APPENDIX E – STREAMBANK EROSION SOURCE ASSESSMENT – BEAVERHEAD TPA

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E1.0 INTRODUCTION

This appendix includes a summary of the field protocols and results from sediment loading due to streambank erosion along several stream segments in the Beaverhead TMDL Planning Area (TPA). It is an excerpt from the Analysis of Base Parameter Data and Erosion Inventory Data for Sediment TMDL Development within the Beaverhead TPA (Watershed Consulting, Inc., unpublished 2011), which is on file at the DEQ. Sediment loads due to streambank erosion were calculated based on field data collected in 2010/2011. Streambank erosion assessments were conducted over two monitoring timeframes, with 28 monitoring sites assessed during September 2011 and 1 monitoring site assessed during April 2011. Streambank erosion data collected at field monitoring sites was extrapolated to the stream reach and stream segment scales based on information in the Aerial Assessment Database, which was compiled in GIS prior to field data collection. Streambank erosion data collected in the field was also used to estimate sediment loading at the watershed scale and to assess the potential to decrease sediment inputs due to streambank erosion.

E1.1 SEDIMENT IMPAIRMENTS

In the Beaverhead TPA, seventeen stream segments are listed on the 2010 303(d) List for sediment impairments including: the Beaverhead River (lower segment), Blacktail Deer Creek, Clark Canyon Creek, Dyce Creek, Farlin Creek, French Creek, Rattlesnake Creek (upper and lower segments), Reservoir Creek, Scudder Creek, Spring Creek, Steel Creek, Stone Creek (upper and lower segments), Taylor Creek, West Fork Blacktail Deer Creek, and West Fork Dyce Creek.

E2.0 METHODS

Streambank erosion data were collected at 29 monitoring sites in the Beaverhead TPA. At each of the sites, eroding streambanks were assessed for erosion severity and categorized as either “actively/visually eroding” or “slowly eroding/vegetated/undercut.” **Bank Erosion Hazard Index (BEHI)** measurements were performed and **Near Bank Stress (NBS)** was evaluated at each eroding bank (Rosgen, 1996; Rosgen, 2006). Bank erosion severity was rated from “very low” to “extreme” based on the BEHI score, which was determined based on the following six variables: bank height, bankfull height, root depth, root density, bank angle, and surface protection. Near Bank Stress was also rated from “very low” to “extreme” depending on the shape of the channel at the toe of the bank and the force of the water (i.e. “stream power”) along the bank. In addition, the source, or underlying cause, of streambank erosion was evaluated based on observed anthropogenic disturbances within the riparian corridor, as well as current and historic land-use practices observed within the surrounding landscape. Source of streambank instability was identified based on the following near-stream source categories: natural, historic, residential/urban, irrigation, timber, mining, cropland and “other,” for sources not included in the other categories. Sources of erosion in the “historic” or “other” categories included historic mining activities, historic beaver removal, and channel straightening in the Beaverhead TPA. Natural sources of streambank erosion included natural channel scour or wildlife trails. If multiple sources were observed, then a percent of the total influence was estimated for each source.

Streambank erosion data collected at **monitoring sites** were extrapolated to the **stream reach**, **stream segment**, and **sub-watershed** scales based on similar reach type characteristics as identified in the Aerial

Assessment Database. Sediment load calculations were performed for monitoring sites, stream reaches, stream segments, and sub-watersheds which are distinguished as follows:

Monitoring Site	*- A 500, 1000, or 2000 foot section of a stream reach where field monitoring was conducted*
Stream Reach	*-Subdivision of the stream segment based on ecoregion, stream order, gradient and confinement as evaluated in GIS*
Stream Segment	*-assessed segment*
Sub-watershed	*-assessed segment and tributary streams based on 1:100,000 NHD data layer*

The annual sediment load was estimated for each assessed bank based on the streambank length, mean height, and the annual retreat rate for each eroding streambank. The length and mean height were measured in the field, while the annual retreat rate was determined based on the relationship between the BEHI and NBS ratings. Annual retreat rates for the Beaverhead TPA were estimated based on retreat rates from the Lamar River in Yellowstone National Park (Rosgen, 1996) (**Table E-1**). The annual sediment load in cubic feet was then calculated from the field data (annual retreat rate x mean bank height x bank length), converted into cubic yards, and finally converted into tons per year based on the bulk density of streambank material, which was assumed to average 1.3 tons/yard^3 as identified in *Watershed Assessment of River Stability and Sediment Supply* (WARSSS) (Rosgen, 2006; United States Environmental Protection Agency, 2006). This process resulted in a sediment load for each eroding bank expressed in tons per year.

Table E-1. Annual Streambank Retreat Rates (Feet/Year), Lamar River, Yellowstone National Park (adapted from Rosgen 1996).

BEHI	Near Bank Stress					
	very low	low	moderate	high	very high	extreme
very Low	0.002	0.004	0.009	0.021	0.050	0.12
low	0.02	0.04	0.10	0.24	0.57	1.37
moderate	0.10	0.17	0.28	0.47	0.79	1.33
high - very high	0.37	0.53	0.76	1.09	1.57	2.26
extreme	0.98	1.21	1.49	1.83	2.25	2.76

E2.1 Streambank Erosion Sediment Load Extrapolation Method

Monitoring site sediment loads were extrapolated to the stream reach, stream segment and sub-watershed scales based on the aerial assessment reach type analysis and field-verified reach types for assessment sites. Streambank erosion data were extrapolated using the following procedure:

1. Monitoring site sediment loads were extrapolated directly to the stream reach in which the monitoring site was located, based on total loading per 1000/ft.

2. Existing streambank erosion sediment loads were extrapolated to unassesed reaches based on average sediment loading/1000 ft from assessed sites for each reach type. Field data were collected within ten individual reach types that were delineated by confinement, stream order and gradient. Un-assessed reach types were assigned loads from the most applicable and appropriate assessed reach type based on similarities with stream slope, stream order, and best professional judgment **(Table E-2)**.

Table E-2. Measured Reach Types and Average Sediment Loads Applied to Unassessed Reach Types

Measured Reach Type	Number of Monitoring Sites	Measured Reach Type Avg. Sediment Load/1000 ft (tons/yr)	Unassessed Reach Types
MR-2-1-U	1	22.9	MR-2-1-U, MR-2-1-C
MR-4-1-U	2	19.3	MR-4-1-U, MR-4-1-C, MR-10-1-C, MR-10-1-U
MR-0-2-U	7	75.6	MR-0-2-U, MR-0-2-C, MR-0-1-U
MR-2-2-C	1	27.6	MR-2-2-C, MR-2-3-C
MR-2-2-U	5	39.8	MR-2-2-U, MR-2-3-U
MR-4-2-U	1	31.2	MR-4-2-U, MR-4-2-C, MR-10-2-C, MR-10-2-U, MR-4-3-C, MR-4-3-U, MR-10-3-C
MR-0-3-U	2	19.8	MR-0-3-U
MR-0-4-U	2	20.1	MR-0-4-U, MR-0-4-C, MR-2-4-C
MR-0-5-U	3	34.7	MR-0-5-U
MR-0-7-U	5	82.9	MR-0-7-U, MR-0-7-C

E2.2 Streambank Erosion Sediment Load Reduction Analysis Methods

The narrative water quality standards that apply to sediment relate to the naturally occurring condition, which is defined as conditions that occur if all reasonable land, soil, and water conservation practices are applied. To assist with TMDL development, the streambank erosion assessment includes an estimation of sediment loading reductions that could be achieved if implementation of Best Management Practices (BMPs) were applied to achieve naturally occurring condition. Streambank erosion sediment load reductions were evaluated based on field collected data and streambank erosion sources identified in the Aerial Assessment Database through the following process:

1. Anthropogenic activities that remove streamside vegetation or alter channel form tend to de-stabilize streambanks and increase the amount of active streambank erosion. The sediment assessment includes estimating the extent of bank erosion from human and natural influences on a given reach.

2. Therefore, for each reach, a reduction in sediment load can be considered using the proportion of the sediment load attributable to various influences, and the corresponding potential load decrease can be the reduction from existing loading to the load under naturally occurring conditions.

3. To account for uncertainty and allow for reasonable land use, the load reduction calculation entails reducing the human load by 75% for all human loading that is less than 50% of the total load and 100% of the human load above 50%. This approach recognizes that erosion is inevitable and allowable under naturally occurring conditions as defined above.

   As an example of the reduction calculation, in the case of a reach with 100% of the load attributable to human loading, the reduced load would be 12.5% of the total:
   Reduced load = Total load - (((Total load*0.5)*1) + ((Total load* 0.5)*0.75))

   In the case of a reach with less than 50% of the load attributable to human loading, the following calculation was used:
   Reduced load = Total load - ((Total load* % anthropogenic load)*0.75)

4. Because they are assumed to be achieving the naturally occurring condition, no sediment load reductions were applied to reaches with >70% natural sources of erosion. In addition, no load reduction was applied to the natural load in reaches with >70% natural sources.

5. No sediment load reductions were applied to unassessed tributaries of the assessed stream segments.

E3.0 Streambank Erosion Results

E3.1 Streambank Erosion Sediment Load Extrapolation

A total annual sediment load of 1,416.5 tons/year was attributed to the 259 assessed eroding streambanks within the 29 sites monitored for streambank erosion in the Beaverhead TPA. Average annual sediment loads for each monitoring site were normalized to a length of 1,000 feet for the purpose of comparison and extrapolation. Sediment loads per 1000 feet are presented in **Table E-3** for each monitoring site. Sediment loads per 1,000 feet ranged from 2.5 tons/yr at site TAYL 27-01 to 427.1 tons/yr at site SPRG 31-01. **Table E-3** also lists monitoring sites for each reach type, with load totals by reach and reach type.

Table E-3. Loads for Assessment Sites and Reach Types

Reach Type	Site ID	% Natural Erosion	% Anthro. Erosion	SedLoad per 1000 ft (tons/yr)	Assessed Site Bank Erosion Sediment Load
MR-2-1-U	SCUD 11-01	0	100	22.9	11.4
MR-4-1-U	WFDY 17-01	13.3	86.7	15.1	11.9
	STEL 05-01	0	100	23.55	11.8
	Avg/Total	**6.7**	**93.4**	**19.3**	**23.7**
MR -0-2-U	CLKC 32-01	54.2	45.8	33.2	16.6
	DYCE 02-02	0.0	100.0	6.2	3.1
	SPRG 31-01	0.0	100.0	427.1	213.5
	DYCE 02-02	0.0	100.0	6.2	3.1
	STON 20-02	9.6	90.4	16.0	8.0
	STON 22-02	10.0	90.0	3.4	3.4
	STON 22-02B	20.0	80.0	7.7	3.9
	TAYL 32-01	51.9	48.1	35.6	17.8
	Avg/Total	**18.2**	**81.8**	**66.9**	**269.4**
MR-2-2-C	FREN 23-01	60.0	40.0	27.6	13.8
MR-2-2-U	CLKC 19-02	33.3	66.7	95.7	47.9
	FARL 28-01	0.0	100.0	44.9	22.5
	RESR 11-01	51.0	49.0	4.9	2.5
	STON 05-01	11.8	93.6	51.2	25.6
	TAYL 27-01	45.0	55.0	2.5	1.2
	Avg/Total	**28.2**	**72.9**	**39.8**	**99.7**
MR-4-2-U	CLKC 18-02	61.3	38.8	31.2	15.6
MR-0-3-U	RATT 54-04	21.2	78.8	27.6	27.6
	WFBK 08-04	30.4	69.6	11.9	11.9
	Avg/Total	**25.8**	**74.2**	**19.8**	**39.5**

Table E-3. Loads for Assessment Sites and Reach Types

Reach Type	Site ID	% Natural Erosion	% Anthro. Erosion	SedLoad per 1000 ft (tons/yr)	Assessed Site Bank Erosion Sediment Load
MR-0-4-U	GRAS 12-01	27.3	72.7	22.0	22.0
	GRAS 20-11	75.7	24.3	18.1	18.1
	Avg/Total	**51.5**	**48.5**	**20.1**	**40.1**
MR-0-5-U	BLKD 02-08	80.0	20.0	50.1	50.1
	BLKD 02-14	43.3	56.7	28.4	28.4
	BLKD 02-30	59.5	40.5	25.6	25.6
	Avg/Total	**60.9**	**39.1**	**34.7**	**104.1**
MR-0-7-U	BEAV 09-04	0.0	100.0	6.8	10.2
	BEAV 09-06	32.5	67.5	316.8	633.5
	BEAV 09-11	82.0	18.0	37.1	55.6
	BEAV 09-14	48.3	51.7	5.9	11.8
	BEAV 09-15	56.7	43.3	47.8	95.6
	Avg/Total	**43.9**	**56.1**	**82.9**	**806.7**

Field-based assessments identified dominant land uses affecting each eroding bank and included estimating the proportion of sediment loading due to natural and various anthropogenic sources. Historic uses (including historic clearing, mining, grazing, and trapping) and current riparian grazing are the greatest anthropogenic contributors of sediment loads due to streambank erosion for most assessed sites in the Beaverhead TPA (**Figure E-1**). Irrigation is a major contributor to Stone Creek but is not a primary source throughout the TPA.

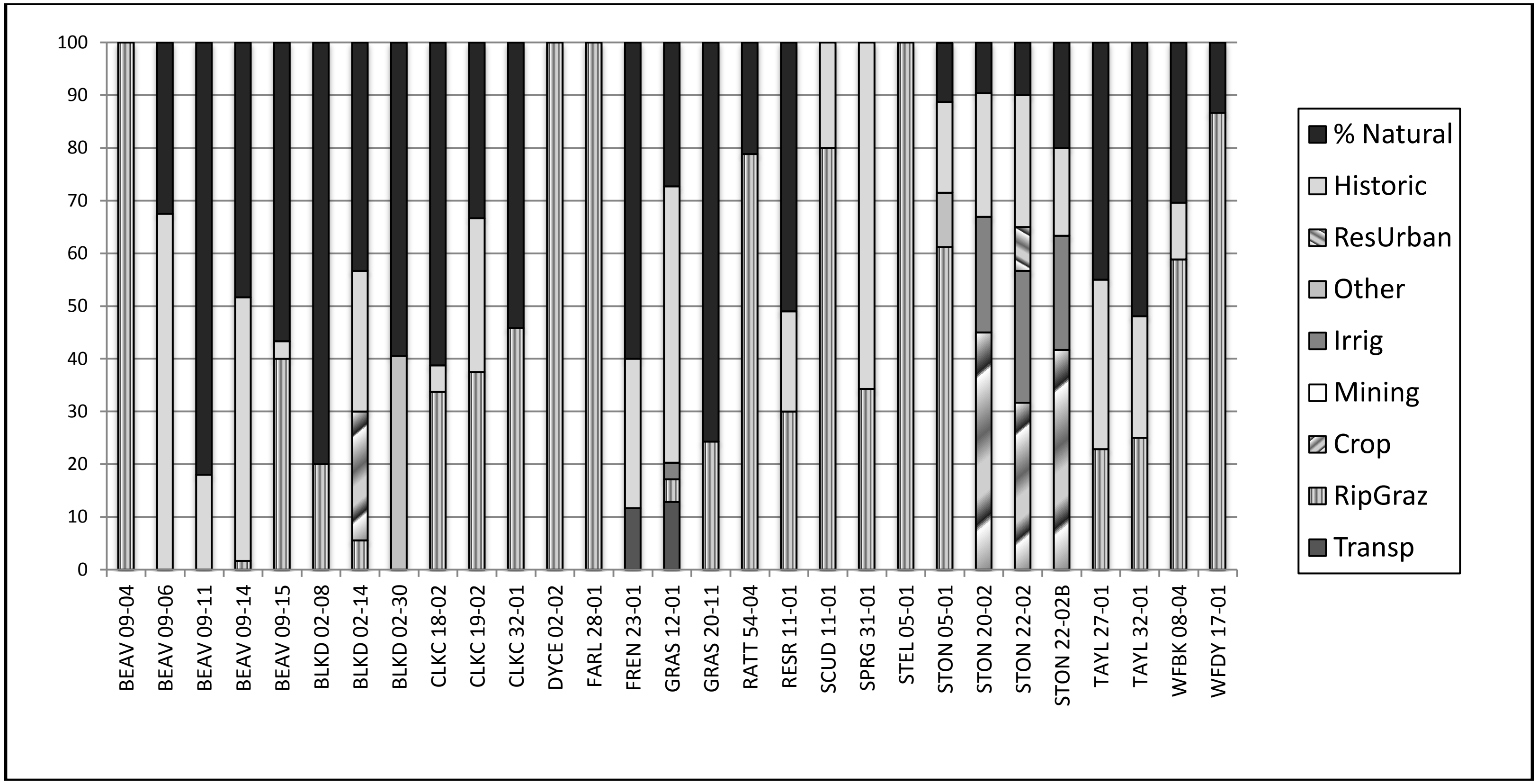

Figure E-1. Streambank Erosion Sources by Reach

Sources of sediment loading are likely to affect different reach types in different ways due to variations in stream energy and landscape controls on access to the stream. For example, low gradient, large streams typically occur in open valley bottoms affected by grazing and agricultural production, whereas higher in the watersheds, erosion is often influenced by roads, timber harvest, or historic mining, as well as riparian grazing where side slopes allow access to the stream.

Sediment loads from assessed sites were averaged by reach type to facilitate sediment load extrapolation to assessed segments and subbasins.

E3.1.1 Load Reductions by Reach Type

As described above, reductions for unassessed reach types are estimated based on erosion rates from assessed reach types, following the reach type groupings listed in **Table E-2**. Extrapolated average streambank erosion sediment load reductions for all reach types on assessed streams in the Beaverhead TPA are presented in **Table E-4**.

Table E-4. Reach Type Streambank Sediment Load Reductions with BMPs

Reach Type	Total Load (tons/yr)	Target Load (tons/yr)	Reduction (tons/yr)	% Reduction
MR-0-1-U	190.25	71.95	118.31	45.00
MR-0-2-C	382.53	176.72	205.81	53.50
MR-0-2-U	10608.69	2998.01	7610.68	65.66
MR-0-3-U	6567.9	2591.2	3976.7	60.5
MR-0-4-C	652.6	229.6	423.0	64.8
MR-0-4-U	2515.1	847.0	1668.1	66.3
MR-0-5-U	6208.3	2313.8	3894.5	62.7
MR-0-7-C	303.9	144.3	159.6	52.5
MR-0-7-U	32251.2	7888.2	24363.0	75.5
MR-10-1-C	316.4	193.6	122.8	38.8
MR-10-1-U	174.8	132.3	42.5	24.3
MR-10-2-C	108.1	74.6	33.5	31.0
MR-10-2-U	54.6	54.6	0.0	0.0
MR-10-3-C	13.9	13.9	0.0	0.0
MR-2-1-C	225.6	72.1	153.5	68.0
MR-2-1-U	466.9	168.9	298.0	63.8
MR-2-2-C	1271.8	614.8	657.0	51.7
MR-2-2-U	3369.59	1341.80	2027.80	54.12
MR-2-3-C	269.99	120.20	149.79	58.00
MR-2-3-U	1012.38	506.87	505.51	44.57
MR-2-4-C	22.3	7.3	15.1	67.5
MR-4-1-C	1100.4	540.2	560.2	50.9
MR-4-1-U	939.6	435.4	504.2	53.7
MR-4-2-C	1006.8	515.8	491.0	48.8
MR-4-2-U	857.3	434.2	423.1	49.4
MR-4-3-C	58.7	50.5	8.2	14.0
MR-4-3-U	249.6	178.8	70.7	28.3

E3.1.2 Extrapolated Loads and Reductions per Assessed Segment

Monitoring site sediment loads were extrapolated to the stream segment scale based on the reach type groups listed in **Table E-2**. Stream segment sediment loads were estimated for all reaches of assessed stream segments included in the Aerial Assessment Database(Watershed Consulting, Inc., unpublished 2011). Average annual streambank erosion sediment loads were estimated for the assessed stream segments in the Beaverhead TPA based on the total length of the stream segment and loading per 1000 foot by reach type.

Segment length, average loading rates (load/mile), and total sediment loads for each listed stream segment are presented in **Table E-5**. In the Beaverhead TPA, streambank erosion sediment loads per assessed segment ranged from 396.3 tons/year in West Fork Dyce Creek to 27,504.5 tons/year in the lower Beaverhead River. The lower and upper segments of the Beaverhead River have the highest sediment load per mile of stream. West Fork Dyce Creek has the lowest streambank erosion estimated sediment load per mile of stream.

The loading reductions listed in **Table E-5** were calculated as the average of load reductions from each reach within the segment. Percent load reduction for each segment is calculated as the total load reduction for reaches within the segment divided by the total load of all reaches within the segment, multiplied by 100 to convert to percent. Reductions represent achievable reductions in loading to the assessed waterbody segments; additional reductions may also be possible from the tributaries to the assessed waterbodies.

Table E-5. Loads and Reductions for Assessed Segments

Assessed Segment	Stream miles	Total Existing Load (tons/yr)	Sediment Load per mile	Load from Anthro. Sources (tons/yr)	Load from Natural Sources (tons/yr)	Target Load (tons/yr)	Reduction (tons/yr)	Avg. % Reduction
Beaverhead River - Lower	62.8	27,504.5	437.7	24552.4	2952.1	6390.1	21114.3	76.8
Beaverhead River -Upper	11.5	5050.6	437.7	4039.6	1011.0	1642.3	3408.3	67.5
Blacktail Deer Creek	39.9	6841.1	171.7	5104.8	1736.2	2591.3	4249.7	62.1
Clark Canyon Creek	8.4	1083.1	129.2	806.7	276.5	409.2	674.0	62.2
Dyce Creek	4.1	1102.4	268.9	805.9	296.4	434.2	668.1	60.6
Farlin Creek	6.0	731.0	122.2	499.7	231.3	318.8	412.2	56.4
French Creek	6.5	853.4	132.1	676.5	176.9	282.7	570.7	66.9
Grasshopper Creek	47.5	5128.9	108.0	3949.3	1179.5	1820.6	3308.3	64.5
Rattlesnake Creek -Lower	8.8	932.4	106.4	773.2	159.2	275.7	656.7	70.4
Rattlesnake Creek -Upper	18.3	2726.8	149.2	1664.0	1062.8	1378.4	1348.4	49.4
Reservoir Creek	12.2	2611.5	213.5	1982.0	629.5	952.2	1659.3	63.5
Scudder Creek	4.7	776.6	167.0	538.8	237.8	331.6	445.0	57.3
Spring Creek	14.9	4037.8	270.8	3398.9	638.9	1143.6	2894.2	71.7
Steel Creek	3.8	413.8	109.8	307.2	106.6	156.6	257.2	62.2
Stone Creek Lower	3.4	1368.4	399.0	1195.1	173.3	344.3	1024.1	74.8
Stone Creek Upper	10.0	2937.5	294.6	2560.0	377.5	744.7	2192.8	74.6
Taylor Creek	11.4	2298.3	201.1	1610.9	687.4	973.6	1324.7	57.6
West Fork Blacktail Deer Creek	15.9	1730.4	109.1	1161.3	569.2	784.2	946.2	54.7
West Fork Dyce Creek	4.6	396.3	86.5	298.1	98.2	147.8	248.6	62.7

E3.1.3 Extrapolated Loads and Reductions per Subbasin

Subbasins and assessed segments were assigned to all reaches in the aerial assessment database in GIS. Subbasin sediment loads were estimated from the sum of the average annual streambank erosion sediment loads on assessed stream segments as calculated in the extrapolation process described in **Section E2.1**.

Subbasins include all assessed segments and associated subwatersheds draining to the pour point (downstream end) of the subbasin. For example, Lower Rattlesnake Creek subbasin includes the segments Upper Rattlesnake Creek and French Creek as well as Lower Rattlesnake Creek. **Table E-6** lists contributing segments, drainage area, and length of assessed streams within each subbasin.

Table E-6. Subbasin Area and Assessed Segments

Subbasin Name	Assessed Segments/ subwatersheds included in Subbasin	Total Drainage Area (acres)	Total Assessed Stream Length (mi)
Clark Canyon Creek	Clark Canyon Creek	11,084	8.4
Beaverhead River -Upper	Beaverhead River –Upper Clark Canyon Creek	37,126	19.9
West Fork Dyce Creek	West Fork Dyce Creek	2,339	4.6
Dyce Creek	Dyce Creek West Fork Dyce Creek	8,733	8.7
Farlin Creek	Farlin Creek	3,615	6.0
Reservoir Creek	Reservoir Creek	8,950	12.2
Scudder Creek	Scudder Creek Steel Creek	4298	8.5
Steel Creek	Scudder Creek	2,370	3.8
Taylor Creek	Taylor Creek	13,614	11.4
Grasshopper Creek	Grasshopper Creek Dyce Creek West Fork Dyce Creek Steel Creek Scudder Creek Farlin Creek Reservoir Creek Taylor Creek	224,603	94.3
French Creek	French Creek	6,769	6.5
Rattlesnake Creek -Upper	Rattlesnake Creek -Upper French Creek	35,318	24.7
Rattlesnake Creek -Lower	Rattlesnake Creek -Lower Rattlesnake Creek –Upper French Creek	92,105	33.5
West Fork Blacktail Deer Creek	West Fork Blacktail Deer Creek	32,879	15.9
Blacktail Deer Creek	Blacktail Deer Creek West Fork Blacktail Deer Creek	202,349	55.8
Stone Creek Upper	Stone Creek Upper	15,975	10.0
Stone Creek Lower	Stone Creek Lower Stone Creek Upper	26,020	13.4
Spring Creek	Spring Creek	32,394	14.9
Beaverhead River - Lower	Entire TPA	905,848	294.5

Streambank erosion sediment load reductions for each subbasin are provided in **Table E-7** to facilitate use with other sub-basin scale analyses, such as upland erosion modeling. Potential reductions in anthropogenic loading as a result of the application of BMPs range from approximately 54% for Upper Rattlesnake Creek to 75% for both subbasins of Stone Creek, with a 69% reduction identified to the entire Beaverhead TPA.

Subbasin totals include only assessed stream segments within the Beaverhead TPA. Average rates of erosion applied to segments may not be applicable to unassessed streams in the subwatersheds, and therefore unassessed tributaries were not included in the load extrapolation. The same BMPs and approach to reducing sediment loading used to achieve reductions on assessed segments apply to unassessed streams, which are influenced by similar land uses.

Table E-7. Subbasin Loads and Reductions

Subbasin	Acres in Drainage	Assessed Stream Miles in Subbasin	Total Existing Load (tons/yr)	Sediment Load per mile	Load from Anthro. Sources (tons/yr)	Load from Natural Sources (tons/yr)	Target Load (tons/yr)	Reduction (tons/yr)	Avg. % Reduction
Beaverhead River - Lower	905,848	294.5	68,524.8	232.7	55,924.4	12,600.3	21,121.9	47,402.8	69.1
Beaverhead River -Upper	37,126	19.9	6133.7	307.9	4846.3	1287.5	2051.5	4082.3	66.6
Blacktail Deer Creek	202,349	55.8	8571.5	153.6	6266.1	2305.4	3375.5	5195.9	60.6
Clark Canyon Creek	11,084	8.4	1083.1	129.2	806.7	276.5	409.2	674	62.2
Dyce Creek	8733	8.7	1498.7	172.7	1104.0	394.6	582.0	916.7	61.2
Farlin Creek	3615	6.0	731	122.2	499.7	231.3	318.8	412.2	56.4
French Creek	6769	6.5	853.4	132.1	676.5	176.9	282.7	570.7	66.9
Grasshopper Creek	224,603	94.3	13,458.8	142.8	9991.9	3466.7	5135.4	8323.4	61.8
Rattlesnake Creek -Lower	92,105	33.5	4512.6	134.7	3113.7	1398.9	1936.8	2575.8	57.1
Rattlesnake Creek -Upper	35,318	24.7	3580.2	144.7	2340.5	1239.7	1661.1	1919.1	53.6
Reservoir Creek	8950	12.2	2611.5	213.5	1982.0	629.5	952.2	1659.3	63.5
Scudder Creek	4298	8.5	1190.4	140.0	846.0	344.4	488.2	702.2	58.9
Spring Creek	32,394	14.9	4037.8	270.8	3398.9	638.9	1143.6	2894.2	71.7
Steel Creek	2370	3.8	413.8	108.9	307.2	106.6	156.6	257.2	62.2
Stone Creek Lower	26,020	13.4	4305.9	321.3	3755.1	550.8	1089.0	3216.9	74.7
Stone Creek Upper	15,975	10.0	2937.5	294.6	2560.0	377.5	744.7	2192.8	74.6
Taylor Creek	13,614	11.4	2298.3	201.1	1610.9	687.4	973.6	1324.7	57.6
West Fork Blacktail Deer Creek	32,879	15.9	1730.4	109.1	1161.3	569.2	784.2	946.2	54.7
West Fork Dyce Creek	2339	4.6	396.3	86.5	298.1	98.2	147.8	248.6	62.7

E4.0 Assumptions and Uncertainty

This assessment assumes that different streams with similar reach type characteristics will have similar physical attributes and sediment loads due to streambank erosion.

The analysis contains several potential sources of uncertainty:

- Since budget and time constraints dictate that only a portion of the streams within the Beaverhead TPA could be assessed in the field, a degree of uncertainty is unavoidable when extrapolating data from assessed sites to un-assessed sites.
- Calculating segment and reach lengths from GIS layers also may a create uncertainty, since layers are digitized based on topographic maps and generally underestimate stream lengths.
- Some degree of uncertainty is inherent in the BEHI methods and categorization of sediment loading by erosion source, as the index values for the BEHI ratings are based on studies conducted in a similar region but different geographic location, and percent loading due to different erosion sources must be estimated using best professional judgment.
- The identification of sediment as a pollutant in many streams in the Beaverhead TPA relate to the fine sediment fraction found on the stream bottom, while streambank erosion sediment modeling examined all sediment sizes.
- Since sediment source modeling may under-estimate or over-estimate sediment inputs due to selection of sediment monitoring sites and the extrapolation methods used, model results should not be taken as an absolutely accurate calculation of sediment production within each sub-watershed. Instead, the streambank erosion assessment model results should be considered an instrument for estimating sediment loads and making general comparisons of sediment loads from various sources.

E5.0 Summary

The 2011 sediment and habitat assessment in the Beaverhead TPA provides a broad-scale analysis of existing sediment conditions within impaired stream segments and estimated streambank erosion sediment loads for use in TMDL development. A total of 612 reaches were delineated during the aerial assessment reach stratification process covering approximately 321 miles of stream. A total of 27 distinct reach types were assigned within the one Level III ecoregion (Middle Rockies) in the Beaverhead TPA based on stream and landscape characteristics. Sediment and habitat variables were assessed at 32 monitoring sites, 29 of which were assessed for streambank erosion. Statistical analysis of the sediment and habitat data from the monitoring sites will aid in developing sediment TMDL targets that are specific for the Beaverhead TPA, while streambank erosion data and calculated load reductions will be utilized in the sediment TMDL. A total annual sediment load of 1,416.5 tons/year was attributed to the 259 assessed eroding streambanks within the 29 sites monitored for streambank erosion in the Beaverhead TPA. A total average annual sediment load of 68,525 tons/year was estimated for the assessed stream segments through the extrapolation process. It is estimated that this sediment load can be reduced to 21,122 tons/year, which is a 69% reduction in sediment load from streambank erosion.

E6.0 References

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