	Fine Gravel <6mm & >2mm (Percent)	Sand/Silt <2mm (Percent)
Bristow Creek	18%	27%	55%
Lake Creek	28%	15%	57%
Libby Creek	48%	14%	37%
Quartz Creek	28%	20%	52%
Raven Creek	10%	10%	80%
Wolf Creek	6%	3%	92%

4.2.2 Streambank Erosion Sediment Load Reductions

Streambank erosion sediment load reductions for each sediment 303(d) listed sub-watershed in the Kootenai-Fisher Project Area are provided in **Table 4-10**. Potential reductions in anthropogenic loading as a result of the application of BMPs range from 7% in Quartz Creek and Bristow Creek to 32% in Wolf Creek. The loading reductions listed in **Table 4-10** were calculated based on the erosion rates of streambanks predominately influenced by natural sources on the 303(d) listed water body segments, but additional reductions may also be possible from the tributaries to the listed water bodies.

Table 4-10. Sub-watershed Sediment Load Reductions with BMPs

Stream Segment	Existing Sediment Load			Reduced Sediment Load through BMPs			Potential Reduction in Total Sediment Load (Tons/Year)	Percent Reduction in Total Sediment Load
	Total Sub-watershed (Tons/Year)	Anthropogenic Sub-watershed Load (Tons/Year)	Natural Sub-watershed Load (Tons/Year)	Total Sub-watershed (Tons/Year)	Anthropogenic Sub-watershed Load (Tons/Year)	Natural Sub-watershed Load (Tons/Year)		
Bristow Creek	253.8	63.9	189.9	235.1	45.2	189.9	18.7	7%
Lake Creek	3,218.1	1822.9	1395.2	2730.7	1335.5	1395.2	487.4	15%
Libby Creek	4,938.3	4117.6	820.7	3498.1	2677.4	820.7	1440.2	29%
Quartz Creek	524.9	130.8	394.1	490.1	96.0	394.1	34.8	7%
Raven Creek	60.9	23.1	37.8	54.8	17.0	37.8	6.1	10%
Wolf Creek	5,659.2	4652.9	1006.3	3866.7	2860.4	1006.3	1792.5	32%
TOTAL	**14,655**	**10,811**	**3,844**	**10,876**	**7,032**	**3,844**	**3,780**	**26%**

5.0 Assumptions and Uncertainty

The Kootenai-Fisher sediment and habitat assessment assumes reaches with similar reach type characteristics will have similar physical attributes and sediment loads due to streambank erosion. Since only a portion of the streams within the Kootenai-Fisher Project Area were assessed in the field, a degree of uncertainty is unavoidable when extrapolating data from assessed reaches to un-assessed reaches. Although the accuracy of the GIS data may influence the length of each reach type, the largest potential sources of inaccuracy within the project are the small sample size per reach type, the near-stream land uses identified based on aerial images, and the retreat rates used for the extrapolation process. These are minimized by careful selection of representative monitoring sites and only using the near-stream land uses for informational purposes within the TMDL document. Since sediment source modeling may under-estimate or over-estimate sediment inputs due to selection of sediment monitoring sites and the extrapolation methods used, model results should not be taken as an absolutely accurate account of sediment production within each sub-watershed. Instead, the streambank erosion assessment model results should be considered an instrument for estimating existing streambank erosion sediment loads and making general comparisons of streambank erosion sediment loads from various sources.

6.0 Summary

The 2011 sediment and habitat assessment in the Kootenai-Fisher Project Area provides a comprehensive analysis of existing sediment conditions within impaired stream segments and estimated streambank erosion sediment loads for use in TMDL development. A total of 84 reaches were delineated during the aerial assessment reach stratification process covering 103.1 miles of stream. Based on the level III ecoregion, there were a total of 19 distinct reach types and sediment and habitat parameters were assessed at 15 monitoring sites. Statistical analysis of the sediment and habitat data from the 15 monitoring sites will aid in developing sediment TMDL targets that are specific for the Kootenai-Fisher Project Area, while streambank erosion data will be utilized in the sediment TMDL. Within the 15 monitoring sites, an average annual sediment load of 246 tons/year was attributed to the 96 assessed eroding streambanks and average annual sediment load of 8,908 tons/year was estimated for the listed stream segments. Out of the 877.6 miles of stream within the assessed sub-watersheds, a total sediment load of 14,655 tons per year was estimated at the sub-watershed scale. It is estimated that this sediment load can be reduced to 10,876 tons/year, which is a 26% reduction in sediment load from streambank erosion.

7.0 References

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Attachment A

Aerial Assessment Database

STREAM	REACH_ID	REACH	SUBREACH	REACH_TYPE	LENGTH_FT	PRI_ECOREG	SEC_ECOREG	STREAM_ORD	CONFINE	GRADIENT	HB_TRIGGER	SB_TRIGGER	LB_LANDUSE	LB_ANTHRO	LB_RP_VEG	LB_RP_HLTH	RB_LANDUSE	RB_ANTHRO	RB_RP_VEG	RB_RP_HLTH	ANTHRO_TRA	ANTHRO_GRA	ANTHRO_CRO	ANTHRO_MIN	ANTHRO_FOR	ANTHRO_IRR	ANTHRO_NAT	ANTHRO_OTH	ANTHRO_TOT
Bristow Creek	BRST 01-01	01	01	NR-4-2-C	6699	15l		2	C	4-10	Start		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Bristow Creek	BRST 02-01	02	1	NR-4-2-U	1184	15l		2	U	4-10	Confinement		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Bristow Creek	BRST 03-01	03	1	NR-4-3-U	9942	15l		3	U	4-10	Stream Order		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Bristow Creek	BRST 04-01	04	01	NR-2-3-U	1980	15l		3	U	2-<4	Gradient		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	0	0	0	0	70	0	30	0	100
Bristow Creek	BRST 04-02	04	02	NR-2-3-U	5050	15l		3	U	2-<4	Gradient	LULC	Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Bristow Creek	BRST 04-03	04	03	NR-2-3-U	4924	15l		3	U	2-<4	Gradient	LULC	Forest	Yes	Brush	Fair	Forest	Yes	Mature Coniferous	Fair	0	0	0	0	80	0	20	0	100
Bristow Creek	BRST 04-04	04	04	NR-2-3-U	1661	15l		3	U	2-<4	Gradient	LULC	Forest	Yes	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	10	0	90	0	100
Bristow Creek	BRST 05-01	05	1	NR-4-3-U	2344	15l		3	U	4-10	Gradient		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Lake Creek	LAKE 01-01	01	1	NR-0-3-U	8145	15q		3	U	<2	Stream Order		Rural Res./Hobby Farm	No	Brush	Good	Rural Res./Hobby Farm	No	Brush	Good	20	0	0	0	0	0	60	20	100
Lake Creek	LAKE 02-01	02	01	NR-0-4-U	18056	15q		4	U	<2	Tributary		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	10	0	0	0	0	0	70	20	100
Lake Creek	LAKE 02-02	02	02	NR-0-4-U	13006	15q		4	U	<2	Tributary	LULC	Range	Yes	Brush	Good	Forest	No	Brush	Good	0	0	0	0	0	0	50	50	100
Lake Creek	LAKE 03-01	03	01	NR-0-4-U	4515	15q		4	U	<2	Tributary		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Lake Creek	LAKE 03-02	03	02	NR-0-4-U	17510	15q		4	U	<2	Tributary	LULC	Rural Res./Hobby Farm	Yes	Mature Deciduous	Good	Rural Res./Hobby Farm	Yes	Brush	Good	20	0	0	0	0	0	20	60	100
Lake Creek	LAKE 03-03	03	03	NR-0-4-U	11402	15q		4	U	<2	Tributary	LULC	Forest	Yes	Mature Coniferous	Good	Hay/Pasture	Yes	Grass	Poor-Fair	10	20	0	0	20	10	10	30	100
Lake Creek	LAKE 04-01	04	1	NR-0-4-U	11526	15q		4	U	<2	Tributary		Forest	Yes	Mature Coniferous	Good	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair-Good	10	0	0	0	20	0	20	50	100
Lake Creek	LAKE 05-01	05	01	NR-0-4-U	3186	15q		4	U	<2	Impoundment		Forest	No	Mature Deciduous	Good	Urban	Yes	Brush	Fair	50	0	0	50	0	0	0	0	100
Lake Creek	LAKE 06-01	06	1	NR-2-4-C	941	15q		4	C	2-<4	Gradient, Confinement		Forest	No	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Poor	0	0	0	0	0	100	0	0	100
Lake Creek	LAKE 07-01	07	1	NR-2-4-U	2981	15q		4	U	2-<4	Confinement		Urban	Yes	Grass	Fair	Urban	Yes	Brush	Fair	50	0	0	0	0	0	0	50	100
Lake Creek	LAKE 08-01	08	1	NR-0-4-U	1501	15q		4	U	<2	Gradient		Urban	Yes	Grass	Fair	Forest	Yes	Brush	Fair	70	0	0	0	0	0	0	30	100
Libby Creek	LIBY 01-01	01	1	NR-2-2-U	5374	15l		2	U	2-<4	Start		Fores	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	80	0	0	0	0	0	20	0	100
Libby Creek	LIBY 02-01	02	01	NR-0-3-U	3489	15l		3	U	<2	Stream Order		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	0	100	100
Libby Creek	LIBY 02-02	02	02	NR-0-3-U	2065	15l		3	U	<2	Stream Order	LULC	Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Libby Creek	LIBY 03-01	03	01	NR-2-3-U	6032	15l		3	U	2-<4	Gradient		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	30	0	0	30	0	0	10	30	100
Libby Creek	LIBY 03-02	03	02	NR-2-3-U	8130	15l		3	U	2-<4	Gradient	Stream morphology	Forest	Yes	Mature Coniferous	Fair-Good	Forest	Yes	Mature Coniferous	Good	20	0	0	0	20	0	0	60	100
Libby Creek	LIBY 04-01	04	01	NR-0-3-U	2358	15l		3	U	<2	Gradient		Forest	No	Mature Coniferous	Fair-Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	0	100	100
Libby Creek	LIBY 05-01	05	01	NR-0-3-C	3106	15l		3	C	<2	Confinement		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	0	100	100
Libby Creek	LIBY 05-02	05	02	NR-0-3-C	5732	15l		3	C	<2	Confinement	Stream morphoplogy	Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	0	100	100
Libby Creek	LIBY 06-01	06	01	NR-0-3-U	1260	15l		3	U	<2	Tributary, Confinement		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	0	0	0	0	0	0	0	100	100
Libby Creek	LIBY 06-02	06	02	NR-0-3-U	7353	15l		3	U	<2	Tributary, Confinement	Stream morphology	Forest	Yes	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	40	0	0	60	100
Libby Creek	LIBY 07-01	07	01	NR-0-3-C	1931	15l		3	C	<2	Confinement		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	0	0	0	0	50	0	0	50	100
Libby Creek	LIBY 07-02	07	02	NR-0-3-C	4449	15l		3	C	<2	Confinement	LULC	Forest	Yes	Mature Coniferous	Good	Forest	yes	Mature Coniferous	Fair-Good	10	0	0	0	70	0	0	20	100
Libby Creek	LIBY 08-01	08	01	NR-0-3-U	4528	15l		3	U	<2	Confinement		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Fair-Good	20	0	0	0	80	0	0	0	100
Libby Creek	LIBY 08-02	08	02	NR-0-3-U	5162	15l		3	U	<2	Confinement	RD	Forest	Yes	Mature Deciduous	Good	Forest	Yes	Mature Deciduous	Good	30	0	0	0	0	0	0	70	100
Libby Creek	LIBY 09-01	09	01	NR-0-4-U	6475	15l		4	U	<2	Stream Order		Forest	No	Mature Deciduous	Good	Forest	Yes	Mature Deciduous	Fair	0	0	0	0	40	0	0	60	100
Libby Creek	LIBY 09-02	09	02	NR-0-4-U	6077	15l		4	U	<2	Stream Order	LULC	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair	0	10	0	0	0	0	0	90	100
Libby Creek	LIBY 09-03	09	03	NR-0-4-U	14582	15l		4	U	<2	Stream Order	LULC	Rural Res./Hobby Farm	Yes	Shrub	Fair	Rural Res./Hobby Farm	Yes	Mature Deciduous	Poor-Fair	20	10	0	0	0	0	0	70	100
Libby Creek	LIBY 09-04	09	04	NR-0-4-U	6708	15l		4	U	<2	Stream Order	LULC	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair-Good	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair-Good	10	0	0	0	20	0	0	70	100
Libby Creek	LIBY 09-05	09	05	NR-0-4-U	22803	15l		4	U	<2	Stream Order	LULC	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair	Rural Res./Hobby Farm	Yes	Mature Deciduous	Fair	20	10	0	0	0	0	0	70	100
Libby Creek	LIBY 09-06	09	06	NR-0-4-U	7814	15l		4	U	<2	Stream Order	LULC	Forest	Yes	Mature Deciduous	Fair	Forest	Yes	Mature Deciduous	Fair-Good	10	10	0	0	0	0	0	80	100
Libby Creek	LIBY 10-01	10	01	NR-0-5-U	12029	15l		5	U	<2	Stream Order		Urban	Yes	Shrub	Poor	Forest	Yes	Shrub	Poor	20	0	0	0	0	0	0	80	100
Quartz Creek	QRTZ 01-01	01	1	NR-2-1-U	2412	15q		1	U	2-<4	Start		Forest	Yes	Brush	Good	Forest	Yes	Brush	Good	10	0	0	0	0	0	90	0	100
Quartz Creek	QRTZ 02-01	02	1	NR-2-1-C	2226	15q		1	C	2-<4	Start		Forest	Yes	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	30	0	0	0	0	0	70	0	100
Quartz Creek	QRTZ 03-01	03	1	NR-2-2-C	10466	15q		2	C	2-<4	Stream Order		Forest	Yes	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	30	0	0	0	0	0	70	0	100
Quartz Creek	QRTZ 04-01	04	1	NR-4-2-U	3758	15q		2	U	4-10	Gradient, Confinement		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Quartz Creek	QRTZ 05-01	05	1	NR-2-2-U	15428	15q		2	U	2-<4	GRADIENT		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Quartz Creek	QRTZ 06-01	06	1	NR-4-2-U	1180	15q		2	U	4-10	GRADIENT		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Quartz Creek	QRTZ 07-01	07	1	NR-4-2-C	5031	15q		2	C	4-10	Confinement		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Quartz Creek	QRTZ 08-01	08	1	NR-2-3-C	925	15q		3	C	2-<4	Stream Order		Forest	Yes	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	50	0	50	0	100
Quartz Creek	QRTZ 09-01	09	01	NR-2-3-U	11271	15q		3	U	2-<4	Confinement		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Quartz Creek	QRTZ 09-02	09	02	NR-2-3-U	3666	15q		3	U	2-<4	Confinement	LULC	Rural Res./Hobby Farm	Yes	Mature Deciduous	Good	Forest	No	Mature Coniferous	Good	20	0	0	0	0	0	0	80	100
Quartz Creek	QRTZ 10-01	10	1	NR-0-3-U	3042	15q		3	U	<2	Gradient		Rural Res./Hobby Farm	No	Mature Coniferous	Good	Forest	No	Mature Deciduous	Good	10	0	0	0	0	0	90	0	100

STREAM	REACH_ID	REACH	SUBREACH	REACH_TYPE	LENGTH_FT	PRI_ECOREG	SEC_ECOREG	STREAM_ORD	CONFINE	GRADIENT	HB_TRIGGER	SB_TRIGGER	LB_LANDUSE	LB_ANTHRO	LB_RP_VEG	LB_RP_HLTH	RB_LANDUSE	RB_ANTHRO	RB_RP_VEG	RB_RP_HLTH	ANTHRO_TRA	ANTHRO_GRA	ANTHRO_CRO	ANTHRO_MIN	ANTHRO_FOR	ANTHRO_IRR	ANTHRO_NAT	ANTHRO_OTH	ANTHRO_TOT
Raven Creek	RAVN 01-01	01	01	NR-10-1-U	471	15l		1	U	>10	START		Forest	Yes	Mature Coniferous	Fair	Forest	Yes	Mature Coniferous	Fair	0	0	0	0	100	0	0	0	100
Raven Creek	RAVN 01-02	01	02	NR-10-1-U	108	15l		1	U	>10		ROAD	Forest	Yes	Grass	Poor	Forest	Yes	Grass	Poor	100	0	0	0	0	0	0	0	100
Raven Creek	RAVN 02-01	02	1	NR-10-1-C	2667	15l		1	C	>10	CONFINEMENT		Forest	Yes	Grass	Fair	Forest	Yes	Mature Coniferous	Fair	0	0	0	0	100	0	0	0	100
Raven Creek	RAVN 03-01	03	1	NR-10-1-U	2456	15l		1	U	>10	Confinement		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	0	0	0	0	100	0	0	0	100
Raven Creek	RAVN 04-01	04	1	NR-4-1-U	4479	15l		1	U	4-10	Gradient		Forest	Yes	Grass	Fair	Forest	Yes	Grass	Fair	0	0	0	0	100	0	0	0	100
Raven Creek	RAVN 05-01	05	1	NR-4-2-U	2772	15l		2	U	4-10	Stream Order		Forest	Yes	Mature Deciduous	Good	Forest	Yes	Mature Deciduous	Good	0	0	0	0	100	0	0	0	100
Raven Creek	RAVN 06-01	06	01	NR-2-2-U	616	15l		2	U	2-<4	Gradient		Range	Yes	Mature Deciduous	Good	Range	Yes	Mature Deciduous	Good	50	0	0	0	0	0	50	0	100
Wolf Creek	WOLF 01-01	01	1	NR-2-1-U	2271	15l		1	U	2-<4	Start		Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Wolf Creek	WOLF 02-01	02	01	NR-2-2-U	1519	15l		2	U	2-<4	Stream Order		Forest	No	Mature Coniferous	Good	Forest	No	Brush	Good	0	0	0	0	0	0	100	0	100
Wolf Creek	WOLF 02-02	02	02	NR-2-2-U	948	15l		2	U	2-<4	Stream Order	LULC	Forest	No	Grass	Good	Forest	No	Grass	Good	0	0	0	0	0	0	100	0	100
Wolf Creek	WOLF 02-03	02	03	NR-2-2-U	1000	15l		2	U	2-<4	Stream Order	LULC	Forest	No	Mature Coniferous	Good	Forest	No	Mature Coniferous	Good	0	0	0	0	0	0	100	0	100
Wolf Creek	WOLF 03-01	03	1	NR-10-2-C	391	15l		2	C	>10	Gradient		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Good	100	0	0	0	0	0	0	0	100
Wolf Creek	WOLF 04-01	04	1	NR-2-2-U	1476	15l		2	U	2-<4	Gradient		Forest	No	Brush	Good	Forest	No	Brush	Good	0	0	0	0	0	0	100	0	100
Wolf Creek	WOLF 05-01	05	01	NR-0-3-U	14509	15l		3	U	<2	Stream Order		Forest	Yes	Brush	Good	Forest	No	Brush	Good	10	0	0	0	0	0	90	0	100
Wolf Creek	WOLF 05-02	05	02	NR-0-3-U	11032	15l		3	U	<2	Stream Order	RD	Forest	Yes	Brush	Good	Forest	Yes	Brush	Good	80	0	0	0	20	0	0	0	100
Wolf Creek	WOLF 05-03	05	03	NR-0-3-U	5069	15l		3	U	<2	Stream Order	RD	Forest	Yes	Brush	Good	Forest	Yes	Brush	good	50	0	0	0	50	0	0	0	100
Wolf Creek	WOLF 06-01	06	1	NR-2-3-U	6203	15l		3	U	2-<4	Gradient		Forest	Yes	Mature Coniferous	Good	Forest	Yes	Mature Coniferous	Fair	0	0	0	0	100	0	0	0	100
Wolf Creek	WOLF 07-01	07	1	NR-2-4-U	2188	15l		4	U	2-<4	Stream Order		Forest	Yes	Brush	Good	Forest	Yes	Brush	Fair	20	10	0	0	10	0	60	0	100
Wolf Creek	WOLF 08-01	08	01	NR-0-4-U	3318	15l		4	U	<2	Gradient		Forest	Yes	Grass	Good	Forest	Yes	Grass	Fair	10	0	0	0	20	0	70	0	100
Wolf Creek	WOLF 08-02	08	02	NR-0-4-U	6926	15l		4	U	<2	Gradient	LULC	Forest	Yes	Brush	Good	Forest	Yes	Brush	Fair	20	0	0	0	70	0	10	0	100
Wolf Creek	WOLF 08-03	08	03	NR-0-4-U	14108	15l		4	U	<2	Gradient	LULC	Forest	Yes	Brush	Good	Forest	Yes	Brush	Fair	10	0	0	0	90	0	0	0	100
Wolf Creek	WOLF 08-04	08	04	NR-0-4-U	9140	15l		4	U	<2	Gradient	LULC	Forest	Yes	Grass	Good	Forest	Yes	Grass	Fair	10	0	0	0	70	0	20	0	100
Wolf Creek	WOLF 08-05	08	05	NR-0-4-U	4941	15l		4	U	<2	Gradient	LULC	Forest	Yes	Grass	Good	Range	Yes	Grass	Fair	20	40	0	0	30	0	10	0	100
Wolf Creek	WOLF 09-01	09	01	NR-0-4-U	2666	15l		4	U	<2	Tributary	LULC	Range	No	Brush	Good	Forest	No	Brush	Good	0	50	0	0	20	0	30	0	100
Wolf Creek	WOLF 09-02	09	02	NR-0-4-U	25937	15l		4	U	<2	Tributary	LULC	Range	Yes	Brush	Good	Range	Yes	Brush	Good	20	10	0	0	0	10	60	0	100
Wolf Creek	WOLF 10-01	10	01	NR-0-4-U	7326	15l		4	U	<2	Tributary		Range	Yes	Brush	Fair	Range	Yes	Brush	Fair	30	10	0	0	0	0	30	30	100
Wolf Creek	WOLF 10-02	10	02	NR-0-4-U	11468	15l		4	U	<2	Tributary	RD	Forest	Yes	Brush	Fair	Forest	Brush	Yes	Fair	100	0	0	0	0	0	0	0	100
Wolf Creek	WOLF 10-03	10	03	NR-0-4-U	4146	15l		4	U	<2	Tributary	RD	Forest	Yes	Brush	Fair	Forest	Yes	Brush	Fair	50	0	0	0	0	0	50	0	100
Wolf Creek	WOLF 10-04	10	04	NR-0-4-U	12540	15l		4	U	<2	Tributary	RD	Forest	Yes	Brush	Fair	Forest	Yes	Brush	Fair	60	0	0	0	0	0	40	0	100
Wolf Creek	WOLF 11-01	11	01	NR-0-4-U	41193	15l		4	U	<2	Tributary		Forest	Yes	Brush	Fair	Forest	Yes	Brush	Fair	50	0	0	0	50	0	0	0	100
Wolf Creek	WOLF 11-02	11	02	NR-0-4-U	5909	15l		4	U	<2	Tributary	LULC	Forest	No	Mature Deciduous	Good	Forest	Yes	Brush	Fair	70	0	0	0	0	0	30	0	100
Wolf Creek	WOLF 11-03	11	03	NR-0-4-U	7875	15l		4	U	<2	Tributary	RD, LULC	Forest	Yes	Brush	Fair	Forest	Yes	Brush	Fair	40	0	0	0	60	0	0	0	100
Wolf Creek	WOLF 11-04	11	04	NR-0-4-U	3205	15l		4	U	<2	Tributary	RD, LULC	Forest	No	Brush	Fair	Forest	Yes	Brush	Fair	30	0	0	0	70	0	0	0	100

Attachment B

Sediment and Habitat Database

Reach ID	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Cross-Sectional Area	Bankfull Mean Depth	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
WOLF09-02	8/22/11	1	NR-0-4-U	B4c	C4	1.1	0.6	<2%	35.1	50.1	1.43	24.6	2.4	77.1	2.2	33	17	18	5		11	1.5	18	6	54	40	0	0	14	200	51
WOLF09-02	8/22/11	2	NR-0-4-U					<2%																							
WOLF09-02	8/22/11	3	NR-0-4-U	B4c	C4	1.1	0.6	<2%	24.3	32.8	1.35	18.0	2.2	37.3	1.5	33	15	15	5												
WOLF09-02	8/22/11	4	NR-0-4-U					<2%																							
WOLF09-02	8/22/11	5	NR-0-4-U					<2%																							
RAVN06-01	8/22/11	1	NR-4-2-U	B4a	B4	1.3	4.5	4-<10%	5.7	4.5	0.79	7.2	1.0	9.5	1.7	18	0	7	20		40	0.7	62	28	154						
RAVN06-01	8/22/11	2	NR-4-2-U	C4a	B4	1.3	4.5	4-<10%	10.7	6.5	0.60	17.8	1.0	27.7	2.6	14	1	20	5												
RAVN06-01	8/22/11	3	NR-4-2-U	C4a	B4	1.3	4.5	4-<10%	5.5	6.1	1.11	5.0	1.6	30.5	5.5	32	2	7	1												
RAVN06-01	8/22/11	4	NR-4-2-U	C4a	B4	1.3	4.5	4-<10%	5.4	4.7	0.87	6.2	1.2	14.4	2.7	33	1	6	3												
RAVN06-01	8/22/11	5	NR-4-2-U					4-<10%																							
RAVN07-01	8/22/11	1	NR-2-2-U					2-<4%													12	0.6	62	0	86	64	0	0	18	200	200
RAVN07-01	8/22/11	2	NR-2-2-U					2-<4%																							
RAVN07-01	8/22/11	3	NR-2-2-U	E4	E4	1.6	0.2	2-<4%	5.8	4.5	0.78	7.4	1.3	39.8	6.9	9	17	42	8												
RAVN07-01	8/22/11	4	NR-2-2-U	E4	E4	1.6	0.2	2-<4%	3.5	2.7	0.78	4.5	1.7	153.5	43.9	3	44	65	61												
RAVN07-01	8/22/11	5	NR-2-2-U	E4	E4	1.6	0.2	2-<4%	6.3	7.3	1.15	5.5	1.8	43.3	6.9	30	7	14	8												
WOLF11-03	8/23/11	1	NR-0-4-U	F3	C3	1.4	1.2	<2%	36.4	49.6	1.36	26.7	2.4	43.4	1.2	128	5	6	0		4	1.6	10	4	23	89	0	7	23	85	139
WOLF11-03	8/23/11	2	NR-0-4-U	F3	C3	1.4	1.2	<2%	53.8	68.7	1.28	42.1	1.9	67.3	1.3	118	6	6	1												
WOLF11-03	8/23/11	3	NR-0-4-U	F3	C3	1.4	1.2	<2%	45.2	75.1	1.66	27.2	2.6	58.2	1.3	111	3	5	0												
WOLF11-03	8/23/11	4	NR-0-4-U					<2%																							
WOLF11-03	8/23/11	5	NR-0-4-U					<2%																							
BRST04-02	8/23/11	1	NR-2-3-U	C3b	B3	1.2	3.4	2-<4%	22.5	28.5	1.27	17.8	2.0	102.5	4.6	93	12	15	7	58	23	0.8	29	7	71						
BRST04-02	8/23/11	2	NR-2-3-U					2-<4%																							
BRST04-02	8/23/11	3	NR-2-3-U	B3	B3	1.2	3.4	2-<4%	23.5	28.8	1.23	19.2	2.3	42.5	1.8	75	10	10	3												
BRST04-02	8/23/11	4	NR-2-3-U					2-<4%																							
BRST04-02	8/23/11	5	NR-2-3-U	C3b	B3	1.2	3.4	2-<4%	23.2	28.9	1.25	18.6	2.3	68.2	2.9	97	0	0	0												
BRST04-04	8/23/11	1	NR-2-3-U	B3a	B3	1.1	4.7	2-<4%	19.4	24.9	1.28	15.1	2.2	27.4	1.4	114	5	5	1	50	29	0.9	31	6	65						
BRST04-04	8/23/11	2	NR-2-3-U	C3a	B3	1.1	4.7	2-<4%	21.2	34.0	1.61	13.2	2.2	48.2	2.3	88	1	3	1												
BRST04-04	8/23/11	3	NR-2-3-U					2-<4%																							
BRST04-04	8/23/11	4	NR-2-3-U					2-<4%																							
BRST04-04	8/23/11	5	NR-2-3-U	B3a	B3	1.1	4.7	2-<4%	23.8	30.0	1.26	18.9	2.2	51.3	2.2	72	0	1	1												

Reach ID	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Cross-Sectional Area	Bankfull Mean Depth	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Number of Pools per 1000 Feet	Mean Residual Pool Depth	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
LIBY09-03	8/24/11	1	NR-0-4-U	C3/4	C3/4			<2%								64	6	7	8	95	3	2.5	29	6	58	23	5	9	37	97	102
LIBY09-03	8/24/11	2	NR-0-4-U	C3	C3/4			<2%								75	4	4	10												
LIBY09-03	8/24/11	3	NR-0-4-U					<2%																							
LIBY09-03	8/24/11	4	NR-0-4-U	C4	C3/4	1.1	1.0	<2%	90.9	172.7	1.90	47.8	2.7	230.9	2.5	55	15	15	10	90											
LIBY09-03	8/24/11	5	NR-0-4-U	B3c	C3/4	1.1	1.0	<2%	74.1	157.1	2.12	35.0	3.4	100.1	1.4	75	2	4	0												
LIBY09-05	8/24/11	1	NR-0-4-U	C4	C4	1.1	0.5	<2%	86.1	176.8	2.05	41.9	3.1	206.1	2.4	44	12	13	9	97	6	2.3	26	8	78	33	5	0	41	148	115
LIBY09-05	8/24/11	2	NR-0-4-U	F4	C4	1.1	0.5	<2%	78.1	147.6	1.89	41.3	2.7	101.1	1.3	48	4	9	10												
LIBY09-05	8/24/11	3	NR-0-4-U	C4	C4	1.1	0.5	<2%	151.0	293.2	1.94	77.8	3.6	451.0	>3.0	57	9	11	7												
LIBY09-05	8/24/11	4	NR-0-4-U					<2%																							
LIBY09-05	8/24/11	5	NR-0-4-U	C4	C4	1.1	0.5	<2%	56.8	143.9	2.53	22.4	3.5	496.8	8.7	50	2	5	1												
GRNT13-01	8/24/11	1	NR-0-3-U	B3	B3	1.2	0-2%	<2%								125	2	2	0		13	1.7	43	10	103						
GRNT13-01	8/24/11	2	NR-0-3-U	B3	B3	1.2	0-2%	<2%								116	6	7	3												
GRNT13-01	8/24/11	3	NR-0-3-U	B3	B3	1.2	0-2%	<2%								117	7	10	3												
GRNT13-01	8/24/11	4	NR-0-3-U	B3	B3	1.2	0-2%	<2%								90	3	3	1												
QRTZ03-01	8/25/11	1	NR-2-2-C	C4	B4c		1.6	2-<4%	20.3	24.4	1.20	16.9	1.7	48.0	2.4	33	13	24	5		17	1.4	28	15	91	49	1	0	56	200	169
QRTZ03-01	8/25/11	2	NR-2-2-C	B4c	B4c		1.6	2-<4%	16.9	19.2	1.14	14.8	1.8	35.9	2.1	48	7	14	2												
QRTZ03-01	8/25/11	3	NR-2-2-C	B4c	B4c		1.6	2-<4%	18.1	17.4	0.96	18.8	1.8	26.1	1.4	34	4	8	3												
QRTZ03-01	8/25/11	4	NR-2-2-C					2-<4%																							
QRTZ03-01	8/25/11	5	NR-2-2-C	C4	B4c		1.6	2-<4%	19.4	19.9	1.03	18.9	1.5	44.9	2.3	55	7	7													
QRTZ10-01	8/25/11	1	NR-0-3-U	B3	B3	1.1	2.3	<2%	39.7	56.7	1.43	27.8	2.1	64.7	1.6	78	9	13	3		5	1.5	19	8	64	49	8	0	53	200	96
QRTZ10-01	8/25/11	2	NR-0-3-U	F3	B3	1.1	2.3	<2%	39.1	60.6	1.55	25.2	2.0	52.1	1.3	83	6	11	3												
QRTZ10-01	8/25/11	3	NR-0-3-U	B3	B3	1.1	2.3	<2%	35.8	51.6	1.44	24.9	2.2	52.8	1.5	92	0	1	7												
QRTZ10-01	8/25/11	4	NR-0-3-U	B3	B3	1.1	2.3	<2%	39.2	58.8	1.50	26.1	2.2	56.2	1.4	74	0	3	1												
QRTZ10-01	8/25/11	5	NR-0-3-U					<2%																							
LAKE03-03	8/26/11	1	NR-0-4-U	C4	C4	1.4	0.2	<2%	70.0	239.9	3.43	20.4	4.7	470.0	6.7	62	1	1	10	94	3	7.0	12	7	75	35	0	8	5	72	156
LAKE03-03	8/26/11	2	NR-0-4-U	C4	C4			<2%								42	10	10	12												
LAKE03-03	8/26/11	3	NR-0-4-U					<2%																							
LAKE03-03	8/26/11	4	NR-0-4-U	C4	C4	1.4	0.2	<2%	141.4	354.2	2.50	56.5	4.3	351.4	>2.5	59	4	4	1	96											
LAKE03-03	8/26/11	5	NR-0-4-U	C4	C4	1.4	0.2	<2%	87.0	311.7	3.58	24.3	4.4	487.0	5.6																
LAKE02-01	8/26/11	1	NR-0-4-U	C4	C4	2.3	0.9	<2%	71.7	174.5	2.43	29.5	3.0	331.7	4.6	49	5	6	7		3	3.9	24	5	75	68	1	0	14	134	198
LAKE02-01	8/26/11	2	NR-0-4-U					<2%																							
LAKE02-01	8/26/11	3	NR-0-4-U	C3	C4	2.3	0.9	<2%	63.7	141.8	2.23	28.6	3.0	159.7	2.5	67	5	9	1												
LAKE02-01	8/26/11	4	NR-0-4-U	C3	C4			<2%								82	5	16	3												
LAKE02-01	8/26/11	5	NR-0-4-U	B3c	C4	2.3	0.9	<2%	68.0	170.3	2.51	27.1	3.3	118.0	1.7	118	1	2	1												

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
WOLF09-02	NR-0-4-U	1	0.8	Y	25
WOLF09-02	NR-0-4-U	2	1.5	Y	7
WOLF09-02	NR-0-4-U	3	1.5	Y	8
WOLF09-02	NR-0-4-U	4	1.3	Y	5
WOLF09-02	NR-0-4-U	5	0.9		
WOLF09-02	NR-0-4-U	6	1.2		
WOLF09-02	NR-0-4-U	7	2.5	Y	12
WOLF09-02	NR-0-4-U	8	0.6	Y	7
WOLF09-02	NR-0-4-U	9	2.3	Y	14
WOLF09-02	NR-0-4-U	10	2.3	Y	13
WOLF09-02	NR-0-4-U	11	1.9	Y	6
RAVN06-01	NR-4-2-U	1	0.3	Y	5
RAVN06-01	NR-4-2-U	2	0.6		
RAVN06-01	NR-4-2-U	3	0.8	Y	5
RAVN06-01	NR-4-2-U	4			
RAVN06-01	NR-4-2-U	5			
RAVN06-01	NR-4-2-U	6	0.7	Y	5
RAVN06-01	NR-4-2-U	7	1.2	Y	7
RAVN06-01	NR-4-2-U	8	1.0	Y	9
RAVN06-01	NR-4-2-U	9	0.9	Y	7
RAVN06-01	NR-4-2-U	10	0.6		
RAVN06-01	NR-4-2-U	11	0.7	Y	1
RAVN06-01	NR-4-2-U	12	0.9		
RAVN06-01	NR-4-2-U	13	0.8		
RAVN06-01	NR-4-2-U	14			
RAVN06-01	NR-4-2-U	15	0.5		
RAVN06-01	NR-4-2-U	16	0.5		
RAVN06-01	NR-4-2-U	17	0.5		
RAVN06-01	NR-4-2-U	18	1.1		
RAVN06-01	NR-4-2-U	19			
RAVN06-01	NR-4-2-U	20	0.4		
RAVN07-01	NR-2-2-U	1			
RAVN07-01	NR-2-2-U	2	0.4		
RAVN07-01	NR-2-2-U	3	0.9		
RAVN07-01	NR-2-2-U	4	0.9		
RAVN07-01	NR-2-2-U	5	0.4	Y	23
RAVN07-01	NR-2-2-U	6	0.4	Y	25
WOLF11-03	NR-0-4-U	1	2.3		
WOLF11-03	NR-0-4-U	2	1.3		
WOLF11-03	NR-0-4-U	3	1.1		
WOLF11-03	NR-0-4-U	4	1.8		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
BRST04-02	NR-2-3-U	1	0.7		
BRST04-02	NR-2-3-U	2	0.8		
BRST04-02	NR-2-3-U	3	0.7		
BRST04-02	NR-2-3-U	4	0.5		
BRST04-02	NR-2-3-U	5	0.3		
BRST04-02	NR-2-3-U	6	0.8		
BRST04-02	NR-2-3-U	7	0.6		
BRST04-02	NR-2-3-U	8	1.1	Y	2
BRST04-02	NR-2-3-U	9	0.7		
BRST04-02	NR-2-3-U	10	1.4		
BRST04-02	NR-2-3-U	11	1.4		
BRST04-02	NR-2-3-U	12	1.1		
BRST04-02	NR-2-3-U	13	0.8		
BRST04-02	NR-2-3-U	14	0.7		
BRST04-02	NR-2-3-U	15	0.8		
BRST04-02	NR-2-3-U	16	0.5		
BRST04-02	NR-2-3-U	17	0.8		
BRST04-02	NR-2-3-U	18	0.5		
BRST04-02	NR-2-3-U	19	1.1		
BRST04-02	NR-2-3-U	20	1.7		
BRST04-02	NR-2-3-U	21	1.0		
BRST04-02	NR-2-3-U	22	0.6		
BRST04-02	NR-2-3-U	23	0.6		
BRST04-04	NR-2-3-U	1	0.5		
BRST04-04	NR-2-3-U	2	0.8		
BRST04-04	NR-2-3-U	3	0.8		
BRST04-04	NR-2-3-U	4	1.1		
BRST04-04	NR-2-3-U	5	1.0		
BRST04-04	NR-2-3-U	6	1.0		
BRST04-04	NR-2-3-U	7	0.6		
BRST04-04	NR-2-3-U	8	1.1		
BRST04-04	NR-2-3-U	9	0.9		
BRST04-04	NR-2-3-U	10	1.7		
BRST04-04	NR-2-3-U	11	0.5		
BRST04-04	NR-2-3-U	12	0.8		
BRST04-04	NR-2-3-U	13	0.5		
BRST04-04	NR-2-3-U	14	0.4		
BRST04-04	NR-2-3-U	15	0.9		
BRST04-04	NR-2-3-U	16	0.8		
BRST04-04	NR-2-3-U	17	0.8		
BRST04-04	NR-2-3-U	18	1.0		
BRST04-04	NR-2-3-U	19	0.4		
BRST04-04	NR-2-3-U	20	0.9		
BRST04-04	NR-2-3-U	21	1.8		
BRST04-04	NR-2-3-U	22	0.4		
BRST04-04	NR-2-3-U	23	0.4		
BRST04-04	NR-2-3-U	24	1.1		
BRST04-04	NR-2-3-U	25	1.0		
BRST04-04	NR-2-3-U	26	1.3	Y	10
BRST04-04	NR-2-3-U	27	0.6		
BRST04-04	NR-2-3-U	28	1.2		
BRST04-04	NR-2-3-U	29	1.1		

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
LIBY09-03	NR-0-4-U	1	3.2	Y	6
LIBY09-03	NR-0-4-U	2	2.2	Y	5
LIBY09-03	NR-0-4-U	3	3.1	Y	14
LIBY09-03	NR-0-4-U	4	2.3	Y	3
LIBY09-03	NR-0-4-U	5	1.9	Y	13
LIBY09-05	NR-0-4-U	1	2.5	Y	7
LIBY09-05	NR-0-4-U	2	1.8	Y	7
LIBY09-05	NR-0-4-U	3	3.7	Y	1
LIBY09-05	NR-0-4-U	4	3.1	Y	4
LIBY09-05	NR-0-4-U	5	3.1	Y	7
LIBY09-05	NR-0-4-U	6	2.9	Y	3
LIBY09-05	NR-0-4-U	7	0.8	Y	4
LIBY09-05	NR-0-4-U	8	1.4	Y	3
LIBY09-05	NR-0-4-U	9	3.0	Y	14
LIBY09-05	NR-0-4-U	10	1.0		
LIBY09-05	NR-0-4-U	11	2.2		
GRNT13-01	NR-0-3-U	1	1.8		
GRNT13-01	NR-0-3-U	2	1.4		
GRNT13-01	NR-0-3-U	3	1.4		
GRNT13-01	NR-0-3-U	4	1.6		
GRNT13-01	NR-0-3-U	5	0.9		
GRNT13-01	NR-0-3-U	6	1.2		
GRNT13-01	NR-0-3-U	7	1.3		
GRNT13-01	NR-0-3-U	8	3.2		
GRNT13-01	NR-0-3-U	9			
GRNT13-01	NR-0-3-U	10	2.1		
QRTZ03-01	NR-2-2-C	1	0.6	Y	1
QRTZ03-01	NR-2-2-C	2	3.1	Y	2
QRTZ03-01	NR-2-2-C	3			
QRTZ03-01	NR-2-2-C	4	1.0	Y	5
QRTZ03-01	NR-2-2-C	5	1.9	Y	3
QRTZ03-01	NR-2-2-C	6	0.8	Y	10
QRTZ03-01	NR-2-2-C	7		Y	9
QRTZ03-01	NR-2-2-C	8	1.1	Y	6
QRTZ03-01	NR-2-2-C	9	1.4	Y	0
QRTZ03-01	NR-2-2-C	10	1.0	Y	3
QRTZ03-01	NR-2-2-C	11	2.3	Y	7
QRTZ03-01	NR-2-2-C	12	1.1	Y	3
QRTZ03-01	NR-2-2-C	13	1.5	Y	3
QRTZ03-01	NR-2-2-C	14	1.7	Y	1
QRTZ03-01	NR-2-2-C	15	1.7	Y	5
QRTZ03-01	NR-2-2-C	16	0.9	Y	6
QRTZ03-01	NR-2-2-C	17	0.7		
QRTZ10-01	NR-0-3-U	1	1.1	Y	5
QRTZ10-01	NR-0-3-U	2	1.0		
QRTZ10-01	NR-0-3-U	3	1.5	Y	3
QRTZ10-01	NR-0-3-U	4	0.8		
QRTZ10-01	NR-0-3-U	5	2.9	Y	0

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Spawning Gravels Identified	Pool Tail-out Fines (%)
LAKE03-03	NR-0-4-U	1	8.8	Y	9
LAKE03-03	NR-0-4-U	2	7.0	Y	14
LAKE03-03	NR-0-4-U	3	6.3	Y	16
LAKE03-03	NR-0-4-U	4	6.8		
LAKE03-03	NR-0-4-U	5	6.2	Y	5
LAKE02-01	NR-0-4-U	1	5.3		
LAKE02-01	NR-0-4-U	2	2.3		
LAKE02-01	NR-0-4-U	3	4.0	Y	0

Attachment C

Streambank Erosion Sediment Loads

Stream Segment	Reach ID	Reach Type	Sediment Load per 1000 Feet (Tons/Year)	Length (Feet)	Reach Sediment Load (Tons/Year)	Transportation (Percent)	Grazing (Percent)	Cropland (Percent)	Mining (Percent)	Silviculture (Percent)	Irrigation (Percent)	Natural (Percent)	Other (Percent)	Transportation (Tons/Year)	Grazing (Tons/Year)	Cropland (Tons/Year)	Mining (Tons/Year)	Silviculture (Tons/Year)	Irrigation (Tons/Year)	Natural (Tons/Year)	Other (Tons/Year)
Bristow Creek	BRST 01-01	NR-4-2-C	2.81	6699	18.8	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	0.0
Bristow Creek	BRST 02-01	NR-4-2-U	2.81	1184	3.3	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
Bristow Creek	BRST 03-01	NR-4-3-U	2.81	9942	27.9	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	27.9	0.0
Bristow Creek	BRST 04-01	NR-2-3-U	6.32	1980	12.5	0	0	0	0	70	0	30	0	0.0	0.0	0.0	0.0	8.8	0.0	3.8	0.0
Bristow Creek	**BRST 04-02**	**NR-2-3-U**	**5.82**	**5050**	**29.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**29.4**	**0.0**
Bristow Creek	BRST 04-03	NR-2-3-U	6.32	4924	31.1	0	0	0	0	80	0	20	0	0.0	0.0	0.0	0.0	24.9	0.0	6.2	0.0
Bristow Creek	**BRST 04-04**	**NR-2-3-U**	**2.34**	**1661**	**3.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**3.9**	**0.0**
Bristow Creek	BRST 05-01	NR-4-3-U	2.81	2344	6.6	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0
Bristow Creek			**TOTAL**	**33783**	**133.6**								**TOTAL**	**0.0**	**0.0**	**0.0**	**0.0**	**33.7**	**0.0**	**99.9**	**0.0**
Bristow Creek													**PERCENT**	**0.00**	**0.00**	**0.00**	**0.00**	**0.25**	**0.00**	**0.75**	**0.00**
Lake Creek	LAKE 01-01	NR-0-3-U	22.00	8145	179.2	20	0	0	0	0	0	60	20	35.8	0.0	0.0	0.0	0.0	0.0	107.5	35.8
Lake Creek	**LAKE 02-01**	**NR-0-4-U**	**5.48**	**18056**	**98.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**76.2**	**23.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**75.4**	**23.5**
Lake Creek	LAKE 02-02	NR-0-4-U	22.00	13006	286.1	0	0	0	0	0	0	50	50	0.0	0.0	0.0	0.0	0.0	0.0	143.1	143.1
Lake Creek	LAKE 03-01	NR-0-4-U	9.42	4515	42.5	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	42.5	0.0
Lake Creek	LAKE 03-02	NR-0-4-U	22.00	17510	385.2	20	0	0	0	0	0	20	60	77.0	0.0	0.0	0.0	0.0	0.0	77.0	231.1
Lake Creek	**LAKE 03-03**	**NR-0-4-U**	**22.14**	**11402**	**252.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**82.6**	**17.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**208.6**	**43.8**
Lake Creek	LAKE 04-01	NR-0-4-U	22.00	11526	253.6	10	0	0	0	20	0	20	50	25.4	0.0	0.0	0.0	50.7	0.0	50.7	126.8
Lake Creek	LAKE 05-01	NR-0-4-U	22.00	3186	70.1	50	0	0	50	0	0	0	0	35.0	0.0	0.0	35.0	0.0	0.0	0.0	0.0
Lake Creek	LAKE 06-01	NR-2-4-C	6.32	941	5.9	0	0	0	0	0	100	0	0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0
Lake Creek	LAKE 07-01	NR-2-4-U	6.32	2981	18.8	50	0	0	0	0	0	0	50	9.4	0.0	0.0	0.0	0.0	0.0	0.0	9.4
Lake Creek	LAKE 08-01	NR-0-4-U	22.00	1501	33.0	70	0	0	0	0	0	0	30	23.1	0.0	0.0	0.0	0.0	0.0	0.0	9.9
Lake Creek			**TOTAL**	**92768**	**1625.9**								**TOTAL**	**205.8**	**0.0**	**0.0**	**35.0**	**50.7**	**5.9**	**704.9**	**623.5**
Lake Creek													**PERCENT**	**0.13**	**0.00**	**0.00**	**0.02**	**0.03**	**0.00**	**0.43**	**0.38**
Libby Creek	LIBY 01-01	NR-2-2-U	6.32	5374	34.0	80	0	0	0	0	0	20	0	27.2	0.0	0.0	0.0	0.0	0.0	6.8	0.0
Libby Creek	LIBY 02-01	NR-0-3-U	22.00	3489	76.7	0	0	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.7
Libby Creek	LIBY 02-02	NR-0-3-U	9.42	2065	19.5	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	0.0
Libby Creek	LIBY 03-01	NR-2-3-U	6.32	6032	38.1	30	0	0	30	0	0	10	30	11.4	0.0	0.0	11.4	0.0	0.0	3.8	11.4
Libby Creek	LIBY 03-02	NR-2-3-U	6.32	8130	51.4	20	0	0	0	20	0	0	60	10.3	0.0	0.0	0.0	10.3	0.0	0.0	30.8
Libby Creek	LIBY 04-01	NR-0-3-U	22.00	2358	51.9	0	0	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.9
Libby Creek	LIBY 05-01	NR-0-3-C	22.00	3106	68.3	0	0	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.3
Libby Creek	LIBY 05-02	NR-0-3-C	22.00	5732	126.1	0	0	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	126.1
Libby Creek	LIBY 06-01	NR-0-3-U	22.00	1260	27.7	0	0	0	0	0	0	0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.7
Libby Creek	LIBY 06-02	NR-0-3-U	22.00	7353	161.8	0	0	0	0	40	0	0	60	0.0	0.0	0.0	0.0	64.7	0.0	0.0	97.1
Libby Creek	LIBY 07-01	NR-0-3-C	22.00	1931	42.5	0	0	0	0	50	0	0	50	0.0	0.0	0.0	0.0	21.2	0.0	0.0	21.2
Libby Creek	LIBY 07-02	NR-0-3-C	22.00	4449	97.9	10	0	0	0	70	0	0	20	9.8	0.0	0.0	0.0	68.5	0.0	0.0	19.6
Libby Creek	LIBY 08-01	NR-0-3-U	22.00	4528	99.6	20	0	0	0	80	0	0	0	19.9	0.0	0.0	0.0	79.7	0.0	0.0	0.0
Libby Creek	LIBY 08-02	NR-0-3-U	22.00	5162	113.6	30	0	0	0	0	0	0	70	34.1	0.0	0.0	0.0	0.0	0.0	0.0	79.5
Libby Creek	LIBY 09-01	NR-0-4-U	22.00	6475	142.5	0	0	0	0	40	0	0	60	0.0	0.0	0.0	0.0	57.0	0.0	0.0	85.5
Libby Creek	LIBY 09-02	NR-0-4-U	22.00	6077	133.7	0	10	0	0	0	0	0	90	0.0	13.4	0.0	0.0	0.0	0.0	0.0	120.3
Libby Creek	**LIBY 09-03**	**NR-0-4-U**	**25.03**	**14582**	**365.0**	**4.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**48.9**	**46.6**	**16.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**178.3**	**170.2**
Libby Creek	LIBY 09-04	NR-0-4-U	22.00	6708	147.6	10	0	0	0	20	0	0	70	14.8	0.0	0.0	0.0	29.5	0.0	0.0	103.3
Libby Creek	**LIBY 09-05**	**NR-0-4-U**	**34.73**	**22803**	**791.9**	**19.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**37.2**	**43.7**	**151.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**294.5**	**346.2**
Libby Creek	LIBY 09-06	NR-0-4-U	22.00	7814	171.9	10	10	0	0	0	0	0	80	17.2	17.2	0.0	0.0	0.0	0.0	0.0	137.5
Libby Creek	LIBY 10-01	NR-0-5-U	22.00	12029	264.6	20	0	0	0	0	0	0	80	52.9	0.0	0.0	0.0	0.0	0.0	0.0	211.7
Libby Creek			**TOTAL**	**137458**	**3026.2**								**TOTAL**	**365.2**	**30.6**	**0.0**	**11.4**	**330.9**	**0.0**	**502.9**	**1785.1**
Libby Creek													**PERCENT**	**0.12**	**0.01**	**0.00**	**0.00**	**0.11**	**0.00**	**0.17**	**0.59**
Quartz Creek	QRTZ 01-01	NR-2-1-U	2.81	2412	6.8	10	0	0	0	0	0	90	0	0.7	0.0	0.0	0.0	0.0	0.0	6.1	0.0
Quartz Creek	QRTZ 02-01	NR-2-1-C	6.32	2226	14.1	30	0	0	0	0	0	70	0	4.2	0.0	0.0	0.0	0.0	0.0	9.8	0.0
Quartz Creek	**QRTZ 03-01**	**NR-2-2-C**	**5.64**	**10466**	**59.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**59.0**	**0.0**
Quartz Creek	QRTZ 04-01	NR-4-2-U	2.81	3758	10.6	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	10.6	0.0
Quartz Creek	QRTZ 05-01	NR-2-2-U	2.81	15428	43.4	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	43.4	0.0
Quartz Creek	QRTZ 06-01	NR-4-2-U	2.81	1180	3.3	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0
Quartz Creek	QRTZ 07-01	NR-4-2-C	2.81	5031	14.1	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	14.1	0.0
Quartz Creek	QRTZ 08-01	NR-2-3-C	6.32	925	5.8	0	0	0	0	50	0	50	0	0.0	0.0	0.0	0.0	2.9	0.0	2.9	0.0
Quartz Creek	QRTZ 09-01	NR-2-3-U	2.81	11271	31.7	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0
Quartz Creek	QRTZ 09-02	NR-2-3-U	6.32	3666	23.2	20	0	0	0	0	0	0	80	4.6	0.0	0.0	0.0	0.0	0.0	0.0	18.5
Quartz Creek	**QRTZ 10-01**	**NR-0-3-U**	**12.67**	**3042**	**38.5**	**16.3**	**0.0**	**0.0**	**0.0**	**65.2**	**0.0**	**18.5**	**0.0**	**6.3**	**0.0**	**0.0**	**0.0**	**25.1**	**0.0**	**7.1**	**0.0**
Quartz Creek			**TOTAL**	**59403**	**250.5**								**TOTAL**	**15.8**	**0.0**	**0.0**	**0.0**	**28.1**	**0.0**	**188.0**	**18.5**
Quartz Creek													**PERCENT**	**0.06**	**0.00**	**0.00**	**0.00**	**0.11**	**0.00**	**0.75**	**0.07**
Raven Creek	RAVN 01-01	NR-10-1-U	0.00	471	0.0	0	0	0	0	100	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Raven Creek	RAVN 01-02	NR-10-1-U	0.00	108	0.0	100	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Raven Creek	RAVN 02-01	NR-10-1-C	0.00	2667	0.0	0	0	0	0	100	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Raven Creek	RAVN 03-01	NR-10-1-U	0.00	2456	0.0	0	0	0	0	100	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Raven Creek	**RAVN 04-01**	**NR-4-1-U**	**6.32**	**4479**	**28.3**	**0.0**	**0.0**	**0.0**	**0.0**	**38.5**	**0.0**	**61.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**10.9**	**0.0**	**17.4**	**0.0**
Raven Creek	**RAVN 05-01**	**NR-4-2-U**	**0.14**	**2772**	**0.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**0.0**
Raven Creek	**RAVN 06-01**	**NR-2-2-U**	**0.12**	**616**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**
Raven Creek			**TOTAL**	**13569**	**28.8**								**TOTAL**	**0.0**	**0.0**	**0.0**	**0.0**	**10.9**	**0.0**	**17.9**	**0.0**
Raven Creek													**PERCENT**	**0.00**	**0.00**	**0.00**	**0.00**	**0.38**	**0.00**	**0.62**	**0.00**
Wolf Creek	WOLF 01-01	NR-2-1-U	2.81	2271	6.4	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0
Wolf Creek	WOLF 02-01	NR-2-2-U	2.81	1519	4.3	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0
Wolf Creek	WOLF 02-02	NR-2-2-U	2.81	948	2.7	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0
Wolf Creek	WOLF 02-03	NR-2-2-U	2.81	1000	2.8	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0
Wolf Creek	WOLF 03-01	NR-10-2-C	0.00	391	0.0	100	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Creek	WOLF 04-01	NR-2-2-U	2.81	1476	4.1	0	0	0	0	0	0	100	0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	0.0
Wolf Creek	WOLF 05-01	NR-0-3-U	9.42	14509	136.7	10	0	0	0	0	0	90	0	13.7	0.0	0.0	0.0	0.0	0.0	123.0	0.0
Wolf Creek	WOLF 05-02	NR-0-3-U	22.00	11032	242.7	80	0	0	0	20	0	0	0	194.2	0.0	0.0	0.0	48.5	0.0	0.0	0.0
Wolf Creek	WOLF 05-03	NR-0-3-U	22.00	5069	111.5	50	0	0	0	50	0	0	0	55.8	0.0	0.0	0.0	55.8	0.0	0.0	0.0
Wolf Creek	WOLF 06-01	NR-2-3-U	6.32	6203	39.2	0	0	0	0	100	0	0	0	0.0	0.0	0.0	0.0	39.2	0.0	0.0	0.0
Wolf Creek	WOLF 07-01	NR-2-4-U	6.32	2188	13.8	20	10	0	0	10	0	60	0	2.8	1.4	0.0	0.0	1.4	0.0	8.3	0.0
Wolf Creek	WOLF 08-01	NR-0-4-U	22.00	3318	73.0	10	0	0	0	20	0	70	0	7.3	0.0	0.0	0.0	14.6	0.0	51.1	0.0
Wolf Creek	WOLF 08-02	NR-0-4-U	22.00	6926	152.4	20	0	0	0	70	0	10	0	30.5	0.0	0.0	0.0	106.7	0.0	15.2	0.0
Wolf Creek	**WOLF 08-03**	**NR-0-4-U**	**19.21**	**14108**	**271.0**	**0.0**	**87.4**	**0.0**	**0.0**	**0.0**	**0.0**	**12.6**	**TOTAL**	**0.0**	**236.9**	**0.0**	**0.0**	**0.0**	**0.0**	**34.1**	**0.0**
Wolf Creek	WOLF 08-04	NR-0-4-U	22.00	9140	201.1	10	0	0	0	70	0	20	**PERCENT**	20.1	0.0	0.0	0.0	140.8	0.0	40.2	0.0
Wolf Creek	WOLF 08-05	NR-0-4-U	22.00	4941	108.7	20	40	0	0	30	0	10	0	21.7	43.5	0.0	0.0	32.6	0.0	10.9	0.0
Wolf Creek	WOLF 09-01	NR-0-4-U	22.00	2666	58.7	0	50	0	0	20	0	30	0	0.0	29.3	0.0	0.0	11.7	0.0	17.6	0.0
Wolf Creek	**WOLF 09-02**	**NR-0-4-U**	**18.36**	**25937**	**476.2**	**0.0**	**59.9**	**0.0**	**0.0**	**23.9**	**0.0**	**16.2**	**0.0**	**0.0**	**285.4**	**0.0**	**0.0**	**113.9**	**0.0**	**76.9**	**0.0**
Wolf Creek	WOLF 10-01	NR-0-4-U	22.00	7326	161.2	30	10	0	0	0	0	30	30	48.4	16.1	0.0	0.0	0.0	0.0	48.4	48.4
Wolf Creek	WOLF 10-02	NR-0-4-U	22.00	11468	252.3	100	0	0	0	0	0	0	0	252.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wolf Creek	WOLF 10-03	NR-0-4-U	22.00	4146	91.2	50	0	0	0	0	0	50	0	45.6	0.0	0.0	0.0	0.0	0.0	45.6	0.0
Wolf Creek	WOLF 10-04	NR-0-4-U	22.00	12540	275.9	60	0	0	0	0	0	40	0	165.5	0.0	0.0	0.0	0.0	0.0	110.3	0.0
Wolf Creek	WOLF 11-01	NR-0-4-U	22.00	41193	906.3	50	0	0	0	50	0	0	0	453.1	0.0	0.0	0.0	453.1	0.0	0.0	0.0
Wolf Creek	WOLF 11-02	NR-0-4-U	22.00	5909	130.0	70	0	0	0	0	0	30	0	91.0	0.0	0.0	0.0	0.0	0.0	39.0	0.0
Wolf Creek	**WOLF 11-03**	**NR-0-4-U**	**6.44**	**7875**	**50.7**	**16.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**83.7**	**0.0**	**8.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**42.5**	**0.0**
Wolf Creek	WOLF 11-04	NR-0-4-U	22.00	3205	70.5	30	0	0	0	70	0	0	0	21.2	0.0	0.0	0.0	49.4	0.0	0.0	0.0
Wolf Creek			**TOTAL**	**207304**	**3843.2**								**TOTAL**	**1431.3**	**612.6**	**0.0**	**0.0**	**1067.6**	**0.0**	**683.4**	**48.4**
Wolf Creek													**PERCENT**	**0.37**	**0.16**	**0.00**	**0.00**	**0.28**	**0.00**	**0.18**	**0.01**