APPENDIX G
2008 SEDIMENT AND HABITAT DATA COLLECTION METHODS AND DATA SUMMARY UPPER GALLATIN TMDL PLANNING AREA

G1.0 INTRODUCTION

This appendix includes a summary of the field protocols and results from stream channel and habitat data collected in the Upper Gallatin TPA during the summer of 2008 to facilitate sediment TMDL development. It is an excerpt from the Upper Gallatin Base Parameter Report (PBS&J 2010), which is on file at DEQ and also contains site visit notes and summary statistics by monitoring site and reach type. During the field assessment, stream channel and habitat data was collected at a total of 16 monitoring sites on 5 streams (**Figure G-1**) following protocols established in Longitudinal Field Methodology for the Assessment of Sediment and Habitat Impairments (MT DEQ 2008a). Data collected at each monitoring site was analyzed with two different approaches:

1. By reach type as assigned in the Aerial Assessment Database, and;
2. Individually for each monitoring site.

In the "reach type" assessment, monitoring sites are grouped based on the reach type as assigned in the Aerial Assessment Database. This assessment is based on the premise behind the study design, which assumes that stream reaches with the same Ecoregion, valley gradient, stream order and confinement will have similar characteristics. This assessment may provide valuable information for defining future sediment TMDL criteria specific to the reach types identified within the Upper Gallatin TPA.

Each monitoring site was also analyzed individually. Analyzing streams individually provides an at-a-glance method for identifying conditions that may differ from what is expected. This analysis may provide valuable information for assessing existing conditions along these stream segments.

G1.1 Aerial Assessment Database

The Aerial Assessment reach stratification process involved dividing each stream into distinct reaches based on four landscape factors: Ecoregion, valley gradient, Strahler stream order, and valley confinement following the methodology outlined in Watershed Stratification Methodology for TMDL Sediment and Habitat Investigations (MT DEQ 2008b). Each individual combination of the four landscape factors is referred to as a "reach type" in this report based on the following definition:

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

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

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

Table G-1. Reach Type Identifiers.

Landscape Factor	Stratification Category	Reach Type Identifier
Level III Ecoregion	Middle Rockies	MR
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
Confinement	unconfined	U
	confined	C

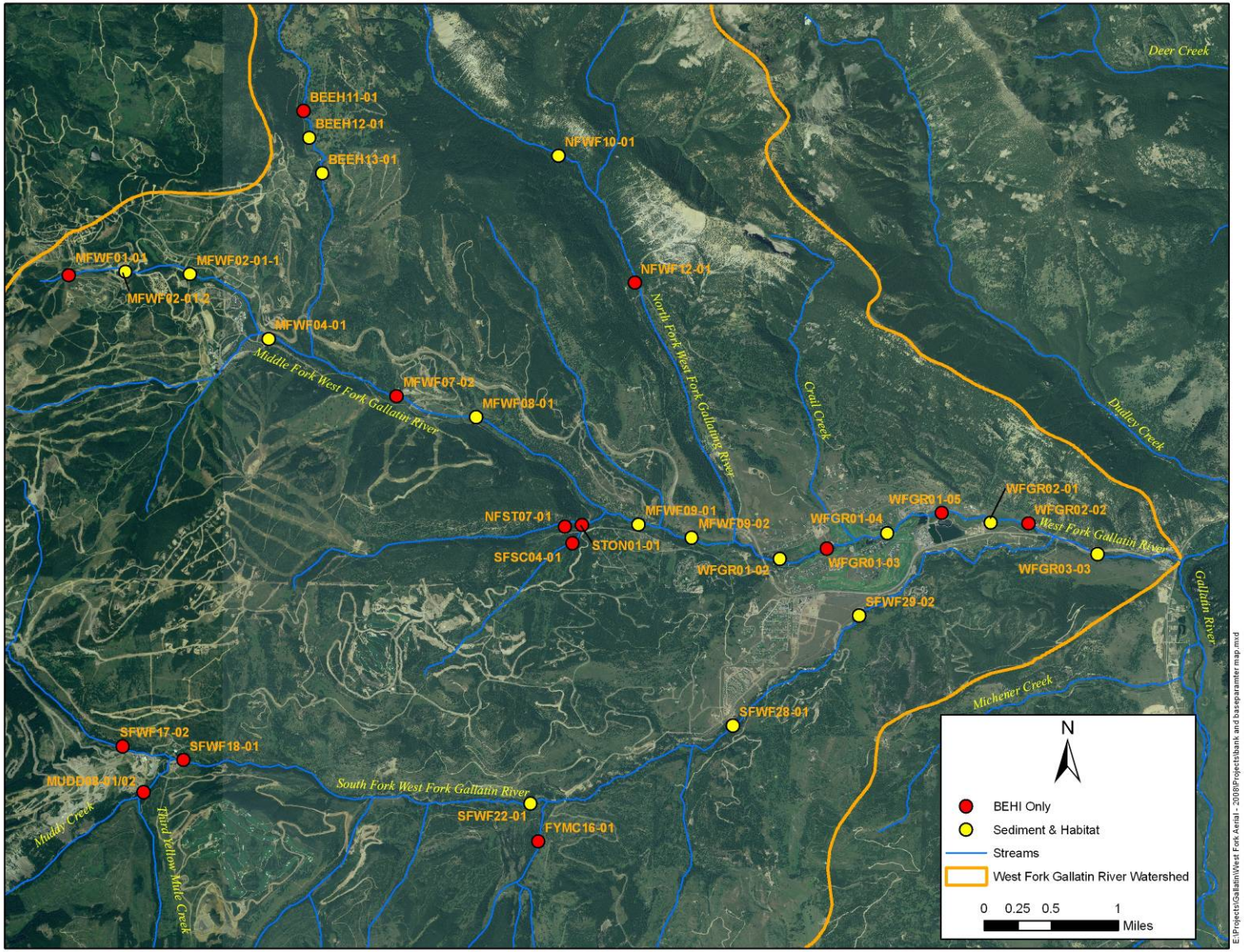
Thus, a stream reach identified as MR-0-3-U is a low gradient (0-<2%), 3rd order, unconfined stream in the Middle Rockies Level III Ecoregion.

In the Upper Gallatin TPA, stream reach data was compiled into an Aerial Assessment Database, which included a total of 157 stream reaches and a total of 14 reach types (**Table G-2**). Out of the 14 reach types identified in the West Fork Gallatin River watershed, 7 were assessed in the field for sediment and habitat conditions. A more complete discussion of this assessment can be found in Aerial Assessment Reach Stratification Upper Gallatin TMDL Planning Area (PBS&J 2009a).

Table G-2. Monitoring Sites in Assessed Reach Types. No reference

Reach Type	Monitoring Sites	Number of Sites
MR-4-1-C	MFWF04-01	1
MR-4-1-U	MFWF02-01-1, MFWF02-01-2, BEEH13-01	3
MR-2-1-U	BEEH12-01	1
MR-2-2-U	MFWF08-01, NFWF10-01	2
MR-2-3-U	MFWF09-01, MFWF09-02, WFGR01-02, WFGR01-04, SFWF28-01	5
MR-0-3-U	WFGR02-01, SFWF22-01, SFWF29-02	3
MR-0-4-U	WFGR03-03	1

Figure G-1. Upper Gallatin TPA Sediment and Habitat Monitoring Sites.



G2.0 FIELD DATA COLLECTION 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 assessments, as presented in the document, Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (MT DEQ 2008a). All field forms used in the study are standard forms used by DEQ for sediment and habitat assessments.

G2.1 Survey Site Delineation

Stream survey sites were delineated beginning at riffle crests at the downstream ends of reaches. Survey sites were measured in the upstream direction at pre-determined lengths based on the bankfull width at the selected downstream riffle. Survey lengths of 500 feet were used for bankfull widths less than 10 feet; survey lengths of 1,000 feet were used for bankfull widths between 10 feet and 50 feet; and survey lengths of 2,000 feet were used for bankfull widths greater than 50 feet. Each survey site was divided into five equally sized study cells. The GPS locations of the downstream and upstream ends of the survey site were recorded and digital photographs were taken.

G2.2 Field Determination of Bankfull

All members of the field crew participated in determining the bankfull elevation. 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. 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.

G2.3 Channel Cross-sections

Channel cross-section measurements were performed at the first riffle in each cell using a line level and a measuring rod. Cross-sections were conducted in each cell containing a riffle feature. At each cross-section, depth measurements at bankfull were collected to a tenth of a foot across the channel at regular intervals. These intervals varied depending on channel width, following protocol in item 15, section 2.3 of the Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (MT DEQ 2008a). The thalweg depth was recorded at the deepest point of the channel independent of the regularly spaced intervals. At each cross-section, GPS coordinates were recorded and photos were taken from the middle of the channel and across the channel, showing the tape across the stream.

G2.4 Floodprone Width Measurements

The floodprone elevation was determined by multiplying the maximum depth value by two (Rosgen 1996). 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.

G2.5 Channel Bed Morphology

The length of the survey site occupied by pools and riffles was identified. Beginning from the downstream end of the survey site, the upstream and downstream stations of "dominant" riffle and pool stream features were recorded. Features were considered "dominant" when occupying over 50% of the stream width. Pools and riffles were measured from head crest or riffle crest, respectively, until the end of that feature (defined as the tail crest for pools). Stream features were identified per standard field method criteria (MT DEQ 2008a).

G2.6 Residual Pool Depth

At each pool encountered, the maximum depth and the depth of the pool tail crest at its deepest point was measured (MT DEQ 2008a). No pool tail crest depth was recorded for dammed pools. The difference between the maximum depth and the tail crest depth is considered the residual pool depth.

G2.7 Pool Habitat Quality

Qualitative assessments of each pool feature were undertaken, including the pool type, size, formative feature, and cover type, along with the depth of any undercut bank associated with the pool.

G2.8 Fine Sediment in Pool Tail-outs

A measurement of the percent of fine sediment in pool tail-outs was taken using the grid toss method at the first and second scour pool of each cell. Grid toss readings were focused in those pool tail-out gravels that appeared to be suitable or potentially suitable for trout spawning. Measurements were taken within the "arc" just upstream of the pool tail crest, following the methodology in Section 2.8 of Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (MT DEQ 2008a). Three measurements were taken across the channel with specific attention given to measurements in gravels determined to be of appropriate size for salmonid spawning. The potential for spawning was recorded as Yes (Y), No (N), or Questionable (Q) at each measurement site.

G2.9 Fine Sediment in Riffles

Using the same grid toss method as used in pools, measurements of fine sediment in riffles were performed. Grid tosses were performed before the pebble counts to avoid disturbances to fine sediments.

G2.10 Woody Debris Quantification

The amount of large woody debris (LWD) was recorded along the entire assessment reach. 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 Section 2.10 of Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (MT DEQ 2008a).

G2.11 Riffle Pebble Count

One Wolman pebble count (Wolman 1954) was performed at the first riffle encountered in cells 1, 3 and 5, providing a minimum of 300 particle sizes measured within each assessment reach. Particle sizes were measured along their intermediate length axis (b-axis) and results were grouped into size categories. The pebble count was performed from bankfull to bankfull using the "heel to toe" method, measuring particle size at the tip of the boot at each step. More specific details of the pebble count methodology can be found in Section 2.11 of Longitudinal Field Methodology for the Assessment of TMDL Sediment and Habitat Impairments (MT DEQ 2008a).

G2.12 Riffle Stability Index

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

G2.13 Riparian Greenline Assessment

Along each monitoring site, an assessment of riparian vegetation cover was performed. Vegetation types were recorded at 10 to 20-foot intervals, depending on the bankfull channel width. The riparian greenline assessment included the general vegetation community type of the groundcover, understory and overstory on both banks. The ground cover vegetation (<1.5 feet tall) was described using the following categories: wetland, grasses or forbs, bare/disturbed ground, rock, or riprap. The understory (1.5 to 15 feet tall) and overstory (>15 feet tall) vegetation were described using the following categories: coniferous, deciduous, or mixed coniferous and deciduous. At 50-foot intervals, a riparian buffer width was estimated on either side of the bank. This width corresponded to the belt of vegetation buffering the stream from adjacent land uses.

G2.14 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. The results of this assessment are reported in the companion document entitled Streambank Erosion Source Assessment Upper Gallatin TMDL Planning Area (PBS&J 2009b).

G2.15 Water Surface Slope

Water surface slope measurements were estimated using a clinometer.

G2.16 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 lands-uses:

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

G3.0 Data Summary

Tables G-3and **G-4** present sediment and habitat data for each individual reach sampled following the aforementioned assessment procedures.

Table G-3. Individual assessment reach data from 2008.

Reach ID	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Mean Residual Pool Depth	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	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
MFWF09-02	7/28/08	1	MR-2-3-U	C4	C4	1.29	1.2	2-<4%	25.7	20.4	1.8	>298	11.6	28	5	15	5	- -	1.9	9	8	0	15	65	0	0	5	15	100
MFWF09-02	7/28/08	2	MR-2-3-U	C3/4	C4	1.29	1.2	2-<4%	20.2	13.8	1.9	310.2	15.4	- -	- -	- -	- -	88						55	5	0	0	98	45
MFWF09-02	7/28/08	3	MR-2-3-U	C3	C4	1.29	1.2	2-<4%	28.5	22.9	2.3	173.5	6.1	69	7	11	1	- -						60	5	0	8	125	10
MFWF09-02	7/28/08	4	MR-2-3-U	B3/4c	C4	1.29	1.2	2-<4%	20.8	13.8	1.9	40.8	2.0	- -	- -	- -	- -	- -						53	3	0	5	190	13
MFWF09-02	7/28/08	5	MR-2-3-U	C4	C4	1.29	1.2	2-<4%	31.8	24.9	1.8	211.8	6.7	51	3	6	5	88						60	5	0	8	125	10
MFWF09-01	7/28/08	1	MR-2-3-U	B3	C3b	1.24	2.3	2-<4%	18.6	14.2	2.1	37.6	2.0	73	4	8	5	- -	1.3	4	34	0	34	28	10	0	3	200	4
MFWF09-01	7/28/08	2	MR-2-3-U	F3/4	C3b	1.24	2.3	2-<4%	19.1	13.1	2.0	23.1	1.2	- -	- -	- -	- -	- -						23	28	0	8	200	0
MFWF09-01	7/28/08	3	MR-2-3-U	C4b	C3b	1.24	2.3	2-<4%	24.3	17.3	2.0	106.3	4.4	47	5	6	2	- -						48	5	0	5	167	0
MFWF09-01	7/28/08	4	MR-2-3-U	C3/4b	C3b	1.24	2.3	2-<4%	28.4	26.7	2.2	293.4	10.3	- -	- -	- -	- -	- -						55	5	0	33	100	10
MFWF09-01	7/28/08	5	MR-2-3-U	C3b	C3b	1.24	2.3	2-<4%	22.9	17.4	1.8	278.9	12.2	76	4	6	1	- -						25	0	0	43	23	50
MFWF08-01	7/29/08	1	MR-2-2-U	C3b	B3	1.11	3.0	2-<4%	16.3	11.0	2.1	55.3	3.4	92	4	12	5	- -	1.4	6	34	9	149	10	3	0	43	200	200
MFWF08-01	7/29/08	2	MR-2-2-U	C3b	B3	1.11	3.0	2-<4%	19.5	15.2	2.2	66.0	3.4	- -	- -	- -	- -	- -						23	3	0	40	200	200
MFWF08-01	7/29/08	3	MR-2-2-U	B3	B3	1.11	3.0	2-<4%	19.9	14.2	2.2	37.9	1.9	80	3	5	3	- -						10	3	0	25	200	200
MFWF08-01	7/29/08	4	MR-2-2-U	- -	B3	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -						10	0	0	23	200	200
MFWF08-01	7/29/08	5	MR-2-2-U	C3b	B3	1.11	3.0	2-<4%	17.0	11.1	2.4	61.0	3.6	70	3	4	0	- -						3	3	0	48	- -	- -
MFWF04-01	7/29/08	1	MR-4-1-C	B4	B4	1.14	3.5	4-<10%	17.8	16.6	1.8	33.8	1.9	61	5	9	5	- -	1.1	15	58	3	100	30	0	0	28	175	200
MFWF04-01	7/29/08	2	MR-4-1-C	C4b	B4	1.14	3.5	4-<10%	16.0	12.7	1.8	63.0	3.9	27	9	16	7	- -						28	0	0	25	200	200
MFWF04-01	7/29/08	3	MR-4-1-C	C4b	B4	1.14	3.5	4-<10%	21.2	23.7	1.4	102.2	4.8	55	4	4	1	- -						45	0	0	8	200	200
MFWF02-01-1	7/29/08	1	MR-4-1-U	E4b	E4b	1.34	2.3	4-<10%	8.2	9.7	1.2	35.2	4.3	27	15	24	7	- -	0.8	25	50	2.5	55	70	0	0	15	200	200
MFWF02-01-1	7/29/08	2	MR-4-1-U	C4b	E4b	1.34	2.3	4-<10%	11.7	18.0	1.4	35.7	3.1	23	5	7	4	- -						20	0	0	25	150	150
MFWF02-01-1	7/29/08	3	MR-4-1-U	E4b	E4b	1.34	2.3	4-<10%	5.1	5.0	1.1	55.1	10.8	- -	- -	- -	- -	- -						75	0	0	15	31	31
MFWF02-01-1	7/29/08	4	MR-4-1-U	C4b	E4b	1.34	2.3	4-<10%	13.5	20.8	1.0	50.5	3.7	26	5	8	3	- -						45	0	0	5	25	25
WFGR02-01	7/30/08	1	MR-0-3-U	C3	C3	1.29	1.5	0-<2%	44.2	30.4	2.3	324.2	7.3	105	5	9	3	- -	1.4	7	0	0	11	48	0	0	0	125	200
WFGR02-01	7/30/08	2	MR-0-3-U	C3	C3	1.29	1.5	0-<2%	40.9	25.7	2.3	289.9	7.1	- -	- -	- -	- -	- -						70	0	0	0	200	200
WFGR02-01	7/30/08	3	MR-0-3-U	C3	C3	1.29	1.5	0-<2%	34.0	19.0	2.2	180.0	5.3	85	8	12	3	- -						30	0	0	0	125	200
WFGR02-01	7/30/08	4	MR-0-3-U	C3	C3	1.29	1.5	0-<2%	39.0	28.1	2.0	219.0	5.6	- -	- -	- -	- -	- -						58	0	0	3	- -	- -
WFGR02-01	7/30/08	5	MR-0-3-U	C3	C3	1.29	1.5	0-<2%	33.3	22.5	2.6	163.3	4.9	70	9	12	1	- -						50	13	0	3	200	200
WFGR01-04	7/30/08	1	MR-2-3-U	C3b	C3	1.10	2.0	2-<4%	40.7	33.7	2.4	>291.7	7.2	116	7	8	1	- -	- -	0	0	0	0	43	0	0	0	18	60
WFGR01-04	7/30/08	2	MR-2-3-U	C3b	C3	1.10	2.0	2-<4%	30.8	21.7	2.1	154.8	5.0	- -	- -	- -	- -	- -						68	5	0	0	11	28
WFGR01-04	7/30/08	3	MR-2-3-U	- -	C3	- -	- -	2-<4%	- -	- -	- -	- -	- -	87	13	13	15	- -						63	3	0	0	19	5
WFGR01-04	7/30/08	4	MR-2-3-U	C3b	C3	1.10	2.0	2-<4%	25.5	14.9	2.4	61.5	2.4	- -	- -	- -	- -	- -						55	0	0	0	50	33
WFGR01-04	7/30/08	5	MR-2-3-U	B3	C3	1.10	2.0	2-<4%	38.6	28.6	2.1	60.6	1.6	74	17	19	3	- -						80	0	0	0	55	13

Table G-3. Individual assessment reach data from 2008.

Reach ID	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Mean Residual Pool Depth	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	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
WFGR01-02	7/30/08	1	MR-2-3-U	C4b	C3b	1.21	2.4	2-<4%	29.5	18.5	2.0	>234.5	7.9	48	11	12	2	- -	1.4	4	1	2	13	38	10	0	35	18	>200
WFGR01-02	7/30/08	2	MR-2-3-U	C3/4b	C3b	1.21	2.4	2-<4%	27.6	17.2	2.2	>247.6	9.0	- -	- -	- -	- -	- -						55	3	0	50	43	>200
WFGR01-02	7/30/08	3	MR-2-3-U	C3b	C3b	1.21	2.4	2-<4%	34.3	27.5	2.0	98.3	2.9	67	5	9	6	- -						48	0	8	60	10	>200
WFGR01-02	7/30/08	4	MR-2-3-U	C3/4b	C3b	1.21	2.4	2-<4%	37.3	26.8	2.1	267.3	7.2	- -	- -	- -	- -	- -						45	8	5	53	88	>200
WFGR01-02	7/30/08	5	MR-2-3-U	C3b	C3b	1.21	2.4	2-<4%	43.3	35.0	1.7	149.3	3.4	93	3	5	1	- -						53	0	0	8	133	84
SFWF22-01	7/31/08	1	MR-0-3-U	- -	C4	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	2.1	11	15	10	106	5	15	0	80	10	>200
SFWF22-01	7/31/08	2	MR-0-3-U	C4	C4	1.76	<2%	0-<2%	45.0	23.2	3.3	356.0	7.9	52	7	8	1	- -						45	5	0	8	190	81
SFWF22-01	7/31/08	3	MR-0-3-U	- -	C4	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -						28	0	0	0	450	25
SFWF22-01	7/31/08	4	MR-0-3-U	C3	C4	- -	- -	0-<2%	- -	- -	- -	- -	- -	65	9	16	3	- -						20	8	0	0	256	144
SFWF22-01	7/31/08	5	MR-0-3-U	- -	C4	1.76	<2%	0-<2%	38.0	19.3	2.7	278.0	7.3	- -	- -	- -	- -	- -						0	0	0	33	200	200
SFWF28-01	7/31/08	1	MR-2-3-U	C3b	B3	1.10	2.1	2-<4%	45.0	26.1	3.3	123.0	2.7	95	3	5	10	- -	1.1	4	19	1	27	0	0	0	40	>200	>200
SFWF28-01	7/31/08	2	MR-2-3-U	B3	B3	1.10	2.1	2-<4%	52.2	28.8	2.2	87.2	1.7	- -	- -	- -	- -	- -						3	3	0	68	>200	>200
SFWF28-01	7/31/08	3	MR-2-3-U	B3	B3	1.10	2.1	2-<4%	49.0	27.2	2.4	77.0	1.6	118	2	3	2	55						3	8	0	93	>200	>200
SFWF28-01	7/31/08	4	MR-2-3-U	C3b	B3	1.10	2.1	2-<4%	40.0	22.3	2.6	93.0	2.3	- -	- -	- -	- -	- -						8	10	0	63	>200	>200
SFWF28-01	7/31/08	5	MR-2-3-U	C3b	B3	1.10	2.1	2-<4%	34.2	16.7	3.2	85.2	2.5	82	3	4	0	- -						0	5	0	78	>200	>200
WFGR03-03	8/1/08	1	MR-0-4-U	C3	B3c	1.01	1.5	0-<2%	47.2	22.9	2.8	242.2	5.1	85	10	10	2	- -	1.2	1	11	0	11	30	0	0	98	>200	99
WFGR03-03	8/1/08	2	MR-0-4-U	B3c	B3c	1.01	1.5	0-<2%	52.0	29.5	2.5	85.0	1.6	- -	- -	- -	- -	- -						33	0	0	95	>200	46
WFGR03-03	8/1/08	3	MR-0-4-U	B3c	B3c	1.01	1.5	0-<2%	47.0	22.5	2.8	77.0	1.6	92	10	11	3	- -						18	0	0	85	>200	17
WFGR03-03	8/1/08	4	MR-0-4-U	B3c	B3c	1.01	1.5	0-<2%	45.0	21.9	2.6	79.0	1.8	- -	- -	- -	- -	- -						23	0	0	95	>200	48
WFGR03-03	8/1/08	5	MR-0-4-U	F3	B3c	1.01	1.5	0-<2%	44.0	20.4	3.0	58.0	1.3	98	6	7	1	- -						43	0	0	98	>200	83
BEEH12-01	8/1/08	1	MR-2-1-U	F4	E4	1.47	1.2	2-<4%	23.3	38.0	1.4	25.3	1.1	40	6	14	7	- -	1.1	15	4	0	4	30	10	0	0	7	7
BEEH12-01	8/1/08	2	MR-2-1-U	B4c	E4	1.47	1.2	2-<4%	17.3	20.3	1.2	29.3	1.7	- -	- -	- -	- -	- -						15	30	0	3	12	8
BEEH12-01	8/1/08	3	MR-2-1-U	F4	E4	1.47	1.2	2-<4%	19.1	19.9	1.3	21.1	1.1	36	19	22	5	- -						25	28	0	0	4	5
BEEH12-01	8/1/08	4	MR-2-1-U	F4	E4	1.47	1.2	2-<4%	19.8	21.1	1.3	22.8	1.2	- -	- -	- -	- -	- -						25	5	0	0	7	8
BEEH12-01	8/1/08	5	MR-2-1-U	E4	E4	1.47	1.2	2-<4%	14.4	15.0	1.4	35.4	2.5	58	4	8	10	- -						40	30	0	0	5	13
SFWF29-02	8/4/08	1	MR-0-3-U	C3	C3	1.30	1.0	0-<2%	37.0	17.9	2.6	387.0	10.5	90	2	9	2	- -	2.0	4	21	1	36	58	0	0	38	>200	>200
SFWF29-02	8/4/08	2	MR-0-3-U	C3	C3	1.30	1.0	0-<2%	63.0	67.7	2.5	213.0	3.4	- -	- -	- -	- -	65						45	8	0	50	>200	>200
SFWF29-02	8/4/08	3	MR-0-3-U	C3	C3	1.30	1.0	0-<2%	56.0	43.9	2.5	158.0	2.8	107	5	6	2	69						45	0	0	80	>200	>200
SFWF29-02	8/4/08	4	MR-0-3-U	B3c	C3	1.30	1.0	0-<2%	49.0	29.9	2.7	109.0	2.2	- -	- -	- -	- -	76						33	0	0	90	>200	>200
SFWF29-02	8/4/08	5	MR-0-3-U	C3	C3	1.30	1.0	0-<2%	60.0	39.5	2.3	233.0	3.9	67	5	6	3	- -						48	0	0	38	>200	>200
MFWF02-01-2	8/4/08	1	MR-4-1-U	E4a	E4a	1.27	7.5	4-<10%	3.8	3.4	1.4	29.8	7.8	29	10	12	23	- -	0.5	56	188	2	198	0	0	0	75	>200	145
MFWF02-01-2	8/4/08	2	MR-4-1-U	E4a	E4a	1.27	7.5	4-<10%	4.7	4.7	1.4	72.7	15.5	- -	- -	- -	- -	- -						0	0	0	60	>200	>200
MFWF02-01-2	8/4/08	3	MR-4-1-U	E4a	E4a	1.27	7.5	4-<10%	6.5	8.1	1.2	50.5	7.8	30	9	9	16	- -						0	0	0	65	>200	>200
MFWF02-01-2	8/4/08	4	MR-4-1-U	B4a	E4a	1.27	7.5	4-<10%	8.4	19.0	0.6	19.4	2.3	- -	- -	- -	- -	- -						0	0	0	90	>200	>200
MFWF02-01-2	8/4/08	5	MR-4-1-U	B4a	E4a	1.27	7.5	4-<10%	9.0	18.8	0.7	13.8	1.5	33	10	14	5	- -						0	10	0	45	>100	>100

Table G-3. Individual assessment reach data from 2008.

Reach ID	Date	Cell	Reach Type	Existing Rosgen Stream Type	Potential Rosgen Stream Type	GIS Calculated Sinuosity	Field Slope (Percent)	Aerial Assessment Valley Gradient	Bankfull Channel Width	Width / Depth Ratio	Maximum Depth	Floodprone Width	Entrenchment Ratio	Riffle Pebble Count D50	Riffle Pebble Count Percent <2mm	Riffle Pebble Count Percent <6mm	Riffle Grid Toss Percent <6mm	Riffle Stability Index	Mean Residual Pool Depth	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	Percent Understory Shrub Cover	Percent Bare/Disturbed Ground	Percent Riprap	Percent Overstory Canopy Cover	Right Bank Mean Riparian Zone Width	Left Bank Mean Riparian Zone Width
BEEH13-01	8/5/08	1	MR-4-1-U	B3a	B3a	1.13	5.3	4-<10%	15.1	13.6	1.5	56.6	3.7	67	4	6	3	- -	1.1	23	94	3	153	0	0	0	65	83	>200
BEEH13-01	8/5/08	2	MR-4-1-U	B3a	B3a	1.13	5.3	4-<10%	13.9	12.9	1.3	39.4	2.8	- -	- -	- -	- -	- -						0	3	0	78	33	>158
BEEH13-01	8/5/08	3	MR-4-1-U	B3a	B3a	1.13	5.3	4-<10%	17.7	20.8	1.3	24.7	1.4	81	4	8	15	- -						0	10	0	43	>200	>170
BEEH13-01	8/5/08	4	MR-4-1-U	B3a	B3a	1.13	5.3	4-<10%	14.0	13.0	2.2	25.0	1.8	- -	- -	- -	- -	- -						0	10	0	65	>200	>200
BEEH13-01	8/5/08	5	MR-4-1-U	B3a	B3a	1.13	5.3	4-<10%	15.0	12.8	1.8	22.0	1.5	90	3	6	0	- -						0	25	0	53	>200	>200
NFWF10-01	8/5/08	1	MR-2-2-U	C4b	C4b	1.15	2.0	2-<4%	16.3	11.3	1.8	120.3	7.4	55	6	8	1	- -	1.1	20	75	12	169	0	0	0	80	>200	>200
NFWF10-01	8/5/08	2	MR-2-2-U	C4b	C4b	1.15	2.0	2-<4%	24.0	24.6	1.8	184.0	7.7	- -	- -	- -	- -	- -						0	0	0	65	>200	>200
NFWF10-01	8/5/08	3	MR-2-2-U	C4b	C4b	1.15	2.0	2-<4%	28.1	26.5	1.5	100.1	3.6	34	6	10	5	- -						0	8	0	70	>200	>200
NFWF10-01	8/5/08	4	MR-2-2-U	C4b	C4b	1.15	2.0	2-<4%	19.2	15.1	1.6	69.2	3.6	- -	- -	- -	- -	- -						0	0	0	58	>200	81
NFWF10-01	8/5/08	5	MR-2-2-U	C4b	C4b	1.15	2.0	2-<4%	22.2	20.8	1.9	97.2	4.4	75	3	5	4	- -						0	8	0	80	>125	>130

Table G-4. Pool data per assessment reach.

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Pool Grid Toss Percent <6mm	Spawning Gravels Identified
MFWF09-02	MR-2-3-U	1	1.7	- -	- -
MFWF09-02	MR-2-3-U	2	2.1	1	N
MFWF09-02	MR-2-3-U	3	1.7	4	Y
MFWF09-02	MR-2-3-U	4	2.1	10	N
MFWF09-02	MR-2-3-U	5	1.7	3	N
MFWF09-02	MR-2-3-U	6	1.7	7	Y
MFWF09-02	MR-2-3-U	7	2.1	1	Y
MFWF09-02	MR-2-3-U	8	2.5	1	N
MFWF09-02	MR-2-3-U	9	1.6	- -	- -
MFWF09-01	MR-2-3-U	1	2.3	2	N
MFWF09-01	MR-2-3-U	2	1.0	0	N
MFWF09-01	MR-2-3-U	3	1.4	0	N
MFWF09-01	MR-2-3-U	4	0.5	3	N
MFWF08-01	MR-2-2-U	1	1.9	6	Q
MFWF08-01	MR-2-2-U	2	1.6	5	N
MFWF08-01	MR-2-2-U	3	0.9	3	N
MFWF08-01	MR-2-2-U	4	1.2	2	N
MFWF08-01	MR-2-2-U	5	2.0	0	N
MFWF08-01	MR-2-2-U	6	0.6	1	Q
MFWF04-01	MR-4-1-C	1	1.3	8	Y
MFWF04-01	MR-4-1-C	2	1.1	- -	- -
MFWF04-01	MR-4-1-C	3	0.9	- -	- -
MFWF04-01	MR-4-1-C	4	1.1	4	Y
MFWF04-01	MR-4-1-C	5	0.9	- -	- -
MFWF04-01	MR-4-1-C	6	1.2	5	Y
MFWF04-01	MR-4-1-C	7	- -	- -	- -
MFWF04-01	MR-4-1-C	8	- -	- -	- -
MFWF04-01	MR-4-1-C	9	1.4	1	Y
MFWF02-01-1	MR-4-1-U	1	1.1	3	Y
MFWF02-01-1	MR-4-1-U	2	0.8	1	N
MFWF02-01-1	MR-4-1-U	3	- -	- -	- -
MFWF02-01-1	MR-4-1-U	4	- -	- -	- -
MFWF02-01-1	MR-4-1-U	5	- -	- -	- -
MFWF02-01-1	MR-4-1-U	6	0.6	12	Y
MFWF02-01-1	MR-4-1-U	7	- -	- -	- -
MFWF02-01-1	MR-4-1-U	8	- -	- -	- -
MFWF02-01-1	MR-4-1-U	9	0.7	29	Y
MFWF02-01-1	MR-4-1-U	10	0.6	39	Y

Table G-4. Pool data per assessment reach.

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Pool Grid Toss Percent <6mm	Spawning Gravels Identified
WFGR02-01	MR-0-3-U	1	1.8	5	Y
WFGR02-01	MR-0-3-U	2	1.6	- -	- -
WFGR02-01	MR-0-3-U	3	1.3	3	N
WFGR02-01	MR-0-3-U	4	1.0	- -	- -
WFGR02-01	MR-0-3-U	5	1.5	- -	- -
WFGR02-01	MR-0-3-U	6	1.1	1	N
WFGR02-01	MR-0-3-U	7	1.7	0	not indicated
WFGR01-04	MR-2-3-U	- -	- -	- -	- -
WFGR01-02	MR-2-3-U	1	- -	- -	- -
WFGR01-02	MR-2-3-U	2	1.1	0	Y
WFGR01-02	MR-2-3-U	3	- -	- -	- -
WFGR01-02	MR-2-3-U	4	1.6	- -	- -
SFWF22-01	MR-0-3-U	1	2.8	1	N
SFWF22-01	MR-0-3-U	2	1.7	0	Y
SFWF22-01	MR-0-3-U	3	1.2	- -	- -
SFWF22-01	MR-0-3-U	4	1.2	- -	- -
SFWF22-01	MR-0-3-U	5	2.2	- -	- -
SFWF22-01	MR-0-3-U	6	2.2	1	not indicated
SFWF22-01	MR-0-3-U	7	2.0	0	N
SFWF22-01	MR-0-3-U	8	1.9	0	Q
SFWF22-01	MR-0-3-U	9	4.2	- -	- -
SFWF22-01	MR-0-3-U	10	2.7	9	N
SFWF22-01	MR-0-3-U	11	1.2	5	N
SFWF28-01	MR-2-3-U	1	0.9	1	N
SFWF28-01	MR-2-3-U	2	0.5	1	Y
SFWF28-01	MR-2-3-U	3	0.6	1	N
SFWF28-01	MR-2-3-U	4	0.6	0	not indicated
SFWF28-01	MR-2-3-U	5	1.2	0	N
SFWF28-01	MR-2-3-U	6	0.8	2	not indicated
SFWF28-01	MR-2-3-U	7	2.6	- -	- -
SFWF28-01	MR-2-3-U	8	1.2	0	N
WFGR03-03	MR-0-4-U	1	1.2	1	N
WFGR03-03	MR-0-4-U	2	1.1	5	N
BEEH12-01	MR-2-1-U	1	0.8	4	Y
BEEH12-01	MR-2-1-U	2	0.5	9	Y
BEEH12-01	MR-2-1-U	3	1.1	- -	- -
BEEH12-01	MR-2-1-U	4	1.8	8	Y
BEEH12-01	MR-2-1-U	5	0.8	- -	- -
BEEH12-01	MR-2-1-U	6	1.6	4	Y
BEEH12-01	MR-2-1-U	7	0.8	- -	- -
BEEH12-01	MR-2-1-U	8	1.9	- -	- -
BEEH12-01	MR-2-1-U	9	0.8	- -	- -
BEEH12-01	MR-2-1-U	10	0.6	7	Y
BEEH12-01	MR-2-1-U	11	1.2	6	Y

Table G-4. Pool data per assessment reach.

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Pool Grid Toss Percent <6mm	Spawning Gravels Identified
BEEH12-01	MR-2-1-U	12	1.8	- -	- -
BEEH12-01	MR-2-1-U	13	0.9	- -	- -
BEEH12-01	MR-2-1-U	14	0.9	12	Y
BEEH12-01	MR-2-1-U	15	0.7	12	Y
SFWF29-02	MR-0-3-U	1	2.8	1	N
SFWF29-02	MR-0-3-U	2	1.4	1	N
SFWF29-02	MR-0-3-U	3	2.4	7	N
SFWF29-02	MR-0-3-U	4	2.4	3	Q
SFWF29-02	MR-0-3-U	5	1.4	1	N
SFWF29-02	MR-0-3-U	6	1.5	6	Q
SFWF29-02	MR-0-3-U	7	2.0	- -	- -
SFWF29-02	MR-0-3-U	8	1.8	0	N
MFWF02-01-2	MR-4-1-U	1	0.3	26	Y
MFWF02-01-2	MR-4-1-U	2	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	3	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	4	0.4	33	not indicated
MFWF02-01-2	MR-4-1-U	5	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	6	0.7	- -	- -
MFWF02-01-2	MR-4-1-U	7	0.6	7	Y
MFWF02-01-2	MR-4-1-U	8	0.4	1	Y
MFWF02-01-2	MR-4-1-U	9	0.5	- -	- -
MFWF02-01-2	MR-4-1-U	10	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	11	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	12	0.5	- -	- -
MFWF02-01-2	MR-4-1-U	13	0.8	12	Y
MFWF02-01-2	MR-4-1-U	14	0.6	7	Y
MFWF02-01-2	MR-4-1-U	15	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	16	1.0	- -	- -
MFWF02-01-2	MR-4-1-U	17	0.4	- -	- -
MFWF02-01-2	MR-4-1-U	18	0.6	- -	- -
MFWF02-01-2	MR-4-1-U	19	0.6	- -	- -
MFWF02-01-2	MR-4-1-U	20	0.7	6	Y
MFWF02-01-2	MR-4-1-U	21	0.4	33	Y
MFWF02-01-2	MR-4-1-U	22	- -	- -	- -
MFWF02-01-2	MR-4-1-U	23	0.5	- -	- -
MFWF02-01-2	MR-4-1-U	24	0.5	- -	- -
MFWF02-01-2	MR-4-1-U	25	0.4	3	Y
MFWF02-01-2	MR-4-1-U	26	0.9	2	Y
MFWF02-01-2	MR-4-1-U	27	1.2	- -	- -
MFWF02-01-2	MR-4-1-U	28	0.4	- -	- -
BEEH13-01	MR-4-1-U	1	1.4	1	Y
BEEH13-01	MR-4-1-U	2	1.7	1	Y
BEEH13-01	MR-4-1-U	3	0.9	1	Y
BEEH13-01	MR-4-1-U	4	- -	3	Y
BEEH13-01	MR-4-1-U	5	1.8	2	Y
BEEH13-01	MR-4-1-U	6	1.8	0	Y
BEEH13-01	MR-4-1-U	7	1.0	0	Y

Table G-4. Pool data per assessment reach.

Reach ID	Reach Type	Pool	Residual Depth (Feet)	Pool Grid Toss Percent <6mm	Spawning Gravels Identified
BEEH13-01	MR-4-1-U	8	1.3	0	Y
BEEH13-01	MR-4-1-U	9	- -	- -	- -
BEEH13-01	MR-4-1-U	10	2.4	3	Y
BEEH13-01	MR-4-1-U	11	1.7	5	Y
BEEH13-01	MR-4-1-U	12	0.4	- -	- -
BEEH13-01	MR-4-1-U	13	1.0	2	Y
BEEH13-01	MR-4-1-U	14	0.5	3	Y
BEEH13-01	MR-4-1-U	15	0.3	- -	- -
BEEH13-01	MR-4-1-U	16	0.6	- -	- -
BEEH13-01	MR-4-1-U	17	1.0	7	Y
BEEH13-01	MR-4-1-U	18	0.5	- -	- -
BEEH13-01	MR-4-1-U	19	1.0	- -	- -
BEEH13-01	MR-4-1-U	20	0.5	- -	- -
BEEH13-01	MR-4-1-U	21	1.1	3	Y
BEEH13-01	MR-4-1-U	22	1.0	1	N
BEEH13-01	MR-4-1-U	23	0.7	- -	- -
NFWF10-01	MR-2-2-U	1	0.6	8	Y
NFWF10-01	MR-2-2-U	2	1.0	3	N
NFWF10-01	MR-2-2-U	3	1.0	8	Q
NFWF10-01	MR-2-2-U	4	1.0	1	Y
NFWF10-01	MR-2-2-U	5	0.8	5	Y
NFWF10-01	MR-2-2-U	6	0.8	4	N
NFWF10-01	MR-2-2-U	7	1.3	1	Q
NFWF10-01	MR-2-2-U	8	- -	- -	- -
NFWF10-01	MR-2-2-U	9	1.6	12	Q
NFWF10-01	MR-2-2-U	10	1.6	0	Y
NFWF10-01	MR-2-2-U	11	1.0	1	N
NFWF10-01	MR-2-2-U	12	1.6	3	Y
NFWF10-01	MR-2-2-U	13	1.0	1	Y
NFWF10-01	MR-2-2-U	14	1.4	4	Y
NFWF10-01	MR-2-2-U	15	0.8	2	Y
NFWF10-01	MR-2-2-U	16	0.7	1	Y
NFWF10-01	MR-2-2-U	17	0.9	1	N
NFWF10-01	MR-2-2-U	18	1.2	3	Q
NFWF10-01	MR-2-2-U	19	1.2	4	Y
NFWF10-01	MR-2-2-U	20	- -	- -	- -

Y = Spawning Gravels Present
N = Spawning Gravels Absent
Q = Questionable Spawning Gravels

G4.0 REFERENCES

Bilby, R. and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118:368-378.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company, New York.

Meehan, W.R., ed. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. American Fisheries Society, Bethesda, MD. 751 p.

MT DEQ. 2008a. Longitudinal Field Methodology for the Assessment of Sediment and Habitat Impairments. Montana Department of Environmental Quality, Helena, Montana. http://bluewatertaskforce.org/documents/Sediment-Field-Methods_22.pdf

MT DEQ 2008b. Watershed Stratification Methodology for TMDL Sediment and Habitat Investigations. Montana Department of Environmental Quality, Helena, Montana.

PBS&J 2009a. Aerial Assessment Reach Stratification Upper Gallatin TMDL Planning Area. Montana Department of Environmental Quality, Helena, Montana. Available at: http://bluewatertaskforce.org/documents/2008-Aerial-Assessment_26.pdf

PBS&J 2009b. Streambank Erosion Source Assessment Upper Gallatin TMDL Planning Area. Montana Department of Environmental Quality, Helena, Montana.

Rosgen, D. L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Weaver, T. and Fraley, J., 1991. Fisheries Habitat and Fish Populations, Flathead Basin Forest Practices Water Quality and Fisheries Cooperative Program - Final Report. Flathead Basin Commission,Kalispell, MT. pp. 53- 68.

Wolman, M.G., 1954. A method of sampling coarse river-bed material: Trans. Am. Geophys. Union, v. 35, p. 951-956.