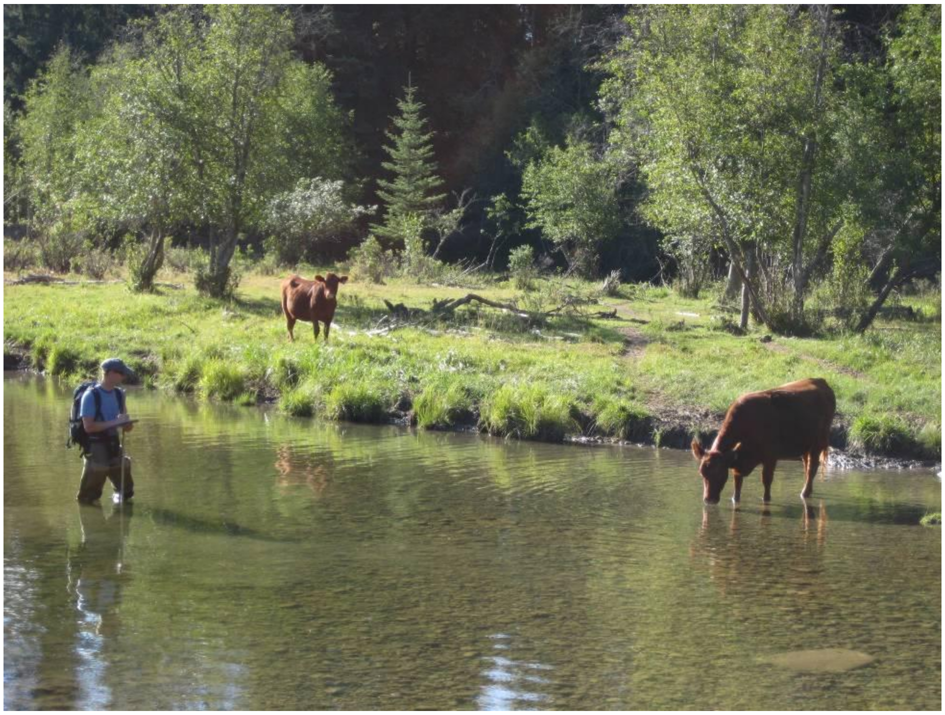
APPENDIX D - SEDIMENT AND HABITAT ASSESSMENT



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D1.0 INTRODUCTION

This appendix is derived from a sediment and habitat assessment report prepared by Water and Environmental Technologies (2008) for presentation to the Kootenai River Network and the Montana Department of Environmental Quality (DEQ). In 2008, DEQ initiated an effort to collect data to support the development of sediment TMDLs for streams within the Tobacco River TPA. The data collection effort involved assessing sediment and habitat conditions within the Tobacco River watershed, as these conditions influence aquatic life beneficial uses. The data collection effort included stream stratification, sampling design, ground surveys, and sediment and habitat analyses, and is intended to assist DEQ in evaluating the impairment status of tributary streams in the Tobacco River TPA and for developing TMDLs where necessary.

The 2006 303(d) List includes the following streams listed as impaired due to sediment: Tobacco River, Grave Creek, Fortine Creek, Deep Creek, Therriault Creek, Lime Creek, Edna Creek, and Swamp Creek. In addition to these streams, Sinclair Creek was included due to stakeholder interest in this stream. A TMDL and Water Quality Restoration Plan has already been prepared for the Grave Creek Watershed (DEQ 2005), but the stream was included in the watershed stratification and a limited assessment efforts for the purposes of consistency and extrapolation of sediment loads.

The stream stratification method is intended to develop waterbody characterizations that can be applied across watersheds, accounting for localized ecological variations. The stratification enables comparison between observed and expected values for sediment and habitat parameters, quantifying the effects of human influences. Stratification for the Tobacco River TPA streams began by dividing the waterbodies into reaches and sub-reaches. These divisions were based on aerial photo interpretation of stream characteristics, landscape conditions, and land-use factors. This preliminary work was completed in summer 2008.

Following the initial primary reach stratification, representative sub-reaches were chosen by DEQ for data collection. A two-day sampling reach reconnaissance was conducted on July 21 and 22, 2008, and field personnel completed full site surveys from August 21 to 28, 2008. Field personnel visited the selected sub-reaches and recorded bank erosion sites, vegetation, and channel characteristics data. Additional sites were surveyed for streambank erosion conditions only from September 8 to 12, 2008. These data were analyzed in January and February 2009, resulting in full descriptions of sediment and habitat conditions for all of the surveyed reaches and the ability to extrapolate to non surveyed reaches.

D2.0 Aerial Assessment Reach Stratification

D2.1 Methods

An aerial assessment of streams in the Tobacco River TPA was conducted using geographic information systems (GIS) software and 2005 color aerial imagery. 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 (NRIS) database. Layers include the following data sets:

- Ecoregion (USEPA)
- Scanned and Rectified Topographic Maps, 1:24,000 and 1:100,000 (USGS)
- National Hydrography Dataset Lakes and Streams (USGS)
- 2005 National Aerial Image Program (NAIP – NRIS)

GIS data layers were used to stratify streams into primary reaches based on stream characteristics, 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* (Montana Department of Environmental Quality, 2008). The reach stratification methodology involves delineating a waterbody stream segment into stream reaches and sub-reaches. This process was completed for the following stream segments in the Tobacco River TPA: Tobacco River, Grave Creek, Fortine Creek, Deep Creek, Therriault Creek, Lime Creek, Edna Creek, Swamp Creek, and Sinclair Creek.

D2.1 Stream Reaches

Waterbody segments are generally delineated by a water use class designated by the State of Montana, e.g. A-1, B-3, C-3 (Administrative Rules of Montana Title 17 Chapter 30, Sub-Chapter 6). Although a waterbody segment is the smallest unit for which an impairment determination is made, the stratification approach described in this document initially stratifies individual waterbody segments into discrete assessment reaches that are delineated by distinct variability in landscape controls such as Ecoregion, Strahler stream order, valley gradient, and valley confinement. The reason for this stratification is that the inherent differences in landscape controls between stream reaches often prevents a direct comparison from being made between the geomorphic attributes of one stream reach to another. By initially stratifying waterbody segments into stream reaches having similar geomorphic landscape controls, it is feasible to make comparisons between similar reaches in regards to observed versus expected channel morphology. Likewise, when land use is used as an additional stratification (e.g. grazed vs. non-grazed sub-reaches), sediment and habitat parameters for impaired stream reaches can be more readily compared to reference reaches that meet the same geomorphic stratification criteria.

The aerial photograph reach stratification methodology involves dividing a stream segment into distinct reaches based on four primary watershed characteristics, including Level IV Ecoregion, valley gradient, Strahler stream order, and valley confinement. Once stream reaches have been classified by the four watershed characteristics, reaches are further divided based on the surrounding vegetation and land-use characteristics as observed in the color aerial imagery using GIS. The result is a series of stream reaches and sub-reaches delineated by landscape and land-use factors. Stream reaches with similar landscape factors can then be compared based on the character of surrounding land-use practices.

For ease of labeling, each listed stream in the assessment was assigned an abbreviation based on the stream name. These labels were use in the individual stream reach classification. **Table D2-1** shows the abbreviations developed for each waterbody.

Table D2-1. Waterbody naming key

Waterbody	Label Abbreviation
Deep Creek	DEP
Edna Creek	ENA
Fortine Creek	FTN
Grave Creek	GRV
Lime Creek	LME
Sinclair Creek	SNC
Swamp Creek	SWP
Therriault Creek	THR
Tobacco River	TOB

D2.2 REACH TYPES

Individual stream reaches were delineated by reach type based on four watershed characteristics. For the purposes of this report, a “reach type” is defined as a unique combination of Ecoregion, valley gradient, Strahler stream order, and valley confinement, and are designated using the following naming convention based on the reach type identifiers provided in **Table D2-2**:

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

Table D2-2. Reach type identifiers

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

For example, a reach identified as NR-0-3-U is in the Northern Rockies Level III Ecoregion, has a low valley gradient (0-2%), is a 3rd order stream, and is within an unconfined valley.

The Tobacco River TPA exists within two Level III Ecoregions, including Northern Rockies (Ecoregion 15) and Canadian Rockies (Ecoregion 41). The Northern Rockies Level III Ecoregion contains three Level IV Ecoregions in the Tobacco River TPA, including the Tobacco Plains (15d), Salish Mountains (15l), and the

Stillwater-Swan Wooded Valley (15t). The Canadian Rockies Level III Ecoregion contains one Level IV Ecoregion in the Tobacco River TPA, which is the Western Canadian Rockies Level IV Ecoregion (41c).

Present reach type combinations for the Tobacco River TPA are provided in **Table D2-3**, including the number of monitoring sites assessed for each reach type. Overall, 32 monitoring sites were selected for field evaluation, including 18 sites that received full site assessments (including all habitat parameters and evaluation of streambank erosion conditions) and 14 sites that received streambank erosion assessments (BEHI) only.

Table D2-3. Stratified reach types within the Tobacco River TPA

Level III Ecoregion	Valley Gradient	Strahler Stream Order	Confinement	Reach Type	Number of Reaches	Number of Full Monitoring Sites	Number of BEHI Monitoring Sites
Canadian Rockies	0 - 2%	2	U	CR-0-2-U	17	4	
		3	U	CR-0-3-U	1		
		4	C	CR-0-4-C	1		
			U	CR-0-4-U	9		
	2 - 4%	1	U	CR-2-1-U	3		
		2	C	CR-2-2-C	1		
			U	CR-2-2-U	7		
		3	U	CR-2-3-U	6	1	
		4	U	CR-2-4-U	2		
	4 - 10%	1	U	CR-4-1-U	6		
		2	C	CR-4-2-C	3		
			U	CR-4-2-U	6	1	2
		3	U	CR-4-3-U	5	1	
		4	U	CR-4-4-U	1		
	>10%	1	C	CR-10-1-C	2		
			U	CR-10-1-U	6		
		2	U	CR-10-2-U	2		
Northern Rockies	0 - 2%	1	U	NR-0-1-U	1		
		2	U	NR-0-2-U	4		
		3	U	NR-0-3-U	24	3	2
		4	U	NR-0-4-U	32	3	4
		5	U	NR-0-5-U	11	2	2
	2 - 4%	1	U	NR-2-1-U	3		
		2	U	NR-2-2-U	5		1
		3	U	NR-2-3-U	12	1	1
	4 - 10%	1	U	NR-4-1-U	3		
		2	U	NR-4-2-U	7		2
		3	U	NR-4-3-U	4	2	
	>10%	1	U	NR-10-1-U	2		
Totals:					**187**	**18**	**14**

Listed waterbodies included in this assessment exist within the different reach types listed above. **Table D2-4** shows the assessed waterbodies and monitoring sites included within each reach type. A map of monitoring site locations is provided as **Attachment A**.

Table D2-4. Monitoring sites in assessed reach types

Reach Type	Waterbody	Monitoring Site (Full and BEHI)
CR-0-2-U	Sinclair Creek, Therriault Creek	SNC-8-2, SNC 10-3, THR-9-5, THR-14-1
CR-2-3-U	Deep Creek	DEP 13-2
CR-4-2-U	Deep Creek, Sinclair Creek, Clarence Creek	DEP 7-1, SNC 5-1, Clarence
CR-4-3-U	Deep Creek	DEP 9-2
NR-0-3-U	Edna Creek, Fortine Creek, Swamp Creek	ENA 11-1, FTN 4-1, FTN 4-3, FTN 6-1, SWP 5-1
NR-0-4-U	Fortine Creek	FTN 9-3, FTN, 12-2, FTN 12-7, FTN 12-9, FTN 13-1, FTN 15-2, FTN 15-3
NR-0-5-U	Tobacco River	TOB 1-1, TOB, 1-3, TOB 2-3, TOB, 2-6
NR-2-2-U	Edna Creek	ENA 8-1
NR-2-3-U	Fortine Creek, Swamp Creek	FTN 7-2, SWP 9-1
NR-4-2-U	Edna Creek Swamp Creek	ENA 7-2, SWP 3-1
NR-4-3-U	Edna Creek, Lime Creek	ENA 10-2, LME 6-1

D3.0 Sediment and Habitat Dataset Review

D3.1 Field Methodology

The following sections include descriptions for the various field methodologies that were employed for the stream assessments. The 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* (Montana Department of Environmental Quality, 2007). All field data were collected on DEQ standard forms for sediment and habitat assessments, and are summarized and provided in tabular format in **Attachment B**. For most survey sites, a minimum of 5 team members were present, which were always divided into 3 teams, referred to as the “Greenline”, “Longitudinal Profile” or “Long-Pro”, 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 instream disturbance.

D3.1.1 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 ft were used for bankfull widths less than 10 ft; survey lengths of 1,000 ft were used for bankfull widths between 10 ft and 50 ft; and survey lengths of 2,000 ft were used for bankfull widths greater than 60 ft. 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 and upstream ends 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**.

D3.1.2 Field Determination of Bankfull

All members of the field crew participated in determining the bankfull elevation prior to breaking into their respective teams. Indicators that were used to estimate the bankfull channel elevation 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.

D3.1.3 Channel Cross-Sections

The “Cross-Section team” was composed of two members of the assessment crew, who also performed pebble counts, riffle stability index, and riffle grid tosses. Channel cross-section surveys were performed at the first riffle in each cell moving upstream using a line level and a measuring rod. Channel surveys were recorded in the **Channel Cross-section Field Form**. Cross-sections were surveyed in each cell containing a riffle. 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 surveyed. If only 1 or 2 riffles were present in the entire reach, all riffle cross-sections were surveyed.

To begin each survey, 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 were present which prevented a clean line across the channel, the protocol provided in the field methodology document was followed (Montana Department of Environmental Quality, 2007). Depth measurements at bankfull were collected to a tenth of a foot across the channel at regular intervals depending on channel width. The thalweg depth was recorded at the deepest point of the channel independent of the regularly spaced intervals. From the recorded data, the following data were calculated for each cross-section:

Mean depth = sum of depth measurements / number of depth measurements (excluding the right bank and left bank measurements, unless they were greater than zero, such as 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

The floodprone elevation was determined by doubling the maximum channel depth. 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, best professional judgment was used to determine the floodprone width. 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.

D3.1.4 Channel Bed Morphology

A variety of channel bed morphology features were measured and recorded by the “Long-Pro” 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 for riffles and 33% for pools. 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 (Montana Department of Environmental Quality, 2007).

D3.1.4.1 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 at its deepest point was measured. No pool tail crest depth was recorded for dammed pools (see **Section 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.

D3.1.4.2 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 estimated relative to bankfull channel width was recorded as Small (S), Medium (M), or Large (L). Small pools were defined as <1/3 of the bankfull channel width; medium pools were >1/3 and <2/3 of the bankfull channel with; and large pools were determined to be those >2/3 of the bankfull channel width or >20 feet wide.
3. Pool formative features were recorded as lateral scour (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.

D3.1.4.3 Fine Sediment in Depositional Spawning Areas

A measurement of the percent of fine sediment in depositional spawning areas was taken using the grid toss method at the first and second scour pool of each cell. Grid toss readings were focused in those 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 *Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments* (Montana Department of Environmental Quality, 2007). 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 presence of spawning gravels was recorded as Yes (Y) No (N) at each pool location.

D3.1.4.4 Fine Sediment in Riffles

Measurements of fine sediment in riffles were recorded by the Cross-Section team using the same grid toss method as used in pools (**Section D3.1.4.3**). Grid tosses were performed in the same general location but before the pebble counts (**Section D3.1.4.6**) to avoid disturbances to fine sediments. These measurements were recorded in the **Riffle Pebble Count Field Form.**

D3.1.4.5 Woody Debris Quantification

The amount of large woody debris (LWD) was recorded by the Habitat 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 the channel form were counted as either single, aggregate or willow bunch. Further description of these categories is provided in *Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments* (Montana Department of Environmental Quality, 2007).

D3.1.4.6 Riffle Pebble Count

A 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. These data 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 can be found in the field methods document (Montana Department of Environmental Quality, 2007).

D3.1.4.7 Riffle Stability Index

In stream reaches that had well developed point bars downstream of riffles, a riffle stability index (RSI) was performed to determine the average size of the largest recently deposited particles, and to calculate an RSI which evaluates riffle particle stability (Kappesser, 2002). For stream reaches in which well developed gravel bars were present, a RSI was determined by first measuring the intermediate axis (*b-axis*) of 15 of the largest recently deposited particles on a depositional bar. This information was recorded in the **Riffle Pebble Count Field Form**. During post-field data processing, the arithmetic mean of the largest recently deposited particles is calculated. This value is then compared to the cumulative particle size distribution of an adjacent riffle, as determined by the Wolman pebble count. The RSI is reported as the cumulative percentile of the particle size classes that are smaller than the arithmetic mean of the largest recently deposited particles. The RSI value generally represents the percent of mobile particles within the riffle that is adjacent to the sampled bar.

D3.1.5 Riparian Greenline Assessment

After the entire survey station length was measured by the "Greenline" team member, an assessment of riparian vegetation cover was performed. The reach was walked by the "Greenline" team member who noted the general vegetation community type of the groundcover, 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 feet 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, riparian buffer width was estimated for both banks by evaluating 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.

D3.1.6 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) and Near Bank Stress (NBS) 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 **Sections** D**4.2** and D**4.3**.

D3.1.7 Water Surface Slope

Where possible, 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-site.

D3.1.8 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; and
- Description of riparian vegetation conditions.

D3.1.9 Quality Assurance/Quality Control

Quality assurance and quality control (QA/QC) was achieved through strict adherence to the project's sampling and analysis plan (Water & Environmental Technologies, 2008). Prior to field data collection, one full day of training was held to familiarize the entire crew with all the field forms and procedures. During each stream assessment, the field team leader and most experienced crew members led the separate teams. Equipment checks were done each morning and field maps were reviewed with drivers before approaching field sites. Field forms were distributed and double-checked before teams left the vehicles to the survey sites. At the conclusion of each stream assessment, all field forms were reviewed for completeness and accuracy. Any questions that arose from field teams were brought to the attention of the field team leader until resolved to the leader's satisfaction.

Despite the best efforts to adhere to the project's sampling and analysis plan (SAP), some deviations did occur while in the field and during data processing. Additionally, parameters used for sediment loading calculations were adjusted during data processing and following review of field photos to better represent actual field conditions. These adjustments and any deviations from the SAP are described in QA/QC notes provided in **Attachment C**.

D3.2 SAMPLING PARAMETER DESCRIPTIONS AND SUMMARIES BY REACH TYPE

The following sections provide definitions of sampling parameters that were measured at each reach, and basic statistical summaries of data for each parameter organized by reach type. Parameters described in this section include width/depth ratio, entrenchment ratio, percent understory shrub cover, percent bare/disturbed ground, riffle pebble count data (% <2 mm and <6 mm, D50), riffle grid toss data (% <6 mm), riffle stability index, mean pool depth, pool frequency, pool grid toss data (% <6 mm), and large woody debris (LWD) frequency. Data for each individual measurement site were used in the statistical analysis (i.e. data from each of the individual cross sections in one assessment reach were used), and then sample reaches and waterbodies were grouped into reach types as shown in **Table D2-3**.

Data provided for each parameter include box plots and data tables organized by each reach type and for the total planning area. The box plots and data tables provide the minimum and maximum observed values, and the 25th (Q1), 50th (median), and 75th (Q3) percentile values. Outliers, defined as values which are 1.5 times outside the interquartile range, are indicated by an asterisk on the box plots. Examples of these statistical parameters are shown on the first box plot of this section (**Figure D3-1)**. The statistics tables also provide the number of data cases available for each parameter. Parameters with a limited number of cases (N<4) will appear as a single line on the box plots.

D3.2.1 Width/Depth Ratio

The stream channel 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 (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."***

The channel width/depth ratio is one of several standard measurements used to classify stream channels, making it a useful variable for comparing conditions on reaches within the same stream type. A comparison of observed and expected width/depth ratio is a useful indicator of channel over-widening 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 over-widened often are associated with excess sediment deposition and streambank erosion, contain shallower, warmer water, and provide fewer deepwater habitat refugia for fish.

The measured width/depth ratios for are presented in **Figure D3-1** by reach type, and summary statistics are provided in **Table D3-1**. All surveyed cross sections are included in the statistics generated within each reach type**.**

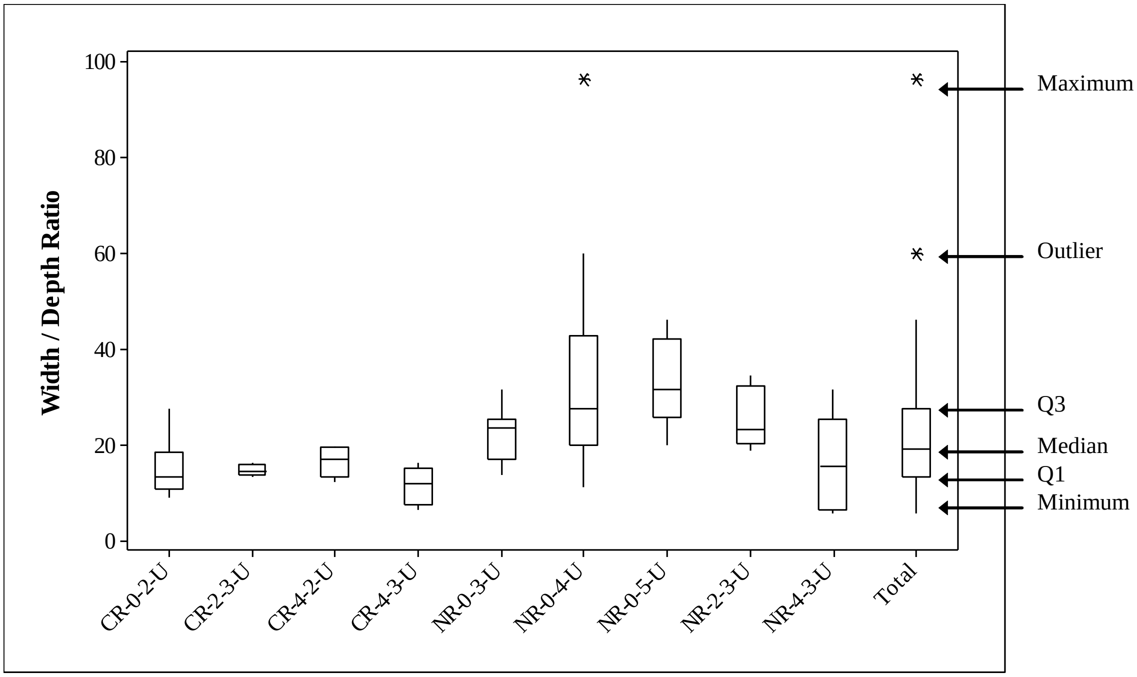

Figure D3-1. Boxplot of width/depth ratio by reach type

Table D3-1. Summary statistics of width/depth ratio by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	17	9.1	11	13.5	18.5	27.5
CR-2-3-U	1	4	13.6	13.8	14.4	15.9	16.3
CR-4-2-U	1	5	12.5	13.5	17.1	19.6	19.8
CR-4-3-U	1	4	6.4	7.7	11.9	15.3	16.4
NR-0-3-U	3	11	13.8	17.3	23.7	25.5	31.7
NR-0-4-U	3	11	11.2	20.2	27.8	43.1	96.5
NR-0-5-U	2	9	20	26	31.7	42.3	46.3
NR-2-3-U	1	5	19.1	20.3	23.2	32.5	34.6
NR-4-3-U	2	9	5.9	6.7	15.6	25.6	31.6
Total	**18**	**75**	**5.9**	**13.5**	**19.3**	**27.8**	**96.5**

D3.2.2 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 incision, 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 flood events. Greater scouring energy in incised channels results in higher sediment loads derived from eroding banks. If the stream is not actively degrading (down-cutting), the sources of human caused incision may be historical in nature and may not currently be present, although sediment loading may continue to occur. The 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 incision and the large potential for sediment loading in incised channels.

The entrenchment ratios by reach type are presented in **Figure D3-2**, and summary statistics are provided in **Table D3-2**. All surveyed cross sections are included in the statistics generated within each reach type**.**

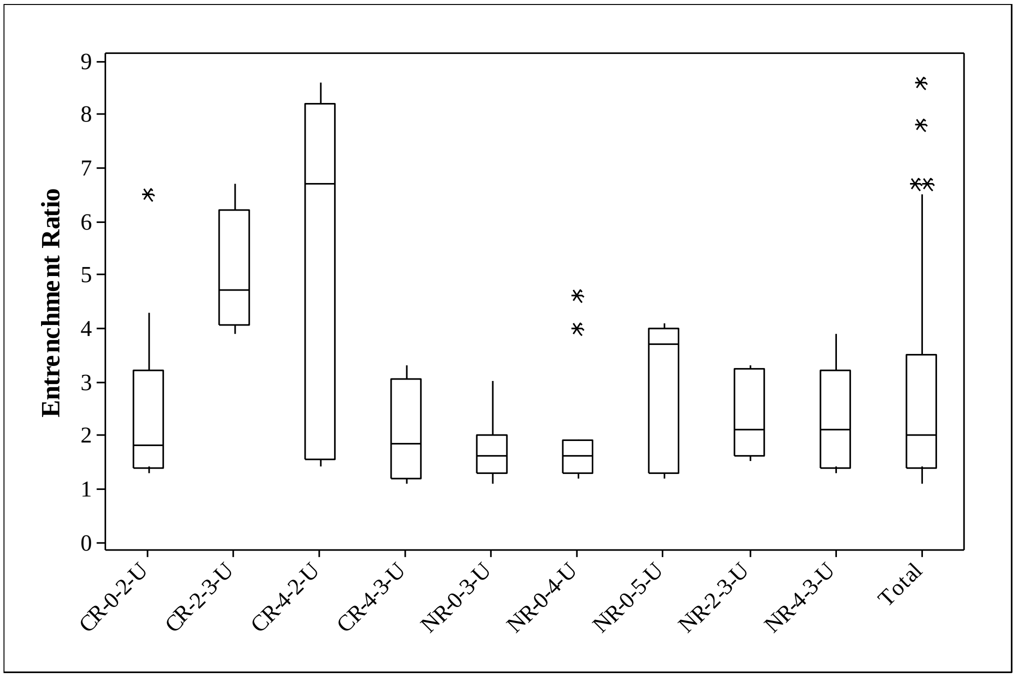

Figure D3-2. Entrenchment ratio by reach type

Table D3-2. Summary statistics of entrenchment ratio by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	17	1.3	1.4	1.8	3.2	6.5
CR-2-3-U	1	4	3.9	4.1	4.7	6.2	6.7
CR-4-2-U	1	5	1.4	1.6	6.7	8.2	8.6
CR-4-3-U	1	4	1.1	1.2	1.8	3.0	3.3
NR-0-3-U	3	11	1.1	1.3	1.6	2.0	3.0
NR-0-4-U	3	11	1.2	1.3	1.6	1.9	4.6
NR-0-5-U	2	9	1.2	1.3	3.7	4.0	4.1
NR-2-3-U	1	5	1.5	1.6	2.1	3.3	3.3
NR-4-3-U	2	9	1.3	1.4	2.1	3.2	3.9
Total	**18**	**75**	**1.1**	**1.4**	**2.0**	**3.5**	**8.6**

D3.2.3 Riffle Pebble Count: Substrate Fines (% <2 mm)

Clean stream bottom substrates are essential for optimum habitat for many fish and aquatic insect communities. The most obvious forms of degradation occur when critical habitat components such as spawning gravels (Chapman and McLeod, 1987) and cobble surfaces are physically covered by fines, thereby decreasing inter-gravel oxygen and reducing or eliminating the quality and quantity of habitat for fish, macroinvertebrates and algae (Waters, 1995; Lisle, 1989). Chapman and McLeod found that size of bed material is inversely related to habitat suitability for fish and macroinvertebrates and that excess sediment decreased both density and diversity of aquatic insects. Specific aspects of sediment-invertebrate relationships may be described as follows: 1) invertebrate abundance is correlated with substrate particle size; 2) fine sediment reduces the abundance of original populations by reducing interstitial habitat normally available in large-particle substrate (gravel, cobbles); and 3) species type, species richness, and diversity all change as particle size of substrate changes from large (gravel, cobbles) to small (sand, silt, clay) (Waters, 1995).

The percent of fine sediment in a stream channel provides a measure of the siltation occurring in a river system and is an indicator of stream bottom habitat. Although it is difficult to correlate percent surface fines with sediment loading 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 pebble count is one indicator of aquatic habitat condition and can indicate excessive sediment loading. The Wolman pebble count method provides a survey of the particle distribution of the entire channel width, allowing investigators to calculate a percentage of the surface substrate (as frequency of occurrence) composed of fine sediment.

In addition to being a direct measure of impairment to the aquatic macroinvertebrate community, riffle percent surface fines can be used as an indicator of possible impairment condition to coldwater fish since the elevated riffle surface fines are likely an indicator of elevated subsurface fines within spawning gravels.

The pebble count measurements for particles <2 mm by reach type are presented in **Figure D3-3**, and summary statistics are provided in **Table D3-3**.

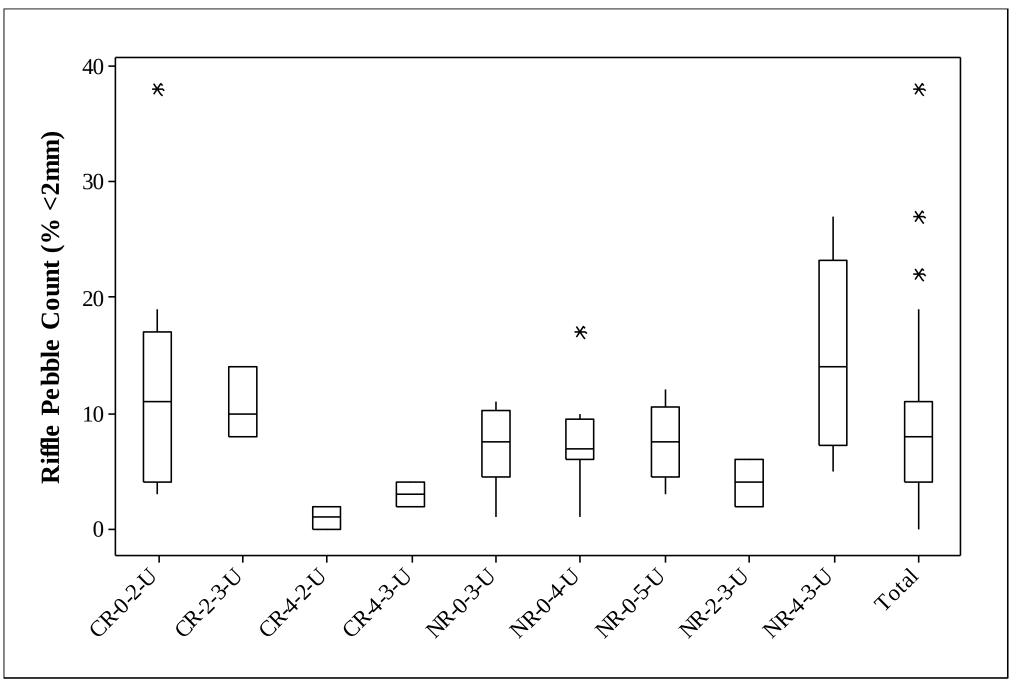

Figure D3-3. Riffle pebble count (% <2 mm) by reach type

Table D3-3. Summary statistics of riffle pebble count (% <2 mm) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	11	3	4	11	17	38
CR-2-3-U	1	3	8	8	10	14	14
CR-4-2-U	1	3	0	0	1	2	2
CR-4-3-U	1	3	2	2	3	4	4
NR-0-3-U	3	8	1	5	8	10	11
NR-0-4-U	3	9	1	6	7	10	17
NR-0-5-U	2	6	3	5	8	11	12
NR-2-3-U	1	3	2	2	4	6	6
NR-4-3-U	2	6	5	7	14	2	27
Total	**18**	**52**	**0**	**4**	**8**	**11**	**38**

D3.2.4 Riffle Pebble Count: Substrate Fines (% <6 mm)

As with surface fine sediment smaller than 2 mm diameter, an accumulation of surface fine sediment less than 6 mm diameter may also indicate excess sedimentation and has the potential to negatively impact the spawning success of coldwater fish. The size distribution of substrate material in the streambed is also indicative of habitat quality for salmonid spawning and incubation. Excess surface fine substrate may have detrimental impacts on aquatic habitat by cementing spawning gravels, thus reducing their accessibility, preventing flushing of toxins in egg beds, reducing oxygen and nutrient delivery to eggs and embryos, and impairing emergence of fry (Meehan, 1991). Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35 mm and the emergence success of westslope cutthroat trout and bull trout.

The pebble count measurements for sediment fines (% <6 mm) by reach type are presented below in **Figure D3-4** and summary statistics are provided in **Table D3-4**.

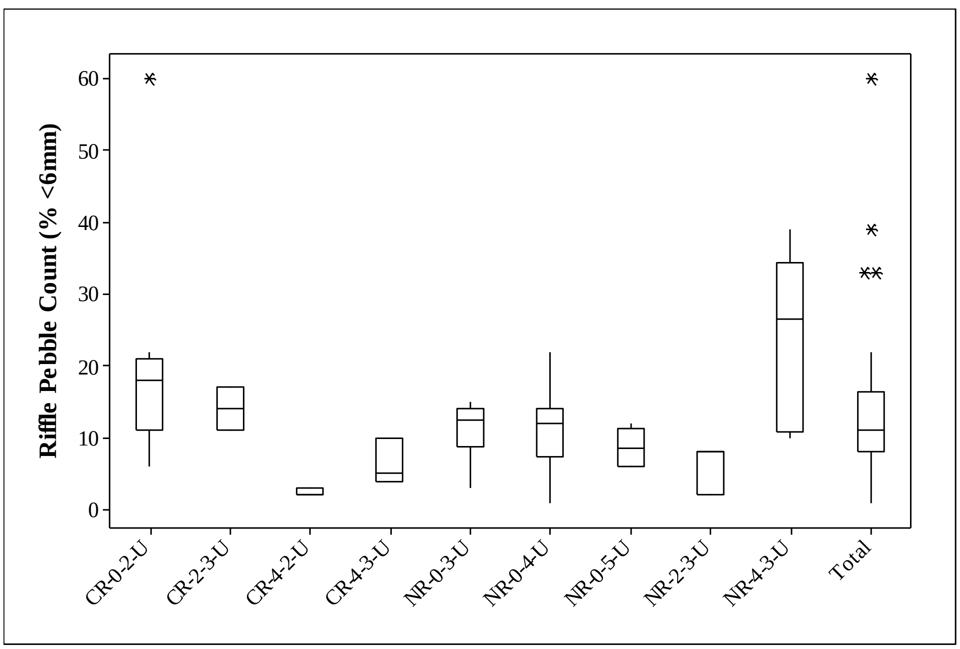

Figure D3-4. Riffle pebble count (% <6 mm) by reach type

Table D3-4. Summary statistics of riffle pebble count (% <6 mm) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	11	6	11	18	21	60
CR-2-3-U	1	3	11	11	14	17	17
CR-4-2-U	1	3	2	2	2	3	3
CR-4-3-U	1	3	4	4	5	10	10
NR-0-3-U	3	8	3	9	13	14	15
NR-0-4-U	3	9	1	8	12	14	22
NR-0-5-U	2	6	6	6	9	11	12
NR-2-3-U	1	3	2	2	8	8	8
NR-4-3-U	2	6	10	11	27	35	39
Total	**18**	**52**	**1**	**8**	**11**	**17**	**60**

D3.2.5 Riffle Pebble Count: D50

The D50 represents the median (50th percentile) particle size of a riffle as determined by the Wolman pebble count. This value can be used to evaluate the suitability of a riffle as spawning gravel for salmonids. Kondolf and Wolman (1993) state that the appropriate size of spawning gravels varies based on stream size and fish species, since larger fish are capable of moving larger particles. In general, appropriate sized spawning gravels should be less than approximately 40 mm for salmonids.

Results of the riffle pebble count D50 are presented below by reach type in **Figure D3-5** and summary statistics are provided in **Table D3-5**.

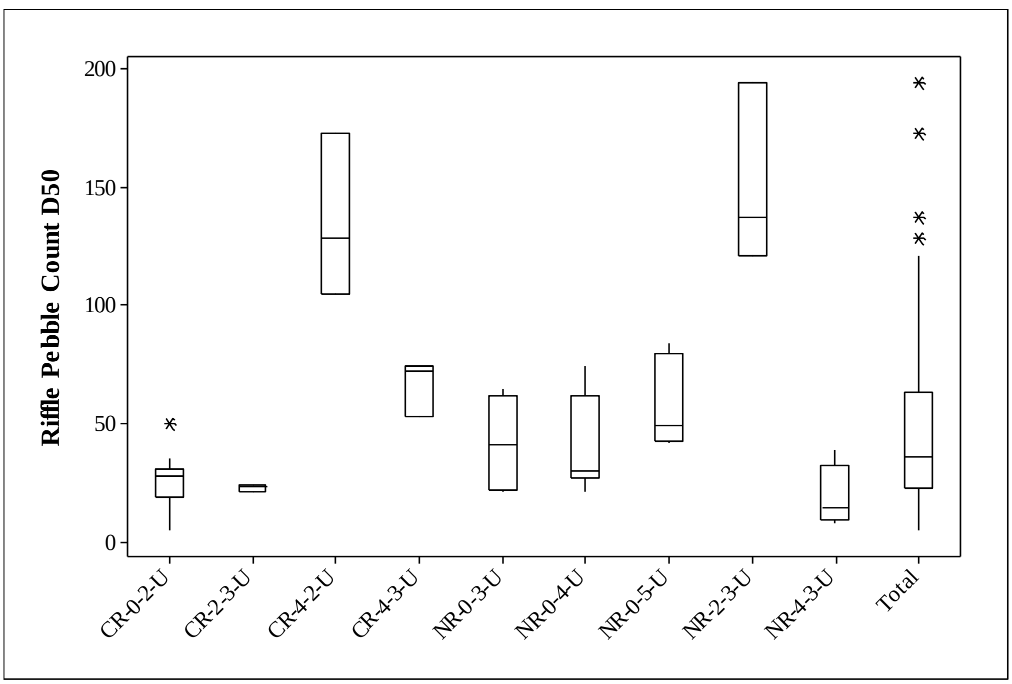

Figure D3-5. Riffle pebble count D50 (mm) by reach type

Table D3-5. Summary statistics of riffle pebble count D50 (mm) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	11	5	19	28	31	50
CR-2-3-U	1	3	21	21	23	24	24
CR-4-2-U	1	3	105	105	128	173	173
CR-4-3-U	1	3	53	53	72	74	74
NR-0-3-U	3	8	21	22	41	61.5	65
NR-0-4-U	3	9	21	27	30	62	74
NR-0-5-U	2	6	42	42.8	49.5	79.5	84
NR-2-3-U	1	3	121	121	137	194	194
NR-4-3-U	2	6	8	9.5	14.5	32.3	39
Total	**18**	**52**	**5**	**22.3**	**36**	**63.5**	**194**

D3.2.6 Riffle Stability Index

The riffle stability index (RSI) is used to evaluate riffle particle mobility in an area receiving excessive sediment input (Kappesser, 2002). The mobile fraction in a riffle is estimated by comparing the particle sizes in the riffle to the arithmetic mean of the largest mobile particles on an adjacent depositional bar. Riffle particles of the size class smaller than the largest particles on a depositional bar are interpreted as mobile, and the RSI value represents the percent of mobile particles within a riffle. Riffles that have received excessive sediment from upstream eroding banks have a higher percent of mobile particles than riffles in equilibrium. The following breaks are provided as general guidelines for interpreting RSI values:

RSI Value	Description
< 40	High bedrock component to riffle (very stabile system) or channel has been scoured
40 – 70	Stream is in dynamic equilibrium – good channel and watershed stability
70 – 85	Riffle is somewhat loaded with excessive sediment
> 85	Riffle is loaded with excessive sediment

Limited RSI data were collected during this field effort due to the frequency of poorly developed point bars downstream of actively eroding banks. The riffle stability index results for all reaches are provided below in **Table D3-6**.

Table D3-6. Riffle stability index results for all reaches

Reach ID	Cell	Reach Type	Arithmetic Mean (cm)	Riffle Stability Index
DEP 13-2	1	CR-2-3-U	53	93
ENA 10-2	3	NR-4-3-U	34	44
FTN 6-1	1	NR-0-3-U	94	67
SWP 5-1	2	NR-0-3-U	85	51

D3.2.7 Riffle Grid Toss: Substrate Fines (% <6 mm)

The wire grid toss is a standard procedure frequently used in aquatic habitat assessment. This measurement does not cover the entire channel width, as in the Wolman pebble count, but rather provides a more focused measurement of surface fines in a subsample of the cross-section.

The riffle grid toss results for sediment fines (% <6 mm) are presented below in **Figure D3-6** and summary statistics are provided in **Table D3-7**. The scale was adjusted on the boxplot to show greater detail; as a result, one outlier for CR-0-2-U (100% fines) is not shown in the figure.

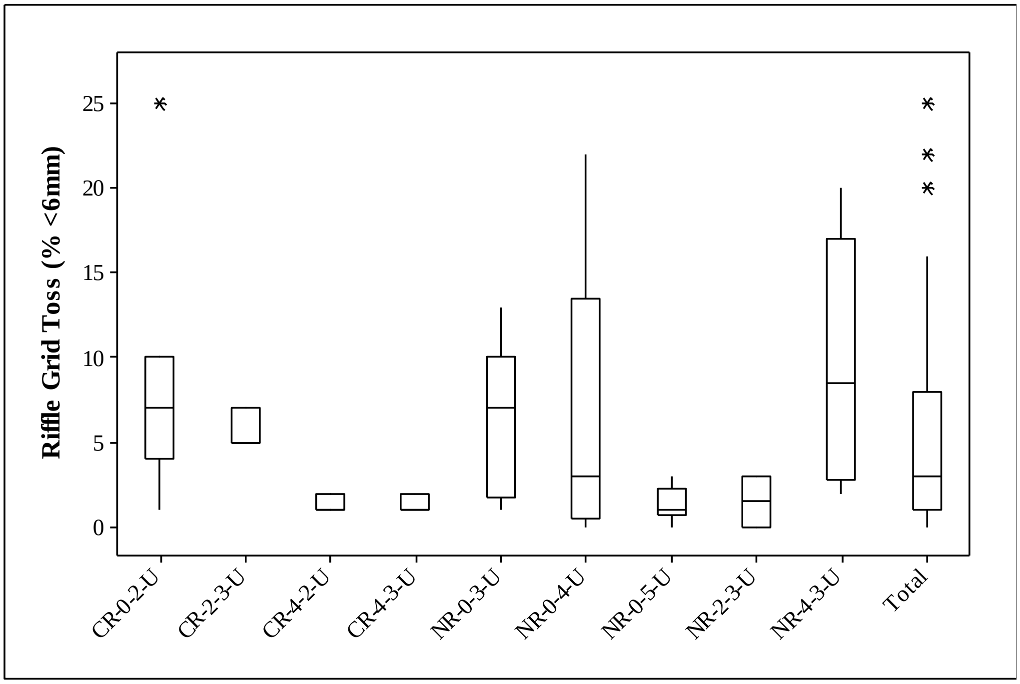

Figure D3-6. Riffle grid toss (% <6 mm) by reach type

Table D3-7. Summary statistics of riffle grid toss (% <6 mm) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	11	1	4	7	10	100
CR-2-3-U	1	3	5	5	5	7	7
CR-4-2-U	1	3	1	1	1	2	2
CR-4-3-U	1	3	1	1	1	2	2
NR-0-3-U	3	8	1	2	7	10	13
NR-0-4-U	3	9	0	1	3	14	22
NR-0-5-U	2	6	0	1	1	2	3
NR-2-3-U	1	3	0		2		3
NR-4-3-U	2	6	2	3	9	17	20
Total	**18**	**52**	**0**	**1**	**3**	**8**	**100**

D3.2.8 Pool Grid Toss within Depositional Spawning Areas: Sediment Fines (% <6 mm)

Grid toss measurements in depositional spawning areas provide a measure of fine sediment accumulation in potential spawning sites. Excess surface fine substrate may have detrimental impacts on aquatic habitat by cementing spawning gravels, thus reducing their accessibility, preventing flushing of toxins in egg beds, reducing oxygen and nutrient delivery to eggs and embryos, and impairing emergence of fry (Meehan, 1991). Weaver and Fraley (1991) observed a significant inverse relationship between the percentage of material less than 6.35mm and the emergence success of westslope cutthroat trout and bull trout

Grid toss results for sediment fines (% <6 mm) found within depositional spawning areas are provided below in **Figure D3-7** and summary statistics are provided in **Table D3-8**. The data presented represents only those features sampled that were identified as having the appropriate sized gravels to support spawning. There were four assessment sites (Clarence, DEP 9-2, LME 6-1, and SWP 9-1) where spawning gravels were not noted; as a result, these reach types were not reported. Also, the boxplot scale was adjusted to show greater detail throughout the reach types; as a result, three outliers for reach type CR-0-2-U (100% fines) are not shown in the figure.

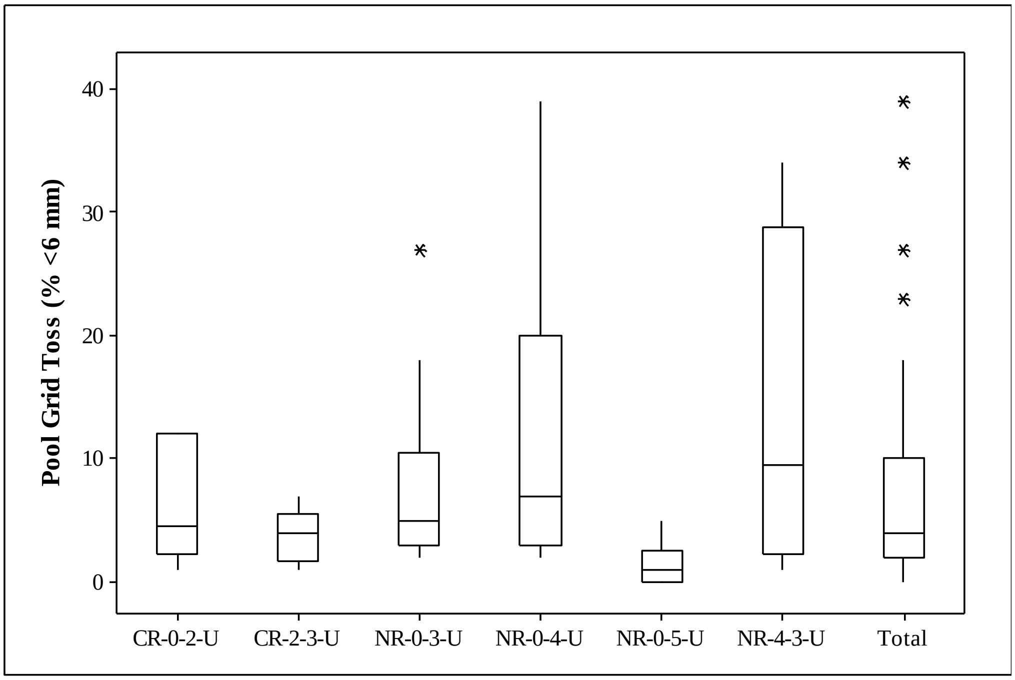

Figure D3-7. Pool grid toss (% <6 mm) by reach type

Table D3-8. Summary statistics of pool grid toss (% <6 mm) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	16	1	2	5	12	100
CR-2-3-U	1	10	1	2	4	6	7
NR-0-3-U	3	17	2	3	5	11	27
NR-0-4-U	3	9	2	3	7	20	39
NR-0-5-U	2	9	0	0	1	3	5
NR-4-3-U	1	4	1	2	10	29	34
Total	**14**	**65**	**0**	**2**	**4**	**10**	**100**

D3.2.9 Pool Residual Depth

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.

Data are presented below in **Figure D3-8** and **Table D3-9**. Note that the summary database contains the average residual pool depth for each monitoring site, while this analysis utilized all residual pool depth measurements for scour pools. Residual pool depths for dammed pools were not calculated.

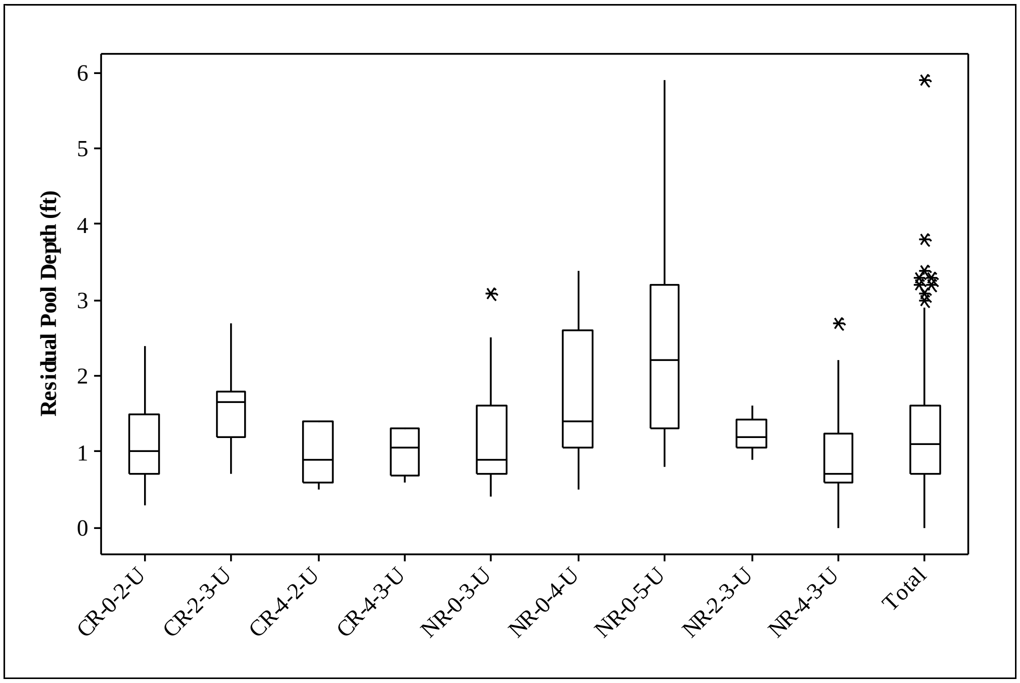

Figure D3-8. Residual pool depth (ft) by reach type

Table D3-9. Summary statistics of residual pool depth (ft) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	65	0.3	0.7	1.0	1.5	2.4
CR-2-3-U	1	16	0.7	1.2	1.7	1.8	2.7
CR-4-2-U	1	7	0.5	0.6	0.9	1.4	1.4
CR-4-3-U	1	6	0.6	0.7	1.1	1.3	1.3
NR-0-3-U	3	35	0.4	0.7	0.9	1.6	3.1
NR-0-4-U	3	30	0.5	1.1	1.4	2.6	3.4
NR-0-5-U	2	15	0.8	1.3	2.2	3.2	5.9
NR-2-3-U	1	8	0.9	1.1	1.2	1.4	1.6
NR-4-3-U	2	21	0.0	0.6	0.7	1.3	2.7
Total	**18**	**203**	**0.0**	**0.7**	**1.1**	**1.6**	**5.9**

D3.2.10 Pool Frequency (reach mean value)

Pool frequency is a measure of the availability of pools within a reach 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.

The pool frequencies per 1,000 ft for each reach type are presented in below **Figure D3-9** and summary statistics are provided in **Table D3-10**. As with residual pool depth, some reach types are represented by only a single value.

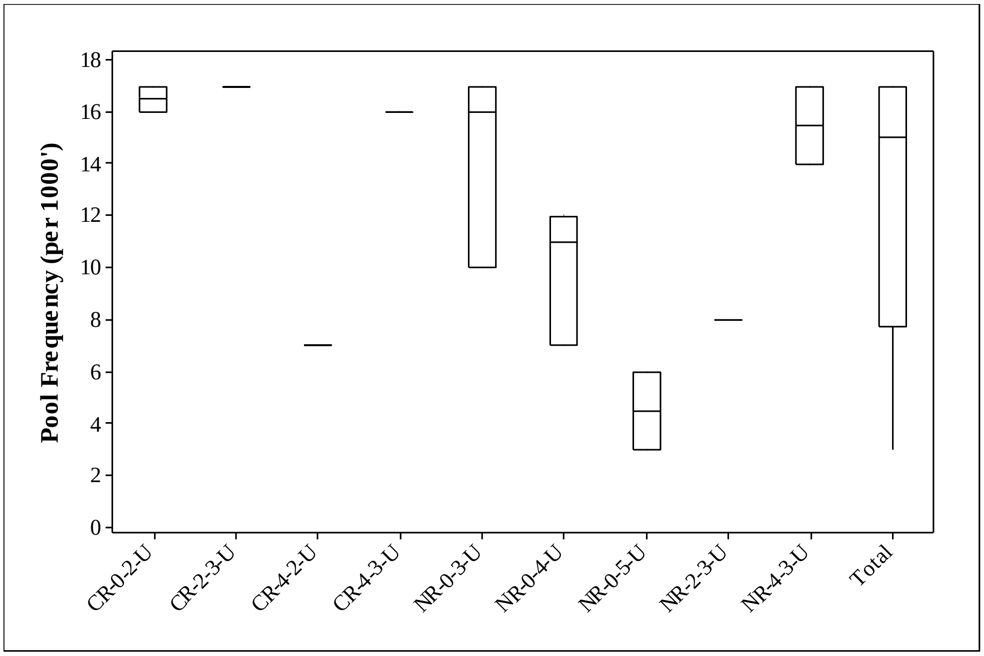

Figure D3-9. Pool frequency (per 1,000 ft) by reach type

Table D3-10. Summary statistics of pool frequency by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	4	16	16	16.5	17	17
CR-2-3-U	1	1	17		17		17
CR-4-2-U	1	1	7		7		7
CR-4-3-U	1	1	16		16		16
NR-0-3-U	3	3	10	10	16	17	17
NR-0-4-U	3	3	7	7	11	12	12
NR-0-5-U	2	2	3		4.5		6
NR-2-3-U	1	1	8		8		8
NR-4-3-U	2	2	14		15.5		17
Total	**18**	**18**	**3**	**7.75**	**15**	**17**	**17**

D3.2.11 Large Woody Debris Frequency

Large woody debris (LWD) is a critical component of salmonid habitat, providing stream complexity, pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989). LWD frequency can be measured and compared to reference reaches or literature values to determine if more or less LWD is present than would be expected under reference conditions. Too little or too much LWD 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 feet, represents an average of target values from other studies. 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.

The LWD frequencies for each reach type are provided below in **Figure D3-10** and summary statistics are provided in **Table D3-11**.

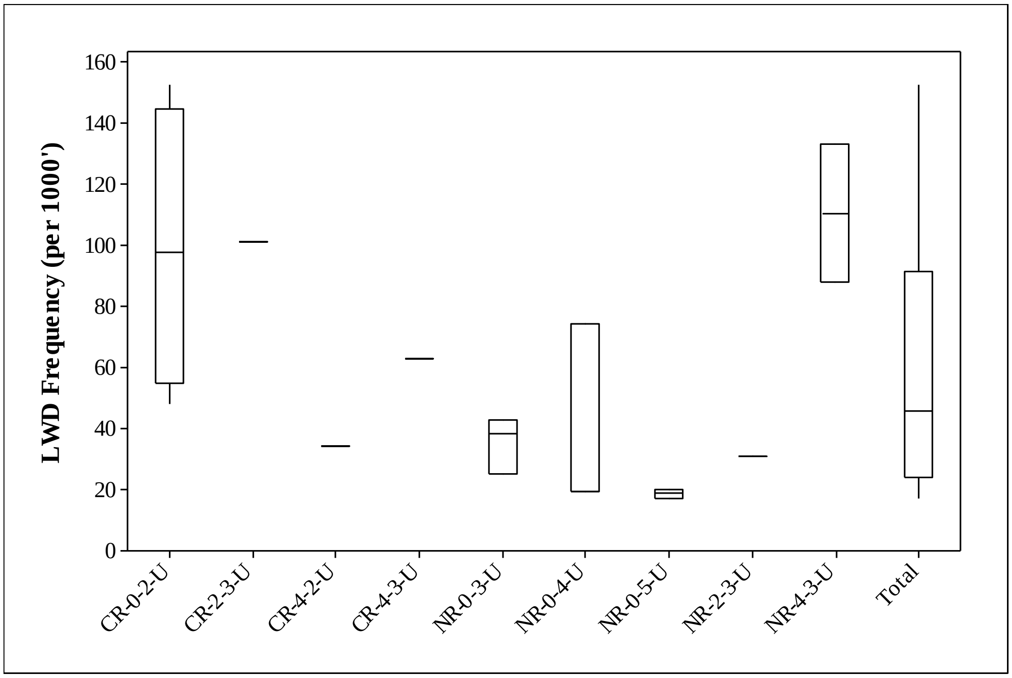

Figure D3-10. LWD frequency (per 1,000 ft) by reach type

Table D3-11. Summary statistics of LWD frequency by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	4	48	54.8	97.5	144.8	153
CR-2-3-U	1	1	101		101		101
CR-4-2-U	1	1	34		34		34
CR-4-3-U	1	1	63		63		63
NR-0-3-U	3	3	25	25	38	43	43
NR-0-4-U	3	3	19	19	19	74	74
NR-0-5-U	2	2	17		18.5		20
NR-2-3-U	1	1	31		31		31
NR-4-3-U	2	2	88		110.5		133
Total	**18**	**18**	**17**	**23.8**	**45.5**	**91.3**	**153**

D3.2.12 Greenline Inventory: Percent Understory Shrub Cover

Riparian shrub cover is an important factor 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 which reduce solar inputs and help maintain cooler water temperatures. 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.

The Greenline understory shrub cover percentages by reach type are presented in **Figure D 3-11**. The summary data are also presented in **Table D3-12**.

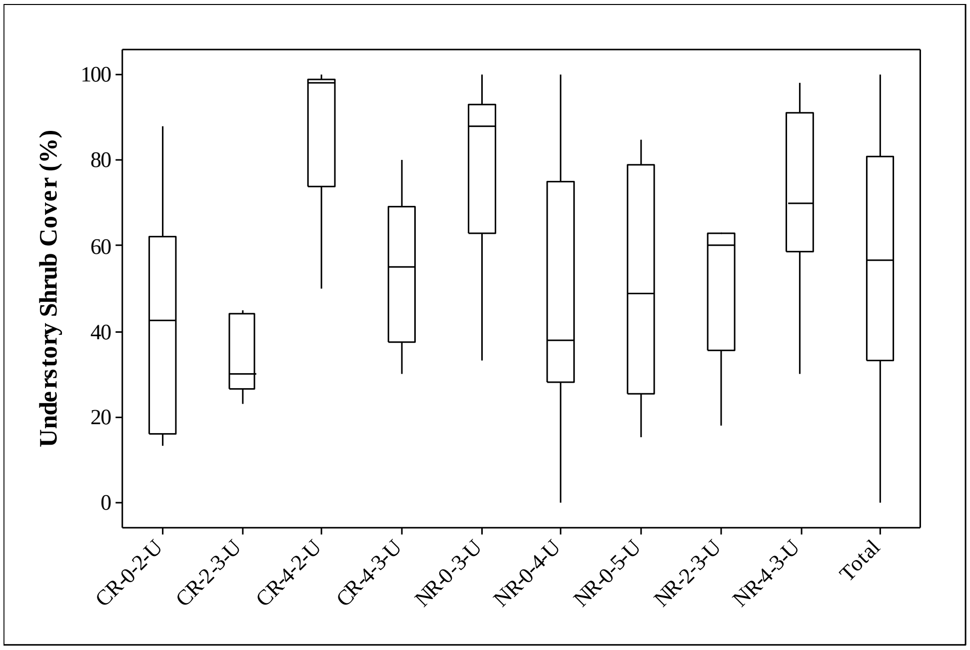

Figure D3-11. Greenline understory shrub cover (%) by reach type

Table D3-12. Summary statistics of understory shrub cover (%) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	20	13	16	43	63	88
CR-2-3-U	1	5	23	27	30	44	45
CR-4-2-U	1	5	50	74	98	99	100
CR-4-3-U	1	5	30	38	55	69	80
NR-0-3-U	3	15	33	63	88	93	100
NR-0-4-U	3	15	0	28	38	75	100
NR-0-5-U	2	10	15	26	49	79	85
NR-2-3-U	1	5	18	36	60	63	63
NR-4-3-U	2	10	30	59	70	91	98
Total	**18**	**90**	**0**	**33**	**57**	**81**	**100**

D3.2.13 Greenline Inventory: Percent Bare/Disturbed 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 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.

Results of the Greenline survey for percent bare/disturbed ground are provided by reach type below. Due to the large number of zero values, a box plot was not completed for the greenline bare ground percentage variable. The tabular data are presented in **Table D3-13**.

Table D3-13. Summary statistics of bare/disturbed ground (%) by reach type

Reach Type	Reaches	Count	Minimum	Q1	Median	Q3	Maximum
CR-0-2-U	4	20	0	0	0	0	10
CR-2-3-U	1	5	0	0	0	0	0
CR-4-2-U	1	5	0	0	0	0	0
CR-4-3-U	1	5	0	3	10	15	20
NR-0-3-U	3	15	0	0	0	0	5
NR-0-4-U	3	15	0	0	0	0	18
NR-0-5-U	2	10	0	0	0	2	4
NR-2-3-U	1	5	0	0	0	0	0
NR-4-3-U	2	10	0	0	0	0	0
Total	**18**	**90**	**0**	**0**	**0**	**0**	**20**

D3.3 Assessment Reach Field Descriptions

The following sections provide brief descriptions of each sampled reach. Descriptions are provided for human impacts, stream channel conditions, and riparian vegetation conditions. Streambank erosion conditions are provided with sediment loading results in **Section D 4.6**. Assessment reaches are organized by waterbody and reach location starting at the downstream end and moving upstream.

D3.3.1 Clarence Creek

Note: *One site on Clarence Creek was assessed instead of Grave Creek reach 2-1.*

Description of Human Impacts and Severity

This reach has no apparent human impacts, and is described as a “very nice” reach.

Description of Stream Channel Conditions
Stream channel is Rosgen type B3/C3b within the sample reach. Stream has large particle size, minimal spawning gravels, and a fairly steep grade. Some algae exist on rocks. Pools are shallow and infrequent. Stream is mostly step/riffle.

Description of Riparian Vegetation Conditions
Riparian vegetation is very dense with lots of woody species and wetter vegetation types including alder, snowberry, and moss.

D3.3.2 Deep Creek

D3.3.2.1 DEP 13-2

Description of Human Impacts and Severity
Reach is between road and Plum Creek mill near Fortine, but has no apparent human impacts.

Description of Stream Channel Conditions
Reach is a Rosgen C4 channel type consisting of a meandering channel through flat valley with minimal riffle development and long runs. Reach contained many lateral scour pools and wood pools, and many wood and debris jams. Beaver activity is evident downstream of reach and evidence of historical beaver activity is evident within the sampled reach. Bank material includes a cobble/gravel deposited over a layer of fines. Channel has small particle size, with higher fines in pools, and point bars near riffles.

Description of Riparian Vegetation Conditions
Reach has good grass cover (reed canary) with alder, chokecherry, sedges, raspberries, and minimal overstory.

D3.3.2.2 DEP 9-2

Description of Human Impacts and Severity
This reach parallels Deep Creek Road. A large (50-100' tall) eroding bank is in cells 2, 3, and 4. Rock barbs were installed in places to deflect flow, causing erosion on opposite bank, as well as scour erosion on large bank. Rock dams were put in to stop stream movement (see note below).

Description of Stream Channel Conditions
Stream channel measurements resemble Rosgen types F4b, C4b, B3, and E3b in various cells of the sample reach depending on entrenchment, width/depth ratio, and sediment size, but stream is likely a B channel type that is in disequilibrium. Stream shows evidence of downcutting, undercutting, and lateral movement due excessive sediment input and human alteration. Reach is steep, with almost all riffle/run, boulder structure. Reach has minimal pools, and no spawning habitat noted due to large cobble substrate. Channel braids in cells 3 and 4, and entire side channel (approximately 10 CFS) runs approximately 100-200' left of left bank and runs past end of reach. Large debris jams have caused deposition and braiding. The lowest cell and the area upstream of cell 5 appear to be returning to reference condition.

Description of Riparian Vegetation Conditions
Reach has good vegetation conditions, with alder, birch, snowberry, conifers, mossy duff layer, and lots of downed wood. All vegetation appears natural.

D3.3.2.3 DEP-7-1
Description of Human Impacts and Severity
Reach has a bridge at upper end of reach. Logged clear-cuts exist nearby, but there is no evidence of impact on stream.

Description of Stream Channel Conditions
Reach is a cascading step-pool system with steep gradient, lots of woody debris, and log jams that form dams. Substrate is predominantly large cobble. Several small trout were observed during sampling. Reach is a good example of reference reach for high elevation tributaries.

Description of Riparian Vegetation Conditions
Riparian vegetation is in great condition, and includes dense conifer overstory and lots of cedar, alder, raspberry and moss.

D3.3.3 Edna Creek
D3.3.3.1 ENA 11-1
Description of Human Impacts and Severity
Site is heavily impacted by agriculture, and surrounding land is actively mowed for hay.

Description of Stream Channel Conditions
Stream has high amount of fines with few stretches of gravel. Several fish were observed in the stream. Site has several multi-channel sections with heavily vegetated islands.

Description of Riparian Vegetation Conditions
Site has very extensive reed canary grass covering the banks and riparian corridor, and frequent clumps of willow that cover the entire channel (20-50 feet in length).

D3.3.3.2 ENA 10-2
Description of Human Impacts and Severity
No human impacts were present in this reach.

Description of Stream Channel Conditions
Stream channel is a B4c/C4 type channel that also resembles an F4 channel type in areas due to entrenchment. Reach shows no signs of human impact, although some historic beaver activity is present, and some areas appear overwidened. Channel has medium sized gravel substrate.

Description of Riparian Vegetation Conditions
Riparian vegetation was in good condition, with all vegetation buffers greater than 200 feet.

D3.3.3.3 ENA 8-1
Description of Human Impacts and Severity
Site has no visible evidence of human impacts although road runs adjacent to right bank (50-100 feet distance). The riparian corridor has not been recently logged.

Description of Stream Channel Conditions
Reach is step-pool system with occasional cascades over rocks or logs and nice pool development.

Description of Riparian Vegetation Conditions
Alders formed a dense corridor that was difficult to pass through. Overstory is dense with conifers and cedar.

D3.3.3.4 ENA 7-2
Description of Human Impacts and Severity
Site has no apparent human impacts, and is in old growth forest with many large larch and cedar.

Description of Stream Channel Conditions
Reach is step-pool system with lots of woody debris. Lower end of reach contains a massive log jam and deadfall which is impossible to walk through.

Description of Riparian Vegetation Conditions
Site has excellent riparian vegetation including cedar, alder, and conifers.

D3.3.4 Fortine Creek
D3.3.4.1 FTN 15-3
Description of Human Impacts and Severity
Reach has a railroad bridge at upper end of reach, and automobile bridge at lower end of reach. Evidence of historic riparian grazing exists, but a fence lines the left bank along entire reach.

Description of Stream Channel Conditions
Site has moderate pool development, and channel seems to be slightly overwidened (possibly from historic grazing). Approximately 50 spawning salmon were observed during sampling.

Description of Riparian Vegetation Conditions
Site has good riparian buffer on right bank. Left bank buffer is less extensive and has agriculture fields within 100-200 feet of stream. Some knapweed and reed canary grass exists with cottonwood overstory.

D3.3.4.2 FTN 15-2
Description of Human Impacts and Severity
Railroad tracks exist along right bank for entire reach. Channel was likely channelized in the past. Approximately 100 feet of log riprap exists at upper end of reach.

Description of Stream Channel Conditions
Site has poor pool development. Some spawning salmon were present along the reach.

Description of Riparian Vegetation Conditions
Site has fair to good vegetation along left bank, and fair brush cover on right bank. Vegetation includes cottonwood overstory, not much knapweed, and occasional reed canary grass.

D3.3.4.3 FTN 13-1
Description of Human Impacts and Severity
Reach has railroad encroachment at lower end of reach. There appears to have been some effort to restore banks.

Description of Stream Channel Conditions
Stream channel is primarily Rosgen type B4c, but resembles an F4 channel in areas of entrenchment. Multiple compound pools exist, with infrequent small riffles. Channel is downcut toward upper end of reach and above top of reach.

Description of Riparian Vegetation Conditions
Riparian vegetation is mature and good condition with alder, snowberry, and reed canary grass.

D3.3.4.4 FTN 12-9

Description of Human Impacts and Severity
Reach has minimal human impacts. Area was logged ~15 years ago (owner mentioned) and they didn't log close to the stream. There is a 20-50 feet riparian buffer.

Description of Stream Channel Conditions
Reach has two beaver dams that divert flow into side channels. Channel with the most water was sampled. Reach has minimal pool development, and rocks are slimy and covered with brown algae. Site may be receiving nutrient input from livestock upstream.

Description of Riparian Vegetation Conditions
Riparian vegetation conditions are okay, but not great. Site consists of mostly a conifer overstory with brush and grass. Game use is evident and the landowner is doing some cleanup on the floodplain.

D3.3.4.5 FTN 12-7

Description of Human Impacts and Severity
Reach has severe grazing impacts with heavily browsed vegetation. An attempt to fence out cows appears to be unsuccessful. Upper end of reach has had past restoration and tree planting.

Description of Stream Channel Conditions
Stream channel is Rosgen type B4c/C4 in the upper reach and type B3c in the lower reach where larger substrate was encountered. Channel is severely overwidened in several places. Large substrate is cemented in fine sediment or films of algae. Channel is also downcutting in areas.

Description of Riparian Vegetation Conditions
Riparian vegetation is in poor quality due to grazing. Shrubs and woody species have been browsed. Alder, grasses, and some sedges exist in areas with no grazing.

D3.3.4.6 FTN 12-2

Description of Human Impacts and Severity
Reach has evidence of historic logging along both banks. Trees were cut down at the bank edge.

Description of Stream Channel Conditions
Stream reach is low gradient with average pool development. There were some muddy areas within the sample reach, and a fine film of sediment coated the streambed material.

Description of Riparian Vegetation Conditions
Site has average riparian conditions. The vegetation is not very dense on the old floodplain. The forest is conifer dominated with occasional alder and reed canary grass.

D3.3.4.7 FTN 9-3

Description of Human Impacts and Severity

Reach has some evidence of historic riparian logging. Several invasive weeds were noted, including spotted knapweed and tansy, although most vegetation appears natural.

Description of Stream Channel Conditions

Reach is a Rosgen B4c/C4 channel type. Reach is slow and meandering with flat long pools and short sporadic riffles. Reach appears overwidened in places. Some woody debris and log jams. Pools have minimal or no spawning gravels and substrate has a coating of fine sediment on top. There is evidence of beaver activity, but no dams or lodges were encountered.

Description of Riparian Vegetation Conditions

Riparian vegetation is in fairly good condition, with reed canary grass, alder, chokecherry, and snowberry. Overstory is minimal at top of reach, but more common toward reach bottom.

D3.3.4.8 FTN 7-2

Description of Human Impacts and Severity

Site has minimal human impact with no evidence of logging except for two big old growth logs that may have come from past logging upstream. Railroad seems far enough away from the measured reach to have no impact on stream.

Description of Stream Channel Conditions

Stream channel has minimal pool development, and not a lot of deadfall. Rocks did not have much algae.

Description of Riparian Vegetation Conditions

Reach has good riparian vegetation with conifer overstory, some alders, and few noxious weeds.

D3.3.4.9 FTN 6-1

Description of Human Impacts and Severity

Reach is channelized at the top and bottom by railroad. Some historic logging activity is present.

Description of Stream Channel Conditions

Reach is B3c/B4c channel type which resembles a F3 channel type is areas due to entrenchment. Both gravel and cobble substrate exists. Bottom of reach has some beaver activity in the railroad section, while middle of reach looked more natural with large cobble substrate. Top of reach is again channelized by railroad. Beaver dams exist at top of reach with deep pools and some good spawning gravel.

Description of Riparian Vegetation Conditions

River left had riprap at top and bottom of reach adjacent to railroad. Top of reach was historically logged near stream. Middle of reach looked good with alder and mature conifers.

D3.3.4.10 FTN 4-3

Description of Human Impacts and Severity

Severe grazing impacts were noted throughout the upper four cells of this reach. Cattle crossings exist everywhere, especially through riffles and pool tails. Riparian areas are trampled, with lots of fine sediment in stream.

Description of Stream Channel Conditions

Stream channel is a Rosgen C4 channel type. Reach is slow, flat and meandering through a meadow, with minimal riffle development, long scour pools, and minimal woody debris. An old beaver dam exists at station 835.

Description of Riparian Vegetation Conditions

Reach has lots of grass cover with sedges, alder and willow, although almost no overstory.

D3.3.4.11 FTN 4-1

Description of Human Impacts and Severity

Site is within old growth forest and has no apparent human impacts (right and left bank) other than man-made log cascades within stream channel.

Description of Stream Channel Conditions

Reach contains lots of woody debris (log jams) and three man-made log cascades. Channel has lots of step pools from logs, and logs totally crossing stream. Some fish were observed.

Description of Riparian Vegetation Conditions

Stream reach has good riparian corridor in old growth forest. Banks have alder, and no noxious weeds were observed.

D3.3.5 Lime Creek

D3.3.5.1 LME 6-1

Description of Human Impacts and Severity

Minimal human impacts were observed, although there is evidence of historic logging at the upper end of reach. Road culvert may be influencing some bank erosion near top. An old log bridge exists in cell 3.

Description of Stream Channel Conditions

Stream channel measurements suggest reach is a Rosgen type E4b channel with a high entrenchment ratio and low width/depth ratio, but stream appears to be a B type channel that is incised in areas. Lots of natural fines exist and stream has chalky appearance from eroded limestone. Large particles are cemented together and will break with hand pressure. No spawning gravels exist. Field measured slope is approximately 4%. Lots of woody debris exists in channel, with minimal pools and long riffles.

Description of Riparian Vegetation Conditions

Vegetation is in very good condition with thick canopy and understory including alder, snowberry, dogwood, young and old coniferous trees, and few old stumps. Banks have shallow rooting depth.

D3.3.6 Sinclair Creek

D3.3.6.1 SNC 10-3

Description of Human Impacts and Severity

Stream reach is encroached by roads on both sides, and likely receives sediment input from downstream culvert (backup) or from upstream land uses. Debris (tires, metal, coolers, and garbage) exists throughout reach. Reach located in Town of Eureka.

Description of Stream Channel Conditions

Stream reach is a Rosgen type B4c channel in riffle areas, and B5c throughout much of the reach due to high percent of fine material. The stream has few small riffles, and is overwidened and multi-channel in areas. Some evidence of backwater exists, possibly from backup from the downstream culvert. Reach contains lots of wood and has long shallow pools with high fines. Several deeper pools exist near upper end. Channel looks to be aggrading.

Description of Riparian Vegetation Conditions

Riparian vegetation primarily includes reed canary grass, cottonwoods, chokecherry, and alder. Vegetation is in relatively good condition considering human impacts.

D3.3.6.2 SNC 8-2

Description of Human Impacts and Severity

Bridges exist at upstream and downstream ends of reach, with grazing on both sides of stream. Recent riparian fencing and restoration was done on section upstream of reach. Some evidence of grazing exists upstream, but not severe.

Description of Stream Channel Conditions

Stream reach is a B4c/C4 Rosgen type channel, but resembles a F4 type channel in areas due to entrenchment. Overall, reach has good morphological structure with lots of woody debris and good fish habitat, but minimal spawning gravels. One dead bull trout (approx. 4”) was observed. Lower end of reach is incised.

Description of Riparian Vegetation Conditions

Riparian vegetation includes old stands of alder and hawthorn. Vegetation has been impacted by grazing, but appears to be recovering.

D3.3.6.3 SNC 5-1

Description of Human Impacts and Severity

Site has no signs of human impact, and is a very remote stream in tight valley.

Description of Stream Channel Conditions

Reach consists of cascading step pool system. Reach is steep with lots of large woody debris and large boulders. There is evidence of large flood that has moved extremely large material (> 3ft boulders) well out in floodplain. Site may serve as reference reach for high mountain tributary.

Description of Riparian Vegetation Conditions

Site has minimal grasses and understory with large old growth overstory consisting of conifer and cedar. Thick forest duff exists in most areas.

D3.3.7 Swamp Creek

D3.3.7.1 SWP 9-1

Description of Human Impacts and Severity

Reach contains very little human influence. Reach has been clear-cut at lower end, but has good buffer from streams. A stream gauging device was present at station 600 in cell 4.

Description of Stream Channel Conditions

The stream reach is a Rosgen type B3/C3b channel within the sample reach. Stream is a step-pool system near top half of reach, with large substrate and low quality pools. Amount of woody debris appears to be low, but natural to this system.

Description of Riparian Vegetation Conditions

Riparian vegetation is in good condition with large cottonwoods, pine, and aspen. Banks have some willow, alder, and reed grass.

D3.3.7.2 SWP 5-1

Description of Human Impacts and Severity

Stream reach has previously been logged in riparian areas. Grazing impacts are minor. Some grade control structure and geotextile fabric exists in channel, possibly from past restoration work. A new pipe arch bridge exists at upstream road crossing, which is causing channel widening and erosion downstream.

Description of Stream Channel Conditions

This reach is a Rosgen type B4 channel in the upper cells, and a type F4b in the lower cells due to entrenchment. The stream contains large cobble substrate. At time of sampling, stream contained very low flow relative to the channel size, and flow becomes disconnected in places. Some algae exist in stagnant areas. Channel contains frequent large woody debris.

Description of Riparian Vegetation Conditions

Stream contains willow, snowberry, and alder along banks. A few sedges were also present. Some weeds species were observed near bridge at top of reach, possibly due to recent disturbance.

D3.3.7.3 SWP 3-1

Description of Human Impacts and Severity

Site has good riparian corridor (not logged) for lower part of reach, but corridor was narrow at upper end due to historic logging near the creek.

Description of Stream Channel Conditions

Site is a step pool system with lots of woody debris and big trees across the stream. Many sections up to 75-100' were totally covered with down trees. Very little water was in the creek at time of sampling, but there were some trapped fish in several pools.

Description of Riparian Vegetation Conditions

Site has abundant vegetation with conifer and cedar overstory. Understory has lots of alder and small conifers. Upper end of reach sees more impact from historic logging than lower end.

D3.3.8 Therriault Creek

D3.3.8.1 THR 14-1 (Extending onto THR 13-2)

Description of Human Impacts and Severity

Culvert below bottom of reach appears undersized and is failing and causing deposition upstream. Some signs of historic grazing exist, but new fencing has been installed along riparian areas. Stream has some evidence of historic riparian logging. Some residential impacts exist, including clearing around residences.

Description of Stream Channel Conditions

Stream reach is a Rosgen type C4 channel in the upper portion, and resembles an E4 type channel in the lower cells due to low width/depth ratio. Reach has long reaches of compound riffles, and long distances between pools. Some sediment aggradation occurs above culvert. Woody debris is plentiful, and is forming plunge pools between compound riffles.

Description of Riparian Vegetation Conditions

Stream contains minimal understory on lower reach likely due to historic grazing. Alder bunches are present, but no willows. There is evidence of historic logging in riparian areas in upper part of reach.

D3.3.8.2 THR 9-5

Description of Human Impacts and Severity

Reach contains historic riparian logging. Some active logging is occurring on upper bench, but not significant. Lots of unnatural wood (planed and milled) exists in stream. Stream has two side channels within reach.

Description of Stream Channel Conditions

Stream reach resembles an E4 type channel with low width/depth ratio and gravel substrate, but is also slightly entrenched in areas resembling a B4c type channel. Reach has fairly steep slope, poor spawning habitat, and marginal pool habitat.

Description of Riparian Vegetation Conditions

Vegetation is in good condition with dense understory, minimal coniferous overstory, and good grass cover in riparian areas. Reach contains evidence of past riparian logging.

D3.3.9 Tobacco River

D3.3.9.1 TOB 2-6

Description of Human Impacts and Severity

Stream reach has rural residential encroachment, and severely eroding banks with poor restoration work and flood control. Railroad grade is on river left and upper end of reach.

Description of Stream Channel Conditions

Stream channel is Rosgen type C4 in the lower cells, and type F4 in the upper cells due to entrenchment. Stream appears to be aggrading and is overwidened in places. Reach has multiple transverse bars with high bedload that appears to be from eroding banks.

Description of Riparian Vegetation Conditions

Reach has fair riparian vegetation with alder, dogwood, and chokecherry. Vegetation has been impacted in some areas from rural residents.

D3.3.9.1 TOB 2-3

Description of Human Impacts and Severity

Site is very confined by bridge at downstream end, with urban impacts to the north and railroad and lumber yard to south. A walking trail exists along river in lower half of reach. Reach experiences high human impact within downtown Eureka. Upper part of reach is more natural. Lots of riprap exists along reach to stop eroding banks.

Description of Stream Channel Conditions

Reach is confined at lower part between railroad and town, but generally has good riffles, poor habitat, fair amount of woody debris, and good point bar development. Significant active spawning noted.

Description of Riparian Vegetation Conditions

Vegetation has lots of urban impacts including a limited overstory. Vegetation appears to be less disturbed toward top of reach. Grasses are in good condition with some alder and cottonwoods.

D3.3.9.2 TOB 1-3

Description of Human Impacts and Severity

The only evidence of agriculture is at upper end of reach (grazing). There is a good riparian buffer along most of stream on both sides. Rural residence exists on east side at good distance.

Description of Stream Channel Conditions

Site has good riffle/pool development, very abundant spawning activity, fair amount of woody debris and good point bar development. Therriault Creek enters at station 810.

Description of Riparian Vegetation Conditions

Site has significant weed impact (knapweed, reed canary grass) at upper end. Overstory is mostly cottonwood with snowberry, chokecherry, and alder understory. Site has good overall riparian buffer along reach which minimizes impact from agriculture.

D3.3.9.3 TOB 1-1

Description of Human Impacts and Severity

Stream reach is influenced by rural residential impact and some minor historic grazing. Some restoration work was performed on an eroding bank in cell 3.

Description of Stream Channel Conditions

Stream reach is a Rosgen type C4 channel, but resembles a F4 channel type in cell 2 due to entrenchment. Stream reach is just below confluence of Fortine and Grave Creek, and has high energy, large substrate, moderate erosion, and a minimal number of pools and spawning gravels.

Description of Riparian Vegetation Conditions

Reach appears to be historically grazed, but is recovering. Riparian vegetation includes cottonwoods, conifers, wild rose, horsetail, and some sedges.

D3.4 Sampling Parameter Summaries by Individual Reach

The following section provides descriptions and basic statistics of stream channel and riparian zone parameters measured in each of the 18 reaches where a full habitat assessment was completed.

D3.4.1 Width/Depth Ratio

Width depth ratio data for each site are displayed in **Figure D3-12** and **Table D3-14**. The high w/d ratio noted at FTN 12-7 likely stems from significant grazing impacts and riparian vegetation clearing at the site, which has led to overwidening of the channel.

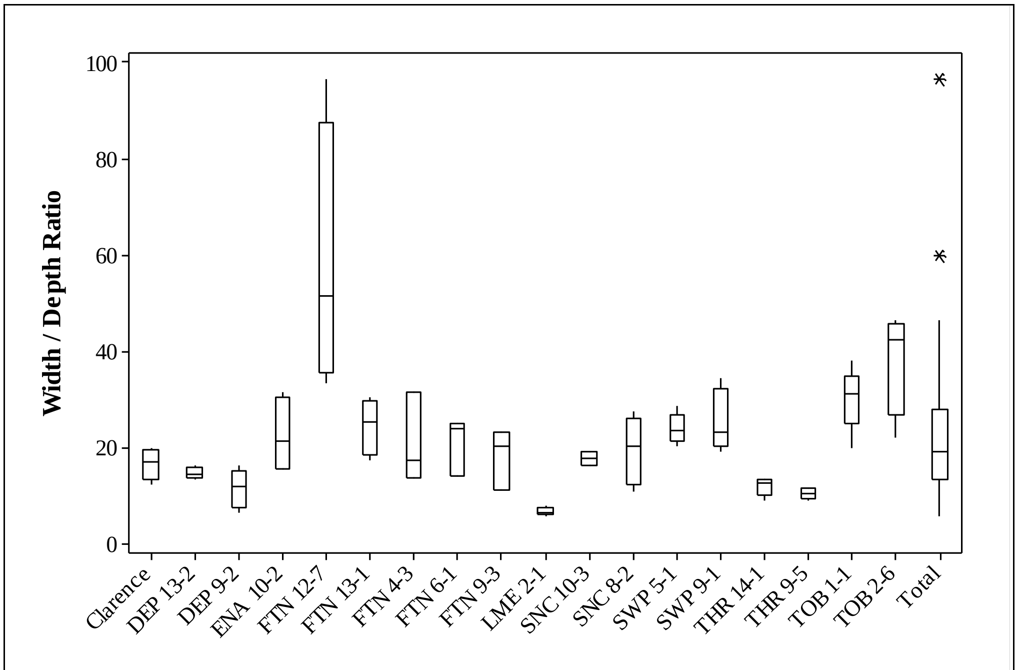

Figure D3-13. Width/depth ratio by reach

Table D3-14. Summary statistics of width/depth ratio by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	5	12.5	13.5	17.1	19.6	19.8
DEP 13-2	4	13.6	13.8	14.4	15.9	16.3
DEP 9-2	4	6.4	7.7	11.9	15.3	16.4
ENA 10-2	5	15.6	15.7	21.5	30.7	31.6
FTN 12-7	4	33.2	35.7	51.5	87.4	96.5
FTN 13-1	4	17.3	18.7	25.3	29.8	30.5
FTN 4-3	3	13.8	13.8	17.3	31.7	31.7
FTN 6-1	3	14.2	14.2	24.0	25.2	25.2
FTN 9-3	3	11.2	11.2	20.2	23.2	23.2
LME 2-1	4	5.9	6.0	6.7	7.7	8.0
SNC 10-3	3	16.2	16.2	17.7	19.3	19.3
SNC 8-2	5	11.0	12.3	20.3	26.3	27.5
SWP 5-1	5	20.4	21.4	23.7	27.0	28.5
SWP 9-1	5	19.1	20.3	23.2	32.5	34.6
THR 14-1	5	9.1	10.2	12.8	13.5	13.5

Table D3-14. Summary statistics of width/depth ratio by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
THR 9-5	4	9.2	9.5	10.6	11.5	11.6
TOB 1-1	5	20.0	25.0	31.1	34.9	38.1
TOB 2-6	4	22.0	26.8	42.3	45.6	46.3
Total	**75**	**5.9**	**13.5**	**19.3**	**27.8**	**96.5**

D3.4.2 Entrenchment Ratio

Entrenchment ratio data for each site are displayed in **Figure D3-13** and **Table D3-15**. The Clarence Creek reach shows wide variability most likely due to the stream down-cutting to reach its confluence with Grave Creek. THR 14-1 is also a transitional reach moving from forested valley into pasture ground, and an undersized culvert near the downstream end may be impacting the reach.

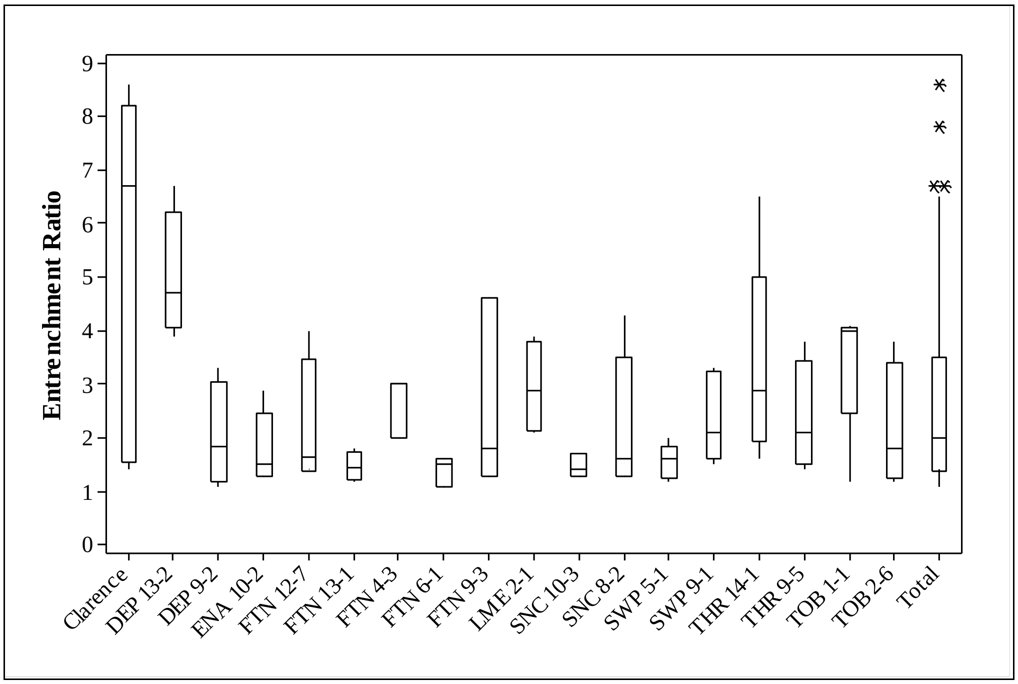

Figure D3-13. Entrenchment ratio by reach

Table D3-15. Summary statistics of entrenchment ratio by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	5	1.4	1.6	6.7	8.2	8.6
DEP 13-2	4	3.9	4.1	4.7	6.2	6.7
DEP 9-2	4	1.1	1.2	1.8	3.1	3.3
ENA 10-2	5	1.3	1.3	1.5	2.5	2.9
FTN 12-7	4	1.4	1.4	1.7	3.5	4.0
FTN 13-1	4	1.2	1.2	1.5	1.8	1.8
FTN 4-3	3	2.0	2.0	3.0	3.0	3.0
FTN 6-1	3	1.1	1.1	1.5	1.6	1.6
FTN 9-3	3	1.3	1.3	1.8	4.6	4.6
LME 2-1	4	2.1	2.2	2.9	3.8	3.9
SNC 10-3	3	1.3	1.3	1.4	1.7	1.7
SNC 8-2	5	1.3	1.3	1.6	3.5	4.3

Table D3-15. Summary statistics of entrenchment ratio by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
SWP 5-1	5	1.2	1.3	1.6	1.9	2.0
SWP 9-1	5	1.5	1.6	2.1	3.3	3.3
THR 14-1	5	1.6	2.0	2.9	5.0	6.5
THR 9-5	4	1.4	1.5	2.1	3.5	3.8
TOB 1-1	5	1.2	2.5	4.0	4.1	4.1
TOB 2-6	4	1.2	1.3	1.8	3.4	3.8
Total	**75**	**1.1**	**1.4**	**2.0**	**3.5**	**8.6**

D3.4.3 Riffle Pebble Count: Substrate Fines (% <2 mm)

Substrate fines less than 2 mm in riffle pebble count data for each site are displayed in **Figure D3-14** and **Table D3-16**. Two sites, LME 6-1 and SNC 10-3, exhibited high percentages of fine materials. Lime Creek contains fine sediment that appears to be naturally occurring from limestone deposits in the area. SNC 10-3 exhibited significant urban and transportation impacts, including a culvert that appeared to be causing significant deposition of fines upgradient.

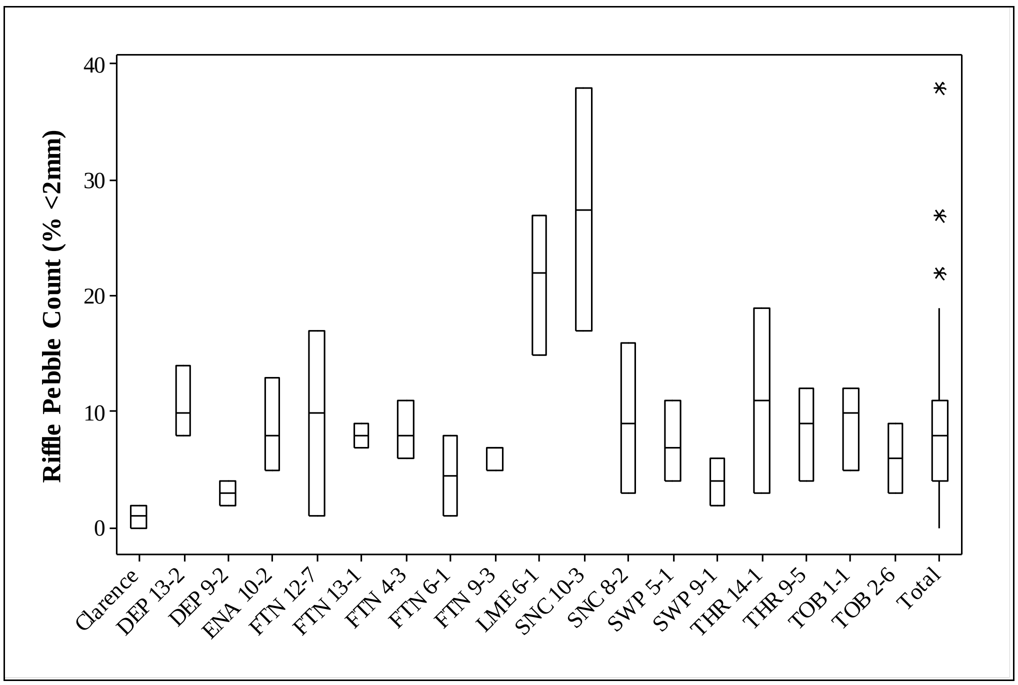

Figure D3-14. Riffle pebble count (% <2 mm) by reach

Table D3-16. Summary statistics of riffle pebble count (% <2 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	3	0	0	1	2	2
DEP 13-2	3	8	8	10	14	14
DEP 9-2	3	2	2	3	4	4
ENA 10-2	3	5	5	8	13	13
FTN 12-7	3	1	1	10	17	17
FTN 13-1	3	7	7	8	9	9
FTN 4-3	3	6	6	8	11	11
FTN 6-1	2	1		4.5		8

Table D3-16. Summary statistics of riffle pebble count (% <2 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
FTN 9-3	3	5	5	7	7	7
LME 6-1	3	15	15	22	27	27
SNC 10-3	2	17		27.5		38
SNC 8-2	3	3	3	9	16	16
SWP 5-1	3	4	4	7	11	11
SWP 9-1	3	2	2	4	6	6
THR 14-1	3	3	3	11	19	19
THR 9-5	3	4	4	9	12	12
TOB 1-1	3	5	5	10	12	12
TOB 2-6	3	3	3	6	9	9
Total	**52**	**0**	**4**	**8**	**11**	**38**

D3.4.4 Riffle Pebble Count: Substrate Fines (% <6mm)

Substrate fines less than 6 mm in riffle pebble count data for each site are displayed in **Figure D3-15** and **Table D3-17**. Similar to the less than 2 mm data, LME 6-1 and SNC 10-3 exhibited elevated percentages of fines less than 6 mm due to impacts listed previously.

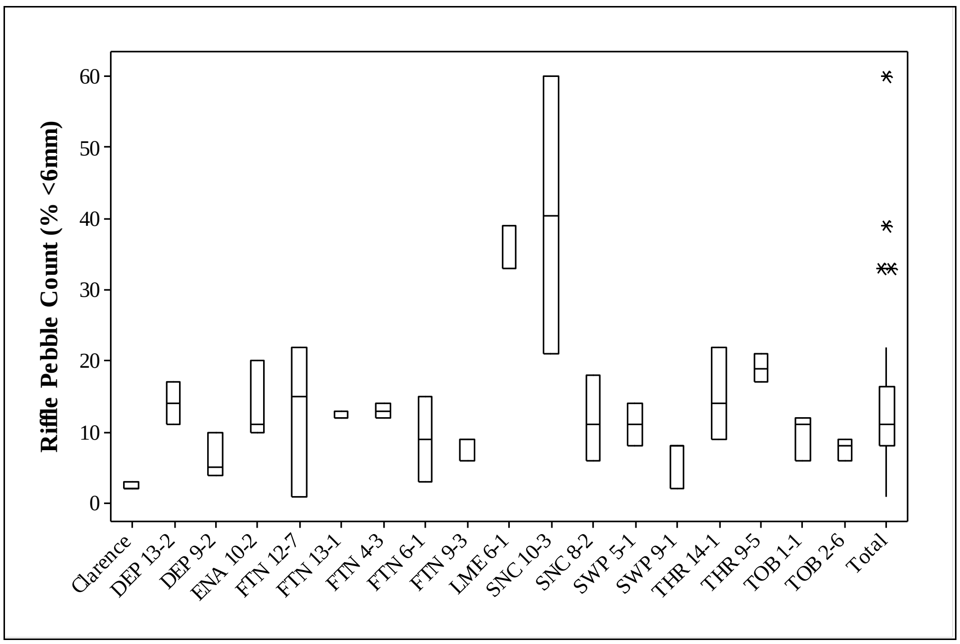

Figure D3-15. Riffle pebble count (% <6 mm) by reach

Table D3-17. Summary statistics of riffle pebble count (% <6 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	3	2	2	2	3	3
DEP 13-2	3	11	11	14	17	17
DEP 9-2	3	4	4	5	10	10
ENA 10-2	3	10	10	11	20	20
FTN 12-7	3	1	1	15	22	22
FTN 13-1	3	12	12	12	13	13
FTN 4-3	3	12	12	13	14	14

Table D3-17. Summary statistics of riffle pebble count (% <6 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
FTN 6-1	2	3		9		15
FTN 9-3	3	6	6	9	9	9
LME 6-1	3	33	33	33	39	39
SNC 10-3	2	21		40.5		60
SNC 8-2	3	6	6	11	18	18
SWP 5-1	3	8	8	11	14	14
SWP 9-1	3	2	2	8	8	8
THR 14-1	3	9	9	14	22	22
THR 9-5	3	17	17	19	21	21
TOB 1-1	3	6	6	11	12	12
TOB 2-6	3	6	6	8	9	9
Total	**52**	**1**	**8**	**11**	**16.5**	**60**

D3.4.5 Riffle Pebble Count: D50 (mm)

The D50 (mm) of riffle pebble counts for each site are displayed in **Figure D3-16** and **Table D3-18**. Similar to the less than 2 mm data, LME 6-1 and SNC 10-3 exhibited elevated percentages of fines less than 6 mm due to impacts listed previously.

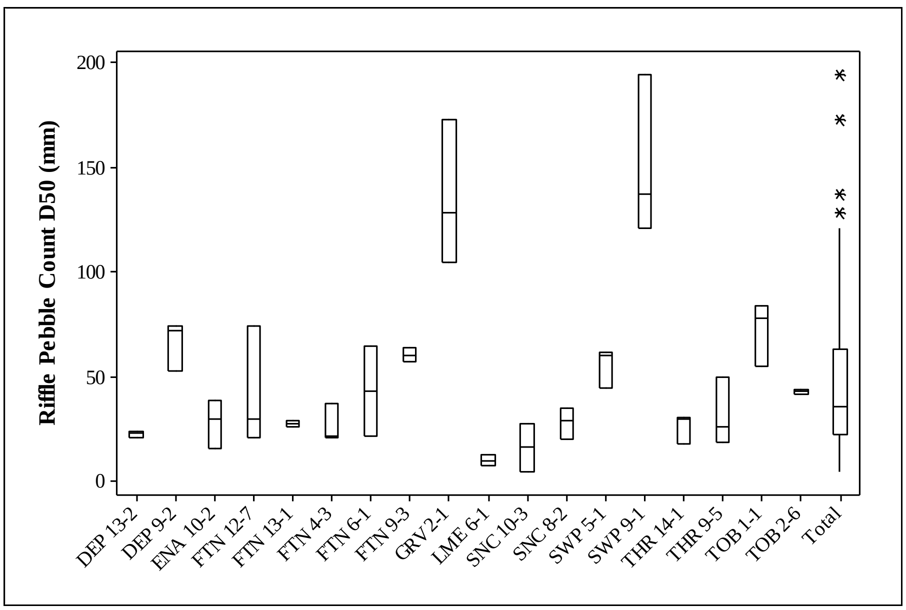

Figure D3-16. Riffle pebble count D50 (mm) by reach

Table D3-18. Summary statistics of riffle pebble count D50 (mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	3	105	105	128	173	173
DEP 13-2	3	21	21	23	24	24
DEP 9-2	3	53	53	72	74	74
ENA 10-2	3	16	16	30	39	39
FTN 12-7	3	21	21	30	74	74
FTN 13-1	3	26	26	28	29	29
FTN 4-3	3	21	21	22	37	37

Table D3-18. Summary statistics of riffle pebble count D50 (mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
FTN 6-1	2	22		44		65
FTN 9-3	3	57	57	60	64	64
LME 6-1	3	8	8	10	13	13
SNC 10-3	2	5		17		28
SNC 8-2	3	20	20	29	35	35
SWP 5-1	3	45	45	60	62	62
SWP 9-1	3	121	121	137	194	194
THR 14-1	3	18	18	30	31	31
THR 9-5	3	19	19	26	50	50
TOB 1-1	3	55	55	78	84	84
TOB 2-6	3	42	42	43	44	44
Total	**52**	**5**	**22**	**36**	**64**	**194**

D3.4.6 Riffle Grid Toss: Substrate Fines (% < 6mm)

Substrate fines less than 6 mm in riffle grid toss data for each site are displayed in **Figure D3-17** and **Table D3-19**. SNC 10-3 displayed elevated fines in riffles due to urban and transportation impacts. FTN 12-7 data were slightly elevated likely due to grazing impacts in this reach. THR 9-5 data were also slightly elevated, which may have been due to rural residential impacts.

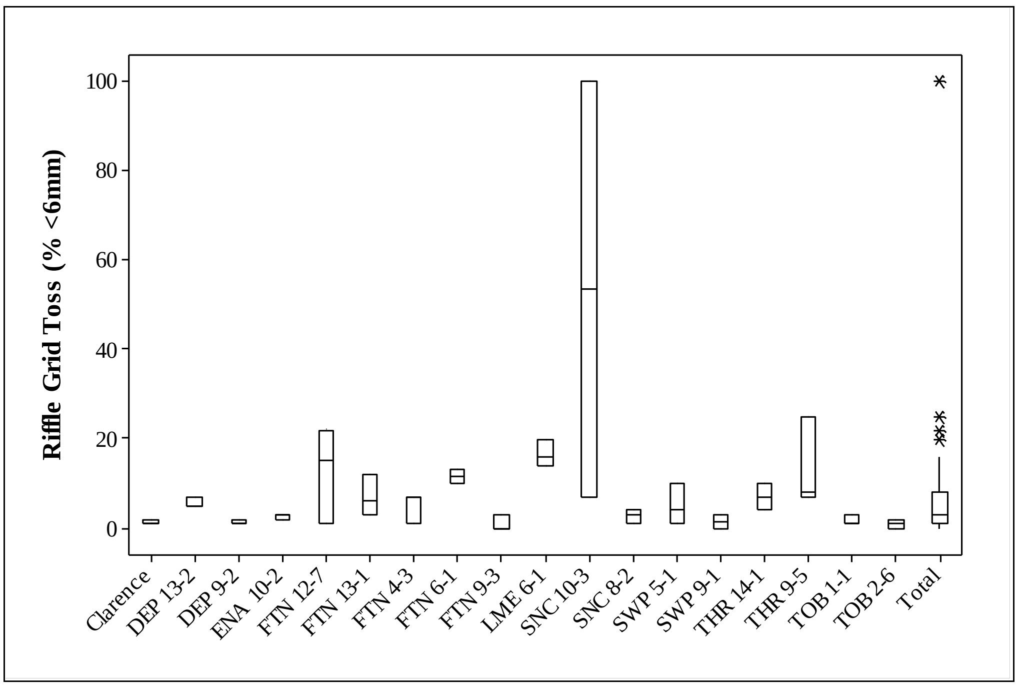

Figure D3-17. Riffle grid toss (% <6 mm) by reach

Table D3-19. Summary statistics of riffle grid toss (% < 6 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	3	1	1	1	2	2
DEP 13-2	3	5	5	5	7	7
DEP 9-2	3	1	1	1	2	2
ENA 10-2	3	2	2	3	3	3

Table D3-19. Summary statistics of riffle grid toss (% < 6 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
FTN 12-7	3	1	1	15	22	22
FTN 13-1	3	3	3	6	12	12
FTN 4-3	3	1	1	7	7	7
FTN 6-1	2	10		11.5		13
FTN 9-3	3	0	0	0	3	3
LME 6-1	3	14	14	16	20	20
SNC 10-3	2	7	*	53.5	*	100
SNC 8-2	3	1	1	3	4	4
SWP 5-1	3	1	1	4	10	10
SWP 9-1	3	0		1.5		3
THR 14-1	3	4	4	7	10	10
THR 9-5	3	7	7	8	25	25
TOB 1-1	3	1	1	1	3	3
TOB 2-6	3	0	0	1	2	2
Total	**52**	**0**	**1**	**3**	**8**	**100**

D3.4.7 Pool Grid Toss within Depositional Spawning Areas: Substrate Fines (% < 6mm)

Substrate fines less than 6 mm in pools exhibiting depositional spawning gravels for each site are displayed in **Figure D3-18** and **Table D3-20**. Some sites did not exhibit any suitable spawning gravels (Clarence, DEP 9-2, LME 6-1, SWP 9-1), and as a result are not included in this analysis. SNC 10-3 again exhibits high fines due to urban and transportation impacts.

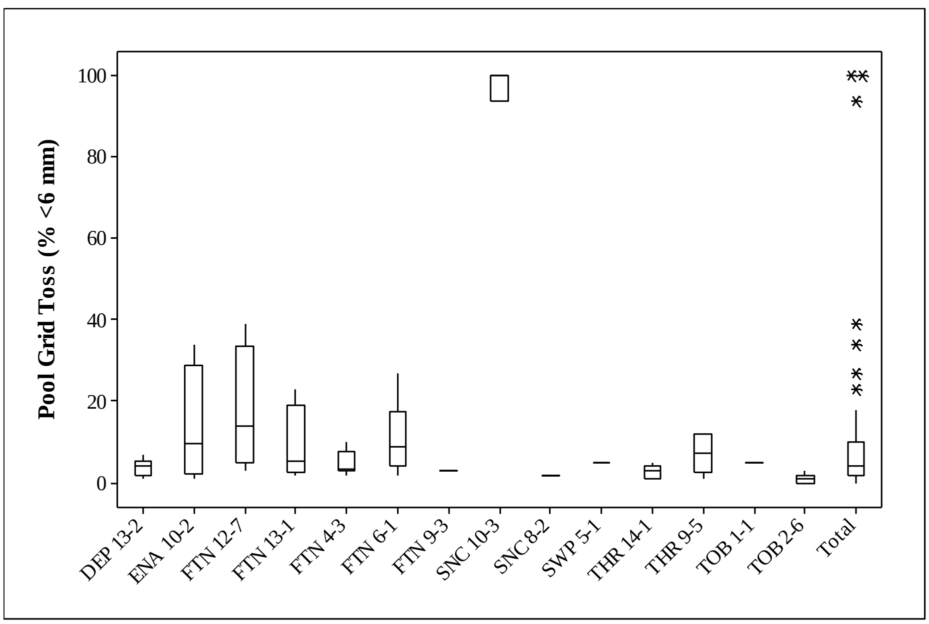

Figure D3-18. Pool grid toss (% <6 mm) by reach

Table D3-20. Summary statistics of pool grid toss (% <6 mm) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
DEP 13-2	10	1	1.75	4	5.5	7
ENA 10-2	4	1	2.25	9.5	28.75	34
FTN 12-7	4	3	5	14	33.5	39
FTN 13-1	4	2	2.5	5.5	19	23
FTN 4-3	8	2	3	3.5	7.75	10
FTN 6-1	8	2	4.25	9	17.5	27
FTN 9-3	1	3		3		3
SNC 10-3	3	94	94	100	100	100
SNC 8-2	1	2		2		2
SWP 5-1	1	5		5		5
THR 14-1	6	1	1	3	4.25	5
THR 9-5	6	1	2.5	7.5	12	12
TOB 1-1	1	5		5		5
TOB 2-6	8	0	0	1	1.75	3
Total	**65**	**0**	**2**	**4**	**10**	**100**

D3.4.8 Residual Pool Depth

Residual pool depth data for each site are displayed in **Figure D3-19** and **Table D3-21**. LME 6-1, SNC 10-3, and SWP 5-1 exhibited low residual pool depths.

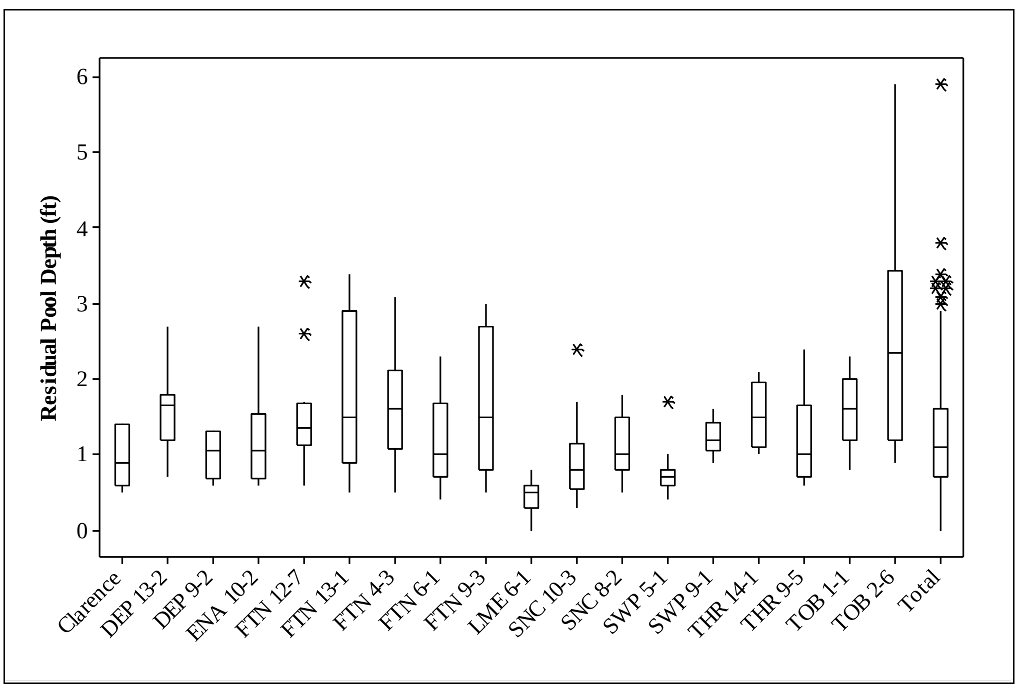

Figure D3-19. Residual pool depth (ft) by reach

Table D3-21. Summary statistics of residual pool depth (ft) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	7	0.5	0.6	0.9	1.4	1.4
DEP 13-2	16	0.7	1.2	1.7	1.8	2.7
DEP 9-2	6	0.6	0.7	1.1	1.3	1.3
ENA 10-2	14	0.6	0.7	1.1	1.6	2.7
FTN 12-7	12	0.6	1.1	1.4	1.7	3.3
FTN 13-1	11	0.5	0.9	1.5	2.9	3.4
FTN 4-3	10	0.5	1.1	1.6	2.1	3.1
FTN 6-1	10	0.4	0.7	1.0	1.7	2.3
FTN 9-3	7	0.5	0.8	1.5	2.7	3.0
LME 6-1	7	0.0	0.3	0.5	0.6	0.8
SNC 10-3	17	0.3	0.6	0.8	1.2	2.4
SNC 8-2	23	0.5	0.8	1.0	1.5	1.8
SWP 5-1	15	0.4	0.6	0.7	0.8	1.7
SWP 9-1	8	0.9	1.1	1.2	1.4	1.6
THR 14-1	9	1.0	1.1	1.5	2.0	2.1
THR 9-5	16	0.6	0.7	1.0	1.7	2.4
TOB 1-1	5	0.8	1.2	1.6	2.0	2.3
TOB 2-6	10	0.9	1.2	2.4	3.4	5.9
Total	**203**	**0.0**	**0.7**	**1.1**	**1.6**	**5.9**

D3.4.9 Greenline Inventory: Percent Understory Shrub Cover

Percent understory shrub cover data from the greenline survey for each site is displayed in **Figure D3-20** and **Table D3-22**.

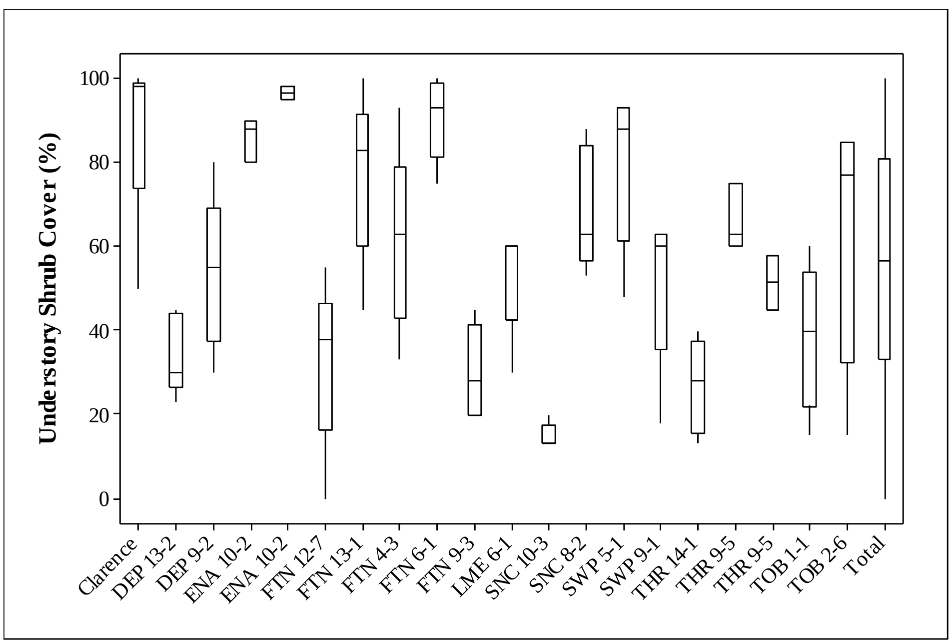

Figure D3-20. Greenline understory shrub cover (%) by reach

Table D3-22. Summary statistics of understory shrub cover (%) by reach

Reach ID	Count	Minimum	Q1	Median	Q3	Maximum
Clarence	5	50	74	98	99	100
DEP 13-2	5	23	26.5	30	44	45
DEP 9-2	5	30	37.5	55	69	80
ENA 10-2	3	80	80	88	90	90
ENA 10-2	2	95		96.5		98
FTN 12-7	5	0	16.5	38	46.5	55
FTN 13-1	5	45	60	83	91.5	100
FTN 4-3	5	33	43	63	79	93
FTN 6-1	5	75	81.5	93	99	100
FTN 9-3	5	20	20	28	41.5	45
LME 6-1	5	30	42.5	60	60	60
SNC 10-3	5	13	13	13	17.5	20
SNC 8-2	5	53	56.5	63	84	88
SWP 5-1	5	48	61.5	88	93	93
SWP 9-1	5	18	35.5	60	63	63
THR 14-1	5	13	15.5	28	37.5	40
THR 9-5	3	60	60	63	75	75
THR 9-5	2	45		51.5		58
TOB 1-1	5	15	22	40	54	60
TOB 2-6	5	15	32.5	77	85	85
Total	**90**	**0**	**33**	**56.5**	**80.75**	**100**

D4.0 Streambank Erosion Source Assessment

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 guidelines provided in *Watershed Assessment of River Stability and Sediment Supply* (Rosgen, 2006). These measurements were used in conjunction with streambank length and erosion source notes to determine sediment loads per 1,000 feet within each surveyed reach.

For sites within the Tobacco River TPA, eroding banks were identified as "actively eroding" or "slowly eroding". A number of eroding bank sites within each reach was evaluated based on the variability of streambank conditions within the reach. The banks selected for evaluation provide a representative sample of conditions throughout the reach, and banks which are similar to the evaluated banks are measured and recorded as "additional banks". At each eroding bank, photos were taken from locations perpendicular and upstream/downstream of the streambank. Photos were labeled according to the streambank site and position of the photograph. Photos of example streambanks are provided in **Attachment D**.

D4.1 Field Measurements and Loading Calculations

D4.1.1 Field Measurements

Within each sampled reach, eroding streambanks were identified and supporting measurements were recorded for the following metrics:

- Bank condition (includes actively eroding or slowly eroding/undercut/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 (%): transportation, grazing, cropland, irrigation, natural, urban, railroad

D4.1.2 Determination of BEHI Scores

To determine the BEHI score for each eroding bank, the following parameters are used:

- Bank height/bankfull height
- Root depth/bank height
- Weighted root density (root density * root depth/bank height)

- Bank angle
- Surface protection

These five bank erosion parameters are used to determine a numerical BEHI index score that ranks erosion potential from very low to extreme based on relationships provided by Rosgen (2006) (**Table D4-1**).

Table D4-1. BEHI score and rating system for individual parameters

Parameter		Very Low	Low	Moderate	High	Very High	Extreme
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 obtaining the BEHI index score for each individual parameter, the index scores are summed to produce a total BEHI score. Bank material factors are then considered, and total BEHI scores may be adjusted up or down. Banks comprised of bedrock, boulders, or cobble have very low erosion potential, and total BEHI scores for banks composed of these materials may be adjusted down by up to 10 points. Banks composed of cobble and/or gravel with a high fraction of sand have increased erosion potential, and total BEHI scores may be adjusted up by 5 to 10 points depending on the amount of sand present and whether the sandy material is exposed to erosion. Stratified banks containing layers of unstable material also have greater erosion potential, and total BEHI scores may be adjusted up by 5 to 10 points if stratified banks are present. After all material adjustments are made to the total BEHI score, the erosion potential is ranked from very low to extreme based on the scale provided below (**Table D4-2**). Photos of example streambanks with each BEHI rating are provided in **Attachment D**.

Table D4-2. Total BEHI score and rating system

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

D4.1.3 Near Bank Stress (NBS) Determination

To calculate Near Bank Stress (NBS) for each eroding bank, the following relationship is used:

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

As with the BEHI scores, the resulting NBS values correspond to a categorical rating that ranks the erosion potential from very low to extreme (**Table D4-3)**. If appropriate measurements are not recorded for NBS determination, the NBS rating is estimated in the field or from photos using best professional judgment.

Table D4-3. Near bank stress (NBS) rating system

NBS Value	Rating
< 1.0	very low
1.0 - 1.5	low
1.51 - 1.8	moderate
1.81 - 2.5	high
2.51 - 3.0	very high
> 3.0	extreme

D4.1.4 Retreat Rate

Once respective BEHI and NBS ratings are found for each eroding bank, the ratings are used to derive the average retreat rate of each streambank based on empirical relationships derived by Rosgen (2006). The average retreat rates (ft/yr) based on BEHI and NBS ratings are provided below in **Table D4-4**.

Table D4-4. Streambank retreat rate (ft/yr) based on BEHI and NBS rating

	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

D4.1.5 Sediment Loading Calculation

Once retreat rate is determined from the BEHI and NBS ratings, the dimensions of the eroding streambank are used to find the total mass eroding from each bank per year. The total mass eroded from each streambank is calculated using the following equation:

*mass eroded (tons/yr) = bank length (ft) * bank height (ft) * retreat rate (ft/yr) * material density (tons/ft^3)*

The sediment load from each streambank is filtered into two bank erosion type categories including actively eroding banks or slowly eroding/undercut/vegetated banks. The total loads for each bank erosion type and for the entire reach are then calculated in tons of sediment per year per 1000 feet of reach.

D4.2 Sediment Loading Results by Assessment Reach

The following sections provide sediment loading results organized by waterbody. One data table is included for each sampled waterbody and includes data from each sampled reach which summarizes sediment loading for each bank erosion type (active or slowly eroding) and for the total reach. Information provided includes the number of banks present for each bank erosion type, the mean BEHI rating for each erosion type present, the percent of reach that is eroding, the percent contribution from each erosion source present, and the sediment load per 1000 feet for each erosion type and for the entire reach. Streambank erosion conditions are described for each reach.

D4.2.1 Sediment Loading Results for Clarence Creek

The sampled reach of Clarence Creek exhibited minimal streambank erosion, with only slowly eroding bank types. Two bank types with five total banks are slowly eroding, but a cobble layer at the base of the banks limits the contribution of fine sediment to the stream channel. The stream may be downcutting to meet Grave Creek. Sediment loading results are provided below in **Table D4-5**.

Table D4-5. Sediment loading results for Clarence Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)	Sediment Load per 1000' (Tons/Year)
					Natural	
Clarence	Active	0	-	0	-	0.0
	Slow	5	moderate	12	100	14.1
	Total	5	-	12	100	14.1

D4.2.2 Sediment Loading Results for Deep Creek

Three reaches were sampled on Deep Creek, including full surveys on DEP 13-2 and DEP 9-2, and streambank erosion assessment only on DEP 7-1. Sediment loading results for Deep Creek sites are provided below in **Table D4-6**.

Reach 13-2 shows minimal erosion except on outside meanders and some erosion due to scour from wood. Overall, the streambank is well vegetated.

Within reach 9-2, a very large mass wasting site exists on river right, consisting of a tall (50-100’) eroding bank with constructed rock barbs which are causing some erosion on river left. This feature creates extensive loading to Deep Creek, and the stream channel appears to be in disequilibrium with its sediment supply. One other bank erosion type exists within this reach with low NBS and a dense vegetation layer over cobble layer.

No streambank erosion was observed in reach 7-1. The site has extremely dense vegetation, with wood, moss and boulders covering the bank.

Table D4-6. Sediment loading results for Deep Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)		Sediment Load per 1000' (Tons/Year)
					Roads	Natural	
DEP 13-2	Active	0	-	0	-	-	0.0
	Slow	5	moderate	7	-	100	2.8
	Total	5	-	7	-	100	2.8
DEP 9-2	Active	2	extreme	10	100	-	117.1
	Slow	3	high	13	24	76	38.4
	Total	5	-	23	81	19	155.5
DEP 7-1	Active	0	-	0	-	-	0.0
	Slow	0	-	0	-	-	0.0
	Total	0	-	0	-	-	0.0

D4.2.3 Sediment Loading Results for Edna Creek

Four locations were sampled on Edna Creek, including reaches 10-2, 11-1, 7-2, and 8-1. Only reach 10-2 received a full site evaluation, while the other three sites were evaluated for bank erosion conditions only. Results of the sediment loading calculations are provided below in **Table D4-7**.

Reach 11-1 has minimal bank erosion with no actively eroding banks. There is evidence of recent beaver activity and numerous places where wildlife is accessing the stream. Reed canary grass armors the banks and prevents erosion. Adjacent cropland is actively mowed for hay.

Only one eroding bank type was noted within reach 10-2. The bank type is slowly eroding with well vegetated banks. Most banks are slightly undercut with low to very low NBS, and all bank erosion appears natural.

Reach 8-1 does not have much bank erosion, and has lots of cover and no actively eroding banks. A number of pieces of deadfall (10-15) are covering the stream with several 60 foot sections that were impossible to walk through.

Reach 7-2 has several slowly eroding banks and one actively eroding bank. Most banks were well covered throughout the reach.

Table D4-7. Sediment loading results for Edna Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)		Sediment Load per 1000' (Tons/Year)
					Cropland	Natural	
ENA 11-1	Active	0	-	0	-	-	0.0
	Slow	5	low	3	100	-	0.1
	Total	5	-	3	100	-	0.1
ENA 10-2	Active	0	-	0	-	-	0.0
	Slow	7	moderate	9	-	100	7.9
	Total	7	-	9	-	100	7.9
ENA 8-1	Active	0	-	0	-	-	0.0
	Slow	4	moderate	4	-	100	8.3
	Total	4	-	4	-	100	8.3
ENA 7-2	Active	1	moderate	2	-	100	0.9
	Slow	4	high	7	-	100	12.7
	Total	5	-	9	-	100	13.6

D4.2.4 Sediment Loading Results for Fortine Creek

Eleven sites were surveyed on Fortine Creek, including 5 full survey sites (4-3, 6-1, 9-3, 12-7, and 13-1) and 6 sites with streambank erosion assessments only (4-1, 7-2, 12-2, 12-9, 15-2, and 15-3). Sediment loading results for Fortine Creek are provided in **Table D4-8**.

Reach 15-3 has moderate erosion with one actively eroding bank, and all other banks were slowly eroding. Several game trails exit the forest and there was hoof shear at these locations.

Reach 15-2 has many slowly eroding banks, but no large actively eroding banks. The cover on the railroad side was surprisingly good.

Reach 13-1 has mostly slowly eroding banks with low to medium NBS. There is one location where a high bank (10') is actively eroding. Above the top of the reach there is massive bank erosion and failure with many adult trees in the stream channel. Eroding bank is approximately 15' high and more than 100' long. Large banks have slumped into channel.

Reach 12-9 has minimal bank erosion, with only one actively eroding (and massive) bank at upper end of reach.

Within reach 12-7, heavy bank erosion and hoof shear exists due to grazing. The site has some evidence of past beaver activity. Most banks are actively eroding, with one vegetated slowly eroding bank.

Eroding banks within reach 12-2 includes one large long bank (actively eroding) and numerous slowly eroding banks. All streambank material is glacial till. Historic logging is noted along both banks, with trees cut right at bank edge.

Two bank types exist in reach 9-3. One is on outside meander bends with a cobble layer under fine sediments. This bank type has large conifers falling in the stream channel. The other bank type is a slowly eroding grassy bank, with fine material and some slumping into stream. Both bank types have medium NBS.

Reach 7-2 has some slowly eroding banks and only one actively eroding bank (downed tree next to stream and on a cliff).

Within reach 6-1, streambanks are eroding at top of reach due to beaver activity and railroad channelization which creates changes in stream energy. The "other" loading source in this reach is from railroad.

Two bank types exist within reach 4-3, including one due to cattle actively crossing stream, and one slowly eroding type on outside meander bends with good wood protection. Bank erosion is not severe considering cattle activity.

Reach 4-1 has many slowly eroding banks and two larger eroding banks due to log jams. All eroding banks appear to be natural.

Table D4-8. Sediment loading results for Fortine Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)					Sediment Load per 1000' (Tons/Year)
					Roads	Grazing	Logging	Natural	Other	
FTN 15-3	Active	1	moderate	4	-	30	-	70	-	3.4
	Slow	3	low	6	-	16	-	84	-	1.5
	Total	4	-	10	-	26	-	74	-	4.9
FTN 15-2	Active	0	-	0	-	-	-	-	-	0.0
	Slow	6	moderate	22	48	-	-	52	-	11.9
	Total	6	-	22	48	-	-	52	-	11.9
FTN 13-1	Active	1	very high	2	-	-	-	100	-	17.0
	Slow	4	high	14	-	-	-	100	-	41.0
	Total	5	-	16	-	-	-	100	-	58.0

Table D4-8. Sediment loading results for Fortine Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)					Sediment Load per 1000' (Tons/Year)
					Roads	Grazing	Logging	Natural	Other	
FTN 12-9	Active	1	high	2	-	-	-	100	-	17.6
	Slow	4	low	8	-	46	14	40	-	1.8
	Total	5	-	10	-	4	1	94	-	19.4
FTN 12-7	Active	5	high	32	-	98	-	2	-	77.6
	Slow	1	moderate	5	-	-	-	100	-	0.2
	Total	6	-	37	-	98	-	2	-	77.8
FTN 12-2	Active	1	high	8	-	-	50	50	-	23.6
	Slow	8	moderate	15	-	-	15	85	-	11.9
	Total	9	-	23	-	-	38	62	-	35.5
FTN 9-3	Active	2	high	9	-	-	-	100	-	19.7
	Slow	1	moderate	14	-	-	-	100	-	1.6
	Total	3	-	23	-	-	-	100	-	21.3
FTN 7-2	Active	1	moderate	3	-	-	-	100	-	31.4
	Slow	5	moderate	7	-	-	-	100	-	6.4
	Total	6	-	10	-	-	-	100	-	37.7
FTN 6-1	Active	3	high	13	-	-	-	55	45	39.7
	Slow	2	moderate	11	-	-	-	100	-	3.8
	Total	5	-	24	-	-	-	59	41	43.4
FTN 4-3	Active	1	high	5	-	80	-	20	-	6.3
	Slow	7	moderate	30	-	-	-	100	-	15.0
	Total	8	-	35	-	24	-	76	-	21.3
FTN 4-1	Active	0	-	0	-	-	-	-	-	0.0
	Slow	11	high	20	-	-	-	100	-	46.5
	Total	11	-	20	-	-	-	100	-	46.5

D4.2.5 Sediment Loading Results for Lime Creek

One full site assessment was conducted on Lime Creek. Reach 6-1 has multiple eroding banks with three bank types present. Some bank erosion is due to game or livestock crossings, and some is due to tree failures into stream potentially due to historic logging activities. Due to fine material in banks, any bank disturbance results in erosion. Loading results for Lime Creek are provided below in **Table D4-9**.

Table D4-9. Sediment loading results for Lime Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)			Sediment Load per 1000' (Tons/Year)
					Roads	Logging	Natural	
LME 6-1	Active	1	high	2	-	20	80	6.2
	Slow	7	high	10	44	1	54	13.6
	Total	8	-	11	30	7	62	19.8

D4.2.6 Sediment Loading Results for Sinclair Creek

Three sites were sampled on Sinclair Creek, including full surveys on reaches 8-2 and 10-3, and streambank erosion assessment on 5-1. Results for Sinclair Creek are provided below in **Table D4-10**.

Reach 10-3 has two eroding bank types. Banks have high protection due to vegetation, but are stratified with a sand layer. Stream shows evidence of deposition. The “other” loading source within this reach is described as urban influence.

Reach 8-2 contains many eroding banks. Banks are bare on meander bends due to grazing, adding cobbles and large gravels to the stream. Stream appears to be recovering due to recent fencing of cattle.

Reach 5-1 has minimal erosion with large material and wood armoring banks. Two slowly eroding banks exist, although they are well protected. One actively eroding bank exists due to tree falling in stream channel.

Table D4-10. Sediment loading results for Sinclair Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)				Sediment Load per 1000' (Tons/Year)
					Roads	Grazing	Natural	Other	
SNC 10-3	Active	0	-	0	-	-	-	-	0.0
	Slow	4	moderate	11	50	-	20	30	53.5
	Total	4	-	11	50	-	20	30	53.5
SNC 8-2	Active	14	high	16	-	100	-	-	42.0
	Slow	0	-	0	-	-	-	-	0.0
	Total	14	-	16	-	100	-	-	42.0
SNC 5-1	Active	1	moderate	4	-	-	100	-	9.0
	Slow	2	moderate	3	-	-	100	-	2.7
	Total	3	-	7	-	-	100	-	11.7

D4.2.7 Sediment Loading Results for Swamp Creek

Three sites were sampled on Swamp Creek, including full surveys on reaches 5-1 and 9-1, and streambank erosion assessment on 3-1. Results for Swamp Creek are provided below in **Table D4-11**.

Reach 9-1 has seven long slowly eroding banks, including four that are undercut and overhanging. Mid-channel boulders are noted, but banks have good protection from large substrate and wood.

Reach 5-1 has multiple eroding banks. Some minor hoof shear is present at game crossings, and new pipe arch bridge upstream of reach may be causing erosion downstream. The natural loading source in this reach is from game crossings.

Only slowly eroding banks were found within reach 3-1. Site has good riparian corridor in lower portion of reach, but historic logging is evident in areas. Many eroding banks were due to trees that have fallen and exposed their roots. Reach has no large eroding banks.

Table D4-11. Sediment loading results for Swamp Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)		Sediment Load per 1000' (Tons/Year)
					Logging	Natural	
SWP 9-1	Active	0	-	0	-	-	0.0
	Slow	7	high	27	-	100	51.6
	Total	7	-	27	-	100	51.6
SWP 5-1	Active	2	high	5	90	10	9.8
	Slow	3	moderate	7	100	-	3.6
	Total	5	-	12	93	7	13.4
SWP 3-1	Active	0	-	0	-	-	0.0
	Slow	7	moderate	6	9	91	1.0
	Total	7	-	6	9	91	1.0

D4.2.8 Sediment Loading Results for Therriault Creek

Two full surveys were conducted on Therriault Creek at reaches 14-1 and 9-5. Sediment loading results are provided below in **Table D4-12**.

Reach 14-1 contains minimal bank erosion, with only two actively eroding banks. Several short slowly eroding occur on outside meander bends. The “other” loading source for this reach is rural residences.

Eroding banks in reach 9-5 are primarily slowly eroding banks on outside meander bends. A few high bank failures exist in short reaches, although they appear relatively stable. There is evidence of historic logging in the riparian area, and some active logging in the bench area above the sampled reach.

Table D4-12. Sediment loading results for Therriault Creek

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)				Sediment Load per 1000' (Tons/Year)
					Grazing	Logging	Natural	Other	
THR 14-1	Active	2	very high	2	14	-	86	-	2.8
	Slow	6	high	5	4	10	48	38	5.1
	Total	8	-	7	7	6	62	24	7.9
THR 9-5	Active	5	high	4	-	57	43	-	12.9
	Slow	8	moderate	10	-	63	37	-	8.5
	Total	13	-	14	-	60	40	-	21.4

D4.2.9 Sediment Loading Results for Tobacco River

Four sites were surveyed on the Tobacco River, including full surveys on reaches 1-1 and 2-6, and streambank erosion assessments on reaches 1-3 and 2-3. Sediment loading results for Tobacco River is provided below in **Table D4-13**.

Reach 2-6 has multiple eroding bank types including two big mass wasting sites. The bases of most banks were composed of gravel/cobble substrate. The “other” loading source for this reach was from railroad and rural residences.

Two bank types exist within reach 2-3, including one tall actively eroding bank type that occurs in three locations, and one slowly eroding bank type with good surface cover from cobbles. Some areas have riprap to control erosion, especially along outside meander bends. The "other" loading source for this reach is urban influence.

One massive glacial till bank exists just downstream of Therriault Creek within reach 1-3. Several slowly eroding grass banks also exist with cobble substrate at base.

Reach 1-1 has several eroding, unstable banks, with lots of cobbles, poor binding vegetation, and minimal bank protection.

Table D4-13. Sediment loading results for Tobacco River

Reach ID	Erosion Type	Number of Banks	Mean BEHI Rating	Percent Eroding Bank	Loading Source (%)				Sediment Load per 1000' (Tons/Year)
					Roads	Grazing	Natural	Other	
TOB 1-1	Active	6	moderate	32	-	1	99	-	47.6
	Slow	2	moderate	8	-	-	100	-	6.6
	Total	8	-	40	-	1	99	-	54.3
TOB 1-3	Active	1	very high	11	-	-	100	-	56.7
	Slow	4	moderate	15	7	7	87	-	11.7
	Total	5	-	26	1	1	98	-	68.4
TOB 2-3	Active	3	moderate	3	50	-	18	32	6.7
	Slow	3	low	8	35	-	65	-	2.7
	Total	6	-	11	46	-	31	23	9.4
TOB 2-6	Active	6	moderate	18	-	-	19	81	75.6
	Slow	2	high	7	-	-	100	-	7.6
	Total	8	-	25	-	-	27	73	83.2

D4.3 Sediment Loading Results by Reach Type

The following sections provide sediment loading results organized by reach type. Data provided includes sediment load per 1000 feet for each erosion type (active, slow, and total) and the percent contribution from each erosion source present. The adjacent land uses for left and right banks are also provided.

D4.3.1 Sediment Loading Results for Reach Type CR-0-2-U

Four sites were sampled of reach type CR-0-2-U. This reach type is in the Canadian Rockies Level IV Ecoregion, has low valley slope (<2%), and includes 2nd order streams within unconfined valleys. The "other" loading source within this reach type was urban influence within reach SNC 10-3, and rural residence within THR 14-1. Loading results are provided below in **Table D4-14**.

Table D4-14. Sediment loading results for reach type CR-0-2-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)					Adjacent Land Use	
	Active	Slow	Total	Roads	Grazing	Logging	Natural	Other	Left Bank	Right Bank
SNC 10-3	0.0	53.5	53.5	50	-	-	20	30	Urban	Urban
SNC 8-2	42.0	0.0	42.0	-	100	-	-	-	Rural/Farm	Hay/Pasture
THR 14-1	2.8	5.1	7.9	-	7	6	62	24	Forest	Rural/Farm
THR 9-5	12.9	8.5	21.4	-	-	60	40	-	Forest	Forest
Average	**14.4**	**16.7**	**31.2**	**13**	**27**	**17**	**31**	**14**		

D4.3.2 Sediment Loading Results for Reach Type CR-2-3-U

Only one site was sampled of reach type CR-2-3-U. This reach type is in the Canadian Rockies Level IV Ecoregion, has moderate valley slope (2-4%), and includes 3rd order streams within unconfined valleys. Loading results are provided below in **Table D4-15**.

Table D4-15. Sediment loading results for reach type CR-2-3-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)	Adjacent Land Use	
	Active	Slow	Total	Natural	Left Bank	Right Bank
DEP 13-2	0.0	2.8	2.8	100	Rural/Farm	Forest

D4.3.3 Sediment Loading Results for Reach Type CR-4-2-U

Three sites were sampled of reach type CR-4-2-U. This reach type is in the Canadian Rockies Level IV Ecoregion, has moderate valley slope (2-4%), and includes 2nd order streams within unconfined valleys. Loading results are provided below in **Table D4-16**.

Table D4-16. Sediment loading results for reach type CR-4-2-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)	Adjacent Land Use	
	Active	Slow	Total	Natural	Left Bank	Right Bank
Clarence	0.0	14.1	14.1	100	Forest	Forest
DEP 7-1	0.0	0.0	0.0	-	Forest	Harvest/Fire
SNC 5-1	9.0	2.7	11.7	100	Forest	Forest
Average	**3.0**	**5.6**	**8.6**	**100**		

D4.3.4 Sediment Loading Results for Reach Type CR-4-3-U

One site was sampled of reach type CR-4-3-U. This reach type is in the Canadian Rockies Level IV Ecoregion, has high valley slope (4-10%), and includes 3rd order streams within unconfined valleys. Loading results are provided below in **Table D4-17**.

Table D4-17. Sediment loading results for reach type CR-4-3-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)		Adjacent Land Use	
	Active	Slow	Total	Roads	Natural	Left Bank	Right Bank
DEP 9-2	117.1	38.4	155.5	81	19	Forest	Forest

D4.3.5 Sediment Loading Results for Reach Type NR-0-3-U

Five sites were sampled of reach type NR-0-3-U. This reach type is in the Northern Rockies Level IV Ecoregion, has low valley slope (<2%), and includes 3rd order streams within unconfined valleys. The "other" loading source within this reach type was from railroads within reach FTN 6-1. Loading results are provided below in **Table D4-18**.

Table D4-18. Sediment loading results for reach type NR-0-3-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)					Adjacent Land Use	
	Active	Slow	Total	Grazing	Crops	Logging	Natural	Other	Left Bank	Right Bank
ENA 11-1	0.0	0.1	0.1	-	100	-	-	-	Hay/Pasture	Hay/Pasture
FTN 4-1	0.0	46.5	46.5	-	-	-	100	-	Forest	Forest
FTN 4-3	6.3	15.0	21.3	24	-	-	76	-	Forest	Forest
FTN 6-1	39.7	3.8	43.4	-	-	-	59	41	Forest	Forest
SWP 5-1	9.8	3.6	13.4	-	-	93	7	-	Harvest/Fire	Harvest/Fire
Average	**11.1**	**13.8**	**24.9**	**5**	**20**	**19**	**48**	**8**		

D4.3.6 Sediment Loading Results for Reach Type NR-0-4-U

Seven sites were sampled of reach type NR-0-4-U, all on Fortine Creek. This reach type is in the Northern Rockies Level IV Ecoregion, has low valley slope (<2%), and includes 4th order streams within unconfined valleys. Loading results are provided below in **Table D4-19**.

Table D4-19. Sediment loading results for reach type NR-0-4-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)				Adjacent Land Use	
	Active	Slow	Total	Roads	Grazing	Logging	Natural	Left Bank	Right Bank
FTN 12-2	23.6	11.9	35.5	-	-	38	62	Forest	Forest
FTN 12-7	77.6	0.2	77.8	-	98	-	2	Forest	Hay/Pasture
FTN 12-9	17.6	1.8	19.4	-	4	1	94	Rural/Farm	Rural/Farm
FTN 13-1	17.0	41.0	58.0	-	-	-	100	Forest	Forest
FTN 15-2	0.0	11.9	11.9	48	-	-	52	Forest	Road
FTN 15-3	3.4	1.5	4.9	-	26	-	74	Rural/Farm	Rural/Farm
FTN 9-3	19.7	1.6	21.3	-	-	-	100	Forest	Forest
Average	**22.7**	**10.0**	**32.7**	**7**	**18**	**6**	**69**		

D4.3.7 Sediment Loading Results for Reach Type NR-0-5-U

Four sites were sampled of reach type NR-0-5-U, all of which were on the Tobacco River. This reach type is in the Northern Rockies Level IV Ecoregion, has low valley slope (<2%), and includes 5th order streams within unconfined valleys. The "other" loading source within this reach type was railroad and rural residences within reach TOB 2-6, and urban influence within reach TOB 2-3. Loading results are provided below in **Table D4-20**.

Table D4-20. Sediment loading results for reach type NR-0-5-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)				Adjacent Land Use	
	Active	Slow	Total	Roads	Grazing	Natural	Other	Left Bank	Right Bank
TOB 1-1	47.6	6.6	54.3	-	1	99	-	Forest	Forest
TOB 1-3	56.7	11.7	68.4	1	1	98	-	Hay/Pasture	Rural/Farm
TOB 2-3	6.7	2.7	9.4	46	-	31	23	Urban	Urban
TOB 2-6	75.6	7.6	83.2	-	-	27	73	Range	Hay/Pasture
Average	**46.6**	**7.2**	**53.8**	**12**	**1**	**63**	**24**		

D4.3.8 Sediment Loading Results for Reach Type NR-2-2-U

One site was sampled of reach type NR-2-2-U. This reach type is in the Northern Rockies Level IV Ecoregion, has moderate valley slope (2-4%), and includes 2nd order streams within unconfined valleys. Loading results are provided below in **Table D4-21**.

Table D4-21. Sediment loading results for reach type NR-2-2-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)	Adjacent Land Use	
	Active	Slow	Total	Natural	Left Bank	Right Bank
ENA 8-1	0.0	8.3	8.3	100	Forest	Road

4.3.9 Sediment Loading Results for Reach Type NR-2-3-U

Two sites were sampled of reach type NR-2-3-U. This reach type is in the Northern Rockies Level IV Ecoregion, has moderate valley slope (2-4%), and includes 3rd order streams within unconfined valleys. Loading results are provided below in **Table D4-22**.

Table D4-22. Sediment loading results for reach type NR-2-3-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)	Adjacent Land Use	
	Active	Slow	Total	Natural	Left Bank	Right Bank
FTN 7-2	31.4	6.4	37.7	100	Forest	Forest
SWP 9-1	0.0	51.6	51.6	100	Rural/Farm	Rural/Farm
Average	**15.7**	**29.0**	**44.6**	**100**		

D4.3.10 Sediment Loading Results for Reach Type NR-4-2-U

Two sites were sampled of reach type NR-4-2-U. This reach type is in the Northern Rockies Level IV Ecoregion, has high valley slope (4-10%), and includes 2nd order streams within unconfined valleys. Loading results are provided below in **Table D4-23**.

Table D4-23. Sediment loading results for reach type NR-4-2-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)		Adjacent Land Use	
	Active	Slow	Total	Logging	Natural	Left Bank	Right Bank
ENA 7-2	0.9	12.7	13.6	0	100	Forest	Forest
SWP 3-1	0.0	1.0	1.0	9	91	Forest	Forest
Average	**0.4**	**6.8**	**7.3**	**5**	**95**		

D4.3.11 Sediment Loading Results for Reach Type NR-4-3-U

Two sites were sampled of reach type NR-4-3-U. This reach type is in the Northern Rockies Level IV Ecoregion, has high valley slope (4-10%), and includes 3rd order streams within unconfined valleys. Loading results are provided below in **Table D4-24**.

Table D4-24. Sediment loading results for reach type NR-4-3-U

Reach ID	Sediment Load per 1000' (tons/year)			Loading Source (%)			Adjacent Land Use	
	Active	Slow	Total	Roads	Logging	Natural	Left Bank	Right Bank
ENA 10-2	0.0	7.9	7.9	-	-	100	Forest	Forest
LME 6-1	6.2	13.6	19.8	30	7	62	Forest	Forest
Average	**3.1**	**10.7**	**13.8**	**15**	**4**	**81**		

D5.0 REFERENCES

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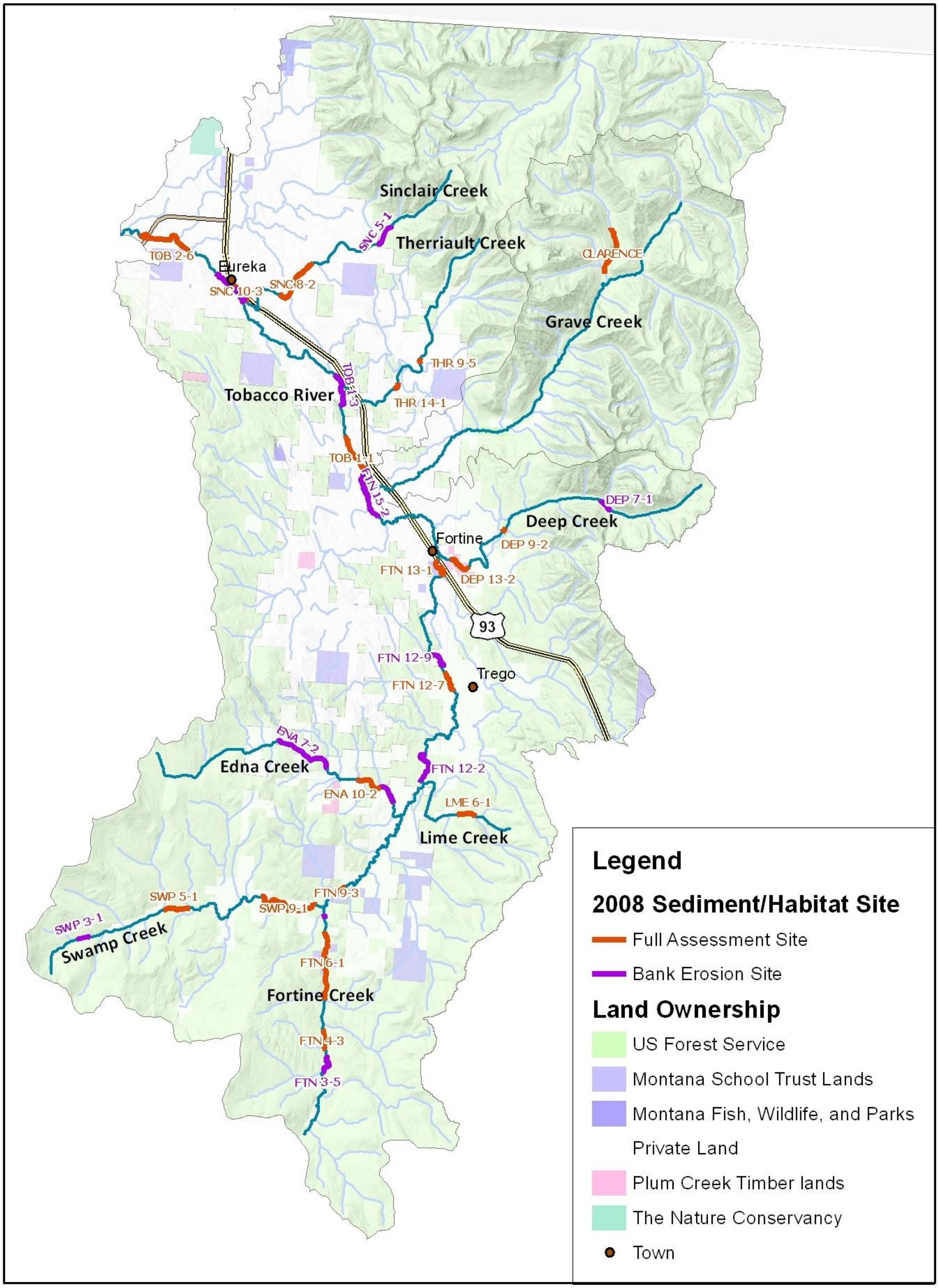
ATTACHMENT A – MONITORING SITE LOCATION MAP



Sinclair Creek
SNC 5-1
Therriault Creek
CLARENCE
TOB 2-6
Eureka
SNC 8-2
SNC 10-3
Grave Creek
THR 9-5
TOB 1-3
Tobacco River
THR 14-1
TOB 1-1
FTN 15-2
DEP 7-1
Deep Creek
Fortine
DEP 9-2
FTN 13-1
DEP 13-2
93
FTN 12-9
Trego
FTN 12-7
ENA 7-2
Edna Creek
FTN 12-2
ENA 10-2
LME 6-1
Lime Creek
SWP 5-1
FTN 9-3
SWP 9-1
SWP 3-1
Swamp Creek
FTN 6-1
Fortine Creek
FTN 4-3
FTN 3-5
Legend
2008 Sediment/Habitat Site
Full Assessment Site
Bank Erosion Site
Land Ownership
US Forest Service
Montana School Trust Lands
Montana Fish, Wildlife, and Parks
Private Land
Plum Creek Timber lands
The Nature Conservancy
Town

ATTACHMENT B – SEDIMENT AND HABITAT FIELD DATA

Table B-1. BEHI Sediment Load Data

Stream	Reach ID	Date	Reach Type	Erosion Type	Number of Banks	Mean BEHI Score	Mean BEHI Rating	Length of Eroding Bank (Feet)	Eroding Bank (% of reach)	Monitoring Site Sediment Load (Tons/Year)	Sediment Load per 1000 Feet (Tons/Year)	Road Load (tons /year)	Road Load (%)	Grazing Load (tons /year)	Grazing Load (%)	Cropland Load (tons /year)	Cropland Load (%)	Logging Load (tons /year)	Logging Load (%)	Natural Load (tons /year)	Natural Load (%)	"Other" Load (tons /year)	"Other" Load (%)
Clarence Creek	Clarence	8/26/08	CR-4-2-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	Clarence	8/26/08	CR-4-2-U	Slow	5	24.2	moderate	249	12.5	14.1	14.1	0.0	0	0.0	0	0.0	0	0.0	0	14.14	100	0.0	0
	Clarence	8/26/08	CR-4-2-U	Total	5			249	12.5	14.1	14.1	0.0	0	0.0	0	0.0	0	0.0	0	14.14	100	0.0	0
Deep Creek	DEP 13-2	8/27/08	CR-2-3-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	DEP 13-2	8/27/08	CR-2-3-U	Slow	5	26.9	moderate	131	6.6	2.8	2.8	0.0	0	0.0	0	0.0	0	0.0	0	2.79	100	0.0	0
	DEP 13-2	8/27/08	CR-2-3-U	Total	5			131	6.6	2.8	2.8	0.0	0	0.0	0	0.0	0	0.0	0	2.79	100	0.0	0
	DEP 7-1	9/9/08	CR-4-2-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	DEP 7-1	9/9/08	CR-4-2-U	Slow	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	DEP 7-1	9/9/08	CR-4-2-U	Total	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	100	0.0	0
	DEP 9-2	8/27/08	CR-4-3-U	Active	2	53.0	extreme	201	10.1	117.1	117.1	117.1	100	0.0	0	0.0	0	0.0	0	0.00	0	0.0	0
	DEP 9-2	8/27/08	CR-4-3-U	Slow	3	36.3	high	257	12.9	38.4	38.4	9.3	24	0.0	0	0.0	0	0.0	0	29.05	76	0.0	0
	DEP 9-2	8/27/08	CR-4-3-U	Total	5			458	22.9	155.5	155.5	126.4	81	0.0	0	0.0	0	0.0	0	29.05	19	0.0	0
Edna Creek	ENA 10-2	8/21/08	NR-4-3-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	ENA 10-2	8/21/08	NR-4-3-U	Slow	7	29.3	moderate	181	9.1	7.9	7.9	0.0	0	0.0	0	0.0	0	0.0	0	7.87	100	0.0	0
	ENA 10-2	8/21/08	NR-4-3-U	Total	7			181	9.1	7.9	7.9	0.0	0	0.0	0	0.0	0	0.0	0	7.87	100	0.0	0
	ENA 11-1	9/12/08	NR-0-3-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	ENA 11-1	9/12/08	NR-0-3-U	Slow	5	16.4	low	62	3.1	0.1	0.1	0.0	0	0.0	0	0.1	100	0.0	0	0.00	0	0.0	0
	ENA 11-1	9/12/08	NR-0-3-U	Total	5			62	3.1	0.1	0.1	0.0	0	0.0	0	0.1	100	0.0	0	0.00	0	0.0	0
	ENA 7-2	9/11/08	NR-4-2-U	Active	1	26.3	moderate	49	2.5	0.9	0.9	0.0	0	0.0	0	0.0	0	0.0	0	0.86	100	0.0	0
	ENA 7-2	9/11/08	NR-4-2-U	Slow	4	33.7	high	138	6.9	12.7	12.7	0.0	0	0.0	0	0.0	0	0.0	0	12.73	100	0.0	0
	ENA 7-2	9/11/08	NR-4-2-U	Total	5			187	9.4	13.6	13.6	0.0	0	0.0	0	0.0	0	0.0	0	13.59	100	0.0	0
	ENA 8-1	9/11/08	NR-2-2-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	ENA 8-1	9/11/08	NR-2-2-U	Slow	4	27.7	moderate	73	3.7	8.3	8.3	0.0	0	0.0	0	0.0	0	0.0	0	8.27	100	0.0	0
	ENA 8-1	9/11/08	NR-2-2-U	Total	4			73	3.7	8.3	8.3	0.0	0	0.0	0	0.0	0	0.0	0	8.27	100	0.0	0

Table B-1. BEHI Sediment Load Data

Stream	Reach ID	Date	Reach Type	Erosion Type	Number of Banks	Mean BEHI Score	Mean BEHI Rating	Length of Eroding Bank (Feet)	Eroding Bank (% of reach)	Monitoring Site Sediment Load (Tons/Year)	Sediment Load per 1000 Feet (Tons/Year)	Road Load (tons /year)	Road Load (%)	Grazing Load (tons /year)	Grazing Load (%)	Cropland Load (tons /year)	Cropland Load (%)	Logging Load (tons /year)	Logging Load (%)	Natural Load (tons /year)	Natural Load (%)	"Other" Load (tons /year)	"Other" Load (%)
Fortine Creek	FTN 12-2	9/10/08	NR-0-4-U	Active	1	35.2	high	159	8.0	23.6	23.6	0.0	0	0.0	0	0.0	0	11.8	50	11.79	50	0.0	0
	FTN 12-2	9/10/08	NR-0-4-U	Slow	8	26.0	moderate	308	15.4	11.9	11.9	0.0	0	0.0	0	0.0	0	1.8	15	10.10	85	0.0	0
	FTN 12-2	9/10/08	NR-0-4-U	Total	9			467	23.4	35.5	35.5	0.0	0	0.0	0	0.0	0	13.6	38	21.89	62	0.0	0
	FTN 12-7	8/23/08	NR-0-4-U	Active	5	36.3	high	634	31.7	77.6	77.6	0.0	0	75.9	98	0.0	0	0.0	0	1.66	2	0.0	0
	FTN 12-7	8/23/08	NR-0-4-U	Slow	1	22.8	moderate	100	5.0	0.2	0.2	0.0	0	0.0	0	0.0	0	0.0	0	0.22	100	0.0	0
	FTN 12-7	8/23/08	NR-0-4-U	Total	6			734	36.7	77.8	77.8	0.0	0	75.9	98	0.0	0	0.0	0	1.88	2	0.0	0
	FTN 12-9	9/11/08	NR-0-4-U	Active	1	38.0	high	48	2.4	17.6	17.6	0.0	0	0.0	0	0.0	0	0.0	0	17.63	100	0.0	0
	FTN 12-9	9/11/08	NR-0-4-U	Slow	4	19.5	low	150	7.5	1.8	1.8	0.0	0	0.8	46	0.0	0	0.3	14	0.71	40	0.0	0
	FTN 12-9	9/11/08	NR-0-4-U	Total	5			198	9.9	19.4	19.4	0.0	0	0.8	4	0.0	0	0.3	1	18.35	94	0.0	0
	FTN 13-1	8/23/08	NR-0-4-U	Active	1	44.7	very high	49	2.5	17.0	17.0	0.0	0	0.0	0	0.0	0	0.0	0	17.03	100	0.0	0
	FTN 13-1	8/23/08	NR-0-4-U	Slow	4	35.7	high	280	14.0	41.0	41.0	0.0	0	0.0	0	0.0	0	0.0	0	40.98	100	0.0	0
	FTN 13-1	8/23/08	NR-0-4-U	Total	5			329	16.5	58.0	58.0	0.0	0	0.0	0	0.0	0	0.0	0	58.01	100	0.0	0
	FTN 15-2	9/10/08	NR-0-4-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	FTN 15-2	9/10/08	NR-0-4-U	Slow	6	23.7	moderate	439	22.0	11.9	11.9	5.7	48	0.0	0	0.0	0	0.0	0	6.14	52	0.0	0
	FTN 15-2	9/10/08	NR-0-4-U	Total	6			439	22.0	11.9	11.9	5.7	48	0.0	0	0.0	0	0.0	0	6.14	52	0.0	0
	FTN 15-3	9/10/08	NR-0-4-U	Active	1	24.1	moderate	75	3.8	3.4	3.4	0.0	0	1.0	30	0.0	0	0.0	0	2.41	70	0.0	0
	FTN 15-3	9/10/08	NR-0-4-U	Slow	3	14.7	low	120	6.0	1.5	1.5	0.0	0	0.2	16	0.0	0	0.0	0	1.27	84	0.0	0
	FTN 15-3	9/10/08	NR-0-4-U	Total	4			195	9.8	4.9	4.9	0.0	0	1.3	26	0.0	0	0.0	0	3.67	74	0.0	0
	FTN 4-1	9/10/08	NR-0-3-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	FTN 4-1	9/10/08	NR-0-3-U	Slow	11	34.1	high	395	19.8	46.5	46.5	0.0	0	0.0	0	0.0	0	0.0	0	46.55	100	0.0	0
	FTN 4-1	9/10/08	NR-0-3-U	Total	11			395	19.8	46.5	46.5	0.0	0	0.0	0	0.0	0	0.0	0	46.55	100	0.0	0
	FTN 4-3	8/28/08	NR-0-3-U	Active	1	33.6	high	95	4.8	6.3	6.3	0.0	0	5.0	80	0.0	0	0.0	0	1.25	20	0.0	0
	FTN 4-3	8/28/08	NR-0-3-U	Slow	7	23.6	moderate	596	29.8	15.0	15.0	0.0	0	0.0	0	0.0	0	0.0	0	15.04	100	0.0	0
	FTN 4-3	8/28/08	NR-0-3-U	Total	8			691	34.6	21.3	21.3	0.0	0	5.0	24	0.0	0	0.0	0	16.30	76	0.0	0
	FTN 6-1	8/23/08	NR-0-3-U	Active	3	33.7	high	268	13.4	39.7	39.7	0.0	0	0.0	0	0.0	0	0.0	0	21.72	55	17.9	45
	FTN 6-1	8/23/08	NR-0-3-U	Slow	2	27.0	moderate	219	11.0	3.8	3.8	0.0	0	0.0	0	0.0	0	0.0	0	3.77	100	0.0	0
	FTN 6-1	8/23/08	NR-0-3-U	Total	5			487	24.4	43.4	43.4	0.0	0	0.0	0	0.0	0	0.0	0	25.50	59	17.9	41
	FTN 7-2	9/11/08	NR-2-3-U	Active	1	27.0	moderate	63	3.2	31.4	31.4	0.0	0	0.0	0	0.0	0	0.0	0	31.36	100	0.0	0
	FTN 7-2	9/11/08	NR-2-3-U	Slow	5	25.7	moderate	140	7.0	6.4	6.4	0.0	0	0.0	0	0.0	0	0.0	0	6.36	100	0.0	0
	FTN 7-2	9/11/08	NR-2-3-U	Total	6			203	10.2	37.7	37.7	0.0	0	0.0	0	0.0	0	0.0	0	37.72	100	0.0	0
	FTN 9-3	8/27/08	NR-0-4-U	Active	2	35.6	high	185	9.3	19.7	19.7	0.0	0	0.0	0	0.0	0	0.0	0	19.75	100	0.0	0
	FTN 9-3	8/27/08	NR-0-4-U	Slow	1	24.9	moderate	272	13.6	1.6	1.6	0.0	0	0.0	0	0.0	0	0.0	0	1.57	100	0.0	0
	FTN 9-3	8/27/08	NR-0-4-U	Total	3			457	22.9	21.3	21.3	0.0	0	0.0	0	0.0	0	0.0	0	21.32	100	0.0	0
Lime Creek	LME 6-1	8/26/08	NR-4-3-U	Active	1	30.5	high	16	1.6	3.1	6.2	0.0	0	0.0	0	0.0	0	0.6	20	2.49	80	0.0	0
	LME 6-1	8/26/08	NR-4-3-U	Slow	7	30.4	high	95	9.5	6.8	13.6	3.0	44	0.0	0	0.0	0	0.1	1	3.68	54	0.0	0
	LME 6-1	8/26/08	NR-4-3-U	Total	8			111	11.1	9.9	19.8	3.0	30	0.0	0	0.0	0	0.7	7	6.17	62	0.0	0

Table B-1. BEHI Sediment Load Data

Stream	Reach ID	Date	Reach Type	Erosion Type	Number of Banks	Mean BEHI Score	Mean BEHI Rating	Length of Eroding Bank (Feet)	Eroding Bank (% of reach)	Monitoring Site Sediment Load (Tons/Year)	Sediment Load per 1000 Feet (Tons/Year)	Road Load (tons /year)	Road Load (%)	Grazing Load (tons /year)	Grazing Load (%)	Cropland Load (tons /year)	Cropland Load (%)	Logging Load (tons /year)	Logging Load (%)	Natural Load (tons /year)	Natural Load (%)	"Other" Load (tons /year)	"Other" Load (%)
Sinclair Creek	SNC 10-3	8/26/08	CR-0-2-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	SNC 10-3	8/26/08	CR-0-2-U	Slow	4	28.7	moderate	228	11.4	53.5	53.5	26.7	50	0.0	0	0.0	0	0.0	0	10.69	20	16.0	30
	SNC 10-3	8/26/08	CR-0-2-U	Total	4			228	11.4	53.5	53.5	26.7	50	0.0	0	0.0	0	0.0	0	10.69	20	16.0	30
	SNC 5-1	9/9/08	CR-4-2-U	Active	1	21.4	moderate	72	3.6	9.0	9.0	0.0	0	0.0	0	0.0	0	0.0	0	8.96	100	0.0	0
	SNC 5-1	9/9/08	CR-4-2-U	Slow	2	22.2	moderate	68	3.4	2.7	2.7	0.0	0	0.0	0	0.0	0	0.0	0	2.72	100	0.0	0
	SNC 5-1	9/9/08	CR-4-2-U	Total	3			140	7.0	11.7	11.7	0.0	0	0.0	0	0.0	0	0.0	0	11.68	100	0.0	0
	SNC 8-2	8/25/08	CR-0-2-U	Active	14	35.0	high	321	16.1	42.0	42.0	0.0	0	42.0	100	0.0	0	0.0	0	0.00	0	0.0	0
	SNC 8-2	8/25/08	CR-0-2-U	Slow	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	SNC 8-2	8/25/08	CR-0-2-U	Total	14			321	16.1	42.0	42.0	0.0	0	42.0	100	0.0	0	0.0	0	0.00	0	0.0	0
Swamp Creek	SWP 3-1	9/10/08	NR-4-2-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	SWP 3-1	9/10/08	NR-4-2-U	Slow	7	21.0	moderate	117	5.9	1.0	1.0	0.0	0	0.0	0	0.0	0	0.1	9	0.88	91	0.0	0
	SWP 3-1	9/10/08	NR-4-2-U	Total	7			117	5.9	1.0	1.0	0.0	0	0.0	0	0.0	0	0.1	9	0.88	91	0.0	0
	SWP 5-1	8/24/08	NR-0-3-U	Active	2	34.1	high	93	4.7	9.8	9.8	0.0	0	0.0	0	0.0	0	8.8	90	1.0	10	0.0	0
	SWP 5-1	8/24/08	NR-0-3-U	Slow	3	23.6	moderate	149	7.5	3.6	3.6	0.0	0	0.0	0	0.0	0	3.6	100	0.0	0	0.0	0
	SWP 5-1	8/24/08	NR-0-3-U	Total	5			242	12.1	13.4	13.4	0.0	0	0.0	0	0.0	0	12.4	93	1.0	7	0.0	0
	SWP 9-1	8/24/08	NR-2-3-U	Active	0			0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
	SWP 9-1	8/24/08	NR-2-3-U	Slow	7	32.4	high	535	26.8	51.6	51.6	0.0	0	0.0	0	0.0	0	0.0	0	51.57	100	0.0	0
	SWP 9-1	8/24/08	NR-2-3-U	Total	7			535	26.8	51.6	51.6	0.0	0	0.0	0	0.0	0	0.0	0	51.57	100	0.0	0
Therriault Creek	THR 14-1	8/25/08	CR-0-2-U	Active	2	40.9	very high	43	2.2	2.8	2.8	0.0	0	0.4	14	0.0	0	0.0	0	2.44	86	0.0	0
	THR 14-1	8/25/08	CR-0-2-U	Slow	6	35.9	high	91	4.6	5.1	5.1	0.0	0	0.2	4	0.0	0	0.5	10	2.45	48	1.9	38
	THR 14-1	8/25/08	CR-0-2-U	Total	8			134	6.7	7.9	7.9	0.0	0	0.6	7	0.0	0	0.5	6	4.89	62	1.9	24
	THR 9-5	8/25/08	CR-0-2-U	Active	5	37.8	high	76	3.8	12.9	12.9	0.0	0	0.0	0	0.0	0	7.4	57	5.55	43	0.0	0
	THR 9-5	8/25/08	CR-0-2-U	Slow	8	27.6	moderate	198	9.9	8.5	8.5	0.0	0	0.0	0	0.0	0	5.4	63	3.09	37	0.0	0
	THR 9-5	8/25/08	CR-0-2-U	Total	13			274	13.7	21.4	21.4	0.0	0	0.0	0	0.0	0	12.7	60	8.64	40	0.0	0
Tobacco River	TOB 1-1	8/22/08	NR-0-5-U	Active	6	24.0	moderate	1281	32.0	95.2	47.6	0.0	0	1.3	1	0.0	0	0.0	0	93.90	99	0.0	0
	TOB 1-1	8/22/08	NR-0-5-U	Slow	2	27.1	moderate	306	7.7	13.3	6.6	0.0	0	0.0	0	0.0	0	0.0	0	13.27	100	0.0	0
	TOB 1-1	8/22/08	NR-0-5-U	Total	8			1587	39.7	108.5	54.3	0.0	0	1.3	1	0.0	0	0.0	0	107.17	99	0.0	0
	TOB 1-3	9/9/08	NR-0-5-U	Active	1	41.3	very high	450	11.3	113.4	56.7	0.0	0	0.0	0	0.0	0	0.0	0	113.36	100	0.0	0
	TOB 1-3	9/9/08	NR-0-5-U	Slow	4	21.6	moderate	585	14.6	23.4	11.7	1.6	7	1.6	7	0.0	0	0.0	0	20.24	87	0.0	0
	TOB 1-3	9/9/08	NR-0-5-U	Total	5			1035	25.9	136.7	68.4	1.6	1	1.6	1	0.0	0	0.0	0	133.60	98	0.0	0
	TOB 2-3	9/9/08	NR-0-5-U	Active	3	28.2	moderate	123	3.1	13.5	6.7	6.7	50	0.0	0	0.0	0	0.0	0	2.36	18	4.4	32
	TOB 2-3	9/9/08	NR-0-5-U	Slow	3	15.1	low	317	7.9	5.4	2.7	1.9	35	0.0	0	0.0	0	0.0	0	3.51	65	0.0	0
	TOB 2-3	9/9/08	NR-0-5-U	Total	6			440	11.0	18.8	9.4	8.6	46	0.0	0	0.0	0	0.0	0	5.86	31	4.4	23
	TOB 2-6	8/22/08	NR-0-5-U	Active	6	28.8	moderate	728	18.2	151.1	75.6	0.0	0	0.0	0	0.0	0	0.0	0	28.77	19	122.3	81
	TOB 2-6	8/22/08	NR-0-5-U	Slow	2	31.8	high	262	6.6	15.3	7.6	0.0	0	0.0	0	0.0	0	0.0	0	15.27	100	0.0	0
	TOB 2-6	8/22/08	NR-0-5-U	Total	8			990	24.8	166.4	83.2	0.0	0	0.0	0	0.0	0	0.0	0	44.04	26	122.3	74

Table B-2. Fine Sediment in Pool Tail-outs

Reach ID	Date	Cell	Pool Grid Toss Percent <6mm	Spawning Gravels Present?
CLARENCE	8/26/08	1	30	No
CLARENCE	8/26/08	2	0	No
CLARENCE	8/26/08	2	0	No
CLARENCE	8/26/08	3	1	No
DEP 13-2	8/27/08	1	1	Yes
DEP 13-2	8/27/08	1	5	Yes
DEP 13-2	8/27/08	2	4	Yes
DEP 13-2	8/27/08	2	4	Yes
DEP 13-2	8/27/08	3	5	Yes
DEP 13-2	8/27/08	3	2	Yes
DEP 13-2	8/27/08	4	7	Yes
DEP 13-2	8/27/08	4	3	Yes
DEP 13-2	8/27/08	5	1	Yes
DEP 13-2	8/27/08	5	7	Yes
DEP 9-2	8/27/08	1	7	No
DEP 9-2	8/27/08	3	3	No
DEP 9-2	8/27/08	4	1	No
DEP 9-2	8/27/08	4	0	No
ENA 10-2	8/21/08	1	34	Yes
ENA 10-2	8/21/08	1	9	No
ENA 10-2	8/21/08	2	5	No
ENA 10-2	8/21/08	2	6	Yes
ENA 10-2	8/21/08	3	5	No
ENA 10-2	8/21/08	3	7	No
ENA 10-2	8/21/08	4	13	Yes
ENA 10-2	8/21/08	4	3	No
ENA 10-2	8/21/08	5	3	No
ENA 10-2	8/21/08	5	1	Yes
FTN 12-7	8/23/08	1	3	Yes
FTN 12-7	8/23/08	1	3	No
FTN 12-7	8/23/08	2	10	No
FTN 12-7	8/23/08	2	8	No
FTN 12-7	8/23/08	3	15	No
FTN 12-7	8/23/08	3	44	No
FTN 12-7	8/23/08	4	11	Yes
FTN 12-7	8/23/08	4	39	Yes
FTN 12-7	8/23/08	5	17	Yes
FTN 12-7	8/23/08	5	18	No
FTN 13-1	8/23/08	1	6	No
FTN 13-1	8/23/08	1	5	No
FTN 13-1	8/23/08	2	7	Yes
FTN 13-1	8/23/08	2	1	No
FTN 13-1	8/23/08	3	2	Yes
FTN 13-1	8/23/08	4	4	Yes
FTN 13-1	8/23/08	5	23	Yes
FTN 4-3	8/28/08	1	10	Yes
FTN 4-3	8/28/08	1	4	Yes
FTN 4-3	8/28/08	2	8	Yes

Table B-2. Fine Sediment in Pool Tail-outs

Reach ID	Date	Cell	Pool Grid Toss Percent <6mm	Spawning Gravels Present?
FTN 4-3	8/28/08	2	4	No
FTN 4-3	8/28/08	3	3	Yes
FTN 4-3	8/28/08	3	3	Yes
FTN 4-3	8/28/08	4	2	Yes
FTN 4-3	8/28/08	4	3	Yes
FTN 4-3	8/28/08	5	7	Yes
FTN 6-1	8/23/08	1	18	Yes
FTN 6-1	8/23/08	1	5	No
FTN 6-1	8/23/08	2	7	Yes
FTN 6-1	8/23/08	2	25	No
FTN 6-1	8/23/08	3	5	Yes
FTN 6-1	8/23/08	3	4	Yes
FTN 6-1	8/23/08	4	11	Yes
FTN 6-1	8/23/08	4	2	Yes
FTN 6-1	8/23/08	5	16	Yes
FTN 6-1	8/23/08	5	27	Yes
FTN 9-3	8/27/08	1	1	No
FTN 9-3	8/27/08	1	3	Yes
FTN 9-3	8/27/08	2	4	No
FTN 9-3	8/27/08	2	0	No
FTN 9-3	8/27/08	3	0	No
LME 6-1	8/26/08	1	95	No
LME 6-1	8/26/08	1	100	No
LME 6-1	8/26/08	1	100	No
LME 6-1	8/26/08	2	72	No
LME 6-1	8/26/08	2	100	No
LME 6-1	8/26/08	3	89	No
LME 6-1	8/26/08	5	80	No
SNC 10-3	8/26/08	1	12	No
SNC 10-3	8/26/08	1	11	No
SNC 10-3	8/26/08	2	100	Yes
SNC 10-3	8/26/08	2	100	Yes
SNC 10-3	8/26/08	3	94	Yes
SNC 10-3	8/26/08	3	100	No
SNC 10-3	8/26/08	4	100	No
SNC 10-3	8/26/08	4	52	No
SNC 10-3	8/26/08	5	99	No
SNC 10-3	8/26/08	5	90	No
SNC 8-2	8/25/08	1	2	Yes
SNC 8-2	8/25/08	1	2	No
SNC 8-2	8/25/08	2	1	No
SNC 8-2	8/25/08	2	1	No
SNC 8-2	8/25/08	3	1	No
SNC 8-2	8/25/08	3	1	No
SNC 8-2	8/25/08	4	1	No
SNC 8-2	8/25/08	4	1	No
SNC 8-2	8/25/08	5	0	No
SNC 8-2	8/25/08	5	3	No

Table B-2. Fine Sediment in Pool Tail-outs

Reach ID	Date	Cell	Pool Grid Toss Percent <6mm	Spawning Gravels Present?
SWP 5-1	8/24/08	1	2	No
SWP 5-1	8/24/08	1	5	Yes
SWP 5-1	8/24/08	2	1	No
SWP 5-1	8/24/08	2	1	No
SWP 5-1	8/24/08	3	5	No
SWP 5-1	8/24/08	3	2	No
SWP 5-1	8/24/08	4	2	No
SWP 5-1	8/24/08	4	19	No
SWP 5-1	8/24/08	5	1	No
SWP 5-1	8/24/08	5	0	No
SWP 9-1	8/24/08	1	2	No
SWP 9-1	8/24/08	2	1	No
SWP 9-1	8/24/08	3	1	No
SWP 9-1	8/24/08	4	0	No
THR 14-1	8/25/08	1	3	Yes
THR 14-1	8/25/08	1	4	Yes
THR 14-1	8/25/08	2	5	Yes
THR 14-1	8/25/08	3	4	No
THR 14-1	8/25/08	4	7	No
THR 14-1	8/25/08	4	1	Yes
THR 14-1	8/25/08	4	3	Yes
THR 14-1	8/25/08	5	1	Yes
THR 9-5	8/25/08	1	6	No
THR 9-5	8/25/08	1	1	Yes
THR 9-5	8/25/08	2	10	Yes
THR 9-5	8/25/08	2	5	Yes
THR 9-5	8/25/08	3	7	No
THR 9-5	8/25/08	3	12	Yes
THR 9-5	8/25/08	4	3	Yes
THR 9-5	8/25/08	4	14	No
THR 9-5	8/25/08	5	12	Yes
TOB 1-1	8/22/08	2	5	Yes
TOB 1-1	8/22/08	3	0	No
TOB 1-1	8/22/08	4	1	No
TOB 1-1	8/22/08	4	0	No
TOB 1-1	8/22/08	5	0	No
TOB 2-6	8/22/08	1	1	No
TOB 2-6	8/22/08	1	2	Yes
TOB 2-6	8/22/08	2	3	Yes
TOB 2-6	8/22/08	3	1	Yes
TOB 2-6	8/22/08	3	0	Yes
TOB 2-6	8/22/08	4	1	Yes
TOB 2-6	8/22/08	4	0	Yes
TOB 2-6	8/22/08	5	0	No
TOB 2-6	8/22/08	5	0	Yes
TOB 2-6	8/22/08	5	1	Yes

Table B-3. Pool and Large Woody Debris Data

Reach ID	Date	Cell	Mean Residual Pool Depth (ft)	Number of Pools per 1000 Feet	Number of Individual Pieces of LWD per 1000 Feet	Number of LWD Aggregates per 1000 Feet	Total Number of LWD per 1000 Feet
DEP 9-2	8/27/08	1-5	1.0	16	37	4	63
DEP 13-2	8/27/08	1-5	1.6	17	35	8	101
ENA 10-2	8/21/08	1-5	1.2	17	61	9	133
FTN 4-3	8/28/08	1-5	1.7	10	17	1	25
FTN 6-1	8/23/08	1-5	1.0	16	31	1	43
FTN 9-3	8/27/08	1-5	1.7	7	17	0	19
FTN 12-7	8/23/08	1-5	1.5	12	13	0	19
FTN 13-1	8/23/08	1-5	1.7	11	59	1	74
CLARENCE	8/26/08	1-5	1.0	7	28	1	34
LME 6-1	8/26/08	1-5	0.5	14	70	2	88
SNC 8-2	8/25/08	1-5	1.1	17	20	14	120
SNC 10-3	8/26/08	1-5	0.9	17	43	1	48
SWP 5-1	8/24/08	1-5	0.7	17	27	2	38
SWP 9-1	8/24/08	1-5	1.2	8	25	2	31
THR 9-5	8/25/08	1-5	1.2	16	92	7	153
THR 14-1	8/25/08	1-5	1.5	16	31	5	75
TOB 1-1	8/22/08	1-5	1.6	3	14	1	17
TOB 2-6	8/22/08	1-5	2.6	6	17	1	20

Table B-4. Riparian Greenline Data

Reach ID	Date	Cell	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width (ft)	Left Bank Mean Riparian Zone Width (ft)
DEP 9-2	8/27/08	1	30	10	0	73	>200	30
DEP 9-2	8/27/08	2	58	20	0	53	>200	8
DEP 9-2	8/27/08	3	80	10	0	53	>200	20
DEP 9-2	8/27/08	4	45	5	0	58	>200	70
DEP 9-2	8/27/08	5	55	0	0	78	>200	>200
DEP 13-2	8/27/08	1	23	0	0	3	113	63
DEP 13-2	8/27/08	2	30	0	0	3	63	34
DEP 13-2	8/27/08	3	30	0	0	33	88	64
DEP 13-2	8/27/08	4	43	0	0	18	100	>150
DEP 13-2	8/27/08	5	45	0	0	50	>200	>200
ENA 10-2	8/21/08	1	98	0	0	30	27	>30
ENA 10-2	8/21/08	2	95	0	0	8	40	34
ENA 10-2	8/21/08	3	88	0	0	3	29	39
ENA 10-2	8/21/08	4	90	0	0	8	26	32
ENA 10-2	8/21/08	5	80	0	0	5	11	15
FTN 4-3	8/28/08	1	93	0	0	30	0	0
FTN 4-3	8/28/08	2	63	0	0	3	0	0
FTN 4-3	8/28/08	3	53	0	0	0	0	0
FTN 4-3	8/28/08	4	33	0	0	3	>200	>200
FTN 4-3	8/28/08	5	65	0	0	13	>200	>200
FTN 6-1	8/23/08	1	88	0	0	43	>200	63
FTN 6-1	8/23/08	2	75	0	0	68	>200	>200
FTN 6-1	8/23/08	3	98	5	0	33	>200	>200
FTN 6-1	8/23/08	4	100	0	0	28	>200	>200
FTN 6-1	8/23/08	5	93	0	0	28	>200	>188
FTN 9-3	8/27/08	1	38	0	0	30	>200	>200
FTN 9-3	8/27/08	2	45	0	0	65	>200	>200
FTN 9-3	8/27/08	3	28	0	0	13	>200	>200
FTN 9-3	8/27/08	4	20	0	0	10	>200	>200
FTN 9-3	8/27/08	5	20	0	0	0	>200	>188
FTN 12-7	8/23/08	1	38	18	0	23	0	0
FTN 12-7	8/23/08	2	38	0	0	23	0	0

Table B-4. Riparian Greenline Data

Reach ID	Date	Cell	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width (ft)	Left Bank Mean Riparian Zone Width (ft)
FTN 12-7	8/23/08	3	33	0	0	28	0	0
FTN 12-7	8/23/08	4	0	10	0	0	0	0
FTN 12-7	8/23/08	5	55	0	0	3	0	79
FTN 13-1	8/23/08	1	100	0	0	38	>200	>200
FTN 13-1	8/23/08	2	83	0	0	65	>200	>200
FTN 13-1	8/23/08	3	75	0	0	58	>200	>200
FTN 13-1	8/23/08	4	83	0	0	43	>200	>200
FTN 13-1	8/23/08	5	45	0	0	40	>200	>200
CLARENCE	8/26/08	1	100	0	0	55	>200	>200
CLARENCE	8/26/08	2	98	0	0	28	>200	>200
CLARENCE	8/26/08	3	98	0	0	50	>200	>200
CLARENCE	8/26/08	4	50	0	0	33	>200	>200
CLARENCE	8/26/08	5	98	0	0	30	>200	>200
LME 6-1	8/26/08	1	60	0	0	75	>200	>200
LME 6-1	8/26/08	2	60	0	0	40	>200	>200
LME 6-1	8/26/08	3	30	0	0	65	>200	>200
LME 6-1	8/26/08	4	55	0	0	65	>200	>200
LME 6-1	8/26/08	5	60	0	0	50	65	65
SNC 8-2	8/25/08	1	80	0	0	80	15	20
SNC 8-2	8/25/08	2	63	0	0	43	30	13
SNC 8-2	8/25/08	3	53	0	0	85	23	15
SNC 8-2	8/25/08	4	88	0	0	75	25	35
SNC 8-2	8/25/08	5	60	0	0	53	20	10
SNC 10-3	8/26/08	1	13	10	0	10	18	26
SNC 10-3	8/26/08	2	20	0	0	5	11	21
SNC 10-3	8/26/08	3	13	0	0	18	19	30
SNC 10-3	8/26/08	4	15	0	0	5	30	38
SNC 10-3	8/26/08	5	13	0	0	0	28	30
SWP 5-1	8/24/08	1	88	0	0	0	>200	69
SWP 5-1	8/24/08	2	75	0	0	13	>200	150
SWP 5-1	8/24/08	3	48	0	0	20	>200	>200
SWP 5-1	8/24/08	4	93	0	0	15	>200	>200

Table B-4. Riparian Greenline Data

Reach ID	Date	Cell	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width (ft)	Left Bank Mean Riparian Zone Width (ft)
SWP 5-1	8/24/08	5	93	0	0	8	>200	>200
SWP 9-1	8/24/08	1	53	0	0	65	75	>200
SWP 9-1	8/24/08	2	18	0	0	45	>113	>200
SWP 9-1	8/24/08	3	63	0	0	50	>200	>200
SWP 9-1	8/24/08	4	63	0	0	80	>200	>200
SWP 9-1	8/24/08	5	60	0	0	45	>200	>200
THR 9-5	8/25/08	1	58	0	0	50	>200	>125
THR 9-5	8/25/08	2	45	0	0	55	>200	>200
THR 9-5	8/25/08	3	60	0	0	60	>200	>200
THR 9-5	8/25/08	4	75	0	0	55	>200	>200
THR 9-5	8/25/08	5	63	0	0	63	>150	>200
THR 14-1	8/26/08	1	35	0	0	55	18	19
THR 14-1	8/27/08	2	28	0	0	48	15	49
THR 14-1	8/28/08	3	13	0	0	63	34	>200
THR 14-1	8/29/08	4	40	0	0	80	30	125
THR 14-1	8/30/08	5	18	0	0	73	30	58
TOB 1-1	8/22/08	1	29	2	0	58	>74	14
TOB 1-1	8/22/08	2	48	4	0	52	15	9
TOB 1-1	8/22/08	3	40	0	0	40	16	20
TOB 1-1	8/22/08	4	15	0	0	21	6	40
TOB 1-1	8/22/08	5	60	0	0	67	15	34
TOB 2-6	8/22/08	1	85	0	0	54	>200	75
TOB 2-6	8/22/08	2	77	0	0	50	74	>200
TOB 2-6	8/22/08	3	15	0	0	2	>200	29
TOB 2-6	8/22/08	4	85	0	0	63	>200	>181
TOB 2-6	8/22/08	5	50	2	0	15	>58	>200

Table B-5. Channel Cross Section Data

Reach ID	Date	Cell	Latitude	Longitude	Feature	Bankfull Channel Width (ft)	Cross-Sectional Area (ft^2)	Bankfull Mean Depth (ft)	Width / Depth Ratio	Maximum Depth (ft)	Floodprone Width (ft)	Entrenchment Ratio
DEP 9-2	8/27/08	1	48.77628	-114.85604	riffle	17.8	26.3	1.47	12.1	1.8	19.3	1.1
DEP 9-2	8/27/08	2	48.77657	-114.85565	riffle	25.2	38.8	1.54	16.4	2.0	57.7	2.3
DEP 9-2	8/27/08	3	48.77709	-114.85528	riffle	17.5	26.3	1.50	11.7	2.2	24.5	1.4
DEP 9-2	8/27/08	5	48.77816	-114.85435	riffle	19.0	30.4	1.60	6.4	2.3	62.0	3.3
DEP 13-2	8/27/08	1	48.76067	-114.88277	riffle	21.0	30.5	1.45	14.5	1.8	101.0	4.8
DEP 13-2	8/27/08	3	48.76012	-114.88113	riffle	19.0	26.6	1.40	13.6	2.2	126.5	6.7
DEP 13-2	8/27/08	4	48.75962	-114.88077	riffle	17.0	20.2	1.19	14.3	1.7	66.0	3.9
DEP 13-2	8/27/08	5	48.75941	-114.88075	riffle	20.7	26.3	1.27	16.3	2.1	95.7	4.6
ENA 10-2	8/21/08	1	48.66069	-114.93443	riffle	28.4	25.3	0.90	31.6	1.6	37.4	1.3
ENA 10-2	8/21/08	2	48.66088	-114.93542	riffle	21.5	21.5	1.00	21.5	1.8	61.5	2.9
ENA 10-2	8/21/08	3	48.66065	-114.93604	riffle	15.6	15.6	1.00	15.6	1.9	31.1	2.0
ENA 10-2	8/21/08	4	48.66075	-114.93642	riffle	16.4	17.0	1.04	15.8	1.5	24.4	1.5
ENA 10-2	8/21/08	5	48.66027	-114.93716	riffle	29.7	29.7	1.00	29.7	1.4	34.9	1.3
FTN 4-3	8/28/08	1	48.54107	-114.95274	riffle	21.3	26.3	1.23	17.3	1.8	42.8	2.0
FTN 4-3	8/28/08	2	48.54028	-114.95302	riffle	19.7	28.0	1.42	13.8	1.7	58.7	3.0
FTN 4-3	8/28/08	4	48.53973	-114.95251	riffle	26.0	21.4	0.82	31.7	1.5	78.0	3.0
FTN 6-1	8/23/08	1	48.57404	-114.95517	riffle	23.8	22.6	0.99	24.0	1.4	36.8	1.6
FTN 6-1	8/23/08	2	48.57355	-114.95463	riffle	22.7	20.4	0.90	25.2	1.6	24.7	1.1
FTN 6-1	8/23/08	4	48.57274	-114.95472	riffle	17.0	20.4	1.20	14.2	1.9	2.6	1.5
FTN 9-3	8/27/08	1	48.61608	-114.94911	riffle	32.0	44.4	1.38	23.2	1.9	41.5	1.3
FTN 9-3	8/27/08	2	48.61007	-114.94949	riffle	36.0	64.4	1.78	20.2	2.1	65.0	1.8
FTN 9-3	8/27/08	5	48.61016	-114.95115	riffle	20.5	37.6	1.83	11.2	2.2	94.5	4.6
FTN 12-7	8/23/08	1	48.70507	-114.88379	riffle	63.0	66.2	1.05	60.0	1.9	85.0	1.4
FTN 12-7	8/23/08	2	48.70451	-114.88431	riffle	48.7	55.0	1.13	43.1	1.9	192.7	4.0
FTN 12-7	8/23/08	3	48.70388	-114.88387	riffle	91.7	87.1	0.95	96.5	1.8	175.7	1.9
FTN 12-7	8/23/08	5	48.70322	-114.88239	riffle	46.5	65.1	1.40	33.2	2.0	66.5	1.4

Table B-5. Channel Cross Section Data

Reach ID	Date	Cell	Latitude	Longitude	Feature	Bankfull Channel Width (ft)	Cross-Sectional Area (ft^2)	Bankfull Mean Depth (ft)	Width / Depth Ratio	Maximum Depth (ft)	Floodprone Width (ft)	Entrenchment Ratio
FTN 13-1	8/23/08	1	48.75771	-114.89907	riffle	32.9	47.7	1.45	22.7	2.0	42.9	1.3
FTN 13-1	8/23/08	2	48.75750	-114.89875	riffle	46.3	70.4	1.52	30.5	2.1	54.8	1.2
FTN 13-1	8/23/08	3	48.75727	-114.89815	riffle	32.3	37.5	1.16	27.8	1.9	58.3	1.8
FTN 13-1	8/23/08	5	48.75731	-114.89687	riffle	26.5	40.6	1.53	17.3	2.1	42.5	1.6
CLARENCE	8/26/08	1	48.89199	-114.79762	riffle	31.9	52.6	1.65	19.3	2.5	>250	7.8
CLARENCE	8/26/08	2	48.48208	-114.79797	riffle	27.0	51.0	1.88	14.4	3.9	>231	8.6
CLARENCE	8/26/08	3	48.89269	-114.79836	riffle	31.4	57.9	1.84	17.1	2.5	42.9	1.4
CLARENCE	8/26/08	4	48.89322	-114.79822	riffle	25.0	50.0	2.00	12.5	2.7	17.5	1.7
CLARENCE	8/26/08	5	48.89333	-114.79880	riffle	35.6	62.9	1.80	19.8	2.9	>238	6.7
LME 2-1	8/26/08	2	48.64851	-114.87065	riffle	7.7	7.4	0.96	8.0	1.4	29.7	3.9
LME 2-1	8/26/08	3	48.64834	-114.87058	riffle	6.2	6.5	1.05	5.9	1.9	21.7	3.5
LME 2-1	8/26/08	4	48.64854	-114.87017	riffle	7.6	8.4	1.10	6.9	1.8	17.6	2.3
LME 2-1	8/26/08	5	48.64853	-114.86967	riffle	8.3	10.8	1.30	6.4	2.0	17.3	2.1
SNC 8-2	8/25/08	1	48.88638	-115.00020	riffle	28.0	28.6	1.02	27.5	1.7	37.3	1.3
SNC 8-2	8/25/08	2	48.88681	-115.00156	riffle	17.0	21.4	1.26	13.5	1.5	27.6	1.6
SNC 8-2	8/25/08	3	48.88713	-115.00123	riffle	14.0	17.8	1.27	11.0	1.7	37.4	2.7
SNC 8-2	8/25/08	4	48.88725	-115.00053	riffle	22.3	24.5	1.10	20.3	1.5	30.8	4.3
SNC 8-2	8/25/08	5	48.88750	-115.00018	riffle	22.5	20.3	0.90	25.0	1.5	95.3	1.3
SNC 10-3	8/26/08	1	48.87679	-115.04916	riffle	19.3	23.0	1.19	16.2	1.5	25.3	1.3
SNC 10-3	8/26/08	2	48.87649	-115.04852	riffle	22.0	25.1	1.14	19.3	1.6	34.6	1.4
SNC 10-3	8/26/08	3	48.87632	-115.04777	riffle	22.0	22.7	1.13	17.7	1.5	35.0	1.7
SWP 5-1	8/24/08	1	48.59672	-115.05782	riffle	30.5	32.6	1.07	28.5	1.9	49.5	1.6
SWP 5-1	8/24/08	2	48.59711	-115.05901	riffle	23.2	21.1	0.90	25.5	1.7	39.7	1.7
SWP 5-1	8/24/08	3	48.59714	-115.05924	riffle	22.0	21.6	0.98	22.4	1.7	43.5	2.0
SWP 5-1	8/24/08	4	48.59729	-115.06017	riffle	23.0	22.3	0.97	23.7	1.5	30.0	1.3
SWP 5-1	8/24/08	5	48.59715	-115.06081	riffle	25.1	30.9	1.23	20.4	1.6	30.6	1.2
SWP 9-1	8/24/08	1	48.60279	-114.96725	riffle	38.0	41.8	1.10	34.6	2.5	78.0	2.1

Table B-5. Channel Cross Section Data

Reach ID	Date	Cell	Latitude	Longitude	Feature	Bankfull Channel Width (ft)	Cross-Sectional Area (ft^2)	Bankfull Mean Depth (ft)	Width / Depth Ratio	Maximum Depth (ft)	Floodprone Width (ft)	Entrenchment Ratio
SWP 9-1	8/24/08	2	48.60233	-114.96745	riffle	41.5	56.9	1.37	30.3	2.4	131.5	3.2
SWP 9-1	8/24/08	3	48.60209	-114.96777	riffle	38.0	62.5	1.64	23.2	1.9	58.0	1.5
SWP 9-1	8/24/08	4	48.60206	-114.96840	riffle	32.2	48.3	1.50	21.5	2.4	53.2	1.7
SWP 9-1	8/24/08	5	48.60153	-114.96926	riffle	30.0	47.1	1.57	19.1	2.5	98.0	3.3
THR 9-5	8/25/08	1	48.84865	-114.92039	riffle	15.5	23.6	1.50	10.2	1.9	59.3	3.8
THR 9-5	8/25/08	2	48.84912	-114.92059	riffle	16.0	23.5	1.46	11.0	1.7	38.0	2.4
THR 9-5	8/25/08	3	48.84964	-114.92064	riffle	13.3	19.4	1.45	9.2	1.7	24.3	1.8
THR 9-5	8/25/08	4	48.84989	-114.92025	riffle	17.6	26.8	1.52	11.6	2.2	25.2	1.4
THR 14-1	8/25/08	1	48.83928	-114.93488	riffle	19.0	28.3	1.48	12.8	2.2	124.0	6.5
THR 14-1	8/25/08	2	48.83981	-114.93499	riffle	18.0	23.9	1.33	13.5	1.8	52.0	2.9
THR 14-1	8/25/08	3	48.84013	-114.93456	riffle	17.0	28.7	1.68	13.5	2.0	26.5	1.6
THR 14-1	8/25/08	4	48.84044	-114.93462	riffle	16.3	29.2	1.79	9.1	2.5	37.3	2.3
THR 14-1	8/25/08	5	48.84091	-114.93479	riffle	16.5	24.4	1.47	11.2	2.0	58.5	3.5
TOB 1-1	8/22/08	1	48.80305	-114.95797	riffle	69.0	160.2	2.30	30.0	3.2	>284	4.1
TOB 1-1	8/22/08	2	48.80222	-114.95694	riffle	70.0	157.7	2.25	31.1	2.9	8.4	1.2
TOB 1-1	8/22/08	3	48.80104	-114.95586	riffle	83.0	172.6	2.08	20.0	2.9	>304	3.7
TOB 1-1	8/22/08	4	48.80056	-114.95496	riffle	77.0	155.5	2.02	38.1	3.4	>309	4.0
TOB 1-1	8/22/08	5	48.79984	-114.95361	riffle	78.5	194.7	2.48	31.7	3.3	>311	4.0
TOB 2-6	8/22/08	1	48.89653	-115.11347	riffle	55.0	137.5	2.50	22.0	3.5	67.5	1.2
TOB 2-6	8/22/08	2	48.89666	115.11205	riffle	96.0	223.7	2.33	41.2	2.8	135.0	1.4
TOB 2-6	8/22/08	4	48.89611	-115.11171	riffle	92.8	198.6	2.14	43.4	2.8	>352.8	3.8
TOB 2-6	8/22/08	5	48.89594	-115.11224	riffle	95.0	195.0	2.05	46.3	3.5	>303	2.2

ATTACHMENT C – QUALITY ASSURANCE/QUALITY CONTROL REVIEW

GENERAL DESCRIPTION OF FIELD ACTIVITIES

Sediment and habitat monitoring was conducted in the Tobacco River TMDL Planning Area in the summer/fall of 2008. Three separate field visits were conducted as part of this assessment:

On July 22-23, 2008, a field reconnaissance crew consisting of Banning Starr (DEQ) and Josh Vincent (Water & Environmental Technologies) conducted site visits of potential field assessment sites which were previously identified using aerial photography and GIS. Sites were inspected for their sampling feasibility and ability to gain access to private property.

On August 21-28, 2008, a sediment and habitat field crew consisting of Banning Starr, Steve Cook, and Christina Staten (DEQ), and Josh Vincent, John Trudnowski, John Babcock, and Ty DeBoo (Water & Environmental Technologies) conducted both longitudinal and Bank Erosion Hazard Index (BEHI) field assessments on 18 impaired stream reaches according to the Sampling and Analysis Plan prepared for this project (Sampling and Analysis Plan, Sediment and Habitat Assessment, Tobacco River TPA, July 2008).

On September 8-12, 2008, a field crew consisting of Steve Cook (DEQ) and Josh Vincent (Water & Environmental Technologies) conducted limited field assessments consisting of BEHI data only on an additional 14 impaired reaches.

Field Variance from SAP

During the field assessments, the following activities were noted as deviating from the approved SAP. It was determined during field activities that the assessment conducted on reach THR-14-1 extended upstream into reach 13-2. The reach location is noted correctly in the GIS database.

After completing field activities, it was determined that the assessment of GRV 2-1 was actually completed on Clarence Creek, a tributary of Grave Creek. The reach of Clarence Creek contained good reference data, and as a result, these data were used in the analysis.

BEHI Data Adjustments

Table C-1 provides adjustments made to the field data during sediment load calculations. In many cases, measurements for near bank stress (NBS), including near bank max depth or mean bankfull depth, were not provided, so NBS was estimated either in the field or from photos. The table provides both the original value determined in the field and the adjusted value used for sediment loading calculations. A rationale for why the value was adjusted is also provided.

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
DEP 9-2	2	bank height	50+	10	notes say 3-10' of bank is eroding
DEP 9-2	3	NBS	not calculated	low	used calculated value from bank 1
DEP 9-2	4	bank height	50+	10	notes say 3-10' of bank is eroding
DEP 9-2	4	NBS	not calculated	low	used calculated value from bank 2

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
DEP 9-2	5	NBS	not calculated	moderate	outside meander bend
DEP 13-2	2	NBS	not calculated	low	used calculated value from bank 1
DEP 13-2	4	NBS	not calculated	very low	used calculated value from bank 2
DEP 13-2	5	NBS	not calculated	very low	used calculated value from bank 2
ENA 10-2	2	NBS	not calculated	low	used calculated value from bank 1
ENA 10-2	3	NBS	not calculated	low	used calculated value from bank 1
ENA 10-2	4	NBS	not calculated	low	used calculated value from bank 1
ENA 10-2	5	NBS	not calculated	low	used calculated value from bank 1
ENA 10-2	6	NBS	not calculated	low	used calculated value from bank 1
ENA 10-2	7	NBS	not calculated	low	used calculated value from bank 1
LME 6-1	2	NBS	not calculated	low	used estimated value from field form
LME 6-1	3	NBS	not calculated	low	used estimated value from bank 2
LME 6-1	4	NBS	not calculated	low	used estimated value from bank 2
LME 6-1	5	NBS	not calculated	high	used estimated value from field form
LME 6-1	6	NBS	not calculated	high	used estimated value from field form
LME 6-1	7	NBS	not calculated	very low	used calculated value from bank 1
LME 6-1	8	NBS	not calculated	high	used estimated value from field form
SNC 8-2	6	bank length	not measured	10'	estimated from photo
SNC 8-2	2	NBS	not calculated	low	used estimated value from field form
SNC 8-2	3	NBS	not calculated	very low	used estimated value from field form
SNC 8-2	4	NBS	not calculated	very low	used estimated value from field form
SNC 8-2	5	NBS	not calculated	very low	used estimated value from field form
SNC 8-2	6	NBS	not calculated	very high	used estimated value from field form
SNC 8-2	7	NBS	not calculated	very high	used estimated value from field form
SNC 8-2	8	NBS	not calculated	low	used estimated value from field form
SNC 8-2	9	NBS	not calculated	high	used estimated value from field form
SNC 8-2	10	NBS	not calculated	high	used estimated value from field form
SNC 8-2	11	NBS	not calculated	very low	used calculated value from bank 1
SNC 8-2	12	NBS	not calculated	very high	used estimated value from bank 7
SNC 8-2	13	NBS	not calculated	low	used estimated value from field form
SNC 8-2	14	NBS	not calculated	high	used estimated value from field form
SNC 10-3	3	NBS	not calculated	very low	used calculated value from bank 1
SNC 10-3	4	NBS	not calculated	very low	used calculated value from bank 1
SNC 10-3	4	root depth	3.9	2.8	bank height is 2.8, adjusted so ratio is 1
THR 9-5	4	NBS	not calculated	very low	used calculated value from bank 1
THR 9-5	7	NBS	not calculated	very low	used calculated value from bank 1
THR 9-5	10	NBS	not calculated	moderate	used estimated value from field form
THR 9-5	3	NBS	not calculated	very low	used calculated value from bank 2
THR 9-5	6	NBS	not calculated	moderate	used estimated value from field form
THR 9-5	8	NBS	not calculated	very high	used estimated value from field form
THR 9-5	9	NBS	not calculated	moderate	used estimated value from field form
THR 9-5	11	NBS	not calculated	high	used estimated value from field form
THR 9-5	12	NBS	not calculated	low	used estimated value from field form
THR 9-5	13	NBS	not calculated	low	used estimated value from field form
THR 9-5	9	bankfull height	1.7	1.6	bank height is 1.6, adjusted so ratio is 1

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
THR 9-5	13	bankfull height	1.7	1.6	bank height is 1.6, adjusted so ratio is 1
TOB 2-6	3a	NBS	very low	extreme	extreme NBS from station 1172-1268
TOB 2-6	3b	NBS	very low	high	high NBS from station 1268-1483
TOB 2-6	6	BEHI	moderate	low	notes say low-very low load, protected
TOB 2-6	4	NBS	not calculated	very low	used estimated value from field form
TOB 2-6	6	NBS	not calculated	low	used estimated value from field form
TOB 2-6	7	NBS	not calculated	very low	used calculated value from bank 5
THR 14-1	5	bankfull height	2.2	1.8	bank height is 1.8, adjusted so ratio is 1
THR 14-1	6	bankfull height	2.2	1.1	bank height is 1.1, adjusted so ratio is 1
THR 14-1	4	NBS	not calculated	very low	used calculated value from bank 1
THR 14-1	5	NBS	not calculated	very low	used calculated value from bank 1
THR 14-1	6	NBS	not calculated	moderate	used estimated value from field form
THR 14-1	7	NBS	not calculated	very low	used calculated value from bank 1
THR 14-1	8	NBS	not calculated	high	used estimated value from field form
THR 14-1	3	NBS	not calculated	high	used estimated value from field form
SWP 5-1	3	NBS	not calculated	low	used estimated value from field form
SWP 5-1	3	bank length	not measured	15	estimated from photo
SWP 5-1	5	NBS	not calculated	moderate	used estimated value from field form
SWP 9-1	2	root depth	0.6 - 1.5	1.1	range given, used mean value
SWP 9-1	3	root depth	0.6 - 1.5	1.1	range given, used mean value
SWP 9-1	5	root depth	0.6 - 1.5	1.1	range given, used mean value
SWP 9-1	7	root depth	0.6 - 1.5	1.1	range given, used mean value
SWP 9-1	6	bankfull height	2.9	2.4	bank height is 2.4, adjusted so ratio is 1
SWP 9-1	7	bankfull height	2.3	1.8	bank height is 1.8, adjusted so ratio is 1
SWP 9-1	3	NBS	not calculated	moderate	mid-channel boulders
SWP 9-1	4	NBS	not calculated	moderate	mid-channel boulders
SWP 9-1	5	NBS	not calculated	moderate	mid-channel boulders
SWP 9-1	6	NBS	not calculated	moderate	mid-channel boulders
SWP 9-1	7	NBS	not calculated	moderate	mid-channel boulders
GRV 2-1	1-5	stratification	YES	5	recorded as "YES", given value of +5
GRV 2-1	2	NBS	not calculated	low	used estimated value from field form
GRV 2-1	3	NBS	not calculated	low	used estimated value from field form
GRV 2-1	4	NBS	not calculated	low	used estimated value from field form
GRV 2-1	5	NBS	not calculated	low	used estimated value from field form
FTN 6-1	2	bank length	88	172	bank on both sides, length doubled
FTN 6-1	2	NBS	not calculated	moderate	used calculated value from bank 1
FTN 6-1	4	NBS	not calculated	high	used estimated value from field form
FTN 6-1	3	NBS	not calculated	very low	used estimated value from field form
FTN 6-1	5	NBS	not calculated	low	used estimated value from field form
FTN 6-1	3	bank length	98	196	bank on both sides, length doubled
FTN 4-3	7	stratification	YES	5	recorded as "YES", given value of +5
FTN 4-3	7	NBS	extreme	moderate	photos show sloughing, used estimate
FTN 4-3	4	bankfull height	2.1	1.8	bank height is 1.8, adjusted so ratio is 1
FTN 4-3	5	bankfull height	2.1	1.8	bank height is 1.8, adjusted so ratio is 1
FTN 4-3	8	bankfull height	2.1	1.9	bank height is 1.9, adjusted so ratio is 1

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
FTN 4-3	2	NBS	not calculated	moderate	used calculated value from bank 1
FTN 4-3	3	NBS	not calculated	moderate	used calculated value from bank 1
FTN 4-3	4	NBS	not calculated	moderate	used calculated value from bank 1
FTN 4-3	5	NBS	not calculated	moderate	used calculated value from bank 1
FTN 4-3	6	NBS	not calculated	moderate	used calculated value from bank 1
FTN 4-3	8	NBS	not calculated	moderate	used calculated value from bank 1
FTN 9-3	2	NBS	not calculated	very low	used calculated value from bank 1
FTN 9-3	3	NBS	high	low	long bank next to pool, used estimate
FTN 9-3	3	BEHI	moderate	low	long vegetated bank, root depth is low
FTN 12-7	1	bankfull height	1.4	1.2	bank height is 1.2, adjusted so ratio is 1
FTN 12-7	4	bank angle	45-90	67	range given, used mean value
FTN 12-7	6	bank angle	45-90	67	range given, used mean value
FTN 12-7	4	NBS	very low	moderate	transverse bar w/ moderate NBS
FTN 12-7	5	NBS	not calculated	moderate	described as 1/2 low and 1/2 high NBS
FTN 12-7	6	NBS	not calculated	very low	used estimated value from field form
FTN 12-7	3	NBS	low	very low	heavy vegetated long bank, estimated
FTN 12-7	3	BEHI	moderate	low	heavily vegetated long bank
FTN 13-1	4	NBS	low	moderate	used estimated value
FTN 13-1	2	NBS	not calculated	moderate	used estimated value from field form
FTN 13-1	3	NBS	not calculated	moderate	used estimated value from field form
FTN 13-1	4	NBS	not calculated	moderate	used estimated value from field form
TOB 1-1	3	NBS	not calculated	very low	used calculated value from bank 2
TOB 1-1	4	NBS	not calculated	very low	used calculated value from bank 2
TOB 1-1	7	NBS	not calculated	very high	outside meander bend, estimated value
TOB 1-1	8	NBS	not calculated	high	outside meander bend, estimated value
TOB 1-1	6	bankfull height	2.3	2	bank height is 2.0, adjusted so ratio is 1
TOB 1-1	6	NBS	not calculated	low	used estimated value from field form
FTN 15-3	2	NBS	not calculated	very low	no bankfull mean depth, estimated value
FTN 15-3	3	NBS	not calculated	moderate	used estimated value from field form
FTN 15-3	4	NBS	not calculated	moderate	used estimated value from field form
FTN 4-1	1	NBS	not calculated	moderate	used estimated value from field form
FTN 4-1	2	NBS	not calculated	low	used estimated value from field form
FTN 4-1	3	NBS	not calculated	moderate	used estimated value from bank 1
FTN 4-1	4	NBS	not calculated	low	used estimated value from bank 2
FTN 4-1	5	NBS	not calculated	high	used estimated value from field form
FTN 4-1	6	NBS	not calculated	low	used estimated value from field form
FTN 4-1	7	NBS	not calculated	moderate	used estimated value from bank 1
FTN 4-1	8	NBS	not calculated	high	used estimated value from field form
FTN 4-1	9	NBS	not calculated	moderate	used estimated value from bank 1
FTN 4-1	10	NBS	not calculated	moderate	used estimated value from bank 1
FTN 4-1	11	NBS	not calculated	low	used estimated value from bank 2
ENA 7-2	4	bankfull height	1.7	1.3	bank height is 1.3, adjusted so ratio is 1
ENA 7-2	1	NBS	not calculated	moderate	used estimated value
ENA 7-2	2	NBS	not calculated	moderate	used estimated value
ENA 7-2	3	NBS	not calculated	moderate	used estimated value

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
ENA 7-2	4	NBS	not calculated	moderate	used estimated value
ENA 7-2	5	NBS	not calculated	moderate	used estimated value
FTN 12-2	1	NBS	not calculated	moderate	used estimated value from field form
FTN 12-2	1	BEHI	high	moderate	long bank, heavy veg below bankfull
FTN 12-2	2	NBS	not calculated	low	used estimated value from field form
FTN 12-2	3	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	4	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	5	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	6	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	7	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	8	NBS	not calculated	low	used estimated value from bank 2
FTN 12-2	9	NBS	not calculated	low	used estimated value from bank 2
ENA 11-1	2	bankfull height	1.0	0.6	bank height is 0.6, adjusted so ratio is 1
ENA 11-1	4	bankfull height	1.0	0.9	bank height is 0.9, adjusted so ratio is 1
ENA 11-1	1	NBS	not calculated	very low	estimated from photos
ENA 11-1	2	NBS	not calculated	very low	estimated from photos
ENA 11-1	3	NBS	not calculated	very low	estimated from photos
ENA 11-1	4	NBS	not calculated	very low	estimated from photos
ENA 11-1	5	NBS	not calculated	very low	estimated from photos
ENA 8-1	1	NBS	not calculated	moderate	used estimated value from field form
ENA 8-1	2	NBS	not calculated	very high	used estimated value from field form
ENA 8-1	3	NBS	not calculated	very high	used estimated value from bank 2
ENA 8-1	4	NBS	not calculated	moderate	used estimated value from bank 1
FTN 7-2	1	NBS	not calculated	moderate	used estimated value from field form
FTN 7-2	2	NBS	not calculated	low	estimated from photo
FTN 7-2	3	NBS	not calculated	high	used estimated value from field form
FTN 7-2	4	NBS	not calculated	low	used estimated value from bank 2
FTN 7-2	5	NBS	not calculated	low	used estimated value from field form
FTN 7-2	6	NBS	not calculated	low	used estimated value from bank 2
FTN 7-2	1	bankfull height	1.8	1.7	bank height is 1.7, adjusted so ratio is 1
FTN 12-9	5	NBS	not calculated	high	used estimated value from field form
FTN 12-9	1	NBS	not calculated	moderate	used estimated value from field form
FTN 12-9	2	bankfull height	2.0	1.3	bank height is 1.3, adjusted so ratio is 1
FTN 12-9	3	bankfull height	2.0	1.5	bank height is 1.5, adjusted so ratio is 1
FTN 12-9	4	bankfull height	2.0	1.6	bank height is 1.6, adjusted so ratio is 1
FTN 12-9	2	root depth	6.0	1.3	bank height is 1.3, adjusted so ratio is 1
FTN 12-9	3	root depth	6.0	1.5	bank height is 1.5, adjusted so ratio is 1
FTN 12-9	4	root depth	6.0	1.6	bank height is 1.6, adjusted so ratio is 1
FTN 12-9	4	material adjust.	0	10	erosion from hoof shear, in photo
FTN 12-9	4	BEHI	low	moderate	increase due to material adjustment
FTN 12-9	2	NBS	not calculated	low	used estimated value from field form
FTN 12-9	3	NBS	not calculated	low	used estimated value from field form
FTN 12-9	4	NBS	not calculated	low	used estimated value from bank 2
FTN 15-2	1	NBS	not calculated	moderate	used estimated value from field form
FTN 15-2	2	NBS	not calculated	moderate	used estimated value from field form

Table C-1. BEHI adjustments

Reach	Bank	Parameter	Original Value	Adjusted Value	Rationale
FTN 15-2	3	NBS	not calculated	moderate	used estimated value from field form
FTN 15-2	4	NBS	not calculated	moderate	used estimated value from field form
FTN 15-2	5	NBS	not calculated	low	used estimated value from field form
FTN 15-2	6	NBS	not calculated	low	used estimated value from field form
FTN 15-2	3	bankfull height	2.2	1.9	bank height is 1.9, adjusted so ratio is 1
FTN 15-2	5	bankfull height	2.2	1.9	bank height is 1.9, adjusted so ratio is 1
SWP 3-1	5	bankfull height	1.5	1.4	bank height is 1.4, adjusted so ratio is 1
SWP 3-1	6	bankfull height	1.5	1.0	bank height is 1.0, adjusted so ratio is 1
SWP 3-1	1	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	2	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	3	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	4	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	5	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	6	NBS	not calculated	low	photo estimate, woody debris in bank
SWP 3-1	7	NBS	not calculated	low	photo estimate, woody debris in bank
SNC 5-1	1	bankfull height	not measured	2.0	estimated from photos
SNC 5-1	2	bankfull height	not measured	2.0	estimated from photos
SNC 5-1	3	bankfull height	not measured	2.0	estimated from photos
SNC 5-1	1	NBS	not calculated	low	used estimated value from field form
SNC 5-1	2	NBS	not calculated	moderate	used estimated value from field form
SNC 5-1	3	NBS	not calculated	high	used estimated value from field form
TOB 2-3	1	NBS	not calculated	high	used estimated value from field form
TOB 2-3	2	NBS	not calculated	moderate	used estimated value from field form
TOB 2-3	4	NBS	not calculated	moderate	used estimated value from field form
TOB 2-3	3	NBS	not calculated	moderate	used estimated value from field form
TOB 2-3	5	NBS	not calculated	moderate	used estimated value from field form
TOB 2-3	6	NBS	not calculated	low	used estimated value from field form
TOB 1-3	1	NBS	not calculated	moderate	used estimated value from field form
TOB 1-3	3	NBS	not calculated	moderate	used estimated value from bank 1
TOB 1-3	4	NBS	not calculated	moderate	used estimated value from bank 1
TOB 1-3	5	NBS	not calculated	moderate	used estimated value from bank 1
TOB 1-3	2	NBS	not calculated	high	used estimated value from field form

Attachment D – Example Streambank Photos

Very Low BEHI Rating: No banks were assessed with a "very low" BEHI rating.

Figure D-1. Low BEHI Rating: Sites ENA 11-1 (bank 1) and FTN 7-2 (bank 1)

Figure D-2. Moderate BEHI Rating: Sites LME 6-1 (bank 1) and TOB 1-1 (bank 2)

Figure D-3. High BEHI Rating: Sites FTN 13-1 (bank 1) and THR 14-1 (bank 1)

Figure D-4. Very High BEHI Rating: Sites THR 9-5 (bank 5) and THR 14-1 (bank 2)

Figure D-5. Extreme BEHI Rating: Sites TOB 2-6 (bank 3) and DEP 9-2 (bank 1)