ATTACHMENT A - FLATHEAD-STILLWATER TMDL PLANNING AREA SEDIMENT AND HABITAT ASSESSMENT SUMMARY REPORT

Flathead-Stillwater TMDL Planning Area Sediment and Habitat Assessment Summary Report

Prepared by:
Watershed Consulting, LLC
P.O. Box 1701
Kalispell, MT 59903

Submitted to:
Montana DEQ
1520 E. Sixth Avenue
Helena, MT 59620

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1.0 INTRODUCTION

The Flathead-Stillwater Total Maximum Daily Load Planning Area (FS-TPA) is located entirely in Flathead County in Northwestern Montana and includes the entire Stillwater River fourth level HUC watershed. The TPA comprises the northwestern area of the larger Flathead Lake Basin and is generally defined by the Salish Mountains to the East and the Whitefish Range to the West. These ranges cradle the narrow valley carved by the south-flowing Flathead River, which empties into Flathead Lake. The Ashley Creek and Stillwater River drainages, the main feeder streams of the Flathead River in the FS-TPA, comprise approximately 239 square miles (DEQ 2001). Much of the higher elevations on either side of the valley north of the Whitefish and Kalispell urban areas are within the Flathead National Forest.

Primary land use of the Flathead Basin is evergreen forest in the higher elevations, where timber harvest levels have declined significantly over the last 15 years. Grazing and agricultural activities have expanded in recent decades in the lower foothills dominated by grasslands. The Stillwater/Whitefish sub-basin contains a fast-growing urban area, whose population, according to 2000 census data, grew by 20% in the last decade and 42% since 1980 (DEQ 2001). Networks of public access dirt roads are abundant in the mountainous reaches, with moderate to high levels of vehicle traffic for recreational purposes in summer months. Higher elevation lakes such as Tally, Ashley and Smith are popular among local residents and tourists.

The FS-TPA encompasses six tributary watersheds that are included on the 2006 State of Montana's 303(d) list for sediment impacts and habitat limitations. Haskill Creek, which is not listed on the 2006 list, is also included for investigation in this study. Studied streams, their stream classes and the cause and source of the 2006 listing are provided in Table 1-1 (DEQ 2008a).

Table 1-1. Tributaries in the FS-TPA, stream class, and 2006 impairment source description and impairment cause.

Listed Stream Segment	Class	Source Description	Cause
Ashley Creek- Ashley Lake to Smith Lake	B-1	Channelization, Crop Production (Crop Land or Dry Land), Grazing in Riparian or Shoreline Zones, Loss of Riparian Habitat, Source unknown	Alteration in stream-side or littoral vegetative covers, Chlorophyll-a, Dissolved Oxygen, Phosphorous, Sedimentation/Siltation, Water Temperature, Total Kjehldahl Nitrogen
Ashley Creek- Smith Lake to Bridge on Kalispell Airport Road	B-2	Agriculture	Low flow alterations
Ashley Creek- Bridge on Kalispell Airport Road to Flathead River	C-2	Discharges from municipal separate storm sewer systems, Irrigated crop production,	Alteration in stream-side or littoral vegetative covers, chlorophyll-a,

		Municipal point source discharges, Natural sources, Upstream source,	Nitrate/Nitrite, Nitrogen (total), Dissolved Oxygen, Phosphorous, Water temperature, Total Kjehldahl Nitrogen
East Fork Swift Creek	A-1	Silviculture Activities, Streambank Modifications/Destabilization	Low flow alterations, Physical substrate habitat alterations
Haskill Creek- Basin pond to Whitefish River	A-1	No previous assessments	No previous assessments
Haskill Creek- Headwaters to Basin pond	A-1	Insufficient data- no previous assessments	Insufficient data- no previous assessments
Logan Creek- above Tally Lake	B-1	Silviculture Activities, Streambank Modifications/Destabilization, Forest Roads,	Other flow regime alterations, Physical substrate habitat alterations, Sedimentation/Siltation
Sheppard Creek	B-1	Crop production, Grazing in riparian or shoreline zones, Silviculture harvesting, Forest roads	Alterations in stream-side or littoral vegetative covers, Nitrate/Nitrite, Phosphorous, Sedimentation/Siltation
Stillwater River- Logan Creek to mouth	B-2	Loss of Riparian Habitat, Site Clearance (Land Development or Redevelopment), Source unknown	Alterations in stream-side or littoral vegetative covers, Nitrates, Phosphorous, Sedimentation/Siltation
West Fork Swift Creek	A-1	Silviculture activities, Highway/Road/Bridge runoff (Non-construction related)	Alterations in stream-side or littoral vegetative covers, Low flow alterations, Sedimentation/Siltation

Data has been periodically collected in the FS-TPA in support of TMDL development over the past few years. In 2008, a more comprehensive and consistent effort was conducted to gather information specific to sediment, morphology and habitat data. Watershed Consulting (WSC) was contracted by Montana DEQ to assist in the assessments and analysis of sediment and habitat conditions as they influence aquatic life beneficial uses in the SF-TPA.

Assessment began by stratifying streams in the area by key geomorphic characteristics to develop unique reach categories that could be applied in comparative analysis across watersheds. Stratification enables comparison between observed and expected values for sediment and habitat parameters, and supports quantification of the effects of anthropogenic influences. Water bodies were divided into reaches and sub-reaches based on aerial photo interpretation, landscape conditions, and land-use factors. This preliminary stratification work was completed in summer 2008. The details of the stratification are provided in Section 2.

Following the initial stratification, representative sub-reaches were chosen by DEQ for data collection. WSC conducted a two day sampling reach verification reconnaissance with the DEQ on July 31 and August 1, 2008. Site surveys at the selected sub-reaches were conducted from September 3 to 16, 2008 and encompassed a total approximately 21 stream miles. Surveyed reaches are mapped in Figure 1-1. Watershed Consulting and DEQ personnel recorded bank erosion data and vegetation and channel characteristics. These data were analyzed in December 2008 and January 2009, resulting in full descriptions of sediment and habitat conditions for all of the surveyed reaches. Details of the field study are included in Sections 3 and 4.

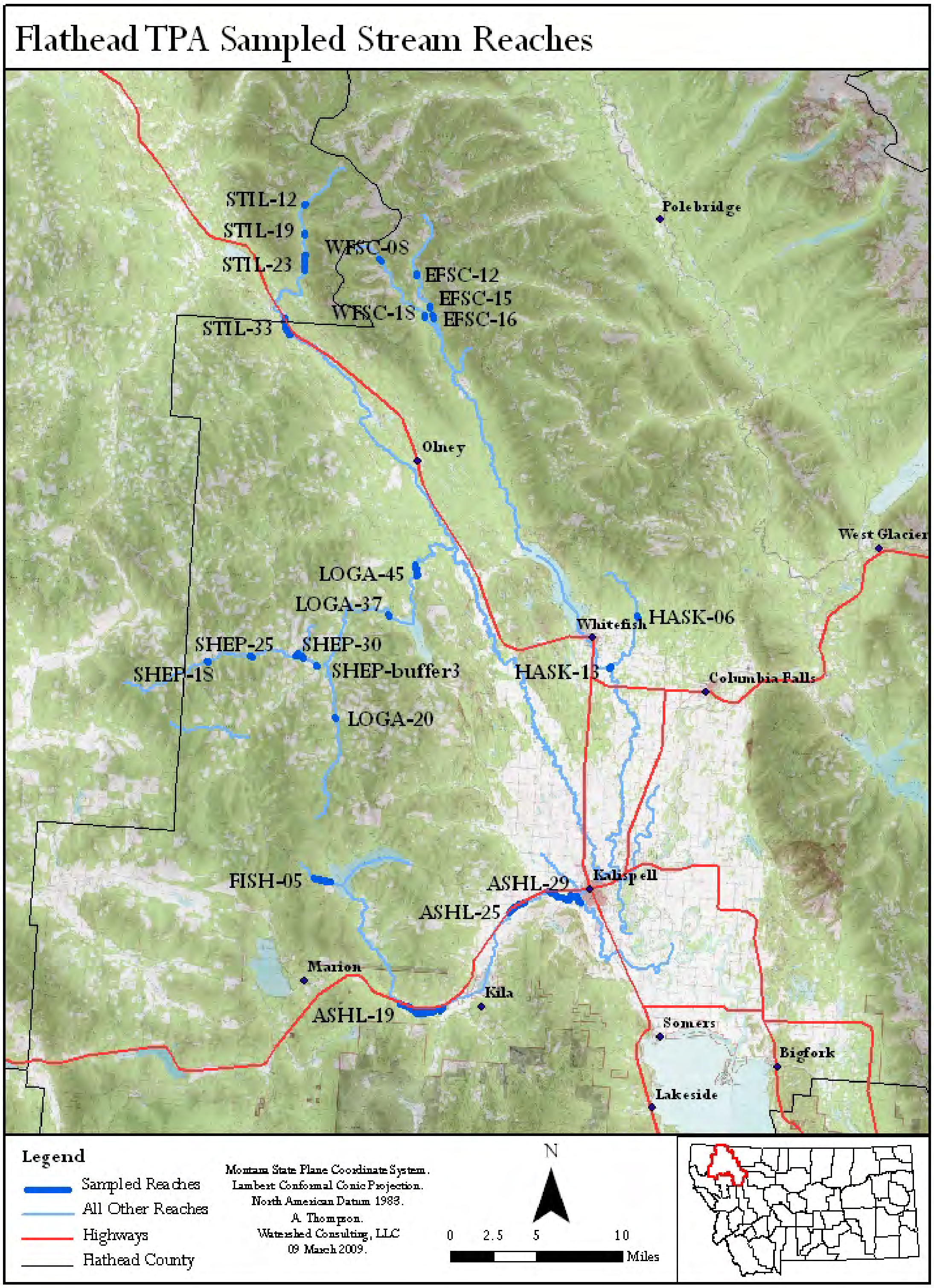

Figure 1-1. Reaches surveyed in the Flathead-Stillwater TPA during the 2008 assessment.

2.0 AERIAL ASSESSMENT REACH STRATIFICATION

2.1 Methods

An aerial assessment of streams in the SF-TPA was conducted using ESRI ArcGIS 9 and 2005 color aerial imagery. Other relevant geographic data layers were acquired from the U.S. Geological Survey (USGS), the U.S. Environmental Protection Agency (USEPA) and the Montana State National Resource Information System (MT NRIS) database. Additional layers include the following data sets:

- Ecoregion (USEPA)
- Scanned and Rectified Topographic Maps, 1:24,000 (USGS)
- National Hydrography Dataset Lakes and Streams (USGS)
- 2005 National Aerial Image Program (NAIP – NRIS)

GIS data layers were used to stratify streams into reaches based on landscape and land-use factors. The stream reach stratification methodology applied in this study is described in *Watershed Stratification Methodology for TMDL Sediment and Habitat Investigations* (DEQ 2008a), with additional background information provided in *White Paper: A Watershed Stratification Approach for TMDL Sediment and Habitat Impairment Verification* (DEQ 2008b).

2.1.1 Stream Reaches and Reach Types

The sediment and habitat assessment study was conducted for the following streams and stream segments:

- Ashley Creek- Ashley Lake to Smith Lake
- Ashley Creek- Smith Lake to Bridge on Kalispell Airport Road
- Ashley Creek- Bridge on Kalispell Airport Road to Flathead River
- East Fork Swift Creek
- Haskill Creek- Basin pond to Whitefish River
- Haskill Creek- Headwaters to Basin pond
- Logan Creek- above Tally Lake
- Sheppard Creek
- Stillwater River- Logan Creek to mouth
- West Fork Swift Creek

The aerial photograph reach stratification methodology involves dividing a **stream segment** (see Table 1.1) into distinct **stream reaches** based on four landscape factors:

- Level IV Ecoregion
- Valley gradient
- Strahler stream order
- Valley confinement

Each individual combination of the four stream reach factors will be referred to as a "**reach type**" in this report.

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

Reach types were described using the following naming convention:

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

The following identifiers were applied for each of the four factors:

- Level III Ecoregion:
  NR = Northern Rockies
  CR = Canadian Rockies

- Valley Gradient:
  0 = 0-<2%
  2 = 2-<4%
  4 = 4-10%
  10 = >10%

- Strahler Stream Order:
  1 = first order
  2 = second order
  3 = third order
  4 = fourth order

- Confinement:
  U = unconfined
  C = confined

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. Possible reach type combinations based on the Level III Ecoregion identified in the SF-TPA are presented in Table 2-1.

Table 2-1. Possible Level III Ecoregion, Valley Gradient,

Strahler Stream Order, and Confinement Combinations.			
Ecoregion III	**Valley Gradient**	**Strahler Stream Order**	**Confinement**
Northern Rockies	> 10 % 4 - 10 % 2 - < 4 % < 2 %	1 2 3 4	Unconfined Confined

Stratification was completed by DEQ for listed stream segments throughout the FS-TPA in 2008. A listing of the stream reach types determined from the landscape factors listed above is provided in Table 2-2. The column *number of monitoring sites* refers to the survey sites assessed by Watershed Consulting.

Table 2-2. Level III Ecoregion, Valley Gradient, Strahler Stream Order and Confinement Combinations Identified in Aerial Assessments

Level III Ecoregion	Valley Gradient	Strahler Stream Order	Confine-ment	Reach Type	Level IV Ecoregion Codes	Number of Reaches	Number of Monitoring Sites
Canadian Rockies	0 - <2%	2	U	CR-0-2-U	41c	3	1
		3	U	CR-0-3-U	41c	2	0
		4	U	CR-0-4-U	41c	2	0
	2% - 4%	1	C	CR-2-1-C	41c	1	0
		2	U	CR-2-2-U	41b, c	7	2
		3	U	CR-2-3-U	41b, c	4	0
		4	U	CR-2-4-U	41b, c	6	2
		4	C	CR-2-4-C	41c	1	0
	4% - 10%	1	U	CR-4-1-U	41c	4	0
		1	C	CR-4-1-C	41c	2	0
		2	U	CR-4-2-U	41b, c	5	0
		3	U	CR-4-3-U	41b	2	0
	>10%	1	U	CR-10-1-U	41c	12	0
		1	C	CR-10-1-C	41c	4	0
		2	U	CR-10-2-U	41c	1	0
		2	C	CR-10-2-C	41c	1	0
Northern	0 - <2%	1	U	NR-0-1-U	15c	2	0

Rockies		2	U	NR-0-2-U	15c, l, t	26	1
		3	U	NR-0-3-U	15c, l, t	58	3
		4	U	NR-0-4-U	15c, l, t	71	5
		5	U	NR-0-5-U	15c, t	33	0
	2% - 4%	1	U	NR-2-1-U	15l	2	0
		2	U	NR-2-2-U	15l, t	18	2
		3	U	NR-2-3-U	15c, l, t	19	1
		4	U	NR-2-4-U	15l, t	15	1
		4	C	NR-2-4-C	15t	1	0
	4% - 10%	1	U	NR-4-1-U	15l	18	1
		2	U	NR-4-2-U	15l, t	14	0
		3	U	NR-4-3-U	15l, t	2	0
		3	C	NR-4-3-C	15l, t	3	0
	>10%	1	U	NR-10-1-U	15l, t	11	0
		2	U	NR-10-2-U	15l, t	4	0
		3	U	NR-10-3-U	15l	1	0
		3	C	NR-10-3-C	15l	1	0

Note that the Northern Rockies Level III Ecoregion contains 3 Level IV Ecoregions in the SF-TPA:

- 15t- Stillwater-Swan Wooded Valley
- 15c- Flathead Valley
- 15l- Salish Mountains

For the reach type analysis, reach types in the Canadian Rockies Level III Ecoregion are within one of two Level IV Ecoregions (USEPA 2002):

- 41c- Western Canadian Rockies
- 41b- Crestal Alpine-Subalpine

2.1.2 Sub-Reaches

In addition to classifying stream reaches into **reach types**, stream segments were divided based on the surrounding vegetation, gradient and land-use/land cover characteristics as observed in the

2005 color aerial imagery using ArcGIS. These sub-reaches are defined by a stream acronym and a number, assigned in ascending numerical order from upstream to downstream, and referred to in this report as a **Reach ID**. Changes in Level IV Ecoregions are captured by these sub-reaches, as no Reach ID extends across two Level IV Ecoregions.

Survey sites were chosen to represent the range of landscape characteristics and land use/land cover influences existing in the TPA. Table 2-3 lists the **Reach IDs** for assessed reaches within the project area.

Table 2-3. Sampled Sub-reaches in project area sorted by reach type

Level III Ecoregion	Reach Type	Reach ID	Number Sampled
Canadian Rockies	CR-0-2-U	EFSC-12	1
	CR-2-2-U	STIL-12; WFSC-08	2
	CR-2-4-U	STIL-19; STIL-23	2
Northern Rockies	NR-0-2-U	EFSC-15	1
	NR-0-3-U	HASK-13; LOGA-20; SHEP-25; WFSC-18	4
	NR-0-4-U	ASHL-19; ASHL-25; ASHL-29; LOGA-45; STIL-33	5
	NR-2-2-U	EFSC-16; SHEP-18	2
	NR-2-3-U	HASK-06	1
	NR-2-4-U	LOGA-37	1
	NR-4-1-U	FISH-05	1

The result of the aerial stratification methodology is a series of stream reaches and sub-reaches delineated by landscape and land-use factors. The overall objective of such stratification is to improve the potential for comparison of stream reaches with similar landscape factors (i.e. their degree of impairment, approximate loads under natural conditions, perceived and actual contributions from agriculture, mining, development, etc.) and to maintain continuity in data collection. Ultimately, such a methodology will aid the state in its overall objectives for managing and monitoring streams over large and diverse areas.

3.0 Sediment and Habitat Dataset Review

3.1 Field Methodology

In this section the various field methodologies used for this study are described. Methods follow standard DEQ protocols for sediment and habitat assessment, as presented in the document, "Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments" (DEQ 2008c). All field forms used in the study are standard forms used by DEQ for sediment and habitat assessments. These forms are included in Appendix A. On-site training in field methodologies and field forms was conducted by DEQ for the entire assessment team during the first two days of the assessment period (see section 3.1.9). For most survey sites a minimum of 5 team members were present, which were always divided into 3 teams, referred to as the "Greenline," "Substrate," and "Cross-Section" teams in this section. The teams worked independently moving upstream through the survey site and in a pre-established order so as to create the least possible in-stream disturbance.

3.1.1 Survey Site Delineation

Stream survey sites were delineated beginning at riffle crests at the downstream ends of reaches. Survey sites were measured upstream at pre-determined lengths based on the bankfull width at the selected downstream riffle. Survey lengths of 500' were used for bankfull widths less than 10'; lengths of 1000' were used for bankfull widths between 10' and 50'; lengths of 1500' were used for bankfull widths between 50' and 60'; and lengths of 2000' were used for bankfull widths greater than 60'. Each survey site was divided into 5 equally sized study cells. For each site, the field team leader identified the appropriate downstream riffle crest to begin a reach. Where no riffles were present or the stream was dry, the field team leader identified the appropriate starting point.

The GPS location of the downstream end of the survey site was recorded on the **Sediment and Habitat Assessment Site Information Form**.

Digital photographs were taken at both upstream and downstream ends of the survey site, looking both upstream and downstream. Photo numbers and a brief description were recorded in the **Photo Log**.

3.1.2 Field Determination of Bankfull

All members of the field crew (except for the "Greenline" team member) participated in determining the bankfull elevation prior to breaking into their respective teams.

Bankful indicators used included scour lines, changes in vegetation types, tops of point bars, changes in slope, changes in particle size and distribution, stained rocks and inundation features. Multiple locations and indicators were examined, and bankfull elevation estimates and their corresponding indicators were recorded in the **Bankfull Elevation and Slope Assessment Field Form** by the field team leader. Final determination of the appropriate bankfull elevation was determined by the team leader, and informed by the team experience and notes from the field form.

3.1.3 Channel Cross-sections

The "Cross Section team" was composed of two members of the assessment crew, who also performed pebble counts (3.1.4.6) riffle stability index (3.1.4.7) and riffle grid tosses (3.1.4.4).

Channel cross-section measurements were performed at the first riffle in each cell using a line level and a measuring rod and recorded in the **Channel Cross-section Field Form**.

Cross-sections were conducted in each cell containing a riffle feature. In the case that riffles were present in only 1 or 2 cells, but those cells contained multiple riffles, additional cross-sections were performed at the most downstream unmeasured riffle, such that a minimum of three cross-sections were conducted. If only 1 or 2 riffles were present in the entire reach, they were measured. In no cases of this assessment was the stream devoid of riffles.

To begin, the cross-section team placed a bank pin at the pre-determined bankfull elevation (using bankfull indicators as guides) on the right and left banks. A measuring tape was strung perpendicular to the stream channel at the most "well-defined" portion of the riffle and tied to the bank pins.

Where mid-channel bars or other features or crossings were present in the channel which prevented a "clean" line across the channel, protocol provided in section 2.3 of the "Longitudinal Field Methodology" document were followed (DEQ 2008c).

Depth measurements at bankfull were collected to a tenth of a foot across the channel at regular intervals. These intervals varied depending on channel width, following protocol in item 15, section 2.3 of the "Longitudinal Field Methodology" document (DEQ 2008c). Thalweg depth was recorded at the deepest point of the channel independent of the regularly spaced intervals.

From the recorded data, the following were calculated for each cross-section:

Mean depth = sum of depth measurements / number of depth measurements (exclude the RBF and LBF measurements, unless they are greater than zero, such as when there is a vertical bank)

Cross-sectional area = bankfull width x mean bankfull depth

Width/depth ratio = bankfull width / mean bankfull depth

Entrenchment ratio = floodprone width / bankfull width.

In the case that cross-sectional areas determined from different cross-sections varied greatly, a cross-section was re-strung and measured again. In some cases, major alterations in stream features caused these discrepancies, which were noted in the field form.

The floodprone elevation was determined by multiplying the maximum depth value by 2. The floodprone width was then determined by stringing a tape from the bankfull channel margin on both right and left banks until the tape (pulled tight and "flat") touched ground at the floodprone elevation. The total floodprone width was calculated by adding the bankfull channel width to the distances on either end of the channel to the floodprone elevation. When dense vegetation or other features prevented a direct line of tape from being strung, investigators determined the floodprone width using a range finder and Best Professional Judgment.

GPS coordinates for each cross-section were recorded. Photos were taken upstream and downstream of the cross section from the middle of the channel. A photo was also taken across the channel, showing the tape across the stream.

3.1.4 Channel Bed Morphology

A variety of channel bed morphology features was measured and recorded by the "Substrate" team, which usually consisted of two team members, and included the field team leader. The length of the survey site occupied by pools and riffles was identified and recorded in the **Pools, Riffles and Large Woody Debris Field Form.** Beginning from the downstream end of the survey site, the upstream and downstream stations of "dominant" riffle and pool stream features were recorded. Features were considered "dominant" when occupying over 50% of the stream width. Pools and riffles were measured from head crest or riffle crest, respectively, until the end of that feature (defined as the tail crest for pools).

Runs and glides were not recorded in the field form. Stream features were identified per standard field method criteria (DEQ 2008c).

3.1.4.1 Residual Pool Depth

At all pools encountered, a residual pool depth measurement was taken. Backwater pools were not measured. Measured pools were recorded at each "station" (distance in feet) of occurrence, beginning at the downstream end (station 0) of the survey site. The depth of the pool tail crest (see DEQ 2008c) at its deepest point was measured. No pool tail crest depth was recorded for dammed pools (see 3.1.4.2).

The maximum depth of each pool was also recorded. In the case of dry channels, readings were taken from channel bed surface to bankfull height.

3.1.4.2 Pool Habitat Quality

Qualitative assessments of each pool feature were undertaken and recorded in the **Pools, Riffles and Large Woody Debris Field Form** as follows:

1. Pool types were determined to be either Scour **(S)** or Dammed **(D)**.

2. Pool size was relative to bankfull channel width was recorded as Small **(S)**, Medium **(M)**, or Large **(L)**. Small pools were defined as those <1/3 of the bankfull channel; medium pools were >1/3 and <2/3 of the bankfull channel; and large pools were determined to be those >2/3 of the bankfull channel or >20 feet wide.

3. Pool formative features were recorded as either Lateral Scours **(LS)**, Plunge **(P)**, Boulder **(B)**, or Woody Debris **(W)**.

4. The primary pool cover type was recorded using the following codes:

V = Overhanging Vegetation
D = Depth
U = Undercut
B = Boulder
W = Woody Debris
N = No apparent cover

5. When undercut banks were present, their depths were measured to a tenth of a foot by inserting a measuring rod horizontally into the undercut bank.

3.1.4.3 Fine Sediment in Pool Tail-outs

A measurement of the percent of fine sediment in pool tail outs was taken using the grid toss method at the first and second scour pool of each cell. Grid toss readings were focused in those pool tail gravels that appeared to be suitable or potentially suitable for trout spawning.

Measurements were taken within the "arc" just upstream of the pool tail crest, following the methodology in section 2.8 of the field methods document (DEQ 2008c). Three measurements were taken across the channel with specific attention given to measurements in gravels determined to be of appropriate size for salmonid spawning. The potential for spawning was recorded as Yes **(Y)**, No **(N)**, or Unclear **(?)** at each measurement site.

3.1.4.4 Fine Sediment in Riffles

Using the same grid toss method as used in pools by the "Substrate" team (section 3.1.4.3), measurements of fine sediment in riffles were recorded by the "Cross Section" team. Grid tosses were performed in the same general location but before the pebble counts (section 3.1.4.6) and to avoid disturbances to fine sediments. These measurements were recorded in the **Riffle Pebble Count Field Form.**

3.1.4.5 Woody Debris Quantification

The amount of large woody debris (LWD) was recorded by the "Substrate" team along the entire assessment reach in the **Pools, Riffles and Large Woody Debris Field Form**. Large pieces of woody debris located within the bankfull channel and which were relatively stable as to influence channel form were counted as either single, aggregate or willow bunch. Further description of these categories is provided in section 2.10 of the field assessment protocols (DEQ 2008c).

3.1.4.6 Riffle Pebble Count

One Wolman pebble count (Wolman 1954) was performed by the "Cross Section" team at the first riffle encountered in cells 1, 3 and 5 as the team progressed upstream, providing a minimum of 300 particle sizes measured within each assessment reach. These measurements were recorded in the **Riffle Pebble Count Field Form**. Particle sizes were measured along their intermediate length axis (*b-axis*) and results were grouped into size categories. The team progressed from bankfull to bankfull using the "heel to toe" method, measuring particle size at the tip of the boot at each step. More specific details of the pebble count methodology and protocol followed in cases where riffles were not encountered in the designated cells can be found in section 2.11 of the field methods document provided to the team prior to field assessment efforts (DEQ 2008c).

3.1.4.7 Riffle Stability Index

In streams that had developed point bars, a riffle stability index was performed to determine the average size of the largest recently deposited particle. This information was recorded in the **Riffle Pebble Count Field Form**.

For streams in which gravel bars were present, a total of 3 stability index measurements were conducted, which consisted of intermediate axis (*b-axis*) measurements of 15 particles determined to be among the largest size group to be recently deposited and which occur on over 10% of the point bar. During post-field data processing, the riffle stability index was calculated as the geometric mean of the survey site dataset.

3.1.5 Riparian Greenline Assessment

After the entire survey length was strung by the "greenline" team member, an assessment of riparian vegetation cover was performed. The greenline, which is located at approximately the bankfull channel margin, was walked by the "greenline" team member, who noted the general vegetation community type of the groundcover, and understory and overstory on both banks. Vegetation types were recorded at 10-foot intervals and were entered in the **Riparian Greenline Field Form**.

The ground cover vegetation (<1.5 foot tall) was described using the following categories:

W = Wetland vegetation, such as sedges and rushes
G = Grasses or forbs, rose, snowberry (vegetation lacking binding root structure)
B = Bare/disturbed ground
R = Rock, when a large cobble or bolder is encountered
RR = Riprap

The understory (1.5 to 15 feet tall) and overstory (>15 feet tall) vegetation was described using the following categories:

C = Coniferous
D = Deciduous, riparian shrubs and trees with sufficient rooting mass and depth to provide protection to the streambanks
M = mixed coniferous and deciduous

At 50-foot intervals, a riparian buffer width was estimated on either side of the bank. This width corresponded to the belt of vegetation buffering the stream from adjacent land uses. Upon conclusion of the greenline measurements, the total numbers of each type of vegetation were tallied.

3.1.6 Streambank Erosion Assessment

An assessment of all actively/visually eroding and slowly eroding/undercut/vegetated streambanks was conducted along each survey site. This assessment consisted of the Bank Erosion Hazard Index (BEHI; see Section 4) and Near Bank Stress estimation which are used to quantify sediment loads from bank erosion. All streambank measurements were recorded in the **Streambank Erosion Field Form** and **Additional Streambank Erosion Measurements Form.** Further information related to the streambank erosion assessment methodology and results is included in Section 4.

3.1.7 Water Surface Slope

Three water surface slope measurements were estimated using a clinometer and recorded in the **Elevation & Water Surface Slope Field Form** at each survey site. Two crew members, usually part of the "Cross Section" team stood at the water's surface in a riffle or similar stream feature and at a distance from each other with a direct line-of-sight.

3.1.8 Field Notes

At the completion of data collection at each survey site, field notes were collected by the field leader with inputs from the entire field team. The following four categories contributed to field notes, which served to provide an overall context for the condition of the stream channel relative to surrounding and historical uses:

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

3.1.9 Quality Assurance/Control

Two days of on-site training were held to familiarize the entire crew with all the field forms and procedures. The field team leader and most experienced crew members led the separate teams during these first two days. At the conclusion of the first days' training, all field forms were reviewed for completeness and accuracy.

To ensure the highest quality data collection, several protocols were followed at every site visit. Equipment checks were done every morning and field maps were reviewed with drivers before approaching the site. Field forms were distributed and double-checked before teams left the vehicles to the survey sites. Any questions that arose from field teams were brought to the attention of the field team leader until doubts and questions were resolved to the leaders' satisfaction.

3.2 Assessment Variables and Summary Statistics

Erosion and sediment transport and deposition are natural functions of stream channels. Sediment deposition is needed to build streambanks and floodplains. Regular flooding allows sediment deposition to build floodplain soils and prevents excess scour of the stream channel. Riparian vegetation and natural instream barriers such as large woody debris, beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent or excessive erosion is taking place due to altered channel morphology or riparian vegetation, excess sediment is transported through the channel and may be deposited in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

Excessive sediment deposition may alter aquatic habitat quality and channel morphology by reducing pool depths, covering natural stream substrate, causing channel aggradation, altering shear stress on streambanks, or resulting in altered floodplain deposition patterns. Excess sediment often has detrimental effects on habitat for aquatic organisms. High suspended sediment levels reduce light penetration, which may cause a decline in primary production. As a result, aquatic invertebrate communities may also decline, in turn resulting in a decline in fish populations. Deposited particles may also obscure sources of food, habitat, hiding places, and nesting sites for invertebrates.

Excess sediment may also impair biological processes of individual aquatic organisms. When present in high levels, sediment may clog the gills of fish and cause other abrasive damage. High levels of benthic fine sediment can also impair reproductive success of fish. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. An accumulation of benthic fine sediment reduces the flow of water through gravels harboring salmonid eggs, hindering emergence of newly hatched fish, depleting oxygen supply to embryos, and causing metabolic wastes to accumulate around embryos, resulting in higher mortality rates (Armour and others 1991).

This sediment and habitat assessment focuses on environmental variables that are related to aquatic habitat condition and sediment supply in stream systems. The evaluated habitat and sediment variables are described below in the following subsections, in which results from field assessments are also presented. Results for each variable include a comparison among reach types and individual sites.

3.2.1 Width/Depth Ratio

Width/depth ratio is defined as the channel width at bankfull height divided by the mean bankfull depth (Rosgen 1996). 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 in 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"

Width/depth ratio is one of several standard measurements used to classify stream channels (Rosgen 1996), making it a useful variable for comparing conditions on reaches within the same stream type. Comparison of observed and expected width/depth ratio is a useful indicator of channel overwidening and aggradation, which are often linked to excess streambank erosion or acute or chronic erosion from sources upstream of the study reach. Channels that are overwidened often are associated with excess sediment deposition and streambank erosion, contain shallower, warmer water, and provide fewer deepwater habitat refugia for fish.

Width/depth data can be compared to guideline threshold values from previous studies to indicate if width/depth ratios observed on reaches in the FSTPA are greater than those expected for minimally impacted channels. Results exceeding the guideline values may indicate overwidening. A general threshold value for width/depth ratio is 23 for Rosgen B type channels and 30 for C channels. These values represent an average of target values used in previous TMDL assessments in northwest Montana. All study reaches fall within the range of B and C channel types and include Bc and Cb channels.

3.2.1.1 Reach Type Comparison

Width/depth ratio measured in the study reaches is plotted by reach type in Figure 3-1. Summary statistics for width/depth ratio of reach types are included in Table 3-1 following the box plot.

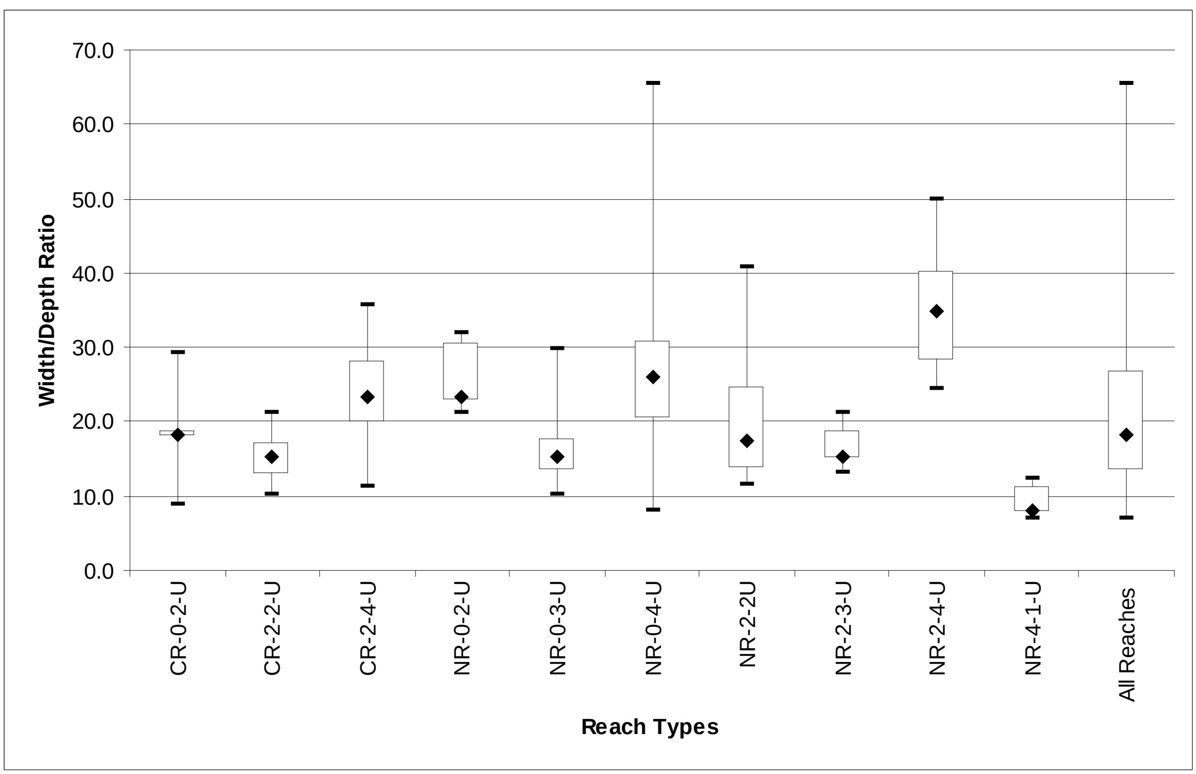

Figure 3-1. Width/Depth Ratio Segregated by Reach Type

Table 3-1. Summary of Width/Depth Ratio Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	5	10	10	5	19	23	10	5	5	5	97
Minimum	8.9	10.3	11.2	21.3	10.3	8.0	11.6	13.0	24.3	6.9	6.9
25th Percentile	17.9	12.8	19.7	22.7	13.3	20.4	13.8	15.1	28.2	7.7	13.3
Median	18.3	15.4	23.2	23.4	15.4	26.0	17.6	15.4	34.8	8.0	18.3
75th Percentile	18.8	17.1	28.2	30.5	17.6	30.7	24.7	18.9	40.1	11.4	26.9
Maximum	29.1	21.2	35.8	32.0	29.9	65.4	40.8	21.2	49.8	12.2	65.4

3.2.2 Entrenchment Ratio

Stream entrenchment ratio is equal to the floodprone width divided by the bankfull width (Rosgen 1996). Entrenchment ratio is used to help determine if a stream shows departure from its natural stream type. It is an indicator of stream incisement, and therefore indicates how easily a stream can access its floodplain. Streams are often incised due to detrimental land management or may be naturally incised due to landscape characteristics. A stream that is overly entrenched generally is more prone to streambank erosion due to greater energy exerted on the banks during high flow periods. Greater scouring energy in incised channels results in higher sediment loads derived from eroding banks. If the stream is not actively degrading (downcutting), the sources of human caused incisement are historic in nature and may not currently be present, although sediment loading may continue to occur. Entrenchment ratio is an important measure of channel condition as it relates to sediment loading and habitat condition, due to the long-lasting impacts of incisement and large potential for sediment loading in incised channels.

An expected entrenchment ratio for reaches classified as B channels falls within the range of 1.4-2.2, although an entrenchment ratio as low as 1.2 and as high as 2.4 is not outside the realm of expected channel dimensions. C channels, including Cb channels, generally have entrenchment ratios of greater than 2.2 (Rosgen 1996).

3.2.2.1 Reach Type Comparison

Entrenchment ratio measured in the study reaches is plotted by reach type in Figure 3-2. Summary statistics for entrenchment ratio of reach types are included in Table 3-2 following the box plot.

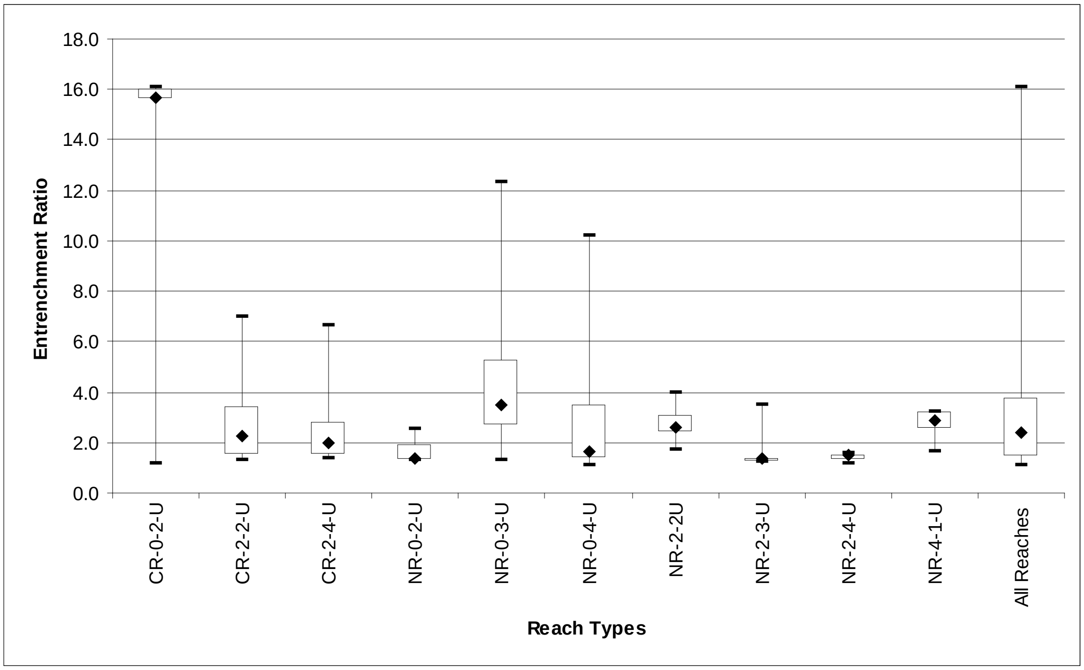

Figure 3-2. Entrenchment Ratio Segregated by Reach Type

Table 3-2. Summary of Entrenchment Ratio Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	5	10	10	5	19	23	9	5	5	5	96
Minimum	1.2	1.3	1.4	1.3	1.3	1.1	1.7	1.2	1.1	1.6	1.1
25th Percentile	15.6	1.5	1.5	1.3	2.7	1.4	2.4	1.2	1.3	2.5	1.4
Median	15.7	2.3	2.0	1.4	3.5	1.6	2.6	1.4	1.5	2.9	2.4
75th Percentile	16.0	3.4	2.8	1.9	5.2	3.5	3.1	1.4	1.5	3.2	3.8
Maximum	16.1	7.0	6.6	2.5	12.3	10.2	4.0	3.5	1.6	3.2	16.1

3.2.3 Riffle Pebble Count: Substrate Fines (<2mm)

Percent surface fines provide a good measure of the siltation occurring in a river system and serve as an indicator of stream bottom aquatic habitat. Although it is difficult to correlate percent surface fines with loading in mass per time directly, the Clean Water Act allows “other applicable measures” for the development of TMDL water quality restoration plans. Percent surface fines have been used successfully in other TMDLs in western Montana addressing sediment related to stream bottom deposits, siltation, and aquatic life uses.

Surface fine sediment measured in the Wolman (1954) pebble count is one indicator of aquatic habitat condition and can indicate excessive sediment loading. Studies have shown that increased substrate fine materials less than 2mm can adversely affect embryo development success by limiting the amount of oxygen needed for development (Meehan 1991). As well, the TMDL for the Flathead Headwaters cites recent work completed in the Boise National Forest in Idaho, which showed a strong correlation between the health of macroinvertebrate communities and percent surface fines defined as all particles less than two millimeters.

Other studies in western Montana have set a threshold value for percent fine substrate (<2mm) at 15% to 20%. The guideline values used in these studies were based on best available conditions and empirical equations developed by Weaver and Fraley (1991). Surface fine sediment is difficult to measure with a great degree of precision using the Wolman pebble count method. To be conservative, any of the study reaches displaying greater than 15% fine sediment <2mm diameter in riffles may indicate an impact to fisheries or aquatic life.

3.2.3.1 Reach Type Comparison

Riffle pebble count (<2mm) measured in the study reaches is plotted by reach type in Figure 3-3. Summary statistics for riffle pebble count (<2mm) of reach types are included in Table 3-3 following the box plot.

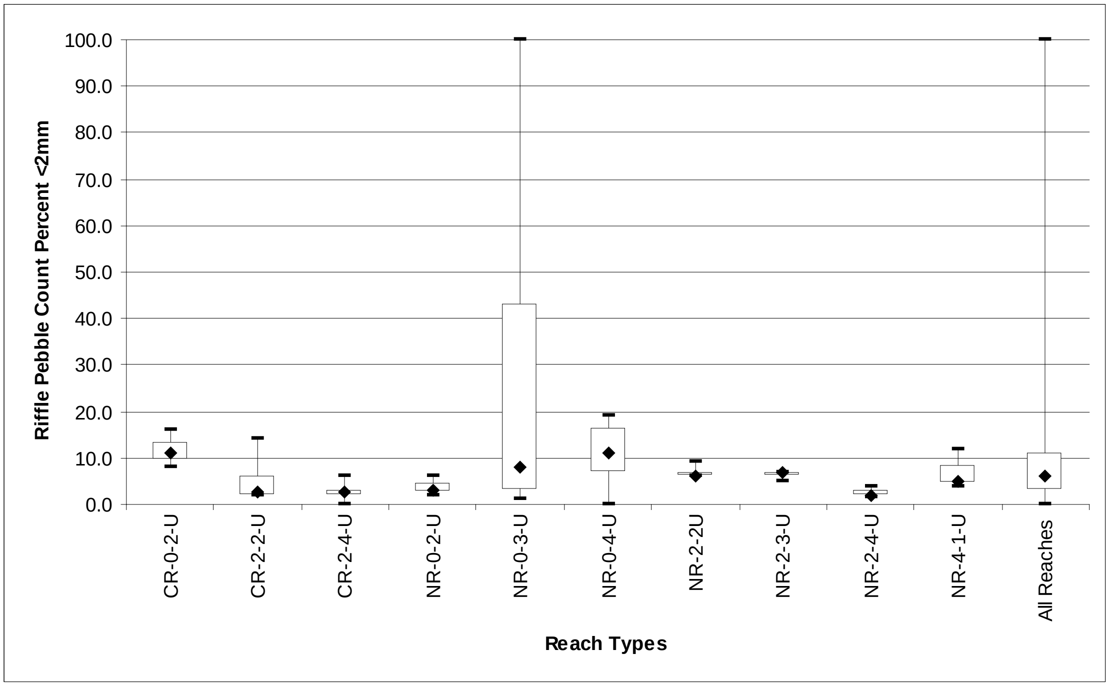

Figure 3-3. Riffle Pebble Count: Substrate Fines (<2mm) Segregated by Reach Type

Table 3-3. Summary of Riffle Pebble Count: Substrate Fines (<2mm) Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	3	6	6	3	12	15	6	3	3	3	60
Minimum	8.0	2.0	0.0	2.0	1.0	0.0	6.0	5.0	1.7	4.0	0.0
25th Percentile	9.5	2.0	2.0	2.5	3.0	7.0	6.0	6.0	1.8	4.5	3.0
Median	11.0	2.5	2.5	3.0	7.8	11.0	6.0	7.0	2.0	5.0	6.0
75th Percentile	13.5	6.0	3.0	4.5	43.0	16.5	6.8	7.0	3.0	8.5	11.0
Maximum	16.0	14.0	6.0	6.0	100.0	19.0	9.0	7.0	4.0	12.0	100.0

3.2.4 Riffle Pebble Count: Substrate Fines (<6mm)

As with surface fine sediment smaller than 2mm diameter, an accumulation of surface fine sediment less than 6mm diameter may indicate excess sedimentation. The size distribution of substrate material in the streambed is also indicative of habitat quality for salmonid spawning and incubation. Excess surface fine substrate smaller than 6.35 mm may have detrimental impacts on aquatic habitat. Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35 mm and the emergence success of westslope cutthroat trout and bull trout.

Previous assessments in western Montana specify a wide range of target values for fine sediment less than 6 mm in diameter. Values vary by stream type and specific sampling method. For this assessment a guideline threshold value for fine sediment <6mm in riffles is 20%, which represents an average value of the guideline values used in previous studies.

3.2.4.1 Reach Type Comparison

Riffle pebble count (<6mm) measured in the study reaches is plotted by reach type in Figure 3-4. Summary statistics for riffle pebble count (<6mm) of reach types are included in Table 3-4 following the box plot.

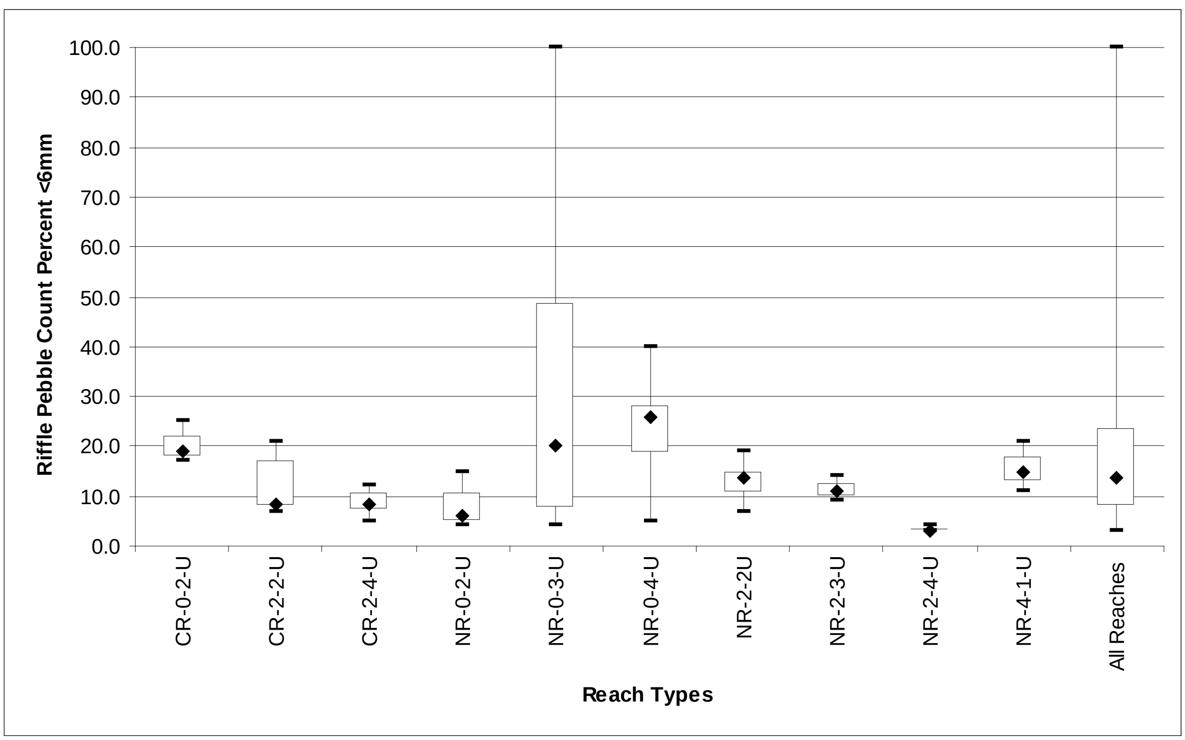

Figure 3-4. Riffle Pebble Count: Substrate Fines (<6mm) Segregated by Reach Type

Table 3-4. Summary of Riffle Pebble Count: Substrate Fines (<6mm) Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	3	6	6	3	12	15	6	3	3	3	60
Minimum	17.0	7.0	5.0	4.0	4.0	5.0	7.0	9.0	3.0	11.0	3.0
25th Percentile	18.0	8.0	7.3	5.0	7.8	18.5	10.8	10.0	3.0	13.0	8.0
Median	19.0	8.5	8.5	6.0	20.0	26.0	13.5	11.0	3.0	15.0	13.5
75th Percentile	22.0	17.3	10.5	10.5	48.5	28.0	14.8	12.5	3.5	18.0	23.5
Maximum	25.0	21.0	12.0	15.0	100.0	40.0	19.0	14.0	4.0	21.0	100.0

3.2.5 Riffle Grid Toss: Substrate Fines (<6mm)

The wire grid toss is a standard procedure frequently used in aquatic habitat assessment.
This method provides a more precise (repeatable) measurement of surface fine sediment than the broader survey approach of the Wolman pebble count. This measurement does not cover the entire channel width, as in the Wolman pebble count, but rather provides a more thorough measurement of surface fines in a subsample of the cross-section.

Previous assessments in western Montana specify a wide range of target values for fine sediment less than 6 mm in diameter. Values vary by stream type and specific sampling method. For this assessment a guideline threshold value for fine sediment <6mm in riffles is 20%, which represents an average value of the guideline values used in previous studies.

3.2.5.1 Reach Type Comparison

Riffle grid toss (fines<6mm) measured in the study reaches is plotted by reach type in Figure 3-5. Summary statistics for riffle grid toss results by reach type are included in Table 3-5 following the box plot.

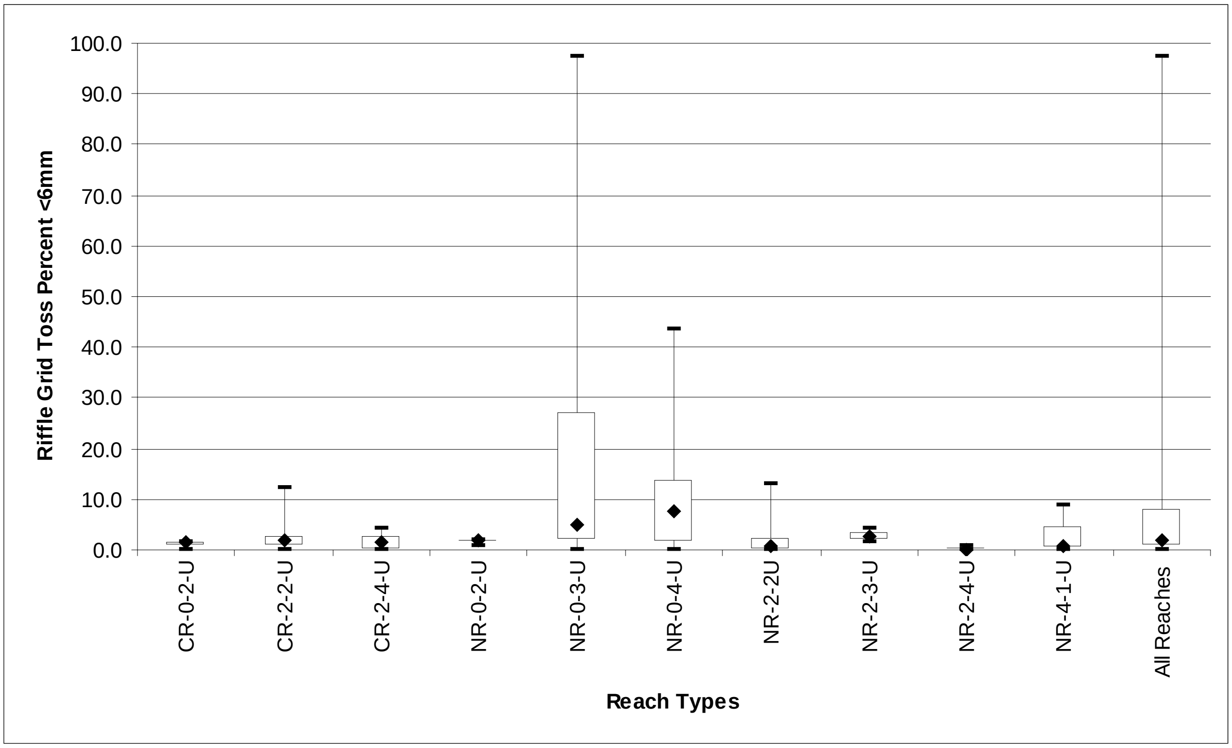

Figure 3-5. Riffle Grid Toss: Substrate Fines (<6mm) Segregated by Reach Type

Table 3-5. Summary of Riffle Grid Toss: Substrate Fines (<6mm) Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	3	6	6	3	12	15	6	3	3	3	60
Minimum	0.0	0.0	0.0	0.7	0.0	0.0	0.0	1.4	0.0	0.0	0.0
25th Percentile	0.7	0.9	0.2	1.4	2.0	1.4	0.2	2.1	0.0	0.4	0.7
Median	1.4	2.1	1.4	2.0	5.1	7.5	0.7	2.7	0.0	0.7	2.0
75th Percentile	1.4	2.7	2.5	2.0	27.2	13.6	2.2	3.4	0.4	4.8	7.8
Maximum	1.4	12.2	4.1	2.0	97.3	43.5	12.9	4.1	0.7	8.8	97.3

3.2.6 Pool Residual Depth (Reach mean value)

Residual pool depth, defined as the difference between pool maximum depth and 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 and high flow periods. Pool residual depth is also an indirect measurement of sediment inputs to listed streams. An increase in sediment loading would be expected to cause pools to fill, thus decreasing residual pool depth over time.

Previous assessments in western Montana specify target values for pool residual depth ranging from 1.5 ft to an average of 3 ft. Few individual pool depths exceeded 3 feet in the assessment reaches in this study, even in minimally impacted reaches, and most reaches had an average residual pool depth of less than 1.2 ft. Due to the stream sizes for most of the streams in the FS-TPA, a guideline value of 1.5 ft for mean residual pool depth appears to be the more suitable metric when examining these results.

3.2.6.1 Reach Type Comparison

Reach mean residual pool depth measured in the study reaches is plotted by reach type in Figure 3-6. Summary statistics for residual pool depth results by reach type are included in Table 3-6 following the box plot.

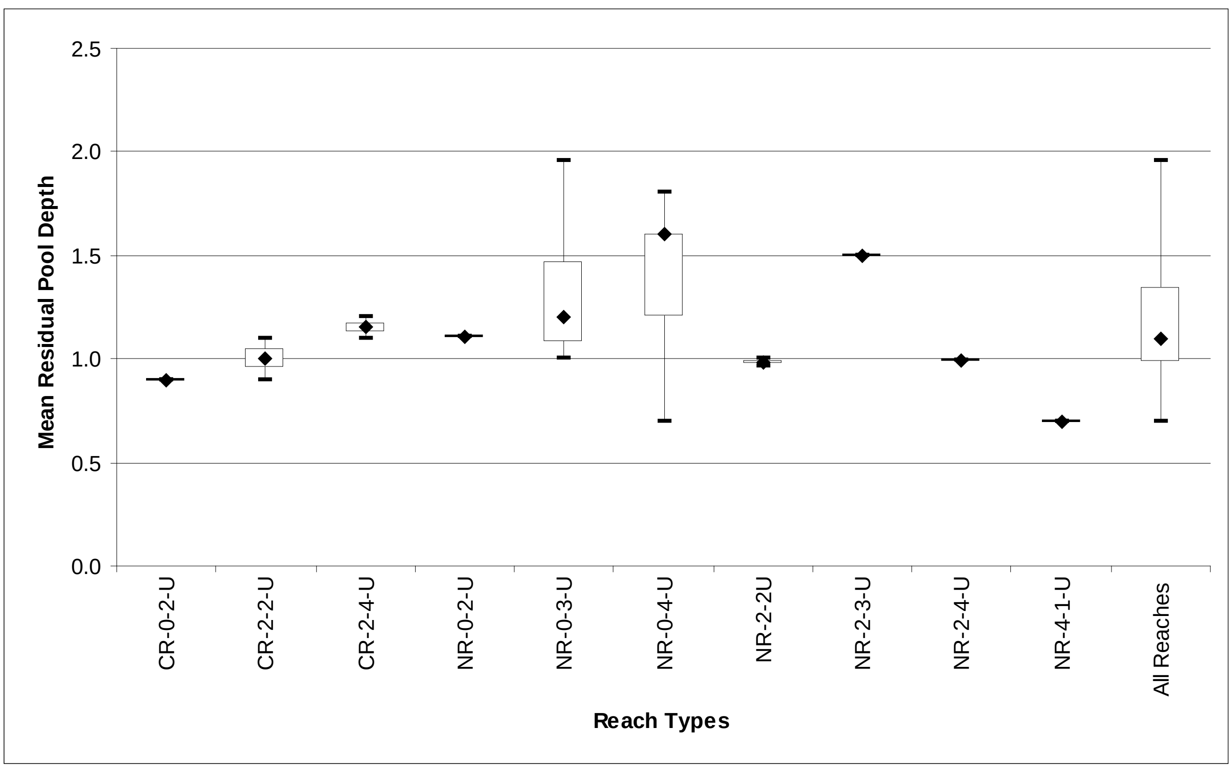

Figure 3-6. Mean Residual Pool Depths Segregated by Reach Type

Table 3-6. Summary of Mean Residual Pool Depth Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	1	2	2	1	4	5	2	1	1	1	20
Minimum	0.9	0.9	1.1	1.1	1.0	0.7	1.0	1.5	1.0	0.7	0.7
25th Percentile	0.9	1.0	1.1	1.1	1.1	1.2	1.0	1.5	1.0	0.7	1.0
Median	0.9	1.0	1.2	1.1	1.2	1.6	1.0	1.5	1.0	0.7	1.1
75th Percentile	0.9	1.1	1.2	1.1	1.5	1.6	1.0	1.5	1.0	0.7	1.4
Maximum	0.9	1.1	1.2	1.1	2.0	1.8	1.0	1.5	1.0	0.7	2.0

3.2.7 Pool Frequency (Count per 1000 ft)

Pool frequency is a measure of the availability of pool habitat 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 affected adversely by riparian habitat degradation resulting in a reduced supply of large woody debris or scouring from stable root masses in streambanks.

Previous assessments from western Montana have specified pool frequency target values that vary according to channel wetted width, and in some cases by stream order and Rosgen type. Average wetted width on assessed stream reaches in the FSTPA was approximately 25 ft. A target value of 47 pools per mile, or approximately 9 pools per thousand feet, was used in previous studies for reaches with a specified wetted width of 25 ft. Although wetted widths differ among the assessed reaches in the FSTPA, reaches with a pool frequency much below 9 pools/1000 ft may have reduced aquatic habitat quality.

3.2.7.1 Reach Type Comparison

Pool frequency measured in the study reaches is plotted by reach type in Figure 3-7. Summary statistics for pool frequency by reach type are included in Table 3-7 following the box plot.

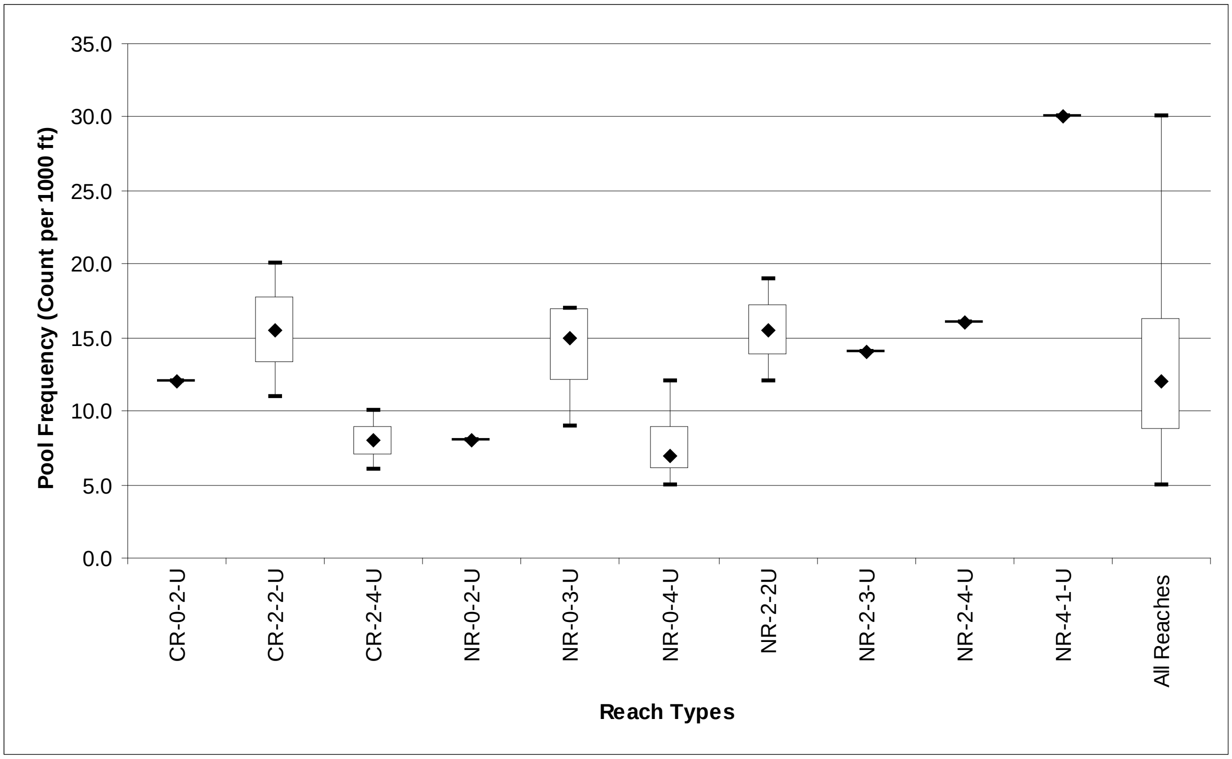

Figure 3-7. Pool Frequency Segregated by Reach Type

Table 3-7. Summary of Pool Frequency Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	1	2	2	1	4	5	2	1	1	1	20
Minimum	12.0	11.0	6.0	8.0	9.0	5.0	12.0	14.0	16.0	30.0	5.0
25th Percentile	12.0	13.3	7.0	8.0	12.0	6.0	13.8	14.0	16.0	30.0	8.8
Median	12.0	15.5	8.0	8.0	15.0	7.0	15.5	14.0	16.0	30.0	12.0
75th Percentile	12.0	17.8	9.0	8.0	17.0	9.0	17.3	14.0	16.0	30.0	16.3
Maximum	12.0	20.0	10.0	8.0	17.0	12.0	19.0	14.0	16.0	30.0	30.0

3.2.8 Large Woody Debris (Frequency per 1000 ft)

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. Large woody debris 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). Large woody debris frequency can be measured and compared to reference reaches or literature values to determine whether more or less LWD is present than would be expected under optimal conditions. Too high or too low an LWD frequency may indicate riparian habitat impairment or upstream influences on habitat quality.

Target values for LWD span a broad range of values, even for streams of similar size. A guideline value of approximately 150 pieces of LWD per mile, or approximately 28 pieces of LWD per 1000 ft, represents an average of target values from other studies with similar average reach width. Results for LWD should be interpreted with caution, as the guideline value for this parameter is tied to a high degree of variability due to land use, vegetative community, and soils among other factors.

3.2.8.1 Reach Type Comparison

Large woody debris frequency measured in the study reaches is plotted by reach type in Figure 3-8. Summary statistics for large woody debris frequency by reach type are included in Table 3-8 following the box plot.

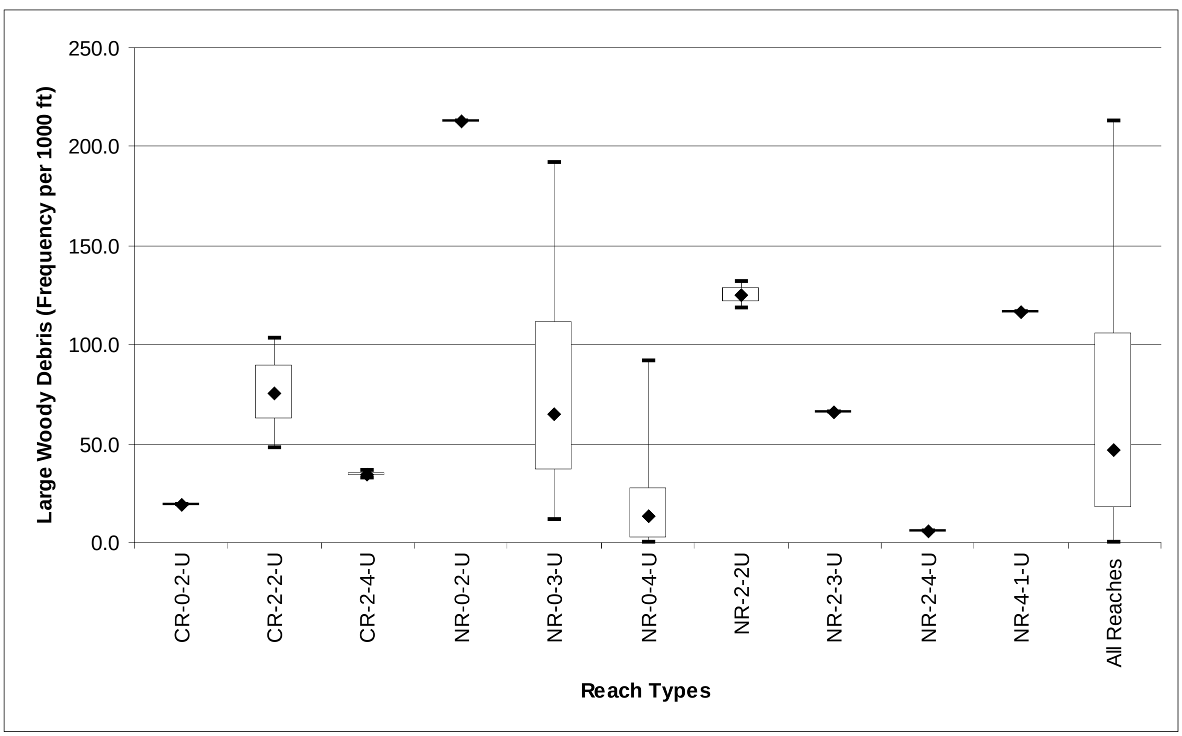

Figure 3-8. Large Woody Debris Segregated by Reach Type

Table 3-8. Summary of Large Woody Debris (LWD) Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	1	2	2	1	4	5	2	1	1	1	20
Minimum	19.0	48.0	32.0	213.0	11.0	0.0	118.0	66.0	6.0	116.0	0.0
25th Percentile	19.0	61.8	33.0	213.0	36.5	2.0	121.5	66.0	6.0	116.0	17.5
Median	19.0	75.5	34.0	213.0	65.0	13.0	125.0	66.0	6.0	116.0	46.5
75th Percentile	19.0	89.3	35.0	213.0	111.8	28.0	128.5	66.0	6.0	116.0	106.3
Maximum	19.0	103.0	36.0	213.0	192.0	92.0	132.0	66.0	6.0	116.0	213.0

3.2.9 Greenline Inventory: Percent Understory Shrub Cover

Riparian shrub cover is one of the most important influences 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. Overhanging branches of riparian shrubs provide important cover for aquatic species. In addition, riparian shrubs provide critical inputs of food for fish and their feed species. Terrestrial insects falling from riparian shrubs provide one main food source for fish. Organic inputs from shrubs, such as leaves and small twigs, provide food for aquatic macroinvertebrates, which are an important food source for fish.

Targets for streambank shrub cover and resulting streambank stability generally fall within the range of 75% to 85%, based on previous studies in Montana and Canada. Study reaches with lower than 75% shrub cover may be prone to excessive streambank erosion or have excessive streambank instability. It is important to keep in mind that understory shrub cover from study reaches may be low due to dense overstory canopy cover and competition from overstory canopy species, as in spruce-dominated reaches on smaller streams.

3.2.9.1 Reach Type Comparison

Percent understory shrub cover measured in the study reaches is plotted by reach type in Figure 3-9. Summary statistics for percent understory shrub cover by reach type are included in Table 3-9 following the box plot.

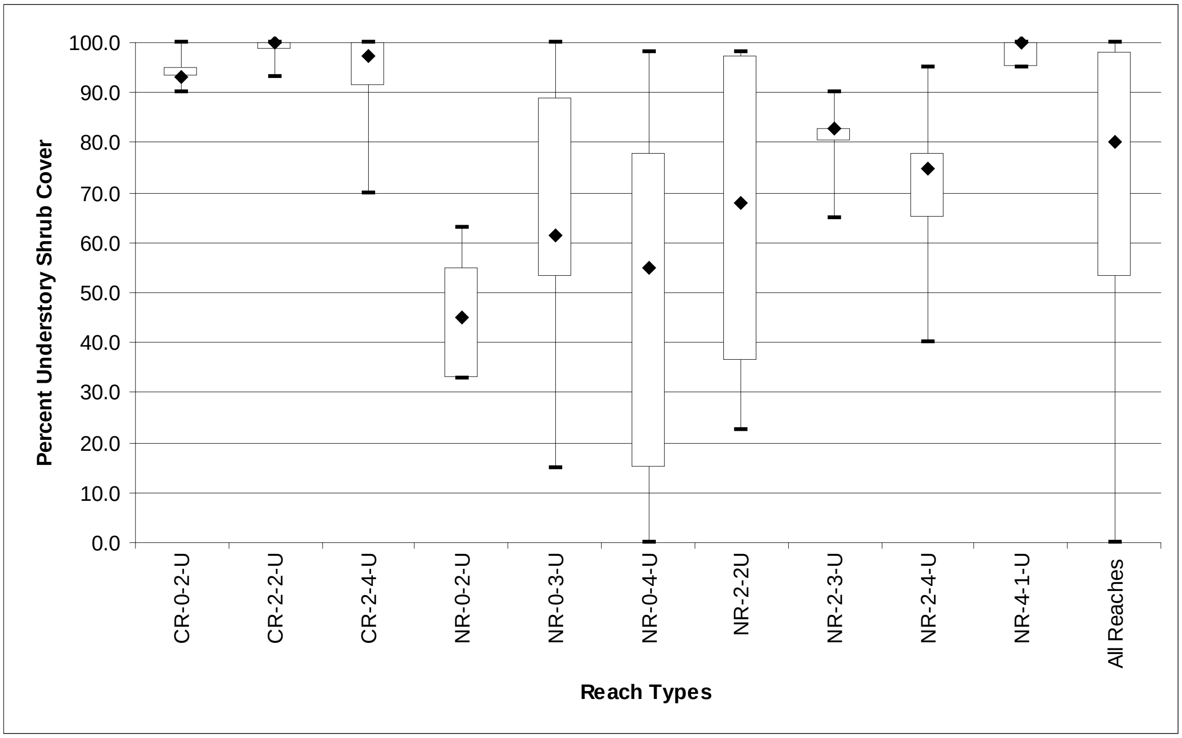

Figure 3-9. Percent Understory Shrub Cover Segregated by Reach Type

Table 3-9. Summary of Understory Shrub Cover Statistics by Reach Type.

	Reach Types										
Statistic	**CR-0-2-U**	**CR-2-2-U**	**CR-2-4-U**	**NR-0-2-U**	**NR-0-3-U**	**NR-0-4-U**	**NR-2-2U**	**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**	**All Reaches**
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	5	10	10	5	20	25	10	5	5	5	100
Minimum	90.0	93.0	70.0	33.0	15.0	0.0	22.5	65.0	40.0	95.0	0.0
25th Percentile	93.0	98.5	91.3	33.0	53.0	15.0	36.3	80.0	65.0	95.0	53.0
Median	93.0	100.0	97.5	45.0	61.5	55.0	67.8	83.0	75.0	100.0	80.0
75th Percentile	95.0	100.0	100.0	55.0	88.8	78.0	97.3	83.0	78.0	100.0	98.0
Maximum	100.0	100.0	100.0	63.0	100.0	98.0	98.0	90.0	95.0	100.0	100.0

3.2.10 Greenline Inventory: Percent 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 in cases where recent ground disturbance was observed, leaving bare soil exposed. 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. Sediment can wash in from unprotected areas due to snowmelt, storm runoff, or flooding. Bare areas are also much more susceptible to erosion from hoof shear. Most stream reaches have a small amount of naturally-occurring bare ground. As conditions are highly variable, this measurement is most useful when compared to reference values from best available conditions within the study area or literature values.

Natural levels of bare ground can vary according to the riparian site type or habitat type, and by the landscape setting of the stream reach. For the purposes of this assessment, a general guideline value of greater than or equal to 10% bare ground is assigned to indicate a potential reduced riparian habitat quality or lowered filtering capacity.

3.2.10.1 Reach Type Comparison

Percent bare ground measured in the study reaches is plotted by reach type in Figure 3-10. Summary statistics for percent bare ground by reach type are included in Table 3-10 following the box plot.

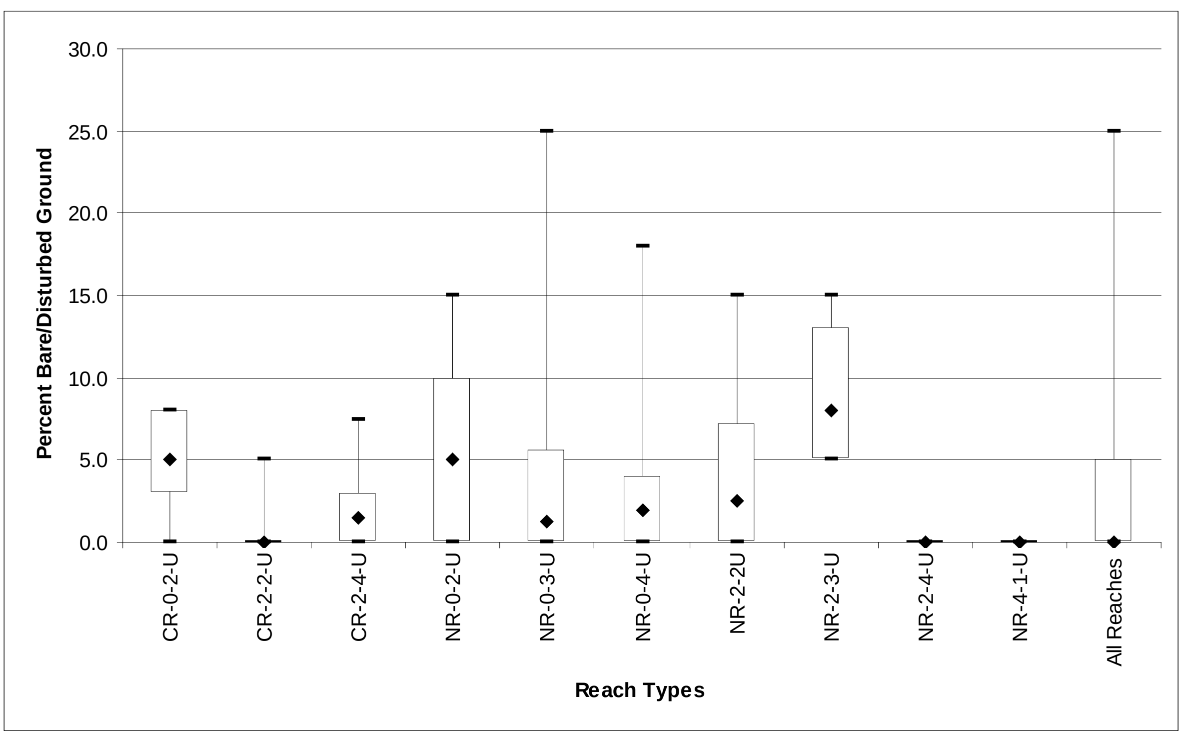

Figure 3-10. Percent Bare Ground Segregated by Reach Type

Table 3-10. Summary of Bare Ground Statistics by Reach Type

	Reach Types										
Statistic	CR-0-2-U	CR-2-2-U	CR-2-4-U	NR-0-2-U	NR-0-3-U	NR-0-4-U	NR-2-2U	NR-2-3-U	NR-2-4-U	NR-4-1-U	All Reaches
Number of Reaches	1	2	2	1	4	5	2	1	1	1	20
Sample Size	5	10	10	5	20	25	10	5	5	5	100
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
25th Percentile	3.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0
Median	5.0	0.0	1.5	5.0	1.3	2.0	2.5	8.0	0.0	0.0	0.0
75th Percentile	8.0	0.0	3.0	10.0	5.6	4.0	7.3	13.0	0.0	0.0	5.0
Maximum	8.0	5.0	7.5	15.0	25.0	18.0	15.0	15.0	0.0	0.0	25.0

3.3 Overview of Sampled Reaches

This section describes the reach types and specific assessment reaches sampled in 2008. Each reach type description is followed by general descriptions of conditions in each assessment reach within that type. Assessment reaches are mapped in Fig. 1-1, Section 1. Reach conditions pertaining to habitat condition and sediment sources are summarized in Table B-1, Appendix B (Stream notes summary).

3.3.1 Reach Type CR-0-2-U

This reach type is within the Canadian Rockies Ecoregion (USEPA 2002) and is characterized by a stream gradient of 0% to 2%. Reaches in this type are on second-order streams (Strahler 1952) within an unconfined valley.

3.3.1.1 Reach EFSC-12

Figure 3-11. Typical stream conditions in EFSC-12 Reach.

Reach EFSC-12 is the only reach within the CR-0-2-U reach type. The reach, classified as a Rosgen C4b stream type (Rosgen 1996) is on the East Fork of Swift Creek above Upper Whitefish Lake. Vegetation outside the riparian area is dominated by mature conifer forest and grass. Past logging activity (50+ years prior) likely caused shifts in stream morphology and stability, particularly at the lower ends of the reach, though good shrub cover and some conifers along banks have stabilized the channel. There is a small amount of visible bank erosion attributed to de-stabilized banks of non-natural origin, mostly at the downstream ends of the reach. The streambed is dominated by coarse gravels and at the time of the survey was mostly dry. In high water, deep pools and wide riffle sections would be present.

3.3.2 Reach Type CR-2-2-U

This reach type is within the Canadian Rockies Level III Ecoregion (USEPA. 2002) and is characterized by stream gradients of 2% to 4% on second-order streams (Strahler 1952) and within an unconfined valley.

3.3.2.1 Reach STIL-12

Figure 3-12. Typical stream conditions in STIL-12 Reach.

Reach STIL-12 is on the Stillwater River in an area dominated by mature conifers (spruce, subalpine fir) on both banks. The riparian communities along the banks are diverse and vigorous, with dense root masses contributing to good bank stability. Bank erosion is minimal and primarily of natural cause. The stream is a C4b Rosgen stream type (Rosgen 1996) with a coarse gravel substrate. Spawning gravels are common, as is large woody debris. Pools are infrequent and shallow.

3.3.2.2 Reach WFSC-08

Figure 3-13. Typical stream conditions in WFSC-08 Reach.

Reach WFSC-08 of the West Fork of Swift Creek is classified as a B4 Rosgen stream type and is dominated by mature conifer forest. Historic logging activity in the drainage is not currently impacting the stream. Understory shrub growth is vigorous. The substrate is medium to coarse gravel, with larger gravels having potentially been deposited recently. Spawning gravels are present. Large woody debris is present, but not abundant.

3.3.3 Reach Type CR-2-4-U

This reach type is within the Canadian Rockies third level Ecoregion. Streams monitored in this Reach Type are in both Crestal Alpine-Subalpine and Western Canadian Rockies fourth level Ecoregions, both characterized by a stream gradient of 2% to 4%, on fourth-order streams (Strahler 1952) and within an unconfined valley.

3.3.3.1 Reach STIL-19

Figure 3-14. Typical stream conditions in STIL-19 Reach.

Reach STIL-19 of the Stillwater River is surrounded by coniferous forest. The reach is a Rosgen C3b stream type within the Crestal Alpine-Subalpine fourth level Ecoregion. Due to past logging around and upstream of the reach, the channel shows signs of adjustment, with some natural bank scours, and a low diversity and presence of large woody debris and pools. Channel substrate is dominated by large gravels to small cobbles and spawning gravels are marginal. There is good shrub diversity and cover in the riparian area, and the surrounding floodplain forest is young.

3.3.3.2 Reach STIL-23

Reach STIL-23 is surrounded by mature mid-seral forest and shrub land. The reach is classified as a B4 stream type in the Western Canadian Rockies fourth level Ecoregion. The reach shows some signs of active adjustment to historic logging activity. Most bank erosion is occurring slowly and influence by natural cycles and high-flow events. Large gravels are the dominant substrate and spawning gravels are present in most cells. Pools and large woody debris are not abundant.

Figure 3-15. Typical stream conditions in STIL-23 Reach.

3.3.4 Reach Type NR-0-2-U

This reach type is within the Northern Rockies level three Ecoregion (USEPA 2002) and is characterized by a stream gradient of 0% to 2%, on second-order streams and within an unconfined valley. There is only one assessment reach in this reach type.

3.3.4.1 Reach EFSC-15

Figure 3-16. Typical stream conditions in EFSC-15 Reach.

Reach EFSC-15 is on the East Fork of Swift Creek in the Stillwater-Swan Wooded Valley fourth-level Ecoregion. It is a B4 Rosgen stream type and is surrounded by mature conifers. Land use impacts to the stream are negligible. Erosion is minimal and the channel is mostly stable, with large amounts of woody debris in the stream. The substrate is predominantly large gravels, of which some are suitable for spawning.

3.3.5 Reach Type NR-0-3-U

This reach type is within the Northern Rockies third level Ecoregion and characterized by a stream gradient of <2% on third-order streams and within an unconfined valley.

3.3.5.1 Reach HASK-13


Figure 3-17. Typical stream conditions in HASK-13 Reach.

The HASK-13 stream reach on Haskill Creek is within the Flathead Valley fourth level Ecoregion. It is a Rosgen C5 stream type with low sinuosity. The riparian vegetation is dominated by invasive grass species and provides a very limited supply of large woody debris. Beaver activity has influenced the stream historically but less so in the last few years. The substrate type is predominantly sand with naturally silted conditions due to beaver. Upstream agricultural activity does not appear to affect habitat conditions in this reach noticeably.

3.3.5.2 Reach LOGA-20


Figure 3-18. Typical stream conditions in LOGA-20 Reach.

The LOGA-20 reach is on Logan Creek in the Salish Mountain fourth level Ecoregion. It is a C4 Rosgen stream type characterized by a low sinuosity and dominated by mature spruce forest. Signs of light recreational use were observed. Large woody debris is present in the stream, although the riparian area is dominated by shrubs. This reach displays a diversity of aquatic habitat. The substrate type is small to medium gravels with some siltation. There is limited spawning habitat.

3.3.5.3 Reach SHEP-25

Figure 3-19. Typical stream conditions in SHEP-25 Reach.

The SHEP-25 reach is on Sheppard Creek within a mature conifer forest in the Salish Mountain level four Ecoregion (USEPA 2002). The reach is classified as a C3 Rosgen Stream type. Cobble substrates are dominant with few gravels suitable for spawning. The stream is well-armored and streambank erosion is infrequent. Large woody debris is present throughout the stream. Fire consumed this area in 2007, and forbs and shrub regrowth currently dominate the riparian area and adjacent uplands.

3.3.5.4 Reach WFSC-18

Figure 3-20. Typical stream conditions in WFSC-18 Reach.

Reach WFSC-18 is within the Stillwater-Swan Wooded Valley level four Ecoregion. It is classified as a C4b Rosgen stream type. No past human impacts are apparent, and this stream reach possesses some of the best available conditions within the study reaches. The riparian shrub community has good vigor and condition, and the channel is stable throughout this reach.

3.3.6 Reach Type NR-0-4-U

This reach type is in the Northern Rockies level three Ecoregion, and is characterized by fourth order streams with a 0-2% stream gradient and within an unconfined valley. Five of the reaches selected for assessment are in this reach type.

3.3.6.1 Reach ASHL-19

Figure 3-21. Typical stream conditions in ASHL-19 Reach.

This reach is in the Salish Mountains level four Ecoregion. Agricultural crops and grazing are the dominant land uses along this reach. It is a B4 Rosgen stream type with a low slope. The stream is incised and has unstable banks trampled by cattle in some areas. Small gravels are dominant and provide ample spawning substrate. Woody debris is very limited, as the riparian area is predominantly introduced grasses and forbs with minimal overstory canopy and understory shrub cover. Sediment loading from actively eroding banks is notable.

3.3.6.2 Reach ASHL-25

Figure 3-22. Typical stream conditions in ASHL-25 Reach.

The ASHL-25 reach is on Ashley Creek in the Flathead Valley fourth level Ecoregion. It is classified a C4 Rosgen stream type. Shrubs are the dominant vegetation and medium-sized gravels the dominant substrate. The stream has been channelized due to its urban setting, confined between housing developments and a highway. The substrate is small to medium gravels. Recent beaver activity is evident in the reach. Introduced riparian species and garbage are common in this reach.

3.3.6.3 Reach ASHL-29

Figure 3-23. Typical stream conditions in ASHL-29 Reach.

This reach, ASHL-29, is in the Flathead Valley fourth level Ecoregion. This reach of Ashley Creek is classified as a B4c Rosgen stream type. The stream energy has been altered from both natural and historic land use causes. Rip-rap in the channel indicates historic manipulation of the channel. Grasses and shrubs are the dominant vegetation. The substrate is small gravels. Erosion is not severe but is widespread.

3.3.6.4 Reach LOGA-45

Figure 3-24. Typical stream conditions in LOGA-45 Reach.

This reach of Logan Creek is in the Stillwater-Swan Wooded Valley fourth level Ecoregion and is a B3 Rosgen stream type. Mature conifers line the riparian areas of this reach. There has been recent and historic logging in the watershed. Riparian shrub cover is good and the channel is stable and well-armored. The cobble substrate has few pools or large woody debris.

3.3.6.5 Reach STIL-33

Figure 3-25. Typical stream conditions in STIL-33 Reach.

This reach of the Stillwater River is in the Stillwater-Swan Wooded Valley fourth level Ecoregion. It is classified as B4c Rosgen stream type and is dominated by mature conifers. Large stumps in the floodplain indicate historic logging. The stream is highly embedded and fine sediment is common throughout the small gravel- dominated substrate. Vigorous riparian shrubs and some exotic grasses on banks are present.

3.3.7 Reach Type NR-2-2-U

This reach type is in the Northern Rockies level three Ecoregion, characterized by a 2-4% stream gradient for second order streams (Strahler 1952) and within an unconfined valley.

3.3.7.1 Reach EFSC-16

Figure 3-26. Typical stream conditions in EFSC-16 Reach.

This reach is in the Stillwater-Swan Wooded Valley fourth level Ecoregion. It is a C4 Rosgen stream type with well-defined pools and excellent riparian vegetation. The substrate is medium to large gravels. This stream reach is an example of best available conditions among the assessed reaches.

3.3.7.2 Reach SHEP-18

Figure 3-27. Typical stream conditions in SHEP-18 Reach.

Reach SHEP-18 is within the Salish Mountains fourth level Ecoregion. Described as a C4b Rosgen stream type, it runs through an area that was completely burned in 2007. Forbs are dominant and woody debris is common in the stream. Substrate is predominantly gravel, and larger substrate creates deep but infrequent pools.

3.3.8 Reach Type NR-2-3-U

This reach type is in the Northern Rockies level three Ecoregion, characterized by a 2-4% stream gradient for third order streams and within an unconfined valley. There is one stream reach in this stream type.

3.3.8.1 Reach HASK-06

Figure 3-28. Typical stream conditions in HASK-06 Reach.

This reach is on Haskill Creek within the Stillwater-Swan Wooded Valley fourth level Ecoregion. The reach is characterized as a B4 Rosgen stream type with low sinuosity. The channel is stable but is recovering from dramatic changes to the riparian area and large woody debris supply due to historic removal of large cedar trees. Some riparian clearing and an old road bed are present but not impacting the stream noticeably. The understory is naturally sparse.

3.3.9 Reach Type NR-2-4-U

This reach type is in the Northern Rockies level three Ecoregion, characterized by a 2-4% stream gradient for fourth order streams and within an unconfined valley. There is one stream reach in this stream type.

3.3.9.1 Reach LOGA-37

Figure 3-29. Typical stream conditions in LOGA-37 Reach.

This reach of Logan Creek is within the Stillwater-Swan Wooded Valley fourth level Ecoregion and is classified as a B3 Rosgen stream type. Streambanks are stable and channel has few pools or large woody debris. The dominant substrate is cobbles. Wildlife browse of the riparian vegetation is moderate.

3.3.10 Reach Type NR-4-1-U

This reach type is in the Northern Rockies level three Ecoregion, characterized by a 4-10% stream gradient for first order streams and within an unconfined valley. There is one stream reach in this stream type.

3.3.10.1 Reach FISH-05

This reach of Fish Creek is within the Salish Mountains fourth level Ecoregion and is classified as an A4 Rosgen stream type. The reach is generally characteristic of Rosgen A-type streams but is not as entrenched. There is infrequent spawning habitat in the gravel substrate, and a light surface of silt is common. There is minimal land use impact on the stream, potentially some from roads upstream of the reach and slight reduction in canopy cover due to timber harvest outside the riparian corridor.

Figure 3-30. Typical stream conditions in FISH-05 Reach.

3.4 Data Summary: Sampled Reach Comparisons

Assessment results are compared among all reaches in the following sections. The results summary in the following section includes box plot charts comparing results from each study reach for each study variable. Summary statistics among reaches for each variable are presented in tables following the box plots. Variables tallied reach wide that are not measured separately among cells in study reaches are not plotted by reach. These variables are Mean Residual Pool Depth, Pool Frequency, and Large Woody Debris.

3.4.1 Width/Depth Ratio

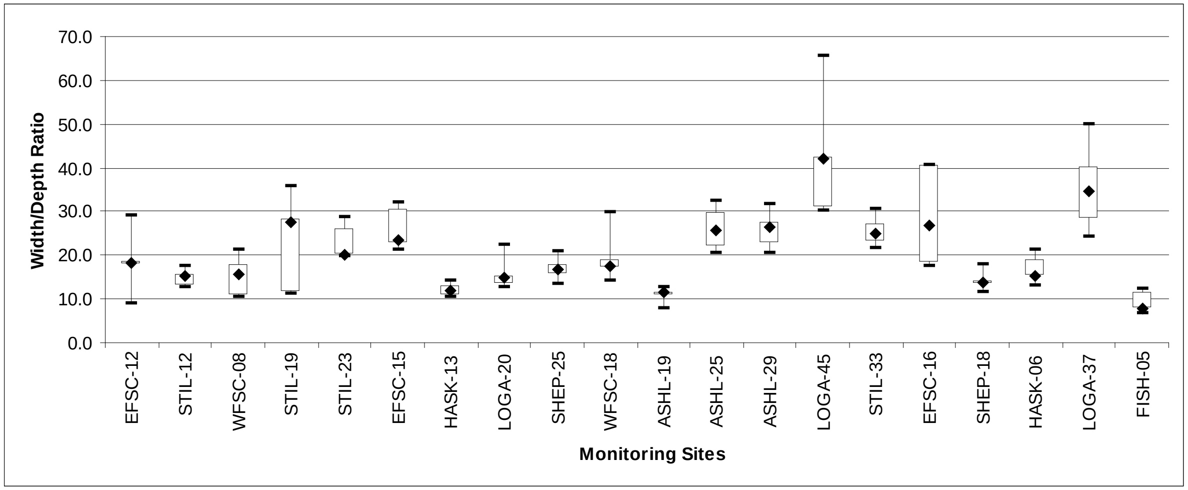

Figure 3-31. Width/Depth Ratio Segregated by Reach

Table 3-11. Summary of Width/Depth Ratio Statistics by Reach

Statistic	Reaches																			
Reach Type	**CR-0-2-U**	**CR-2-2-U**		**CR-2-4-U**		**NR-0-2-U**	**NR-0-3-U**				**NR-0-4-U**					**NR-2-2-U**		**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**
Reach	**EFSC-12**	**STIL-12**	**WFSC-08**	**STIL-19**	**STIL-23**	**EFSC-15**	**HASK-13**	**LOGA-20**	**SHEP-25**	**WFSC-18**	**ASHL-19**	**ASHL-25**	**ASHL-29**	**LOGA-45**	**STIL-33**	**EFSC-16**	**SHEP-18**	**HASK-06**	**LOGA-37**	**FISH-05**
Sample Size	5	5	5	5	5	5	4	5	5	5	5	4	5	5	4	5	5	5	5	5
Minimum	8.9	12.7	10.3	11.2	19.6	21.3	10.3	12.7	13.3	14.3	8.0	20.3	20.5	30.1	21.4	17.4	11.6	13.0	24.3	6.9
25th Percentile	17.9	12.9	10.8	11.5	20.2	22.7	10.7	13.3	15.5	17.1	10.9	21.8	22.8	31.0	23.1	18.1	13.3	15.1	28.2	7.7
Median	18.3	15.2	15.5	27.5	20.3	23.4	11.8	15.0	16.9	17.4	11.4	25.5	26.6	42.1	24.8	26.9	13.7	15.4	34.8	8.0
75th Percentile	18.8	15.7	17.9	28.4	26.2	30.5	13.1	15.4	17.9	19.1	11.5	29.7	27.5	42.3	27.1	40.8	14.0	18.9	40.1	11.4
Maximum	29.1	17.5	21.2	35.8	28.5	32.0	14.2	22.2	20.7	29.9	12.6	32.4	31.7	65.4	30.5	40.8	17.7	21.2	49.8	12.2

3.4.2 Entrenchment Ratio

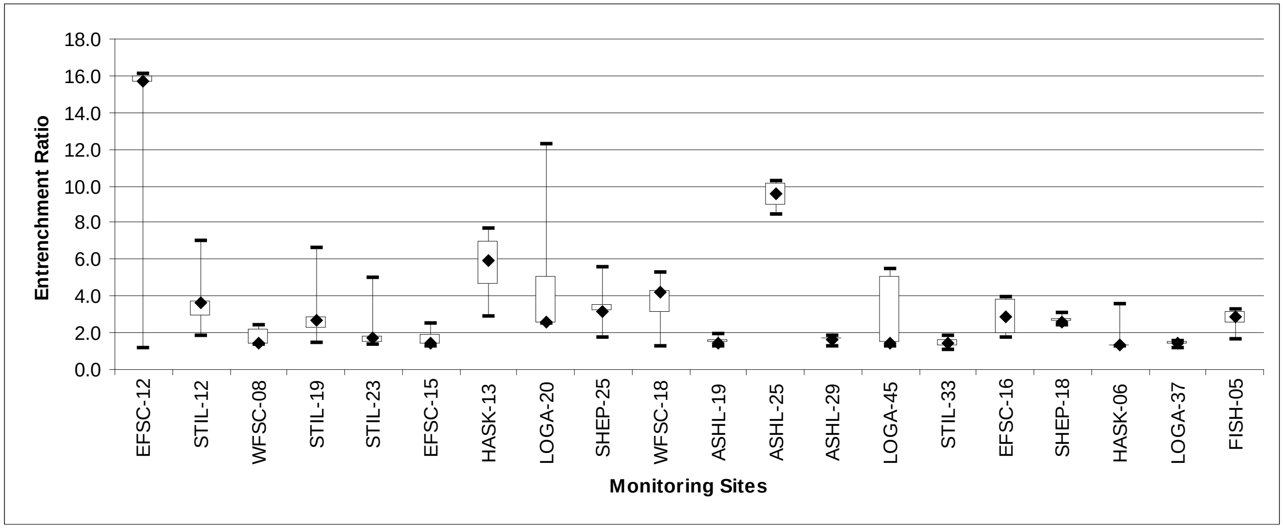

Figure 3-32. Entrenchment Ratio Segregated by Reach

Table 3-12. Summary of Entrenchment Ratio Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	**CR-0-2-U**	**CR-2-2-U**		**CR-2-4-U**		**NR-0-2-U**	**NR-0-3-U**				**NR-0-4-U**					**NR-2-2-U**		**NR-2-3-U**	**NR-2-4-U**	**NR-4-1-U**
Reach	**EFSC-12**	**STIL-12**	**WFSC-08**	**STIL-19**	**STIL-23**	**EFSC-15**	**HASK-13**	**LOGA-20**	**SHEP-25**	**WFSC-18**	**ASHL-19**	**ASHL-25**	**ASHL-29**	**LOGA-45**	**STIL-33**	**EFSC-16**	**SHEP-18**	**HASK-06**	**LOGA-37**	**FISH-05**
Sample Size	5	5	5	5	5	5	4	5	5	5	5	4	5	5	4	4	5	5	5	5
Minimum	1.2	1.9	1.3	1.4	1.4	1.3	2.8	2.5	1.8	1.3	1.2	8.4	1.2	1.3	1.1	1.7	2.4	1.2	1.1	1.6
25th Percentile	15.6	2.9	1.3	2.2	1.4	1.3	4.6	2.5	3.1	3.0	1.4	8.9	1.6	1.4	1.2	1.9	2.5	1.2	1.3	2.5
Median	15.7	3.6	1.4	2.7	1.7	1.4	6.0	2.6	3.2	4.2	1.4	9.6	1.7	1.4	1.4	2.9	2.6	1.4	1.5	2.9
75th Percentile	16.0	3.8	2.2	2.9	1.8	1.9	7.0	5.0	3.5	4.4	1.6	10.1	1.7	5.1	1.6	3.8	2.8	1.4	1.5	3.2
Maximum	16.1	7.0	2.4	6.6	5.0	2.5	7.7	12.3	5.6	5.3	1.9	10.2	1.8	5.5	1.9	4.0	3.1	3.5	1.6	3.2

3.4.3 Riffle Pebble Count (Substrate <2mm)

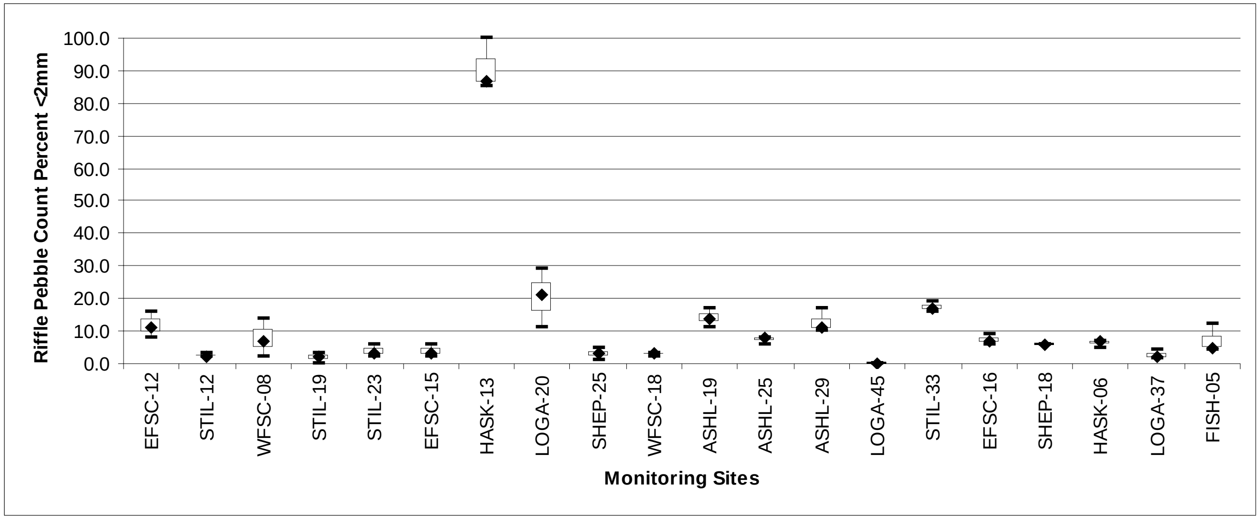

Figure 3-33. Riffle Pebble Count: Substrate Fines (<2mm) Segregated by Reach

Table 3-13. Summary of Riffle Pebble Count: Substrate Fines (<2mm) Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	CR-0-2-U	CR-2-2-U		CR-2-4-U		NR-0-2-U	NR-0-3-U				NR-0-4-U					NR-2-2-U		NR-2-3-U	NR-2-4-U	NR-4-1-U
Reach	EFSC-12	STIL-12	WFSC-08	STIL-19	STIL-23	EFSC-15	HASK-13	LOGA-20	SHEP-25	WFSC-18	ASHL-19	ASHL-25	ASHL-29	LOGA-45	STIL-33	EFSC-16	SHEP-18	HASK-06	LOGA-37	FISH-05
Sample Size	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Minimum	8.0	2.0	2.0	0.0	2.0	2.0	85.0	11.0	1.0	2.0	11.0	6.0	10.0	0.0	16.0	6.0	6.0	5.0	1.7	4.0
25th Percentile	9.5	2.0	4.5	1.0	2.5	2.5	86.0	16.0	2.0	2.5	12.5	7.0	10.5	0.0	16.5	6.5	6.0	6.0	1.8	4.5
Median	11.0	2.0	7.0	2.0	3.0	3.0	87.0	21.0	3.0	3.0	14.0	8.0	11.0	0.0	17.0	7.0	6.0	7.0	2.0	5.0
75th Percentile	13.5	2.5	10.5	2.5	4.5	4.5	93.5	25.0	3.8	3.0	15.5	8.0	14.0	0.0	18.0	8.0	6.0	7.0	3.0	8.5
Maximum	16.0	3.0	14.0	3.0	6.0	6.0	100.0	29.0	4.7	3.0	17.0	8.0	17.0	0.0	19.0	9.0	6.0	7.0	4.0	12.0

3.4.4 Riffle Pebble Count (Substrate <6mm)

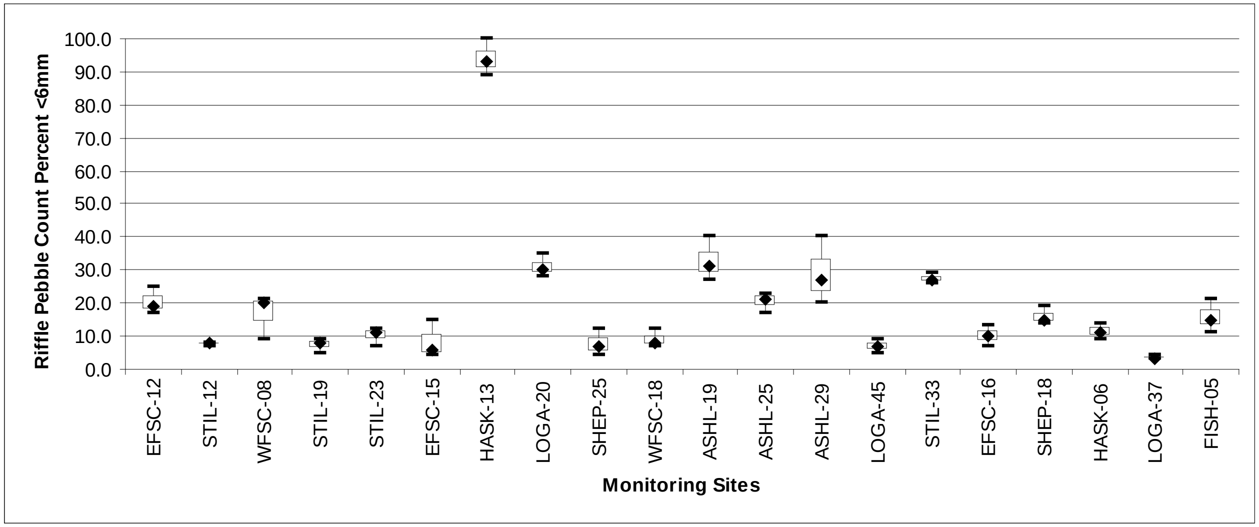

Figure 3-34. Riffle Pebble Count: Substrate Fines (<6mm) Segregated by Reach

Table 3-14. Summary of Riffle Pebble Count: Substrate Fines (<6mm) Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	CR-0-2-U	CR-2-2-U		CR-2-4-U		NR-0-2-U	NR-0-3-U				NR-0-4-U					NR-2-2-U		NR-2-3-U	NR-2-4-U	NR-4-1-U
Reach	EFSC-12	STIL-12	WFSC-08	STIL-19	STIL-23	EFSC-15	HASK-13	LOGA-20	SHEP-25	WFSC-18	ASHL-19	ASHL-25	ASHL-29	LOGA-45	STIL-33	EFSC-16	SHEP-18	HASK-06	LOGA-37	FISH-05
Sample Size	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Minimum	17.0	7.0	9.0	5.0	7.0	4.0	89.0	28.0	4.0	7.0	27.0	17.0	20.0	5.0	26.0	7.0	14.0	9.0	3.0	11.0
25th Percentile	18.0	7.5	14.5	6.5	9.0	5.0	91.0	29.0	5.5	7.5	29.0	19.0	23.5	6.0	26.5	8.5	14.5	10.0	3.0	13.0
Median	19.0	8.0	20.0	8.0	11.0	6.0	93.0	30.0	7.0	8.0	31.0	21.0	27.0	7.0	27.0	10.0	15.0	11.0	3.0	15.0
75th Percentile	22.0	8.0	20.5	8.5	11.5	10.5	96.5	32.5	9.5	10.0	35.5	22.0	33.5	8.0	28.0	11.5	17.0	12.5	3.5	18.0
Maximum	25.0	8.0	21.0	9.0	12.0	15.0	100.0	35.0	12.0	12.0	40.0	23.0	40.0	9.0	29.0	13.0	19.0	14.0	4.0	21.0

3.4.5 Riffle Grid Toss (Substrate <6mm)

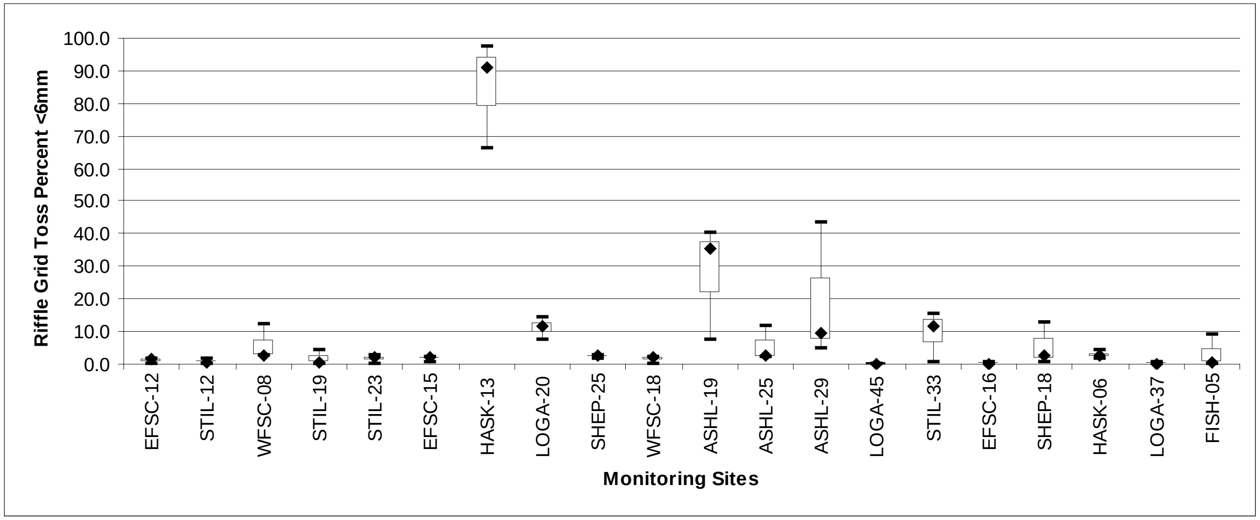

Figure 3-35. Riffle Grid Toss: Substrate Fines (<6mm) Segregated by Reach

Table 3-15. Summary of Riffle Grid Toss: Substrate Fines (<6mm) Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	CR-0-2-U	CR-2-2-U		CR-2-4-U		NR-0-2-U	NR-0-3-U				NR-0-4-U					NR-2-2-U		NR-2-3-U	NR-2-4-U	NR-4-1-U
Reach	EFSC-12	STIL-12	WFSC-08	STIL-19	STIL-23	EFSC-15	HASK-13	LOGA-20	SHEP-25	WFSC-18	ASHL-19	ASHL-25	ASHL-29	LOGA-45	STIL-33	EFSC-16	SHEP-18	HASK-06	LOGA-37	FISH-05
Sample Size	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Minimum	0.0	0.0	2.7	0.0	0.0	0.7	66.0	7.5	1.4	0.0	7.5	2.0	4.8	0.0	0.7	0.0	0.7	1.4	0.0	0.0
25th Percentile	0.7	0.4	2.7	0.4	1.0	1.4	78.6	9.6	2.1	1.0	21.5	2.4	7.2	0.0	6.2	0.0	1.7	2.1	0.0	0.4
Median	1.4	0.7	2.7	0.7	2.0	2.0	91.2	11.6	2.7	2.0	35.4	2.7	9.5	0.0	11.6	0.0	2.7	2.7	0.0	0.7
75th Percentile	1.4	1.1	7.5	2.4	2.4	2.0	94.3	13.0	2.7	2.0	37.8	7.2	26.5	0.0	13.6	0.3	7.8	3.4	0.4	4.8
Maximum	1.4	1.4	12.2	4.1	2.7	2.0	97.3	14.3	2.7	2.0	40.1	11.6	43.5	0.0	15.6	0.7	12.9	4.1	0.7	8.8

3.4.6 Percent Understory Shrub Cover

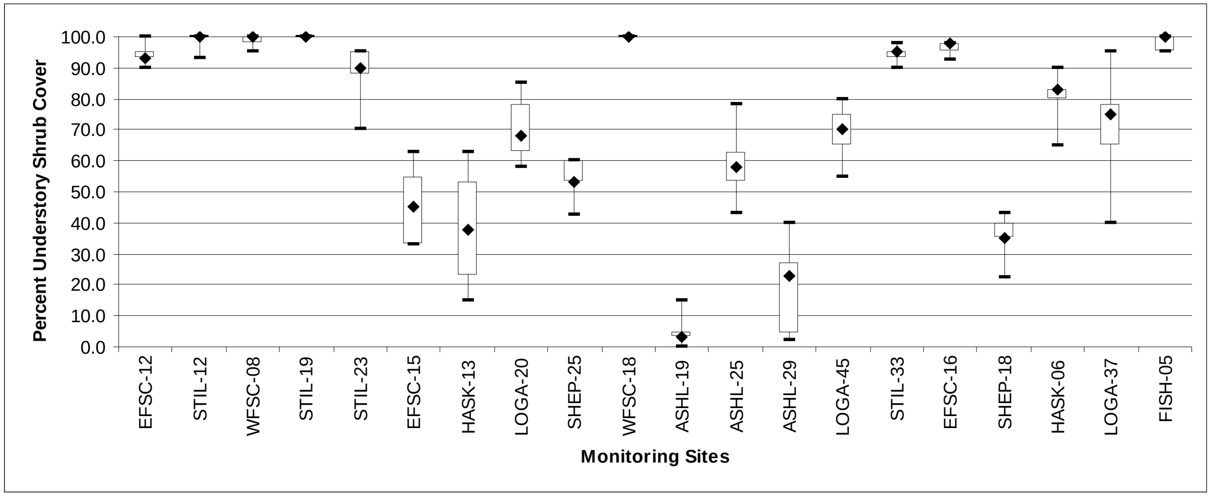

Figure 3-36. Percent Understory Shrub Cover Segregated by Reach

Table 3-16. Summary of Understory Shrub Cover Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	CR-0-2-U	CR-2-2-U		CR-2-4-U		NR-0-2-U	NR-0-3-U				NR-0-4-U					NR-2-2-U		NR-2-3-U	NR-2-4-U	NR-4-1-U
Reach	EFSC-12	STIL-12	WFSC-08	STIL-19	STIL-23	EFSC-15	HASK-13	LOGA-20	SHEP-25	WFSC-18	ASHL-19	ASHL-25	ASHL-29	LOGA-45	STIL-33	EFSC-16	SHEP-18	HASK-06	LOGA-37	FISH-05
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum	90.0	93.0	95.0	100.0	70.0	33.0	15.0	58.0	42.5	100.0	0.0	43.0	2.0	55.0	90.0	92.5	22.5	65.0	40.0	95.0
25th Percentile	93.0	100.0	98.0	100.0	88.0	33.0	23.0	63.0	53.0	100.0	3.0	53.0	4.0	65.0	93.0	95.0	35.0	80.0	65.0	95.0
Median	93.0	100.0	100.0	100.0	90.0	45.0	38.0	68.0	53.0	100.0	3.0	58.0	23.0	70.0	95.0	98.0	35.0	83.0	75.0	100.0
75th Percentile	95.0	100.0	100.0	100.0	95.0	55.0	53.0	78.0	60.0	100.0	5.0	63.0	27.0	75.0	95.0	98.0	40.0	83.0	78.0	100.0
Maximum	100.0	100.0	100.0	100.0	95.0	63.0	63.0	85.0	60.0	100.0	15.0	78.0	40.0	80.0	98.0	98.0	43.0	90.0	95.0	100.0

3.4.7 Percent Bare Ground

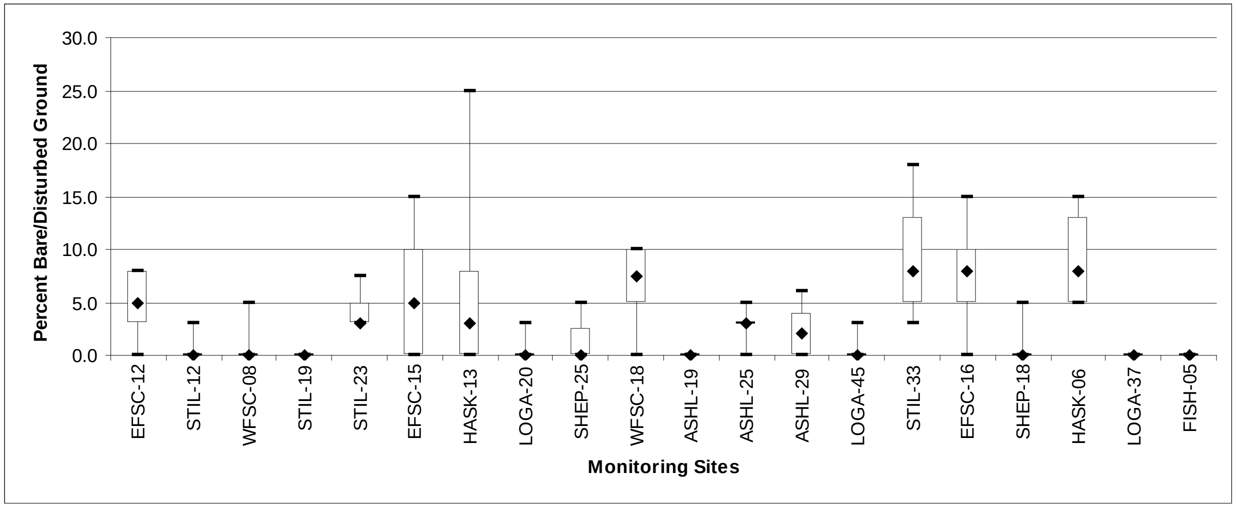

Figure 3-37. Percent Bare Ground Segregated by Reach

Table 3-17. Summary of Bare Ground Statistics Segregated by Reach

Statistic	Reaches																			
Reach Type	CR-0-2-U	CR-2-2-U		CR-2-4-U		NR-0-2-U	NR-0-3-U				NR-0-4-U					NR-2-2-U		NR-2-3-U	NR-2-4-U	NR-4-1-U
Reach	EFSC-12	STIL-12	WFSC-08	STIL-19	STIL-23	EFSC-15	HASK-13	LOGA-20	SHEP-25	WFSC-18	ASHL-19	ASHL-25	ASHL-29	LOGA-45	STIL-33	EFSC-16	SHEP-18	HASK-06	LOGA-37	FISH-05
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	5.0	0.0	0.0
25th Percentile	3.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	5.0	0.0	3.0	0.0	0.0	5.0	5.0	0.0	5.0	0.0	0.0
Median	5.0	0.0	0.0	0.0	3.0	5.0	3.0	0.0	0.0	7.5	0.0	3.0	2.0	0.0	8.0	8.0	0.0	8.0	0.0	0.0
75th Percentile	8.0	0.0	0.0	0.0	5.0	10.0	8.0	0.0	2.5	10.0	0.0	3.0	4.0	0.0	13.0	10.0	0.0	13.0	0.0	0.0
Maximum	8.0	3.0	5.0	0.0	7.5	15.0	25.0	3.0	5.0	10.0	0.0	5.0	6.0	3.0	18.0	15.0	5.0	15.0	0.0	0.0

4.0 STREAMBANK EROSION SOURCE ASSESSMENT

4.1 Overview

For each monitoring reach selected in the aerial photo assessment, measurements were collected to calculate the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS), in accordance with the Watershed Assessment of River Stability and Sediment Supply guidelines (Rosgen 2006). These measurements were used in conjunction with streambank length and erosion source notes to determine sediment loads per 1,000 feet of channel within each surveyed reach.

The BEHI procedure integrates multiple factors which have a direct impact on streambank stability, including the following parameters.

- Ratio of streambank height to bankfull stage.
- Ratio of riparian vegetation rooting depth to streambank height.
- Degree of rooting density.
- Composition of streambank materials.
- Streambank angle.
- Bank material stratigraphy.
- Bank surface protection afforded by woody debris and vegetation.

The BEHI index incorporates these seven variables into a numerical reach score that is used to rank streambank erosion potential on a scale ranging from very low to extreme (Table 4-1). Several sites within each assessment reach were evaluated for streambank integrity. The number of sites evaluated within each reach was based upon the variability of streambank conditions within the reach. Selected sites provided a representative sample of streambank conditions throughout the reach.

Table 4-1. BEHI score and rating matrix (Rosgen 1996)

Parameter		Very Low	Low	Moderate	High	Very High	Extrem
Bank Height Ratio	Value	1.0 – 1.1	1.11 – 1.19	1.2 – 1.5	1.6 – 2.0	2.1 – 2.8	> 2.8
	Index	1.0 – 1.9	2.0 – 3.9	4.0 – 5.9	6.0 – 7.9	8.0 – 9.0	10
Root Depth Ratio	Value	1.0 – 0.9	0.89 – 0.5	0.49 – 0.3	0.29 – 0.15	0.14 – 0.05	<0.05
	Index	1.0 – 1.9	2.0 – 3.9	4.0 – 5.9	6.0 – 7.9	8.0 – 9.0	10
Weighted Root Density	Value	100 – 80	79 – 55	54 – 30	29 – 15	14 – 5	<5
	Index	1.0 – 1.9	2.0 – 3.9	4.0 – 5.9	6.0 – 7.9	8.0 – 9.0	10
Bank Angle	Value	0 – 20	21 – 60	61 – 80	81 – 90	91 – 119	>119
	Index	1.0 – 1.9	2.0 – 3.9	4.0 – 5.9	6.0 – 7.9	8.0 – 9.0	10
Surface Protection	Value	100 – 80	79 – 55	54 – 30	29 – 15	14 – 10	<10
	Index	1.0 – 1.9	2.0 – 3.9	4.0 – 5.9	6.0 – 7.9	8.0 – 9.0	10

After evaluating the core bank integrity parameters describe in Table 1, bank material composition factors are considered. Depending upon bank materials, BEHI score is adjusted up or down (Rosgen 1996). Banks comprised of bedrock, boulders and cobble had very low erosion potential. Banks composed of cobble and/or gravel with a high fraction of sand had increased erosion potential. Stratified banks containing layers of unstable material also displayed greater erosion potential. After adjusting the core BEHI score for bank material composition factors, a final BEHI score and rating is derived (Table 4-2).

Table 4-2. BEHI score and rating following bank materials adjustment

Rating	Very Low	Low	Moderate	High	Very High	Extreme
Score	5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

4.2 Field Measurement of BEHI

Within each sub-reach, eroding streambanks were identified and supporting BEHI measurements recorded. Measurements were completed for the following metrics:

- Bank condition including actively eroding, slowly eroding, undercut, or vegetated banks
- Bank height
- Bankfull height
- Root depth
- Root density
- Bank angle
- Surface protection
- Material adjustments
- Bankfull mean depth
- Near bank maximum depth
- Stationing
- Mean height
- Bank composition (size classes)
- Hoof shear presence
- Sources of streambank instability (percentage)

In addition to these measurements, photos were taken facing each streambank from a location perpendicular and a location upstream of the streambank. Photos were labeled according to the streambank site and position of the photograph.

4.3 Index Calculations

To calculate the BEHI rating for each eroding streambank, the following parameters were used:

- Bank height/bankfull height
- Root depth/bank height
- Weighted root density
- Bank density
- Surface protection

Each parameter is matched to a corresponding index value, derived from statistical relations for sedimentary/metamorphic geologic substrata (Rosgen 1996; 2001). Index values are summarized to create an overall BEHI rating number, which is then converted into a categorical rating (Very Low, Low, Moderate, High, Very High or Extreme).

To calculate the NBS rating for each bank, the following relationship is used:

NBS = Near Bank Maximum Bankfull Depth (ft) / Bankfull Mean Depth (ft)

As with the BEHI ratings, the resulting NBS value corresponds to a categorical rating.

4.4 Retreat Rate

The BEHI and NBS categorical ratings were matched to derive the average retreat rate of each streambank (ft/yr) (Table 4-3).

Table 4-3. BEHI and Near Bank Stress categories and rate of streambank retreat (ft/yr)

	Near Bank Stress					
BEHI	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

4.5 Bank Erosion Sediment Loading

The mass eroded (tons/yr) from each streambank is calculated using the following equation:

Mass eroded = Streambank Length (ft)* Mean Streambank Height (ft) * Retreat Rate (ft/yr)

Mass eroded per each streambank is then filtered into two categories (actively eroding versus slowly eroding, undercut, or vegetated banks). The resulting values for sediment loading due to streambank erosion are multiplied by the percentage attributed to each streambank instability source, then summarized or averaged over the entire length of eroding streambanks for the reach, to derive loads contributed by each source of streambank instability.

4.6 BEHI Results

The following sections provide the BEHI results by reach categories. Each reach category has two accompanying data tables. Reaches are organized by reach type. Summary tables for each reach type are included in Section 4.7.

4.6.1. Reach EFSC-12

The EFSC-12 stream reach is within a valley that has experienced historic logging. Due to some resulting stream instability from historic activities, 16.1% are unstable and actively eroding. Overall stream conditions, however, are natural and the channel is stable. The riparian community is diverse and recruitment is good, limiting the amount of erosion. Typical reach photographs are included in Figure 4-1. BEHI results for Reach EFSC-12 are included in Table 4-4 and Table 4-5.

Figure 4-1. Typical streambank conditions in EFSC-12 Reach

Table 4-4. BEHI statistics for EFSC-12 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
EFSC-12	9/04/2008	Active	35.7	322	16.1	47.0	47.0
		Slow	29.8	32	1.6	2.1	2.1
		Total	32.8	354	17.7	49.1	49.1

Table 4-5. Load Sources for EFSC-12 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
EFSC-12	9/04/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	87.1	12.9
EFSC-12	9/04/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
EFSC-12	9/04/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	87.7	12.3

4.6.2. Reach STIL-12

Reach STIL-12 is in a forested setting with dense riparian vegetation providing bank stabilizing rootmass. Streambanks are generally stable with some slowly-eroding undercut banks located along meander outcurves and constrictions. Typical reach photographs are included in Figure 4-2. BEHI results for Reach STIL-12 are included in Table 4-6 and Table 4-7.

Figure 4-2. Typical streambank conditions in STIL-12 Reach

Table 4-6. BEHI statistics for STIL-12 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
STIL-12	9/07/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	12.8	52	2.6	0.2	0.2
		Total	12.8	52	2.6	0.2	0.2

Table 4-7. Load Sources for STIL-12 Reach

Reach ID	Date	Erosion Rate	Transportation Load (%)	Riparian Grazing Load (%)	Cropland Load (%)	Mining Load (%)	Silviculture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
STIL-12	9/07/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STIL-12	9/07/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
STIL-12	9/07/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.3 Reach WFSC-08

Erosion in this stream reach is natural in cause and infrequent, occurring along 106' of the total reach length, or 5.6%. The limited extent of bank erosion does include some actively eroding banks. Some historic logging and road beds present may have caused some bank instability and subsequent erosion, but the riparian community is vigorous and regenerating well. Typical reach photographs are included in Figure 4-3. BEHI results for Reach WFSC-08 are included in Table 4-8 and Table 4-9.

Figure 4-3. Typical streambank conditions in WFSC-08 Reach

Table 4-8. BEHI statistics for WFSC-08 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
WFSC-08	9/08/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	12.8	52	2.6	0.2	0.2
		Total	12.8	52	2.6	0.2	0.2

Table 4-9. Load Sources for WFSC-08 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
WFSC-08	9/08/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	96.2	3.8
WFSC-08	9/08/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
WFSC-08	9/08/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	96.3	3.7

4.6.4 Reach STIL-19

Reach STIL-19 showed erosion along 16.6% of the total bank length. Field notes indicate frequent bank scour and signs of channel adjustment from past upstream logging, albeit occurring within a natural stream channel with good shrub diversity and cover. The floodplain forest is considered to be young and emerging. Typical reach photographs are included in Figure 4-4. BEHI results for Reach STIL-19 are included in Table 4-10 and Table 4-11.

Figure 4-4. Typical streambank conditions in STIL-19 Reach

Table 4-10. BEHI statistics for STIL-19 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
STIL-19	9/07/2008	Active	38.3	146	7.3	15.2	15.2
		Slow	23.0	187	9.4	5.3	5.3
		Total	30.7	333	16.65	20.5	20.5

Table 4-11. Load Sources for STIL-19 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
STIL-19	9/07/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0
STIL-19	9/07/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	93.9	6.1
STIL-19	9/07/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	59.7	40.3

4.6.5 Reach STIL-23

The STIL-23 reach is within a valley that has experienced historic logging. These past silvicultural activities have destabilized some banks and account for an estimated 10% of the active erosion along the channel. Total sediment contribution to the stream is 24.5 tons/year, attributed primarily to natural causes. The upstream end of this reach shows some signs of adjustment. Typical reach photographs are included in Figure 4-5. BEHI results for Reach STIL-23 are included in Table 4-12 and Table 4-13.

Figure 4-5. Typical streambank conditions in STIL-23 Reach

Table 4-12. BEHI statistics for STIL-23 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
STIL-23	9/25/2008	Active	27.9	80	4.0	18.1	18.1
		Slow	27.1	331	16.6	6.4	6.4
		Total	27.5	411	20.6	24.5	24.5

Table 4-13. Load Sources for STIL-23 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
STIL-23	9/25/2008	Active	0.0	0.0	0.0	0.0	10.0	0.0	90.0	0.0
STIL-23	9/25/2008	Slow	0.0	0.0	0.0	0.0	0.4	0.0	99.6	0.0
STIL-23	9/25/2008	Total	0.0	0.0	0.0	0.0	6.7	0.0	93.3	0.0

4.6.6 Reach EFSC-15

Reach EFSC-15 is within a valley where human impacts are negligible. No active bank erosion was noted and slow streambank erosion is occurring on 9.4% of the reach, totaling 4 tons of sediment/year per 1000 ft. Typical reach photographs are included in Figure 4-6. BEHI results for Reach EFSC-15 are included in Table 4-14 and Table 4-15.

Figure 4-6. Typical streambank conditions in EFSC-15 Reach

Table 4-14. BEHI statistics for EFSC-15 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
EFSC-15	9/05/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	26.7	188	9.4	4.0	4.0
		Total	26.7	188	9.4	4.0	4.0

Table 4-15. Load Sources for EFSC-15 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
EFSC-15	9/05/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EFSC-15	9/05/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
EFSC-15	9/05/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.7 Reach HASK-13

Reach HASK-13 is downstream of agricultural land, but shows minimal impacts from immediate land uses. A total of 26.9 tons of sediment/year are deposited to the stream, primarily from a few areas, totaling 120 feet of streambank, where active erosion is visible (see Figure 4-7, right). Some beaver activity contributes sediment to the stream. Typical reach photographs are included in Figure 4-7. BEHI results for Reach HASK-13 are included in Table 4-16 and Table 4-17.

Figure 4-7. Typical streambank conditions in HASK-13 Reach

Table 4-16. BEHI statistics for HASK-13 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
HASK-13	9/03/2008	Active	38.8	120	6.0	19.7	19.7
		Slow	32.4	226	11.3	7.2	7.2
		Total	35.6	346	17.3	26.9	26.9

Table 4-17. Load Sources for HASK-13 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
HASK-13	9/03/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
HASK-13	9/03/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
HASK-13	9/03/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.8 Reach LOGA-20

The LOGA-20 reach is within a spruce forest valley with minimal human impacts. A total of 218 feet of the reach is eroding, two-thirds of which is naturally occurring slow erosion (see Figure 4-8, left). The riparian community is diverse and well established. Typical reach photographs are included in Figure 4-8. BEHI results for Reach LOGA-20 are included in Table 4-18 and Table 4-19.

Figure 4-8. Typical streambank conditions in LOGA-20 Reach

Table 4-18. BEHI statistics for LOGA-20 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
LOGA-20	9/08/2008	Active	36.9	72	3.6	5.6	5.6
		Slow	30.6	146	7.3	6.7	6.7
		Total	33.8	218	10.9	12.3	12.3

Table 4-19. Load Sources for LOGA-20 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
LOGA-20	9/08/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
LOGA-20	9/08/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
LOGA-20	9/08/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.9 Reach SHEP-25

The SHEP-25 reach is within a burned area which has seen past and present upstream logging. Mature riparian tree species are all burned and banks are dominated by fast-growing forbs and shrubs. The well-armored banks allow for some slow, naturally caused erosion, totaling 6.2 tons/year per 1000 ft. The riparian community is diverse and well established. Typical reach photographs are included in Figure 4-9. BEHI results for Reach SHEP-25 are included in Table 4-20 and Table 4-21.

Figure 4-9. Typical streambank conditions in SHEP-25 Reach

Table 4-20. BEHI statistics for SHEP-25 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
SHEP-25	9/09/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	29.2	169	8.5	6.2	6.2
		Total	29.2	169	8.5	6.2	6.2

Table 4-21. Load Sources for SHEP-25 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
SHEP-25	9/09/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHEP-25	9/09/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
SHEP-25	9/09/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.10 Reach WFSC-18

The WFSC-18 reach is an example of best available conditions among the sample size of this project. Less than 2% of the streambanks show active or slow erosion, totaling 1.7 tons/year. The riparian is dominated by well-established shrubs and surrounded by a mature conifer forest. Typical reach photographs are included in Figure 4-10. BEHI results for Reach WFSC-18 are included in Table 4-22 and Table 4-23.

Figure 4-10. Typical streambank conditions in WFSC-18 Reach

Table 4-22. BEHI statistics for WFSC-18 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
WFSC-18	9/06/2008	Active	30.8	22	1.1	1.5	1.5
		Slow	29.6	11	0.6	0.2	0.2
		Total	30.2	33	1.7	1.7	1.7

Table 4-23. Load Sources for WFSC-18 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
WFSC-18	9/06/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
WFSC-18	9/06/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
WFSC-18	9/06/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.11 Reach ASHL-19

The ASHL-19 reach is within a pasture area used for grazing cattle and hay. Steep streambanks are the major deterrent for cattle being in the stream, whose banks contribute 101.5 tons of sediment to the stream per year. Most of the erosion is characterized as slowly eroding and is attributed equally (49.2%) to the surrounding grazing and crop land uses. Bank trampling, shrub and tree removal, stream incisement and introduced species are all present in this reach. Typical reach photographs are included in Figure 4-11. BEHI results for Reach ASHL-19 are included in Table 4-24 and Table 4-25.

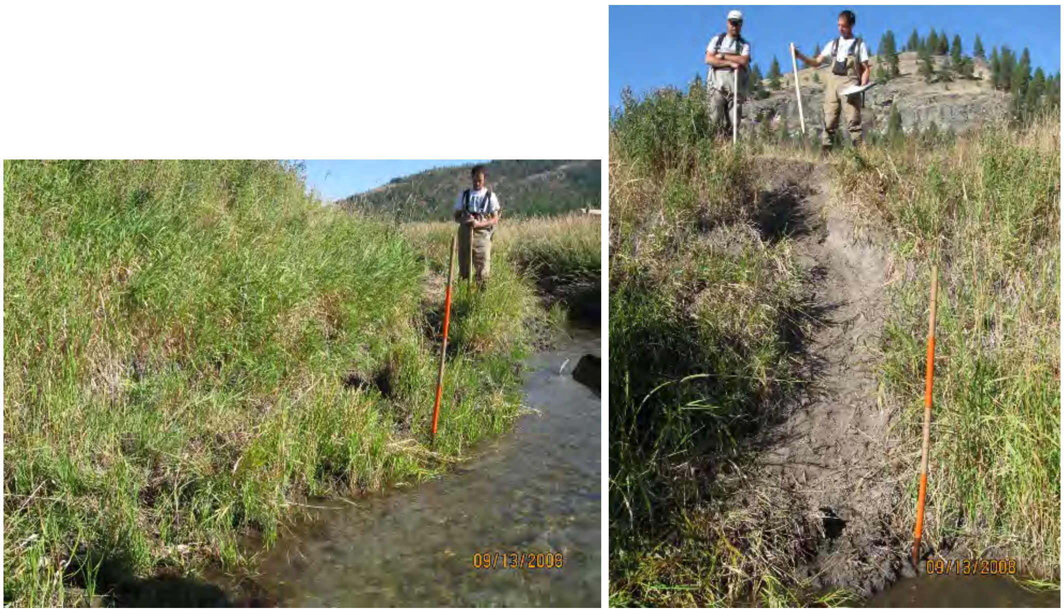

Figure 4-11. Typical streambank conditions in ASHL-19 Reach.

Table 4-24. BEHI statistics for ASHL-19 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
ASHL-19	9/13/2008	Active	34.9	152	7.6	4.4	4.4
		Slow	33.3	417	20.9	97.1	97.1
		Total	34.1	569	28.5	101.5	101.5

Table 4-25. Load Sources for ASHL-19 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
ASHL-19	9/13/2008	Active	0.0	96.7	0.0	0.0	0.0	0.0	3.3	0.0
ASHL-19	9/13/2008	Slow	0.0	49.2	49.2	0.0	0.0	0.0	1.7	0.0
ASHL-19	9/13/2008	Total	0.0	51.3	47.1	0.0	0.0	0.0	1.8	0.0

4.6.12 Reach ASHL-25

The ASHL-25 stream reach is within an urban setting. There is a bridge crossing at the upstream end and the reach has been channelized and confined. Streambank erosion is limited to some slowly eroding banks along 14.5% of the reach. Some beaver activity influences sediment loading but the predominant causes of sediment loading are natural. Typical reach photographs are included in Figure 4-12. BEHI results for Reach ASHL-25 are included in Table 4-26 and Table 4-27.

Figure 4-12. Typical streambank conditions in ASHL-25 Reach

Table 4-26. BEHI statistics for ASHL-25 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
ASHL-25	9/09/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	42.9	290	14.5	16.9	16.9
		Total	42.9	290	14.5	16.9	16.9

Table 4-27. Load Sources for ASHL-25 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
ASHL-25	9/09/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASHL-25	9/09/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
ASHL-25	9/09/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.13 Reach ASHL-29

Streambank erosion in this stream reach is low but widespread, covering 29.4% of the streams total bank length. Riparian grazing and cropland are the surrounding land uses, causing over 50% of the total sediment contribution to the stream, which approaches 35 tons/year. Typical reach photographs are included in Figure 4-13. BEHI results for Reach ASHL-29 are included in Table 4-28 and Table 4-29.

Figure 4-13. Typical streambank conditions in ASHL-29 Reach

Table 4-28. BEHI statistics for ASHL-29 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
ASHL-29	9/14/2008	Active	31.1	588	29.4	34.9	34.9
		Slow	N/A	0	0.0	0.0	0.0
		Total	31.1	588	29.4	34.9	34.9

Table 4-29. Load Sources for ASHL-29 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
ASHL-29	9/14/2008	Active	0.0	29.8	29.8	0.0	0.0	0.0	40.4	0.0
ASHL-29	9/14/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASHL-29	9/14/2008	Total	0.0	29.8	29.8	0.0	0.0	0.0	40.4	0.0

4.6.14 Reach LOGA-45

The LOGA-45 stream reach is within a stable and well-armored stream channel. There was no observed erosion in this stream reach. Typical reach photographs are included in Figure 4-14. BEHI results for Reach LOGA-45 are included in Table 4-30.

Figure 4-14. Typical streambank conditions in LOGA-45 Reach

Table 4-30. BEHI statistics for LOGA-45 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
LOGA-45	9/14/2008	Active					
		Slow		Well-armored banks - no erosion			
		Total					

4.6.15 Reach STIL-33

The STIL-33 reach is within a highly embedded channel in an area that was previously logged. Riparian shrubs and some exotic grasses dominate the streambank vegetation, providing some streambank stability. Over half of the streambank length within the reach shows signs of slow erosion. Most erosion is from low undercut banks, which in total contribute 78.2 tons of sediment/year to the channel. Typical reach photographs are included in Figure 4-15. BEHI results for Reach STIL-33 are included in Table 4-31 and Table 4-32.

Figure 4-15. Typical streambank conditions in STIL-33 Reach

Table 4-31. BEHI statistics for STIL-33 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
STIL-33	9/15/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	33.3	1026	51.3	78.2	78.2
		Total	33.3	1026	51.3	78.2	78.2

Table 4-32. Load Sources for STIL-33 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
STIL-33	9/15/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STIL-33	9/15/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
STIL-33	9/15/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.16 Reach EFSC-16

The EFSC-16 reach is an example of the best available conditions among the streams sampled. No visible erosion was noted in this reach. Typical reach photographs are included in Figure 4-16. BEHI results for Reach EFSC-16 are included in Table 4-33.

Figure 4-16. Typical streambank conditions in EFSC-16 Reach

Table 4-33. BEHI statistics for EFSC-16 Reach

Reach ID	**Date**	**Erosion Rate**	**Mean BEHI Score**	**Length of Eroding Bank (Feet)**	**% of Reach with Eroding Bank**	**Reach Sediment Load (Tons/Year)**	**Total Sediment Load per 1000 Feet (Tons/Year)**
EFSC-16	9/05/2008	Active					
		Slow		Well-armored banks - no erosion			
		Total					

4.6.17 Reach SHEP-18

This stream reach is within a burned valley, whose riparian vegetation has been reduced due to fire. Shrub roots are still intact and shrubs are resprouting. Well-armored banks provide for a stable channel, which shows mostly low and slowly eroding banks. All erosion, totaling 10 tons/year, is natural in cause in this reach. Typical reach photographs are included in Figure 4-17. BEHI results for Reach SHEP-18 are included in Table 4-34 and Table 4-35.

Figure 4-17. Typical streambank conditions in SHEP-18 Reach

Table 4-34. BEHI statistics for SHEP-18 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
SHEP-18	9/09/2008	Active	27.7	69	3.5	4.2	4.2
		Slow	32.8	104	5.2	5.8	5.8
		Total	30.3	173	8.7	10.0	10.0

Table 4-35. Load Sources for SHEP-18 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
SHEP-18	9/09/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
SHEP-18	9/09/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
SHEP-18	9/09/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.6.18 Reach HASK-06

Historic large cedar removal in the floodplain buffering the HASK-06 stream reach has caused some instability in the channel. The natural but sparse understory has dense root masses that stabilize the banks. One area of human-caused erosion from an old road bed is qualified as "other" and accounts for 20% of the total load of 6.6 tons/year for this reach. Typical reach photographs are included in Figure 4-18. BEHI results for Reach HASK-06 are included in Table 4-36 and Table 4-37.

Figure 4-18. Typical streambank conditions in HASK-06 Reach

Table 4-36. BEHI statistics for HASK-06 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
HASK-06	9/04/2008	Active	23.1	177	8.9	6.6	6.6
		Slow	N/A	0	0.0	0.0	0.0
		Total	23.1	177	8.9	6.6	6.6

Table 4-37. Load Sources for HASK-06 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
HASK-06	9/04/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	79.9	20.1
HASK-06	9/04/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HASK-06	9/04/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	79.9	20.1

4.6.19 Reach LOGA-37

The LOGA-37 reach shows no visible erosion. Banks are naturally well-armored with large rock. Healthy riparian communities are present throughout the reach and there are no notable anthropogenic influences on the channel. Typical reach photographs are included in Figure 4-19. BEHI results for Reach LOGA-37 are included in Table 4-38.

Figure 4-19. Typical streambank conditions in LOGA-37 Reach

Table 4-38. BEHI statistics for LOGA-37 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
LOGA-37	9/08/2008	Active					
		Slow		Well-armored banks - no erosion			
		Total					

4.6.20 Reach FISH-05

Stream reach FISH-05 shows a total sediment load of 2.6 tons/year per 1000 ft, a low level when seen in comparison to the best available reaches (although Rosgen stream types and other factors differ). Examples of some of the slowly eroding banks present in the stream are shown in Figure 4-20. Typical reach photographs are included in Figure 4-20. BEHI results for Reach FISH-05 are included in Table 4-39 and Table 4-340.

Figure 4-20. Typical streambank conditions in FISH-05 Reach.

Table 4-39. BEHI statistics for FISH-05 Reach

Reach ID	Date	Erosion Rate	Mean BEHI Score	Length of Eroding Bank (Feet)	% of Reach with Eroding Bank	Reach Sediment Load (Tons/Year)	Total Sediment Load per 1000 Feet (Tons/Year)
FISH-05	9/13/2008	Active	N/A	0	0.0	0.0	0.0
		Slow	33.3	46	4.6	1.3	2.6
		Total	33.3	46	4.6	1.3	2.6

Table 4-40. Load Sources for FISH-05 Reach

Reach ID	Date	Erosion Rate	Trans-portation Load (%)	Riparian Grazing Load (%)	Crop-land Load (%)	Mining Load (%)	Silvi-culture Load (%)	Irrigation Load (%)	Natural Load (%)	"Other Load" (%)
FISH-05	9/13/2008	Active	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FISH-05	9/13/2008	Slow	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
FISH-05	9/13/2008	Total	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0

4.7 Data Summary

The following section details the findings of the BEHI investigations for each reach type. Summary tables in this section present the reach sediment load by category (actively eroding or slowly eroding) and the dominant influence (anthropogenic or natural). Erosion was considered to be anthropogenic if <75% of visible bank erosion was attributed to natural conditions. Across all reaches, anthropogenic loads averaged twice as much as natural load. Reaches STIL-12, EFSC-16 and WFSC-18 were determined to have the most natural erosion conditions of all reaches.

4.7.1 Reach Type CR-0-2-U

The one stream reach in this reach type showed streambank erosion from natural sources.

Table 4-41. Sediment Load Data CR-0-2-U Reach Type

	Reach Sediment Load (tons per 1000')			Dominant Influence*	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
EFSC-12	47.0	2.1	49.1		X
Reach Category Avg. Load	47.0	2.1	49.1	0.0	49.1

4.7.2 Reach Type CR-2-2-U

Streams in this reach type showed only natural causes of erosion, with an average load of 9.6 tons/1000 ft. The WFSC-08 reach contributed significantly more sediment than the STIL-12 reach, which represents some of the best available conditions of the assessed reaches.

Table 4-42. Sediment Load Data CR-2-2-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
STIL-12	0.0	0.2	0.2		X
WFSC-08	18.8	0.1	18.9		X
Reach Category Avg. Load	9.4	0.2	9.6	0.0	9.6

4.7.3 Reach Type CR-2-4-U

The two streams in this reach showed similar total erosion rates, from a variety of sources.

Table 4-43. Sediment Load Data CR-2-4-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
STIL-19	15.2	5.3	20.5	X	
STIL-23	18.1	6.4	24.5		X
Reach Category Avg. Load	16.65	5.85	22.5	20.5	24.5

4.7.4 Reach Type NR-0-2-U

The one stream in this reach type shows minimal amounts of erosion, caused by natural stream and riparian processes.

Table 4-44. Sediment Load Data NR-0-2-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
EFSC-15	0.0	4.0	4.0		X
Reach Category Avg. Load	0.0	4.0	4.0	0.0	4.0

4.7.5 Reach Type NR-0-3-U

Streams in this reach type have an average sediment loading of 11.8 tons/year per 1000 ft of stream. All active and slow erosion in this stream reach type is from natural causes.

Table 4-45. Sediment Load Data NR-0-3-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
HASK-13	19.7	7.2	26.9		X
LOGA-20	5.6	6.7	12.3		X
SHEP-25	0.0	6.2	6.2		X
WFSC-18	1.5	0.2	1.7		X
Reach Category Avg. Load	6.7	5.1	11.8	0.0	11.8

4.7.6 Reach Type NR-0-4-U

There are 5 streams within the NR-0-4-U reach type, which show erosion rates ranging from 0 to 101.5 tons/year. The reach type average is 46.3 tons/year/1000 ft, with two of the stream reaches predominantly influenced by anthropogenic sources.

Table 4-46. Sediment Load Data NR-0-4-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
ASHL-19	4.4	97.1	101.5	X	
ASHL-25	0.0	16.9	16.9		X
ASHL-29	34.9	0.0	34.9	X	
LOGA-45	0.0	0.0	0.0		X
STIL-33	0.0	78.2	78.2		X
Reach Category Avg. Load	7.86	38.44	46.3	68.2	31.7

4.7.7 Reach Type NR-2-2-U

The two streams in this reach type show only natural causes of bank erosion.

Table 4-47. Sediment Load Data NR-2-2-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
EFSC-16	0.0	0.0	0.0		X
SHEP-18	4.2	5.8	10.0		X
Reach Category Avg. Load	2.1	2.9	5.0	0.0	5.0

4.7.8 Reach Type NR-2-3-U

This reach type has one stream segment, which is influenced from natural sources. Erosion is minimal in this reach.

Table 4-48. Sediment Load Data NR-2-3-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
HASK-06	6.6	0.0	6.6		X
Reach Category Avg. Load	6.6	0.0	6.6	0.0	6.6

4.7.9 Reach Type NR-2-4-U

The one stream reach within this stream type shows no erosion.

Table 4-49. Sediment Load Data NR-2-4-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
LOGA-37	0.0	0.0	0.0		X
Reach Category Avg. Load	0.0	0.0	0.0	0.0	0.0

4.7.10 Reach Type NR-4-1-U

The one stream reach within this reach type is in a natural setting with only mild anthropogenic influence from harvest upslope and upstream road crossings. Bank erosion is low and described in the following section.

Table 4-50. Sediment Load Data NR-4-1-U Reach Type

	Reach Sediment Load (tons per 1000')			Predominant Influence	
Reach ID	**Actively Eroding**	**Slowly Eroding**	**Total**	**Anthropogenic**	**Natural**
FISH-05	0.0	2.6	2.6		X
Reach Category Avg. Load	0.0	2.6	2.6	0.0	2.6

4.7.11 Average Loads for all Reach Types

Table 4-51. Summarized BEHI Sediment Loads for all Reaches

	Reach Sediment Load (tons per 1000')		
	Actively Eroding	**Slowly Eroding**	**Total**
Avg. Load	9.6	6.1	15.7
Predominantly Anthropogenic Avg. Load	18.2	34.1	39.2
Predominantly Natural Avg. Load	7.1	8.0	16.1

Spreadsheets with complete data for the BEHI assessment are included on the CD data appendix, Appendix C.

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