APPENDIX G
STREAMBANK EROSION SOURCE ASSESSMENT, UPPER JEFFERSON RIVER WATER QUALITY RESTORATION PLANNING AREA

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1.0 INTRODUCTION

This report presents an assessment of sediment loading due to streambank erosion along stream segments listed as impaired due to sediment in the Upper Jefferson TMDL Planning Areas (TPA). Sediment loads due to streambank erosion were calculated based on field data collected in 2005. Data collected in the field were extrapolated to the listed stream segments based on the Aerial Assessment Database compiled prior to field data collection. These data were also used to estimate sediment loading at the watershed scale and to assess the potential to decrease sediment inputs due to streambank erosion. The following reports provide further background information used in this assessment:

2004 Aerial Photo Review and Field Source Assessment (MDEQ 2004)

2005 Sediment and Stream Morphology Project, Upper Jefferson (MDEQ 2005)

Streambank Erosion Source Assessment, Middle and Lower Big Hole River Water Quality Restoration Planning Areas (MDEQ 2007)

1.1 Sediment Impairments

Eight segments were listed on the 1996 and 2004 303(d) List for sediment impairments including Big Pipestone, Dry Boulder, Fish, Fitz, Halfway, Hells Canyon, and Little Pipestone creeks along with the Jefferson River. On the 2006 303(d) List, Cherry, Fish, Fitz, Halfway, Hells Canyon, Little Pipestone, and Whitetail creeks, along with the Jefferson River were listed for sedimentation/siltation.

Sediment loading due to streambank erosion was assessed in the field at nineteen locations within the Upper Jefferson watershed. Assessments were performed on Big Pipestone, Cherry, Dry Boulder, Fish, Fitz, Halfway, Hells Canyon, Little Pipestone, and Whitetail creeks along with the Jefferson River.

2.0 DATA COLLECTION AND EXTRAPOLATION

Streambank erosion assessments were performed on 91 streambanks along 19 monitoring sections, a 900 or 20 times bankfull width, whichever is larger, section of a reach where detailed monitoring occurs that represents conditions along a stream reach, covering 10 stream segments, a 303d Listed segment, within the Upper Jefferson TPA. In general, one to three monitoring sections were assessed on each stream segment. Eroding streambank assessments were typically performed along a 900-foot monitoring section, though lengths varied from 630 feet on the smallest streams to approximately 2,500 feet on the Jefferson River. A total of 3.9 miles (20,580 feet) of stream were assessed. Monitoring section locations are presented in **Figure 2-1**.

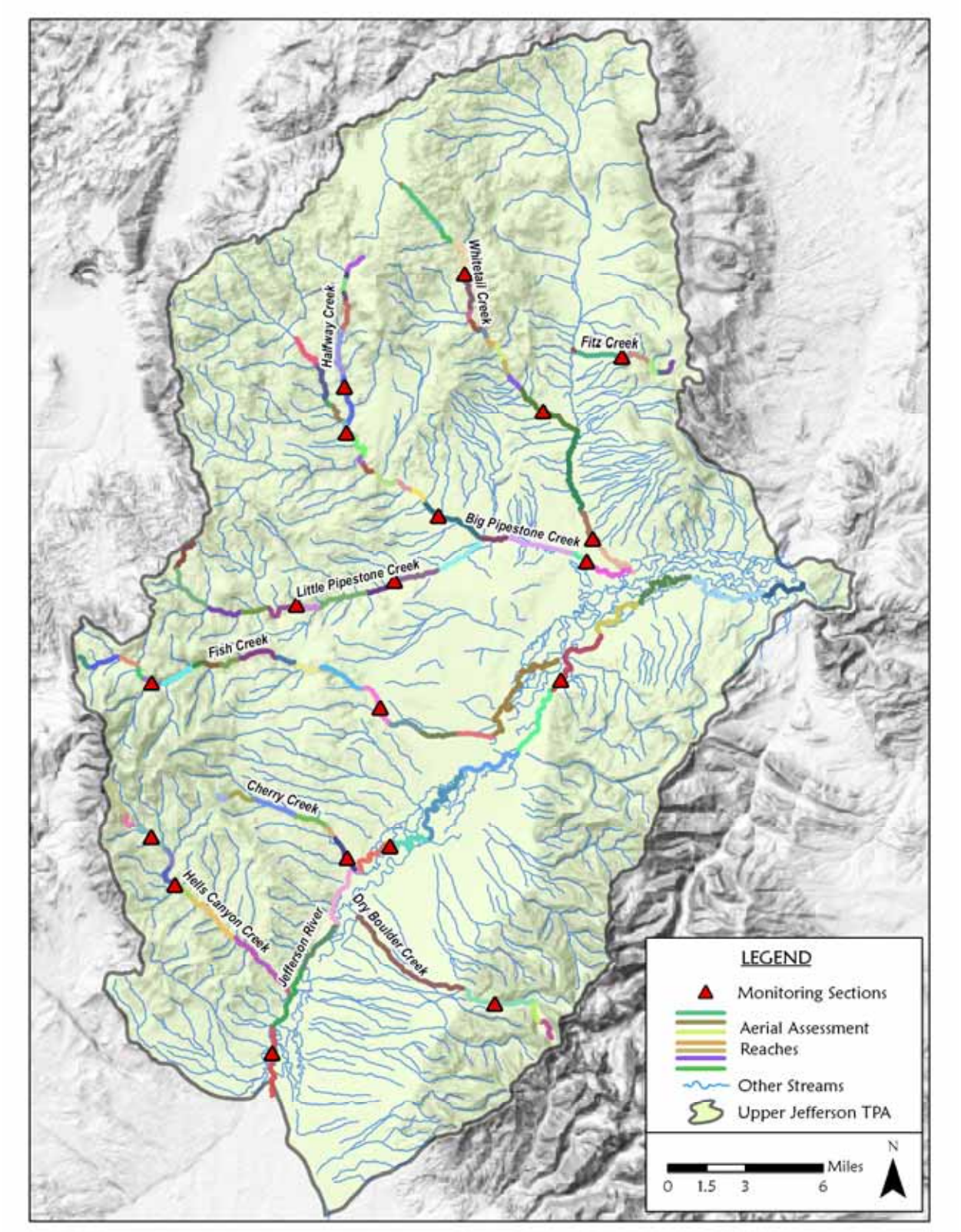

Figure 2-1. Monitoring Sections.

2.1 Field Data Collection

Streambank erosion was assessed by performing Bank Erosion Hazard Index (BEHI) measurements and evaluating the Near Bank Stress (NBS) (Rosgen 1996, 2004). The BEHI score was determined at each eroding streambank based on the following parameters: bank height, bankfull height, root depth, root density, bank angle and surface protection. BEHI categories range from "very low" to "extreme". At each eroding streambank, the NBS was determined by performing a channel cross-section measurement. The NBS is the ratio of the near-bank maximum bankfull depth (measured as the deepest point in the one-third of the channel closest to the bank) to the bankfull mean depth (Rosgen 2004). NBS categories range from "very low" to "extreme". The length, height, and composition of each eroding streambank were noted and the source of streambank instability was identified based on the following near-stream source categories:

- Transportation
- Riparian Grazing
- Cropland
- Mining
- Silviculture
- Irrigation-shifts in stream energy
- Natural Sources
- Other

The source of streambank erosion was evaluated based on observed anthropogenic disturbances and the surrounding land-use practices. For example, an eroding streambank in a heavily grazed area in which all the willows had been removed was assigned a source of "100 percent riparian grazing", while an eroding streambank due to road encroachment upstream was assigned a source of "100 percent transportation". Naturally eroding streambanks were considered the result of "natural sources". The "other" category was chosen when streambank erosion resulted from a source not described in the list. If multiple sources were observed, then a percent was noted for each source.

2.2 Estimating Sediment Loads from Field Data

The length of eroding streambank, mean height, and the annual retreat rate were used to determine the annual sediment input from eroding streambanks (in cubic feet). The length and mean height were measured in the field, while the annual retreat rate was determined based on the relationship between BEHI and NBS scores. Streambank retreat rates measured in the Lamar River in Yellowstone National Park (Rosgen 1996) were applied to streambanks in the Upper Jefferson TPA (**Table 2-1**). The annual sediment input in cubic feet was then converted into cubic yards (divided by 27 cubic feet per yard) and finally converted into tons per year based on the bulk density of the streambank to provide an annual sediment load.

Table 2-1. Annual Streambank Retreat Rates (Feet/Year) (adapted from Rosgen 1996).

		Near Bank Stress				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
BEHI	Low	0.019	0.042	0.089	0.19	
	Moderate	0.082	0.17	0.33	0.62	1.3
	High - Very High	0.29	0.44	0.7	1.1	1.7
	Extreme	0.6	0.83	1.3	1.7	2.3

2.3 Streambank Composition

Bulk density of streambanks in Upper Jefferson TPA was determined based on streambank composition data collected in the field and standard soil weights compiled by the U.S Department of the Interior (USDI 1998). Soil weights in the "well-graded" category were selected to most accurately reflect streambank composition, since "well-graded" suggests a wide array of size classes, which is likely what is found in nature. Based on data collected in the 19 monitoring sections, the average streambank composition was 78.95 percent "silt/sand" and 21.05 percent "gravel/cobbles". This composition most closely resembles the soil group described as "well-graded sand". Based on the minimum value of the USDI dry unit weight for "well-graded sand", a value of 107 pounds/foot^3 (1.44 tons/yard^3) was estimated as the average bulk density of streambank material (USDI 1998) (**Table 2-2**). The minimum value was selected to account for plant roots within the streambank that would decrease the overall soil density.

Table 2-2. Streambank Bulk Density (adapted from USDI 1998).

Sample Area	**Sample Size**	**Mean Composition**		**Soil Group**	**Minimum Dry Unit Weight (Pounds/ Foot3)**	**Minimum Dry Unit Weight (Tons/ Yard3)**
		Sand/ Silt (%)	**Gravel/ Cobbles (%)**			
Upper Jefferson Watershed	91	78.95	21.05	Well-graded sand	107	1.44

2.4 Data Extrapolation

Streambank erosion measured along 19 monitoring sections was extrapolated to the stream reach and stream segment scales based on the Aerial Assessment Database. In the field, monitoring sections were selected in areas that were representative of the overall stream condition at the stream reach scale. Sediment loads derived from the monitoring sections were extrapolated to the stream reach scale. Stream reaches were defined in the Aerial Assessment Database prior to field work through the use of GIS data layers and aerial imagery (2004 Aerial Photo Review and Field Source Assessment, MDEQ 2005). Sediment loads extrapolated to the stream reach scale were then summed to achieve an estimate of sediment input due to streambank erosion to each 303(d) listed stream segment. Sediment loading at the watershed scale and the potential to decrease streambank erosion were also estimated. The extrapolation process was outlined in the *Middle and Lower Big Hole TMDL Planning Area Sediment Monitoring Quality Assurance Project Plan* (MDEQ 2005.

3.0 SEDIMENT LOADING DUE TO STREAMBANK EROSION

3.1 Monitoring Section Sediment Loads

Eroding streambank assessments were performed along a total of 3.9 miles of stream in the Upper Jefferson TPA. A total sediment load of 742.4 tons/year was attributed to eroding streambanks within the monitoring sections. Sediment loads due to streambank erosion from these individual monitoring sections ranged from 0.4 tons/year in monitoring section "FITZ-04" to 306.3 tons/year in monitoring section "JEFF-06". A summary of eroding streambank conditions and sediment loading is presented in **Table 3-1**. Sediment loads calculated for each monitoring section were normalized to a length of 1000 feet for the purpose of comparison and extrapolation. Mean BEHI scores, length of eroding bank, percent of eroding bank, and stream type at the laser level cross-section are also presented for each monitoring section in **Table 3-1**.

At the monitoring section scale, 2.8 percent of the bank erosion load was attributed to transportation, 51.1 percent was attributed to riparian grazing, 2.1 percent was attributed to mining, 0.2 percent was attributed to silviculture, 3.3 percent was attributed to irrigation, 33.6 percent was attributed to natural sources, and 6.9 percent was attributed to "other". The "other" source category includes the impacts from reservoirs in the Upper Jefferson TPA. An overall sediment load from eroding streambanks of 438.12 tons/year (59 percent) was attributed to anthropogenic sources, while 304.28 tons/year (41 percent) was attributed to natural sources. Seventy-nine percent (347.2 tons/year) of the anthropogenically induced sediment load is due to streambank erosion on 5 of the monitoring sections (26 percent of the stream length assessed), while the remaining 14 monitoring sections accounted for 21 percent of the anthropogenically induced streambank sediment load. The 5 monitoring sections contributing 80 percent of the anthropogenically derived sediment load included: JEFF-01, JEFF-06, JEFF-10, LPST-09, and WHTL-16. Sediment loads due to streambank erosion for each monitoring section are provided for each source in **Table 3-2**. Note that Corral-1 and Delano-1, from the *Streambank Erosion Source Assessment, Middle and Lower Big Hole River Water Quality Restoration Planning Area*, both Rosgen-type A streams, were used as a reference for Rosgen-type A streams within the Upper Jefferson Water Quality Restoration Planning Area, and therefore, are included in the monitoring section tables.

Table 3-1. Estimated Monitoring Section Sediment Loads due to Streambank Erosion.

Stream	ReachID	Mean BEHI Score	Length of Eroding Bank (feet)	Reach Length (feet)	Percent of Reach with Eroding Bank	Sediment Loading from Monitoring Section (Tons/Year)	Sediment Loading from 1000' of Stream (Tons/Year)	Rosgen Stream Type at Laser Level Cross-section
Big Pipestone Creek	BPST-05	33.3	43	900	2.4%	3.0	6.9	B4
Big Pipestone Creek	BPST-12	64.7	254	900	14.1%	14.3	32.9	C4
Big Pipestone Creek	BPST-15	32.7	244	900	13.6%	22.2	24.7	C5
Cherry Creek	CHRY-06	30.9	52	850	3.1%	4.1	4.8	E5b
Dry Boulder Creek	DRYB-03	26.6	48	900	2.7%	1.5	1.7	B4a
Fish Creek	FISH-05	31.6	18	630	1.4%	1.4	2.2	B3
Fish Creek	FISH-14	32.4	176	900	9.8%	12.6	14.0	B4c
Fitz Creek	FITZ-04	36.1	6	900	0.3%	0.4	0.4	E4a
Halfway Creek	HLWY-07	41.8	129	900	7.2%	27.4	30.5	B4c
Hells Canyon Creek	HELC-03	31.4	151	900	8.4%	3.5	3.9	B4a
Hells Canyon Creek	HELC-06	43.7	13	900	0.7%	1.4	1.5	B4c
Jefferson River	JEFF-01	29.4	1734	1300	66.7%	182.4	140.3	D4 w/in DA4
Jefferson River	JEFF-06	39	2447	2500	48.9%	306.3	122.5	C4
Jefferson River	JEFF-10	33.2	783	900	43.5%	55.7	61.9	C4
Little Pipestone Creek	LPST-06	29.8	32	900	1.8%	3.6	4.0	B4a
Little Pipestone Creek	LPST-09	35.8	253	900	14.1%	55.2	61.0	E4
Whitetail Creek	WHTL-05	30.7	748	900	41.6%	14.8	16.4	B4c
Whitetail Creek	WHTL-14	30.9	230	900	12.8%	7.4	8.2	B4c
Whitetail Creek	WHTL-16	33.3	229	900	12.7%	25.2	27.9	F4
Delano 1 (Big Hole)	Delano 1	15.6	0	900	0.0%	0	0	A4
Corral 1 (Big Hole)	Corral 1	39.3	31	900	1.7%	1.6	1.8	A4

Table 3-2. Monitoring Section Sediment Loads from Individual Sources due to Streambank Erosion.

Stream	Stream Segment	Sources									Total Load
			Transportation	Riparian Grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural Sources	Other	
Big Pipestone Creek	BPST-05	Tons/Year	0.08	0.60	0.00	0.00	0.00	1.78	0.00	0.53	2.99
		Percent	3%	20%	0%	0%	0%	60%	0%	18%	
Big Pipestone Creek	BPST-12	Tons/Year	0.00	5.19	0.00	0.00	0.00	9.10	0.00	0.00	14.29
		Percent	0%	36%	0%	0%	0%	64%	0%	0%	
Big Pipestone Creek	BPST-15	Tons/Year	0.00	10.72	5.17	0.00	0.00	3.47	2.85	0.00	22.21
		Percent	0%	48%	23%	0%	0%	16%	13%	0%	
Cherry Creek	CHRY-06	Tons/Year	0.00	0.69	0.00	0.00	0.00	0.00	0.42	3.01	4.12
		Percent	0%	17%	0%	0%	0%	0%	10%	73%	
Dry Boulder Creek	DRYB-03	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	1.52	0.00	1.52
		Percent	0%	0%	0%	0%	0%	0%	100%	0%	
Fish Creek	FISH-05	Tons/Year	0.14	0.00	0.00	0.00	0.00	0.00	1.25	0.00	1.39
		Percent	10%	0%	0%	0%	0%	0%	90%	0%	
Fish Creek	FISH-14	Tons/Year	0.00	4.00	0.00	0.00	0.00	0.00	7.36	1.27	12.63
		Percent	0%	32%	0%	0%	0%	0%	58%	10%	
Fitz Creek	FITZ-04	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.37
		Percent	0%	0%	0%	0%	0%	0%	100%	0%	
Halfway Creek	HLWY-07	Tons/Year	0.00	17.32	0.00	0.00	0.00	0.00	6.91	3.19	27.42
		Percent	0%	63%	0%	0%	0%	0%	25%	12%	
Hells Canyon Creek	HELC-03	Tons/Year	0.00	3.38	0.00	0.00	0.00	0.00	0.15	0.00	3.53
		Percent	0%	96%	0%	0%	0%	0%	4%	0%	
Hells Canyon Creek	HELC-06	Tons/Year	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.55	1.37
		Percent	0%	60%	0%	0%	0%	0%	0%	40%	
Jefferson River	JEFF-01	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	159.96	22.41	182.37
		Percent	0%	0%	0%	0%	0%	0%	88%	12%	
Jefferson River	JEFF-06	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	86.01	220.32	306.33
		Percent	0%	0%	0%	0%	0%	0%	28%	72%	
Jefferson River	JEFF-10	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	20.31	35.42	55.73
		Percent	0%	0%	0%	0%	0%	0%	36%	64%	
Little Pipestone Creek	LPST-06	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00	3.58
		Percent	0%	0%	0%	0%	0%	0%	100%	0%	

Table 3-2. Monitoring Section Sediment Loads from Individual Sources due to Streambank Erosion.

Stream	Stream Segment	Sources								Total Load
			Transportation	Riparian Grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural Sources	Other	
Little Pipestone Creek	LPST-09	Tons/Year	0.00	2.18	0.00	0.00	0.00	0.00	10.11	42.94	55.23
		Percent	0%	4%	0%	0%	0%	0%	18%	78%	
Whitetail Creek	WHTL-05	Tons/Year	0.00	12.79	0.00	0.00	0.00	0.98	0.98	0.00	14.75
		Percent	0%	87%	0%	0%	0%	7%	7%	0%	
Whitetail Creek	WHTL-14	Tons/Year	0.00	5.10	0.00	0.00	0.00	1.04	1.28	0.00	7.42
		Percent	0%	69%	0%	0%	0%	14%	17%	0%	
Whitetail Creek	WHTL-16	Tons/Year	0.00	4.25	0.00	0.00	0.00	9.23	1.22	10.45	25.15
		Percent	0%	17%	0%	0%	0%	37%	5%	42%	
Delano 1 (Big Hole)	Delano 1	Tons/Year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Percent	0%	0%	0%	0%	0%	0%	100%	0%	
Corral 1 (Big Hole)	Corral 1	Tons/Year	0.00	0.00	0.00	0.00	0.81	0.00	0.81	0.00	1.62
		Percent	0%	0%	0%	0%	50%	0%	50%	0%	

3.2 Stream Reach Sediment Loads

Sediment loads calculated at the monitoring section scale were extrapolated to the aerial assessment stream reach and stream segment scales. The monitoring section sediment load was extrapolated directly to the stream reach in which it was located. Stream reaches in which no monitoring section was located were assigned a sediment load due to streambank erosion based on the most similar monitoring section. This decision was based on several factors including the existing and potential stream type, valley type, the surrounding landscape, land-use practices, information in the Aerial Assessment Database, a review of 2005 color aerial imagery in GIS, and best professional judgment based on site-specific knowledge acquired during the monitoring section assessment process.

Sources of sediment due to streambank erosion at the stream reach and stream segment scales were determined based on monitoring section data and the Aerial Assessment Database. Sources of streambank erosion at the monitoring section scale were assigned directly to the aerial assessment reach in which they occurred. Sources of sediment to stream reaches in which no monitoring section was located were evaluated using the Aerial Assessment Database, which included information for “prominent land use”, “indictors of potential degradation”, and “potential sources of potential degradation”. Additional information regarding these parameters can be found in the *2004 Aerial Photo Review and Field Source Assessment, Upper Jefferson Watershed* (MDEQ 2004) and the *2005 Sediment and Stream Morphology Project* (MDEQ 2006). A review of color aerial imagery from 2005 and on-the-ground knowledge gained during the assessment process were used as supporting information when assigning sediment sources.

For aerial assessment stream reaches in which no monitoring section was located, 10 to 100% of the sediment load was considered to be the result of natural sediment erosion, the percentage dependent upon anthropogenic sediment sources noted in the 2004 Aerial Assessment or visual sources located on the 2005 NAIP imagery used. Anthropogenic sediment loads along the non-monitored sections were estimated to be 5-20% for reaches with transporation associated sediment and determined by the location and concentration of the road system adjacent to the reach, 20-40% for grazing, cropland, and shifts in stream energy in which the percentage was developed based on the monitoring section values. Mining was given 30% based on the presence of mine features within the 2005 NAIP imagery and if a mine was noted in the 2004 Aerial Assessment, along with on the ground knowledge. This process was performed individually for each reach, with sediment loads assigned to each observed source based on the overall estimated reach load. Thus, sources of sediment in reaches with low overall sediment loads accounted for less of the total sediment load at the reach scale than sources of sediment in reaches with high sediment loads. When no anthropogenic sources were indicated in the aerial assessment database, 100% of the estimated sediment load was considered natural. Data extrapolated to the stream reach scale is presented in the Streambank Erosion Database in **Attachment A**. This database is an extension of the Aerial Assessment Database prepared prior to field data collection.

3.3 Stream Segment Sediment Loads

Sediment loads were extrapolated to 157.5 miles of listed stream segments based on stream reaches defined in the Aerial Assessment Database. Sediment loads extrapolated from the monitoring sections scale to the stream reaches scale were summed to obtain a sediment load for each stream segment (**Attachment A**). A total estimated sediment load of 28,795 tons/year was attributed to eroding streambanks on the assessed stream segments. Estimated sediment loads for 303(d) listed stream segments ranged from 28.9 tons/year or 1.52 tons/year per 1000 feet for Fitz Creek to 16,094 tons/year or 73.45 tons/year per 1000 feet for the Jefferson River. At the stream segment scale, 6.1% of the bank erosion was attributed to transportation, 11.0% was attributed to riparian grazing, 16.4% was attributed to cropland, 1.5% was attributed to mining, 18.9% was attributed to irrigation, 35.2% was attributed to natural sources and 10.9% was attributed to "other". An overall sediment load of 18,651.76 tons/year (64.8%) from eroding banks was attributed to anthropogenic sources, while 10,146.02 tons/year (35.2%) were attributed to natural sources. Sediment loads due to streambank erosion for each stream segment are provided for each source in **Table 3-3**.

Table 3-3. Stream Segment Sediment Loads from Individual Sources due to Streambank Erosion.

Stream Segment	Stream Segment Length (Miles)	Sediment Load	Sources								Total Load	Load per mile	Load per 1000 feet
			Transportation	Riparian Grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural Sources	Other			
Big Pipestone Creek	17.1	Tons/Year	188.74	638.22	247.04	21.15	0.00	685.80	344.56	35.16	2160.7	126.35	23.93
		Percent	8.74%	29.54%	11.43%	0.98%	0.00%	31.74%	15.95%	1.63%			
Cherry Creek	6.4	Tons/Year	2.71	26.45	0.00	0.00	0.00	27.02	54.64	0.00	110.8	17.32	3.28
		Percent	2.45%	23.87%	0.00%	0.00%	0.00%	24.38%	49.30%	0.00%			
Dry Boulder Creek	8.8	Tons/Year	2.43	12.90	0.00	1.14	0.00	12.90	48.79	0.00	78.2	8.88	1.68
		Percent	3.11%	16.50%	0.00%	1.46%	0.00%	16.50%	62.43%	0.00%			
Fish Creek	23.9	Tons/Year	154.89	317.81	136.97	3.14	0.00	233.53	678.81	15.32	1540.5	64.45	12.21
		Percent	10.05%	20.63%	8.89%	0.20%	0.00%	15.16%	44.07%	0.99%			
Fitz Creek	3.6	Tons/Year	1.56	6.40	0.00	0.00	0.00	3.58	17.34	0.00	28.9	8.03	1.52
		Percent	5.41%	22.17%	0.00%	0.00%	0.00%	12.38%	60.04%	0.00%			
Hells Canyon Creek	10.9	Tons/Year	2.93	34.78	0.00	0.00	0.00	6.99	65.54	3.07	113.3	10.39	1.97
		Percent	2.59%	30.70%	0.00%	0.00%	0.00%	6.17%	57.84%	2.71%			
Halfway Creek	7.4	Tons/Year	3.30	133.70	0.00	0.00	0.00	0.00	537.52	10.76	685.3	92.61	17.54
		Percent	0.48%	19.51%	0.00%	0.00%	0.00%	0.00%	78.44%	1.57%			
Jefferson River	41.5	Tons/Year	578.06	384.14	3356.42	400.72	0.00	3357.04	5671.36	2346.23	16094.0	387.81	73.45
		Percent	3.59%	2.39%	20.86%	2.49%	0.00%	20.86%	35.24%	14.58%			
Little Pipestone Creek	16.2	Tons/Year	548.44	711.52	504.19	0.00	0.00	374.96	1652.52	600.47	4392.1	271.12	51.35
		Percent	12.49%	16.20%	11.48%	0.00%	0.00%	8.54%	37.62%	13.67%			
Whitetail Creek	21.6	Tons/Year	270.92	894.83	481.08	0.00	0.00	736.21	1071.92	136.16	3591.1	166.26	31.49
		Percent	7.54%	24.92%	13.40%	0.00%	0.00%	20.50%	29.85%	3.79%			

3.4 Watershed Sediment Loads

Based on a modified version of the USGS National Hydrography Dataset (NHD) in which irrigation ditches were removed, there are 1,458.83 miles of stream in the Upper Jefferson TPA, (**Table 3-4**). Sediment loads due to eroding streambanks were calculated along 3.9 miles of monitoring section and extrapolated to 157.5 miles of listed stream segments, leaving 1301.3 miles of stream unassessed.

Sediment input along the 1,301.3 miles of unassessed streams was evaluated using the 25th percentile of sediment loading from the entire dataset. Based on the 25th percentile of the entire dataset at the stream segment scale, an annual sediment load of 12.1 tons/mile was estimated to be the natural background rate of streambank erosion within the Upper Jefferson TPA. This value is equivalent to 3.95 tons/year of sediment input from every 1000 feet of stream. The 25th percentile for streambank erosion at the monitoring section scale (1000 conversion) was also reviewed, resulting in a value of 2.5 tons/year. The use of the 25th percentile accounts for the likelihood of 1st order tributaries in the watershed contributing little or no sediment due to streambank erosion, while 2nd-4th order tributaries in the watershed likely contribute similar amounts of sediment due to streambank erosion as the assessed segments, from which a median sediment load of 14.87 tons/year per 1000 feet was measured. Thus, an annual background erosion rate of approximately 2-2.5 tons per 1000 feet of stream is thought to be appropriate for streams in the Upper Jefferson TPA. A total estimated sediment load of 44,576.3 tons/year was attributed to eroding streambanks within the Upper Jefferson TPA. Streambank erosion sediment loads and sources at the watershed scale for assessed stream segments are presented in **Table 3-5**.

Table 3-4. Summary of Sediment Loads due to Streambank Erosion at the Watershed Scale.

TMDL Planning Area	Stream Length (Miles)	Length of Stream Assessed using Aerial Imagery (Miles)	Length of Stream Unassessed (Miles)	Estimated Sediment Load for Assessed Streams	Estimated Sediment Load for Unassessed Streams based on Stream Segment Extrapolation (12.13 Tons/Mile/Year)	Total Sediment Load
Upper Jefferson	1458.83	157.5	1301.03	28,794.80	15,781.5	44,576.3

Table 3-5. Watershed Sediment Loads from Individual Sources due to Streambank Erosion.

Stream Segment	Total Stream Length with Watershed based on NHD (Miles)	Sediment Load	Sources								Total Load
			Transportation	Riparian Grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural Sources	Other	
Big Pipestone Creek	219.2	Tons/Year	961.37	1925.95	975.32	27.46	0.00	1377.19	3290.68	839.21	9,397.24
		Percent	0.10	0.20	0.10	0.00	0.00	0.15	0.35	0.09	
Cherry Creek	26.6	Tons/Year	8.71	84.88	0.00	0.00	0.00	86.70	175.32	0.00	355.60
		Percent	0.02	0.24	0.00	0.00	0.00	0.24	0.49	0.00	
Dry Boulder Creek	22.1	Tons/Year	7.46	39.51	0.00	3.49	0.00	39.51	149.49	0.00	239.45
		Percent	0.03	0.17	0.00	0.01	0.00	0.17	0.62	0.00	
Fish Creek	94.5	Tons/Year	240.82	494.12	212.96	4.88	0.00	363.08	1,055.41	23.82	2,395.09
		Percent	0.10	0.21	0.09	0.00	0.00	0.15	0.44	0.01	
Fitz Creek	7.8	Tons/Year	4.32	17.73	0.00	0.00	0.00	9.90	48.00	0.00	79.95
		Percent	0.05	0.22	0.00	0.00	0.00	0.12	0.60	0.00	
Hells Canyon Creek	61.6	Tons/Year	18.81	223.16	0.00	0.00	0.00	44.86	420.52	19.67	727.02
		Percent	0.03	0.31	0.00	0.00	0.00	0.06	0.58	0.03	
Halfway Creek	15.5	Tons/Year	3.77	152.80	0.00	0.00	0.00	0.00	614.30	12.30	783.17
		Percent	0.00	0.20	0.00	0.00	0.00	0.00	0.78	0.02	
Jefferson River	1458.8	Tons/Year	1,194.04	793.48	6,933.01	827.74	0.00	6,934.29	11,714.75	4,846.36	33,243.67
		Percent	0.04	0.02	0.21	0.02	0.00	0.21	0.35	0.15	
Little Pipestone Creek	81	Tons/Year	646.31	838.51	594.17	0.00	0.00	441.88	1,947.44	707.63	5,175.94
		Percent	0.12	0.16	0.11	0.00	0.00	0.09	0.38	0.14	
Whitetail Creek	272.2	Tons/Year	499.65	1,650.28	887.22	0.00	0.00	1,357.76	1,976.88	251.11	6,622.89
		Percent	0.08	0.25	0.13	0.00	0.00	0.21	0.30	0.04	

4.0 POTENTIAL SEDIMENT LOAD REDUCTION

This section is provided for technical guidance in determining sediment allocations for human influenced activities that cause streambank erosion. The results are only one of a number of components that will be considered during the TMDL sediment allocation process. The results are provided to determine a reasonable amount of sediment reduction to sources that influence streambank erosion. The allocation process will also consider economic feasibility of restoration from each significant source and regional BMP effectiveness studies. Determining a potential overall load reduction from streambank erosion also will help define how much sediment production from streambank erosion is likely derived from natural conditions.

4.1 Reference Condition

The Beaverhead-Deerlodge National Forest (BDNF) reference dataset indicates that a "moderate" BEHI score (20-29.5) can be expected on reference streams with the following stream types: A, C, (C3, C4) and E (E3, E4, E5, Ea) (**Table 4-1**) (Bengeyfield 2004). Streams classified as B stream types are on the border of the "moderate" and "high" (30.0-39.5) BEHI categories, with B3 streams falling in "moderate" category and B4 streams falling in the "high" category. Based on the BDNF reference dataset, it was determined that functioning streams in the Upper Jefferson TPA would tend to have a "moderate" BEHI score.

To estimate a potential decrease in sediment loading due to improved streambank stability, BEHI values in the existing dataset that exceeded the "moderate" category were reduced to "moderate". The results of this model are presented in **Table 4-2** for the individual monitoring sections. Reductions calculated at the monitoring section scale were extrapolated to the stream segment scale using the Aerial Assessment Database (**Table 4-3**). This reduction often resulted in a "moderate BEHI/low NBS" combination for an expected retreat rate of 0.17 tons/year. Through BMPs, the actual length and height of eroding bank could also be reduced, which would lead to further reductions in sediment loading.

Table 4-1. Expected BEHI Values for Various Stream Types based on the BDNF Reference Dataset.

A	B3	B4	B	C3	C4	C	E3	E4	E5	Ea	E
24.2	27.1	31.7	29.7	26.9	26.5	26.5	26.3	24.2	22	22.7	23.6

Table 4-2. Monitoring Section Sediment Loads with BEHI Reduced to "Moderate".

Stream	ReachID	Sediment Loading from Monitoring Section (Tons/Year)	Sediment Loading from 1000' of Stream (Tons/Year)	Sediment Loading from Monitoring Section with Moderate BEHI (Tons/Year)	Sediment Loading from 1000' of Stream with Moderate BEHI (Tons/Year)
Big Pipestone Creek	BPST-05	2.99	6.89	1.55	1.72
Big Pipestone Creek	BPST-12	14.29	32.92	4.72	5.24
Big Pipestone Creek	BPST-15	22.21	24.67	11.33	12.59
Cherry Creek	CHRY-06	4.11	4.84	2.29	2.69
Dry Boulder Creek	DRYB-03	1.52	1.68	1.32	1.47
Fish Creek	FISH-05	1.39	2.21	0.54	0.86
Fish Creek	FISH-14	12.63	14.03	5.85	6.50
Fitz Creek	FITZ-04	0.37	0.41	0.37	0.41
Halfway Creek	HLWY-07	27.41	30.46	6.17	6.86
Hells Canyon Creek	HELC-03	3.53	3.92	1.00	1.11
Hells Canyon Creek	HELC-06	1.37	1.53	0.53	0.59
Jefferson River	JEFF-01	182.37	140.29	109.03	83.87
Jefferson River	JEFF-06	306.33	122.53	109.36	43.74
Jefferson River	JEFF-10	55.73	61.92	15.76	17.51
Little Pipestone Creek	LPST-06	3.58	3.98	1.69	1.88
Little Pipestone Creek	LPST-09	55.23	61.01	22.68	25.20
Whitetail Creek	WHTL-05	14.75	16.39	7.71	8.57
Whitetail Creek	WHTL-14	7.42	8.25	4.77	5.30
Whitetail Creek	WHTL-16	25.15	27.95	12.29	13.66
Delano 1 (Big Hole)	Delano 1	0.00	0.00	0.00	0.00
Corral 1 (Big Hole)	Corral 1	1.61	1.79	0.62	0.69

Table 4-3. Potential Sediment Load Reduction from Stream Segments with BEHI Reduced to "Moderate".

Stream Segment	Total Load (Tons/ Year)	Total Load with "Moderate " BEHI (Tons/ Year)	Total Load due to Anthropogenic Sources (Tons/Year)	Total Load with "Moderate" BEHI due to Anthropogenic Sources (Tons/Year)	Potential Reduction in Anthropogenic Sediment Load with "Moderate" BEHI (Tons/Year)	Percent Reduction in Anthropogenic Sediment Load with "Moderate" BEHI
Big Pipestone Creek	2160.66	707.59	1816.10	603.4	1212.7	67%
Cherry Creek	110.82	40.63	56.18	18.7	37.5	67%
Dry Boulder Creek	78.16	68.39	29.37	25.7	3.7	13%
Fish Creek	1540.47	710.59	861.66	398.4	463.3	54%
Fitz Creek	25.50	20.29	10.19	9.3	0.9	9%
Hells Canyon Creek	113.30	39.72	47.77	15.9	31.9	67%
Halfway Creek	221.57	215.81	87.79	69.1	18.7	21%
Jefferson River	16093.98	7890.10	10422.61	4984.7	5437.9	52%
Little Pipestone Creek	4392.10	1555.22	2739.58	1080.0	1659.6	61%
Whitetail Creek	3591.12	1532.28	2519.20	1085.8	1433.4	57%

5.0 REFERENCES

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ATTACHMENT A
STREAMBANK EROSION DATABASE, UPPER JEFFERSON RIVER TMDL PLANNING AREA

Stream	Reach	Sinuosity	Valley Slope	Channel Slope	Rosgen Classification	Most Similar Stream Section used for Modeling Sediment Loading (Monitoring Sections in Bold)	Sediment Load due to Bank Erosion per 1000 Feet (Tons/ Year)	Sediment Load due to Bank Erosion per Mile (Tons/ Year)	Aerial Assessment Reach Length (Miles)	Sediment Load due to Bank Erosion for Entire Aerial Assessment	Sediment Source (Percent)								Sediment Load by Sediment Source (Tons/Year)							
											Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other	Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other
Big Pipestone Creek	BPST-01	1.29	0.064	0.05	C	BPST-05	6.89	36.38	1.35	49.22	5%						65%	30%	2.46	0.00	0.00	0.00	0.00	0.00	31.99	14.76
Big Pipestone Creek	BPST-02	1.16	0.068	0.059	B	BPST-05	6.89	36.38	1.17	42.70	5%			30%			65%		2.13	0.00	0.00	12.81	0.00	0.00	27.75	0.00
Big Pipestone Creek	BPST-03	1.3	0.023	0.018	C	BPST-05	6.89	36.38	0.32	11.61							100%		0.00	0.00	0.00	0.00	0.00	0.00	11.61	0.00
Big Pipestone Creek	BPST-04	1.35	0.059	0.044	B	BPST-05	6.89	36.38	0.76	27.79				30%			70%		0.00	0.00	0.00	8.34	0.00	0.00	19.45	0.00
Big Pipestone Creek	BPST-05	1.35	0.028	0.021	B4	BPST-05	6.89	36.38	0.69	25.27	2%	20%				60%		18%	0.51	5.05	0.00	0.00	0.00	15.16	0.00	4.55
Big Pipestone Creek	BPST-06	1.67	0.064	0.038	B	BPST-05	6.89	36.38	0.95	34.69							100%		0.00	0.00	0.00	0.00	0.00	0.00	34.69	0.00
Big Pipestone Creek	BPST-07	1.42	0.04	0.028	C	BPST-12	32.92	173.82	0.30	52.97							100%		0.00	0.00	0.00	0.00	0.00	0.00	52.97	0.00
Big Pipestone Creek	BPST-08	1.16	0.079	0.068	B	BPST-05	6.89	36.38	0.29	10.68	10%						90%		1.07	0.00	0.00	0.00	0.00	0.00	9.61	0.00
Big Pipestone Creek	BPST-09	1.17	0.025	0.021	C	BPST-12	32.92	173.82	1.05	183.20	10%	35%				40%	15%		18.32	64.12	0.00	0.00	0.00	73.28	27.48	0.00
Big Pipestone Creek	BPST-10	1.23	0.01	0.008	C	BPST-12	32.92	173.82	0.69	119.80	15%	30%	20%			25%	10%		17.97	35.94	23.96	0.00	0.00	29.95	11.98	0.00
Big Pipestone Creek	BPST-11	1.35	0.008	0.006	E	LPST-09	61.01	322.13	0.77	248.31	15%	30%	20%			25%	10%		37.25	74.49	49.66	0.00	0.00	62.08	24.83	0.00
Big Pipestone Creek	BPST-12	1.27	0.008	0.006	C4	BPST-12	32.92	173.82	2.91	505.65		36%				64%			0.00	182.03	0.00	0.00	0.00	323.62	0.00	0.00
Big Pipestone Creek	BPST-13	1.33	0.005	0.004	F	WHTL-16	27.95	147.58	1.08	159.51	15%	30%	20%			25%	10%		23.93	47.85	31.90	0.00	0.00	39.88	15.95	0.00
Big Pipestone Creek	BPST-14	1.07	0.005	0.005	F	WHTL-16	27.95	147.58	2.26	333.00	15%	30%	20%			25%	10%		49.95	99.90	66.60	0.00	0.00	83.25	33.30	0.00
Big Pipestone Creek	BPST-15	1.23	0.004	0.003	C5	BPST-15	24.67	130.26	0.94	121.92		48%	23%				16%	13%	0.00	58.52	28.04	0.00	0.00	0.00	19.51	15.85
Big Pipestone Creek	BPST-16	1.25	0.004	0.003	F	WHTL-16	27.95	147.58	1.59	234.36	15%	30%	20%			25%	10%		35.15	70.31	46.87	0.00	0.00	58.59	23.44	0.00
Cherry Creek	CHRY-01	1.02	0.297	0.291	A+	Corral-1 (Big Hole)	1.79	9.45	0.51	4.77							100%		0.00	0.00	0.00	0.00	0.00	0.00	4.77	0.00
Cherry Creek	CHRY-02	1.04	0.139	0.134	A	Delano-1 (Big Hole)	0.00	0.00	1.08	0.00	10%						90%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cherry Creek	CHRY-03	1.15	0.075	0.065	B	HELC-03	3.92	20.70	1.76	36.33		33%				33%	34%		0.00	11.99	0.00	0.00	0.00	11.99	12.35	0.00
Cherry Creek	CHRY-04	1.12	0.068	0.061	B	HELC-03	3.92	20.70	1.31	27.13	10%					40%	50%		2.71	0.00	0.00	0.00	0.00	10.85	13.57	0.00
Cherry Creek	CHRY-05	1.14	0.043	0.038	B	HELC-06	3.92	20.70	0.50	10.44		40%				40%	20%		0.00	4.18	0.00	0.00	0.00	4.18	2.09	0.00
Cherry Creek	CHRY-06	1.09	0.05	0.046	E5b	CHRY-06	4.84	25.56	1.26	32.14		32%					68%		0.00	10.29	0.00	0.00	0.00	0.00	21.86	0.00
Dry Boulder	DRYB-01	1.13	0.15	0.133	C	DRYB-03	1.68	8.87	0.64	5.69	5%			20%			75%		0.28	0.00	0.00	1.14	0.00	0.00	4.27	0.00
Dry Boulder	DRYB-02	1.19	0.107	0.09	B	DRYB-03	1.68	8.87	0.88	7.84							100%		0.00	0.00	0.00	0.00	0.00	0.00	7.84	0.00
Dry Boulder	DRYB-03	1.05	0.166	0.158	B4a	DRYB-03	1.68	8.87	2.44	21.64							100%		0.00	0.00	0.00	0.00	0.00	0.00	21.64	0.00
Dry Boulder	DRYB-04	1.07	0.063	0.059	B	DRYB-03	1.68	8.87	4.85	42.99	5%	30%				30%	35%		2.15	12.90	0.00	0.00	0.00	12.90	15.05	0.00
Fish Creek	FISH-01	1.1	0.139	0.126	A+	Corral-1 (Big Hole)	1.79	9.45	0.59	5.60	5%			20%			75%		0.28	0.00	0.00	1.12	0.00	0.00	4.20	0.00
Fish Creek	FISH-02	1.08	0.068	0.063	G	FISH-05	2.21	11.67	0.97	11.26	15%						85%		1.69	0.00	0.00	0.00	0.00	0.00	9.57	0.00
Fish Creek	FISH-03	1.11	0.037	0.033	G	FISH-05	2.21	11.67	0.65	7.59	15%	20%					65%		1.14	1.52	0.00	0.00	0.00	0.00	4.93	0.00
Fish Creek	FISH-04	1.11	0.075	0.068	B	FISH-05	2.21	11.67	0.43	5.04	20%	20%		40%			20%		1.01	1.01	0.00	2.02	0.00	0.00	1.01	0.00
Fish Creek	FISH-05	1.07	0.114	0.107	B3	FISH-05	2.21	11.67	0.67	7.76	10%						90%		0.78	0.00	0.00	0.00	0.00	0.00	6.99	0.00
Fish Creek	FISH-06	1.16	0.034	0.029	C	FISH-14	14.03	74.08	1.29	95.81	15%	20%					65%		14.37	19.16	0.00	0.00	0.00	0.00	62.28	0.00
Fish Creek	FISH-07	1.06	0.036	0.034	B	FISH-05	2.21	11.67	0.36	4.24	10%						90%		0.42	0.00	0.00	0.00	0.00	0.00	3.81	0.00
Fish Creek	FISH-08	1.16	0.044	0.038	C	FISH-14	14.03	74.08	0.63	46.59	10%						90%		4.66	0.00	0.00	0.00	0.00	0.00	41.93	0.00
Fish Creek	FISH-09	1.09	0.032	0.029	B	FISH-14	14.03	74.08	0.71	52.26							100%		0.00	0.00	0.00	0.00	0.00	0.00	52.26	0.00
Fish Creek	FISH-10	1.12	0.037	0.033	C	FISH-14	14.03	74.08	1.35	99.96	10%	30%					60%		10.00	29.99	0.00	0.00	0.00	0.00	59.98	0.00
Fish Creek	FISH-11	1.06	0.053	0.005	B	FISH-14	14.03	74.08	0.49	36.52							100%		0.00	0.00	0.00	0.00	0.00	0.00	36.52	0.00
Fish Creek	FISH-12	1.22	0.032	0.026	C	FISH-14	14.03	74.08	1.23	91.46	15%	20%	20%			25%	20%		13.72	18.29	18.29	0.00	0.00	22.87	18.29	0.00
Fish Creek	FISH-13	1.09	0.037	0.034	B	FISH-14	14.03	74.08	1.75	129.43							100%		0.00	0.00	0.00	0.00	0.00	0.00	129.43	0.00

Stream	Reach	Sinuosity	Valley Slope	Channel Slope	Rosgen Classification	Most Similar Stream Section used for Modeling Sediment Loading (Monitoring Sections in Bold)	Sediment Load due to Bank Erosion per 1000 Feet (Tons/ Year)	Sediment Load due to Bank Erosion per Mile (Tons/ Year)	Aerial Assessment Reach Length (Miles)	Sediment Load due to Bank Erosion for Entire Aerial Assessment	Sediment Source (Percent)								Sediment Load by Sediment Source (Tons/Year)							
											Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other	Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other
Fish Creek	FISH-14	1.19	0.021	0.018	B4c	FISH-14	14.03	74.08	2.07	153.22		32%					58%	10%	0.00	49.03	0.00	0.00	0.00	0.00	88.87	15.32
Fish Creek	FISH-15	1.27	0.022	0.017	C	FISH-14	14.03	74.08	1.27	93.89	15%	20%	20%			25%	20%		14.08	18.78	18.78	0.00	0.00	23.47	18.78	0.00
Fish Creek	FISH-16	1.11	0.032	0.029	C	FISH-14	14.03	74.08	1.50	111.24		40%				40%	20%		0.00	44.50	0.00	0.00	0.00	44.50	22.25	0.00
Fish Creek	FISH-17	1.09	0.008	0.007	G	FISH-14	14.03	74.08	1.20	89.08	20%	40%				20%	20%		17.82	35.63	0.00	0.00	0.00	17.82	17.82	0.00
Fish Creek	FISH-18	not classified in AA				FISH-14	14.03	74.08	6.74	499.51	15%	20%	20%			25%	20%		74.93	99.90	99.90	0.00	0.00	124.88	99.90	0.00
Fitz Creek	FITZ-01	1.04	0.178	0.171	A+	Corral-1 (Big Hole)	1.79	9.45	0.37	3.46		10%					90%		0.00	0.35	0.00	0.00	0.00	0.00	3.12	0.00
Fitz Creek	FITZ-02	1.05	0.198	0.189	A+	Corral-1 (Big Hole)	1.79	9.45	0.44	4.18							100%		0.00	0.00	0.00	0.00	0.00	0.00	4.18	0.00
Fitz Creek	FITZ-03	1.08	0.087	0.081	Ba	DRYB-03	1.68	8.87	0.39	3.43		40%					60%		0.00	1.37	0.00	0.00	0.00	0.00	2.06	0.00
Fitz Creek	FITZ-04	1.14	0.127	0.111	E4a	FITZ-04	0.41	2.16	1.01	2.19							100%		0.00	0.00	0.00	0.00	0.00	0.00	2.19	0.00
Fitz Creek	FITZ-05	1.05	0.062	0.059	B	DRYB-03	1.68	8.87	1.34	11.92	10%	30%				30%	30%		1.19	3.58	0.00	0.00	0.00	3.58	3.58	0.00
Fitz Creek	FITZ-06	not classified in AA				FISH-14	14.03	74.08	0.05	3.70	10%	30%					60%		0.37	1.11	0.00	0.00	0.00	0.00	2.22	0.00
Hells Canyon Creek	HELC-01	1.08	0.262	0.243	A+	Corral-1 (Big Hole)	1.79	9.45	1.22	11.54							100%		0.00	0.00	0.00	0.00	0.00	0.00	11.54	0.00
Hells Canyon Creek	HELC-2	1.16	0.095	0.082	B	HELC-03	3.92	20.70	0.64	13.14							100%		0.00	0.00	0.00	0.00	0.00	0.00	13.14	0.00
Hells Canyon Creek	HELC-03	1.05	0.106	0.101	B4a	HELC-03	3.92	20.70	1.24	25.57		96%					4%		0.00	24.55	0.00	0.00	0.00	0.00	1.02	0.00
Hells Canyon Creek	HELC-04	1.13	0.047	0.042	C	HELC-06	1.53	8.08	0.96	7.79	20%	30%					50%		1.56	2.34	0.00	0.00	0.00	0.00	3.90	0.00
Hells Canyon Creek	HELC-05	1.08	0.063	0.058	B	HELC-06	1.53	8.08	0.85	6.86	20%	30%					50%		1.37	2.06	0.00	0.00	0.00	0.00	3.43	0.00
Hells Canyon Creek	HELC-06	1.11	0.048	0.043	B4c	HELC-06	1.53	8.08	0.95	7.66		60%						40%	0.00	4.60	0.00	0.00	0.00	0.00	0.00	3.07
Hells Canyon Creek	HELC-07	1.05	0.056	0.053	B	HELC-06	1.53	8.08	2.16	17.42							100%		0.00	0.00	0.00	0.00	0.00	0.00	17.42	0.00
Hells Canyon Creek	HELC-08	1.11	0.063	0.057	B	HELC-06	1.53	8.08	2.38	19.19						30%	70%		0.00	0.00	0.00	0.00	0.00	5.76	13.43	0.00
Hells Canyon Creek	HELC-09	1.2	0.027	0.023	B	HELC-06	1.53	8.08	0.51	4.11		30%				30%	40%		0.00	1.23	0.00	0.00	0.00	1.23	1.64	0.00
Halfway Creek	HFWY-01		0.011		E	CHRY-06	4.84	25.56	1.00	25.56	10%						90%		2.56	0.00	0.00	0.00	0.00	0.00	23.00	0.00
Halfway Creek	HFWY-02	1.22	0.044	0.036	E	CHRY-06	4.84	25.56	0.29	7.42	10%						90%		0.74	0.00	0.00	0.00	0.00	0.00	6.68	0.00
Halfway Creek	HFWY-03	1.05	0.118	0.112	A+	Corral-1 (Big Hole)	1.79	9.45	0.46	4.37							100%		0.00	0.00	0.00	0.00	0.00	0.00	4.37	0.00
Halfway Creek	HFWY-04	1.13	0.101	0.089	E	CHRY-06	4.84	25.56	0.42	10.80							100%		0.00	0.00	0.00	0.00	0.00	0.00	10.80	0.00
Halfway Creek	HFWY-05	1.17	0.177	0.151	B	HFWY-07	30.46	160.83	1.00	161.41							100%		0.00	0.00	0.00	0.00	0.00	0.00	161.41	0.00
Halfway Creek	HFWY-06	1.31	0.062	0.047	B	HFWY-07	30.46	160.83	2.40	386.05		20%					80%		0.00	77.21	0.00	0.00	0.00	0.00	308.84	0.00
Halfway Creek	HFWY-07	1.35	0.05	0.037	B4c	HFWY-07	9.25	48.84	1.84	89.67		63%					25%	12%	0.00	56.49	0.00	0.00	0.00	0.00	22.42	10.76
Jefferson River	JEFF-01	1.1	0.003	0.003	D4	JEFF-01	140.29	740.73	2.92	2161.87							88%	12%	0.00	0.00	0.00	0.00	0.00	0.00	1902.44	259.42
Jefferson River	JEFF-02	1.09	0.002	0.002	D	JEFF-01	140.29	740.73	2.61	1933.06	15%		25%			30%	30%		289.96	0.00	483.26	0.00	0.00	579.92	579.92	0.00
Jefferson River	JEFF-03	1.05	0.003	0.003	D	JEFF-01	140.29	740.73	2.46	1825.87			40%			40%	20%		0.00	0.00	730.35	0.00	0.00	730.35	365.17	0.00
Jefferson River	JEFF-04	1.23	0.002	0.002	D	JEFF-01	140.29	740.73	2.70	2003.62			30%	20%		30%	20%		0.00	0.00	601.09	400.72	0.00	601.09	400.72	0.00
Jefferson River	JEFF-05	1.36	0.003	0.002	Da	JEFF-01	140.29	740.73	1.91	1414.40									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson River	JEFF-06	1.62	0.003	0.002	C4	JEFF-06	122.53	646.96	2.83	1828.64							28%	72%	0.00	0.00	0.00	0.00	0.00	0.00	512.02	1316.62
Jefferson River	JEFF-07	1.55	0.002	0.001	Da	JEFF-01	140.29	740.73	4.58	3395.02									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson River	JEFF-08	1.2	0.003	0.003	C	JEFF-06	122.53	646.96	2.67	1728.65									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stream	Reach	Sinuosity	Valley Slope	Channel Slope	Rosgen Classification	Most Similar Stream Section used for Modeling Sediment Loading (Monitoring Sections in Bold)	Sediment Load due to Bank Erosion per 1000 Feet (Tons/ Year)	Sediment Load due to Bank Erosion per Mile (Tons/ Year)	Aerial Assessment Reach Length (Miles)	Sediment Load due to Bank Erosion for Entire Aerial Assessment	Sediment Source (Percent)								Sediment Load by Sediment Source (Tons/Year)							
											Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other	Transportation	Riparian grazing	Cropland	Mining	Silviculture	Irrigation - shifts in stream energy	Natural sources	Other
Jefferson River	JEFF-09	1.15	0.002	0.002	Da	JEFF-01	140.29	740.73	3.25	2404.29									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jefferson River	JEFF-10	1.31	0.002	0.002	C4	JEFF-10	61.92	326.94	3.68	1203.42							36%	64%	0.00	0.00	0.00	0.00	0.00	0.00	433.23	770.19
Jefferson River	JEFF-11	1.48	0.002	0.001	C	JEFF-10	61.92	326.94	2.98	973.57			33%			33%	34%		0.00	0.00	321.28	0.00	0.00	321.28	331.01	0.00
Jefferson River	JEFF-12	1.46	0.003	0.002	Da	JEFF-01	140.29	740.73	3.03	2243.24			33%			33%	34%		0.00	0.00	740.27	0.00	0.00	740.27	762.70	0.00
Jefferson River	JEFF-13	1.29	0.001	0.001	C	JEFF-10	61.92	326.94	3.76	1228.86	15%	20%	25%			20%	20%		184.33	245.77	307.22	0.00	0.00	245.77	245.77	0.00
Jefferson River	JEFF-14	1.34	0.002	0.001	C	JEFF-10	61.92	326.94	2.12	691.83	15%	20%	25%			20%	20%		103.77	138.37	172.96	0.00	0.00	138.37	138.37	0.00
Little Pipestone Creek	LPST-01	not classified in AA			Ea	LPST-09	61.01	322.13	1.45	467.04		20%				20%	60%		0.00	93.41	0.00	0.00	0.00	93.41	280.22	0.00
Little Pipestone Creek	LPST-02	not classified in AA			B	LPST-06	3.98	21.01	2.13	44.77	20%						80%		8.95	0.00	0.00	0.00	0.00	0.00	35.81	0.00
Little Pipestone Creek	LPST-03	not classified in AA			B	LPST-06	3.98	21.01	1.42	29.83	20%					30%	50%		5.97	0.00	0.00	0.00	0.00	8.95	14.92	0.00
Little Pipestone Creek	LPST-04	1.12	0.04	0.036	E	LPST-09	61.01	322.13	1.08	347.92	20%	20%	20%			20%	20%		69.58	69.58	69.58	0.00	0.00	69.58	69.58	0.00
Little Pipestone Creek	LPST-05	1.04	0.043	0.041	E	LPST-09	61.01	322.13	1.27	409.48	20%	20%	20%			20%	20%		81.90	81.90	81.90	0.00	0.00	81.90	81.90	0.00
Little Pipestone Creek	LPST-06	1.06	0.071	0.067	B4a	LPST-06	3.98	21.01	1.29	27.08							100%		0.00	0.00	0.00	0.00	0.00	0.00	27.08	0.00
Little Pipestone Creek	LPST-07	1.08	0.03	0.028	E	LPST-09	61.01	322.13	1.88	605.62	20%	20%	20%			20%	20%		121.12	121.12	121.12	0.00	0.00	121.12	121.12	0.00
Little Pipestone Creek	LPST-08	1.08	0.011	0.01	E	LPST-09	61.01	322.13	0.86	277.12	20%	30%					50%		55.42	83.14	0.00	0.00	0.00	0.00	138.56	0.00
Little Pipestone Creek	LPST-09	1.32	0.021	0.016	E4	LPST-09	61.01	322.13	2.39	769.83		4%					18%	78%	0.00	30.79	0.00	0.00	0.00	0.00	138.57	600.47
Little Pipestone Creek	LPST-10	1.1	0.008	0.007	F	LPST-09	61.01	322.13	2.40	771.94	10%	30%	30%				30%		77.19	231.58	231.58	0.00	0.00	0.00	231.58	0.00
Whitetail Creek	WHTL-01	1.44	0.004	0.003	C	WHTL-05	16.39	86.54	0.30	26.24							50%	50%	0.00	0.00	0.00	0.00	0.00	0.00	13.12	13.12
Whitetail Creek	WHTL-02	1.05	0.115	0.11	A	Delano-1 (Big Hole)	0.00	0.00	1.69	0.00							100%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Whitetail Creek	WHTL-03	1.25	0.027	0.022	C	WHTL-05	16.39	86.54	0.31	26.85							100%		0.00	0.00	0.00	0.00	0.00	0.00	26.85	0.00
Whitetail Creek	WHTL-04	1.13	0.09	0.08	B	WHTL-05	16.39	86.54	0.69	59.92							100%		0.00	0.00	0.00	0.00	0.00	0.00	59.92	0.00
Whitetail Creek	WHTL-05	1.32	0.047	0.036	B4c	WHTL-05	16.39	86.54	1.70	146.77		87%				7%	7%		0.00	127.69	0.00	0.00	0.00	10.27	10.27	0.00
Whitetail Creek	wHTL-06	1.23	0.059	0.048	B	WHTL-05	16.39	86.54	1.27	110.11							100%		0.00	0.00	0.00	0.00	0.00	0.00	110.11	0.00
Whitetail Creek	WHTL-07	1.29	0.035	0.027	C	WHTL-05	16.39	86.54	0.35	30.06							100%		0.00	0.00	0.00	0.00	0.00	0.00	30.06	0.00
Whitetail Creek	WHTL-08	1.26	0.037	0.029	B	WHTL-05	16.39	86.54	0.55	47.48							100%		0.00	0.00	0.00	0.00	0.00	0.00	47.48	0.00
Whitetail Creek	WHTL-09	1.13	0.015	0.013	B	WHTL-05	16.39	86.54	0.35	29.96	10%						90%		3.00	0.00	0.00	0.00	0.00	0.00	26.96	0.00
Whitetail Creek	WHTL-10	1.14	0.067	0.059	B	WHTL-05	16.39	86.54	0.37	31.96	10%						90%		3.20	0.00	0.00	0.00	0.00	0.00	28.76	0.00
Whitetail Creek	WHTL-11	1.29	0.024	0.019	C	BPST-12	32.92	173.82	0.70	121.51	10%						90%		12.15	0.00	0.00	0.00	0.00	0.00	109.36	0.00
Whitetail Creek	WHTL-12	1.12	0.036	0.032	B	WHTL-14	8.25	43.56	0.56	24.30							100%		0.00	0.00	0.00	0.00	0.00	0.00	24.30	0.00
Whitetail Creek	WHTL-13	1.16	0.036	0.031	C	BPST-12	32.92	173.82	0.69	120.42	10%	30%					60%		12.04	36.13	0.00	0.00	0.00	0.00	72.25	0.00
Whitetail Creek	WHTL-14	1.22	0.021	0.017	B4c	WHTL-14	8.25	43.56	2.66	115.75		69%				14%	17%		0.00	79.87	0.00	0.00	0.00	16.20	19.68	0.00
Whitetail Creek	WHTL-15	1.81	0.009	0.005	E	LPST-09	61.01	322.13	4.69	1509.20	10%	25%	20%			25%	20%		150.92	377.30	301.84	0.00	0.00	377.30	301.84	0.00
Whitetail Creek	WHTL-16	1.63	0.009	0.006	F4	WHTL-16	27.95	147.58	1.99	292.94		17%				37%	4%	42%	0.00	49.80	0.00	0.00	0.00	108.39	11.72	123.04
Whitetail Creek	WHTL-17	1.82	0.003	0.002	E	LPST-09	61.01	322.13	2.78	896.18	10%	25%	20%			25%	20%		89.62	224.04	179.24	0.00	0.00	224.04	179.24	0.00