APPENDIX B
BIG SPRING CREEK TMDL TECHNICAL ASSISTANCE AERIAL PHOTOGRAPHY ASSESSMENT (FINAL)
BIG SPRING CREEK

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TABLE OF CONTENTS

FIGURES AND TABLES

FIGURES

All Figures are provided separately.

TABLES

1.0 INTRODUCTION

This report presents the results of a remote assessment of channel and riparian vegetation conditions that was conducted for Big Spring Creek in central Montana. This assessment of Big Spring Creek is a portion of the assessment of Big Spring Creek and three of its tributary streams: Cottonwood Creek, Beaver Creek and East Fork of Big Spring Creek. Big Spring Creek is a tributary to the Judith River and is located in Central Montana near Lewistown. Under Section 303(d) of the Clean Water Act, three of the above streams, Big Spring Creek, Cottonwood Creek and Beaver Creek, are listed on the 2002 Montana 303(d) List. Existing data on the East Fork of Big Spring Creek were insufficient for making a beneficial use support determination in 2002, and the stream was scheduled for reassessment. Table 1-1 summarizes 303(d) status of the streams assessed in this report.

Table 1-1 ***303(d) Status of Big Spring Creek and Selected Tributaries in 2002***

Stream	Beneficial Uses Impacted	Probable Causes	Probable Sources
Big Spring Creek	Aquatic Life Cold Water Fishery	Fish Habitat Degradation Nutrients PCBs Riparian Degradation Sedimentation	Municipal Point Sources Agriculture Grazing Land Disposal Septic Systems Hydromodification Channelization
Cottonwood Creek	Aquatic Life Cold Water Fishery Drinking Water Supply Industrial Recreation	Dewatering Fish Habitat Degradation Flow Alteration Nutrients Organic Enrichment Riparian Degradation Sedimentation	Agriculture Grazing Hydromodification Habitat Modification Removal of Riparian Vegetation
Beaver Creek	Aquatic Life Cold Water Fishery Drinking Water Supply Recreation	Bank erosion Dewatering Fish habitat degradation Flow alteration Nutrients Riparian Degradation Sedimentation	Agriculture Grazing Habitat Modification Removal of Riparian Vegetation
East Fork of Big Spring Creek	Scheduled for Reassessment	Scheduled for Reassessment	Scheduled for Reassessment

According to the Montana Water Quality Act, the State of Montana must monitor the extent to which the state's surface water bodies support legally designated beneficial uses. As part of this monitoring, the state must develop Total Maximum Daily Loads (TMDLs) and associated water quality restoration plans for Montana water bodies in which one or more pollutants impair designated beneficial uses. The Montana Department of Environmental Quality (MDEQ) will be developing a TMDL for Big Spring Creek Planning Area.

2.0 METHODS

Black and white stereo aerial photography, 7.5-minute topographic maps and planimetric maps were used to delineate the target streams into relatively homogeneous reaches. Reach breaks were established using the following criteria: 1) at status boundaries as delineated by the applicable planimetric map, 2) at significant changes in channel slope, valley type, 3) at functional changes in riparian vegetation and 4) at the confluence of major tributary streams. Reach names and breaks were transcripted onto the topographic maps and aerial photos. Table 2-1 provides a summary of the topographic and planimetric maps used for each target stream.

Table 2-1 ***Map Summary***

Stream	Topographic Map(s)	Planimetric Map(s)
Big Spring Creek	Danvers Spring Creek Junction Glengarry Lewistown Pike Creek	BLM Lewistown 1:100,000-scale planimetric map
Cottonwood Creek	Spring Creek Junction Glengarry West Fork Beaver Creek Castle Butte Jump Off Peak	BLM Lewistown 1:100,000-scale planimetric map
Beaver Creek	Glengarry West Fork Beaver Creek Castle Butte	Lewis and Clark National Forest Forest Visitors Map
E. Fork of Big Spring Creek	Heath Half Moon Canyon	BLM Big Snowy 1:100,000-scale planimetric map

Within each reach, aerial photography was used to characterize and assess several parameters (described below in Section 2.1) pertaining to channel and riparian vegetation condition for each target stream. The dates of the aerial photographs varied somewhat between the streams: aerial photo coverage from June 6, 1989 was used to assess Big Spring Creek; aerial photos taken on May 30, 1995 were used to assess the three target tributaries to Big Spring Creek. All aerial photographs were at a scale of 1:6,000.

Each target stream was assessed from its mouth to its headwaters, with the exception of East Fork of Big Spring Creek where aerial photo coverage was not available for approximately the lower eight miles of the stream. Because of the lack of photo coverage these eight miles were not included in this assessment.

2.1 Assessment Parameters

The following parameters were included in the aerial photo assessment:

2.1.1 Reach Information

Reach Name: Consists of the first three letters of the target stream name followed by a number (e.g. COT14). Reaches are numbered consecutively from the stream's mouth to its headwaters.

Reach Length (ft): The linear length of the specified stream reach. Measured to the nearest foot using a digital planimeter and topographic map.

2.1.2 Riparian Vegetation Area

Buffer Width: Measured to the nearest 5 feet to a maximum of 50 feet. An average width of the riparian vegetation buffer adjacent to both sides of the stream in the delineated reach.

Vegetation Type (%): Occularly assessed from the aerial photos. Types included (within a 50' buffer): 1) Conifers and Deciduous Trees, 2) Woody Shrubs, 3) Grass/Sedge (groundcover), 4) Bare ground/Disturbed and 5) Impervious/Urban.

Vegetation Condition: This parameter was replaced by "Vegetation Impact Category", described below. The replacement was made to more accurately organize and compare the reaches. This parameter appears on the data collection forms, but no data were collected.

Degraded Riparian Vegetation: number of feet of stream bank (both sides) with human-impacts to riparian vegetation. Impacts included: 1) areas that had physically observable damaged riparian communities (e.g. trampled), 2) complete lack of riparian vegetation and 3) no woody vegetation observable on banks where such vegetation would be expected based on comparison with upstream/downstream reaches. Impacted riparian vegetation areas were transcribed onto topographic maps and impacted areas were measured to the nearest decimal foot with GIS. The percentage of the reach with degraded riparian vegetation was then calculated by the following formula:

(feet degraded riparian vegetation) / (feet of stream bank, both sides) = % of the reach impacted

Vegetation Impact Category: The reaches were ranked according to the level (% of reach) of impacts and assigned to an impact category according to the following criteria: 1) degraded riparian conditions along 50% or more of the reach indicates a **Highly Impacted** condition; 2) degraded riparian conditions along 25-49% of the reach indicates a **Moderately Impacted** condition; and 3) degraded riparian conditions along 1-24% of the reach indicates a **Lightly Impacted** to riparian vegetation condition. Only reaches with no observable impacts to riparian vegetation (% of reach impacted = 0) were ranked as **Not Impacted**.

2.1.3 Channel Condition

Sinuosity: Sinuosity = reach channel length / reach valley length (as measured from an aerial photo)

Valley Gradient or Slope (%): Gradient = change in elevation in feet / distance of elevation change in feet (measured between contour intervals from the topographic map)

Rosgen Type (Level 1): Stream channel classification based on channel slope, sinuosity, valley type, stream pattern and form (Rosgen, 1996).

Rosgen Type Potential (Level 1): Potential (future) Rosgen stream classification based on occular evidence of natural stream geomorphologic transition *or* evidence of a degraded stream condition that with improvement would have a different stream classification

Channel Degradation: Evidence of the following channel degradation characteristics on an aerial photo: 1) Rip rap, 2) Channelization, 3) Unstable Banks, 4) Severely Eroding Banks. Unstable banks were characterized as those with ocular evidence of light to moderate erosion, while severely eroding banks were characterized as those with evidence of wider scale bank slumping, mass wasting or bank failure.

Impacted channel areas were transcribed onto topographic maps and impacted areas were measured to the nearest decimal foot with GIS. The percentage of the reach with each of the above channel characteristics was then calculated by the following formula:

(feet of channel characteristic) / (feet of stream bank, both sides) = % of the reach impacted

Overall Channel Condition: This parameter was replaced by "Channel Impact Category", described below. The replacement was made to more accurately organize and compare the reaches. This parameter appears on the data collection forms, but no data were collected.

Channel Impact Category: The reaches were ranked according to the cumulative score of *anthropogenic* impacts created by the summation of % of each reach in the four channel degradation parameters (rip rap, channelization, unstable banks, severely eroding banks): reaches with a cumulative score greater than 50 were labeled as **Highly Impacted;** reaches with a score of 25 to 49 were labeled as **Moderately Impacted**; reaches with a score of 1 to 24 were labeled as **Lightly Impacted**; reaches with a score of 0 were labeled as **Not Impacted**. In calculating the channel impact score, the eroding stream banks that appeared to result from naturally erodible bank terraces were removed so that only anthropogenic impacts were included.

Meander Cutoff Potential: Subjective rating of Low, Medium or High potential that a stream meander will be cut off in the future due to erosion/deposition.

2.1.4 General Characteristics

Reference Potential: Whether or not the reach could be considered *reference*, or a reach representing "ideal" or least impacted channel and vegetation characteristics

Land Use: Adjacent anthropogenic or natural land use characteristics that may be contributing to water quality impairment and/or bank instability. Land use comments were transcripted onto aerial photos.

3.0 IMPACT SUMMARY

3.1 Big Spring Creek

This section presents a summary and analysis of selected riparian and channel condition variables. Appendix B presents a tabular summary of all of the data collected on Big Spring Creek.

3.1.1 Riparian Vegetation Impacts

Table 3-1 provides a summary of selected characteristics of riparian vegetation on Big Spring Creek. The majority of the reaches were classified as Highly and Moderately Impacted, indicating riparian degradation between 25 and 50 percent of the reach. Big Spring Creek reaches that were ranked as Lightly Impacted or Not Impacted will be considered "Vegetation Reference Reaches" for the purposes of this assessment (Section 4.0).

Table 3-1 ***Riparian Vegetation Characteristics – Big Spring Creek***

Reach	Total Bank Length (ft)	Buffer Width (ft)	Vegetation Type (% of reach)					Degraded Riparian Vegetation (% of reach)	Vegetation Impact Category
			Con/Dec	Woody Shrub	Bare ground/ disturbed	Grass/ Sedge	Impervious/ Urban		
BIG26	10758	0	10	0	0	0	90	100	Highly Impacted
BIG25	8246	5	15	10	10	65	0	98	Highly Impacted
BIG1	4228	10	0	20	20	60	0	96	Highly Impacted
BIG7	4460	15	0	20	20	60	0	93	Highly Impacted
BIG5	5594	0	10	10	5	65	10	92	Highly Impacted
BIG10	12852	30	25	20	20	20	15	76	Highly Impacted
BIG18	14930	15	10	30	10	30	20	75	Highly Impacted
BIG19	6476	25	10	25	10	55	0	69	Highly Impacted
BIG23	16006	30	10	30	10	50	0	64	Highly Impacted
BIG8	10406	25	5	25	30	20	20	62	Highly Impacted
BIG11	11010	40	15	15	10	55	5	62	Highly Impacted
BIG3	7318	25	5	20	20	55	0	61	Highly Impacted
BIG12	8544	25	5	30	5	60	0	60	Highly Impacted
BIG20	12222	40	15	40	10	35	0	55	Highly Impacted
BIG13	7538	50	25	40	15	20	0	54	Highly Impacted
BIG6	7790	15	5	30	10	45	10	51	Highly Impacted
BIG4	5134	50	5	50	5	35	5	49	Moderately Impacted
BIG2	6990	40	0	30	10	60	0	47	Moderately Impacted
BIG24	11644	40	30	30	10	30	0	44	Moderately Impacted
BIG9	5300	40	0	15	20	65	0	43	Moderately Impacted
BIG16	13850	50	35	35	0	30	0	42	Moderately Impacted
BIG17	10918	40	20	40	15	25	0	40	Moderately Impacted
BIG29	10102	20	10	30	0	50	10	40	Moderately Impacted
BIG32	6108	25	20	40	0	30	10	38	Moderately Impacted
BIG15	15746	>50	30	30	10	30	0	36	Moderately Impacted
BIG30	11748	35	20	30	0	45	5	33	Moderately Impacted
BIG33	11610	25	10	30	10	40	10	33	Moderately Impacted
BIG14	12296	35	20	30	10	40	0	32	Moderately Impacted
BIG27	13268	30	10	30	0	40	20	27	Moderately Impacted
BIG21	11628	50	30	40	5	25	0	26	Moderately Impacted
BIG28	12462	25	10	20	0	45	25	19	Moderately Impacted*
BIG31	3962	50	0	50	0	45	5	21	Lightly Impacted
BIG22b	12998	25	15	35	5	45	0	20	Lightly Impacted
BIG35	13670	50	10	35	5	40	10	13	Lightly Impacted
BIG22a	9224	40	40	30	0	30	0	11	Lightly Impacted
BIG34	9824	40	10	45	0	45	0	0	Not Impacted

* Downgraded to Moderately Impacted due to 25% impervious/urban surface

3.1.2 Stream Channel Characteristics

Table 3-2 provides a summary of selected stream channel characteristics of Big Spring Creek. As was the case with the riparian vegetation, most of the reaches fell into the Highly and Moderately Impacted categories. There were no reaches that were considered Not Impacted. Big Spring Creek reaches that were ranked as Lightly Impacted will be considered "Channel Reference Reaches" for the purposes of the Discussions and Recommendations section of this report (Section 4.0). Note that the Cumulative Channel Impact Score is the sum of the four Channel Degradation Characteristics minus the portion of the eroding banks that were classified as natural erosion from unvegetated terraces.

Table 3-2 ***Stream Channel Characteristics – Big Spring Creek***

Reach	Total Bank Length (ft)	Channel Degradation Characteristics (% of reach)				Minus (-) "Natural" Erosion (%)	Cumulative Channel Impact Score	Channel Impact Category
		Rip rap	Channelized	Unstable Banks	Severely Eroding Banks			
BIG25	8246	18	98	0	8	0	125	Highly impacted
BIG26	10758	8	97	4	0	0	109	Highly impacted
BIG6	7790	0	0	68	16	3	81	Highly impacted
BIG28	12998	2	79	0	0	0	81	Highly impacted
BIG18	14930	4	24	43	9	0	80	Highly impacted
BIG11	11010	0	43	18	11	0	73	Highly impacted
BIG19	6476	0	0	64	8	0	72	Highly impacted
BIG7	4460	0	0	46	24	0	70	Highly impacted
BIG1	4228	0	0	34	35	0	69	Highly impacted
BIG10	12852	0	0	58	16	7	67	Highly impacted
BIG5	5594	0	0	35	25	0	60	Highly impacted
BIG3	7318	0	0	38	20	0	58	Highly impacted
BIG23	16006	22	17	9	4	0	52	Highly impacted
BIG12	8544	0	0	30	28	7	51	Moderately impacted
BIG20	12222	0	26	9	16	0	51	Moderately impacted
BIG4	5134	0	0	51	23	28	46	Moderately impacted
BIG8	10406	0	0	33	19	7	46	Moderately impacted
BIG9	5300	0	0	12	31	0	43	Moderately impacted
BIG14	7538	2	0	29	13	2	42	Moderately impacted
BIG13	12296	0	0	27	14	0	42	Moderately impacted
BIG2	6990	0	0	57	33	49	41	Moderately impacted
BIG15	15746	2	0	25	9	0	35	Moderately impacted
BIG35	13670	2	24	2	6	0	33	Moderately impacted
BIG21	11628	4	0	22	4	0	31	Moderately impacted
BIG16	13850	0	0	24	4	0	28	Moderately impacted
BIG34	9824	0	25	0	3	0	28	Moderately impacted
BIG29	10102	1	10	2	9	0	22	Lightly Impacted
BIG27	13268	12	0	0	7	0	19	Lightly Impacted
BIG30	11748	0	0	13	6	0	19	Lightly Impacted
BIG22a	9224	0	0	11	7	0	18	Lightly Impacted
BIG17	10918	0	0	6	12	0	17	Lightly Impacted
BIG33	11610	3	0	7	7	0	16	Lightly Impacted
BIG24	11644	6	0	3	3	0	13	Lightly Impacted
BIG32	6108	0	0	6	7	0	12	Lightly Impacted
BIG31	12462	0	0	10	1	0	11	Lightly Impacted
BIG22b	3962	0	0	4	6	0	10	Lightly Impacted

Table 3-3 provides a comparison of Vegetation and Channel Impact ratings, listed from the most highly impacted to the least impacted. In general, vegetation and channel conditions in each reach were within one impact category of one another. The exception was BIG34, where the vegetation was not impacted but the channel was moderately impacted.

Table 3-3 ***Vegetation/Channel Impact Comparison - Big Spring Creek***

Reach	Vegetation Impact Category	Channel Impact Category	Reach	Vegetation Impact Category	Channel Impact Category	Reach	Vegetation Impact Category	Channel Impact Category
BIG1	Highly Impacted	Highly Impacted	BIG8	Highly Impacted	Moderately Impacted	BIG17	Moderately Impacted	Lightly Impacted
BIG3	Highly Impacted	Highly Impacted	BIG12	Highly Impacted	Moderately Impacted	BIG24	Moderately Impacted	Lightly Impacted
BIG5	Highly Impacted	Highly Impacted	BIG13	Highly Impacted	Moderately Impacted	BIG27	Moderately Impacted	Lightly Impacted
BIG6	Highly Impacted	Highly Impacted	BIG20	Highly Impacted	Moderately Impacted	BIG29	Moderately Impacted	Lightly Impacted
BIG7	Highly Impacted	Highly Impacted	BIG28	Moderately Impacted	Highly Impacted	BIG30	Moderately Impacted	Lightly Impacted
BIG10	Highly Impacted	Highly Impacted	BIG2	Moderately Impacted	Moderately Impacted	BIG32	Moderately Impacted	Lightly Impacted
BIG11	Highly Impacted	Highly Impacted	BIG4	Moderately Impacted	Moderately Impacted	BIG33	Moderately Impacted	Lightly Impacted
BIG18	Highly Impacted	Highly Impacted	BIG9	Moderately Impacted	Moderately Impacted	BIG35	Lightly Impacted	Moderately Impacted
BIG19	Highly Impacted	Highly Impacted	BIG14	Moderately Impacted	Moderately Impacted	BIG22a	Lightly Impacted	Lightly Impacted
BIG23	Highly Impacted	Highly Impacted	BIG15	Moderately Impacted	Moderately Impacted	BIG22b	Lightly Impacted	Lightly Impacted
BIG25	Highly Impacted	Highly Impacted	BIG16	Moderately Impacted	Moderately Impacted	BIG31	Lightly Impacted	Lightly Impacted
BIG26	Highly Impacted	Highly Impacted	BIG21	Moderately Impacted	Moderately Impacted	BIG34	Not Impacted	Moderately Impacted

3.1.3 Previous Assessments

The Fergus County Conservation District performed a Stream Inventory and Assessment of Big Spring Creek in 1990. The 1990 Inventory was performed on the ground. Observations that could be compared with Land & Water's assessment of Big Spring Creek are summarized below in Table 3-4.

Table 3-4 ***1990 Stream Inventory and Assessment (Fergus County) - Big Spring Creek***

Source	"Bank erosion+failure+mass wasting" (ft)	Rip rap (ft)
1990 Inventory	50,730	13,410
Land & Water Equivalent	108,992 (Unstable banks+Severely Eroding Banks)	10,822

All data includes both natural and anthropogenic sources

Land & Water's comparison value for unstable or eroding banks is more than twice the value than that found by the Fergus County inventory. The reasons for the different findings are not clear, but likely result from the different methodologies employed in the two assessments. No information regarding the methods used by the Fergus County Conservation District or how the District defined eroding banks was found for this report.

4.0 DISCUSSION/RECOMMENDATIONS

4.1 Relationship of Riparian Vegetation Characteristics with Channel Erosion

Select riparian characteristics were compared to the total percentage of unstable and eroding banks in each reach in order to provide a quantitative estimate of the correlation between riparian vegetation and bank stability (Table 4-1). The combined % of unstable and eroding banks was sorted and divided in quartiles, and the data presented in Table 4-1 are presented separately for each of these quartiles. Few if any connections between vegetation condition and bank stability are obvious from this comparison, suggesting that a more complicated set of circumstances controls bank stability on Big Spring Creek.

Table 4-1 ***Comparison Between Riparian Vegetation Characteristics and Channel Erosion - Big Spring Creek***

	Riparian Vegetation Characteristics						
Reach	**Buffer Width (ft)**	**Con/Dec (% of reach)**	**Woody Shrub (% of reach)**	**Bare ground/ disturbed (% of reach)**	**Grass/ Sedge (% of reach)**	**Impervious/ Urban (% of reach)**	**Combined Unstable/Eroding Banks (% of reach)**
BIG2	40	0	30	10	60	0	90
BIG6	15	5	30	10	45	10	84
BIG4	50	5	50	5	35	5	74
BIG10	30	25	20	20	20	15	74
BIG19	25	10	25	10	55	0	72
BIG7	15	0	20	20	60	0	70
BIG1	10	0	20	20	60	0	69
BIG5	0	10	10	5	65	10	60
BIG3	25	5	20	20	55	0	58
Averages Quartile 4	*23*	*7*	*25*	*13*	*51*	*4*	*72*
BIG12	25	5	30	5	60	0	58
BIG8	25	5	25	30	20	20	53
BIG18	15	10	30	10	30	20	52
BIG9	40	0	15	20	65	0	43
BIG13	50	25	40	15	20	0	42
BIG14	35	20	30	10	40	0	42
BIG15	>50	30	30	10	30	0	33
BIG11	40	15	15	10	55	5	29
BIG16	50	35	35	0	30	0	28
Averages Quartile 4	*35*	*16*	*28*	*12*	*39*	*5*	*42*
BIG21	50	30	40	5	25	0	27
BIG20	40	15	40	10	35	0	25
BIG30	35	20	30	0	45	5	19
BIG22a	40	40	30	0	30	0	18
BIG17	40	20	40	15	25	0	17
BIG23	30	10	30	10	50	0	13
BIG33	25	10	30	10	40	10	13
BIG32	25	20	40	0	30	10	12
Averages Quartile 4	*36*	*21*	*35*	*6*	*35*	*3*	*18*

Table 4-1 ***Comparison Between Riparian Vegetation Characteristics and Channel Erosion - Big Spring Creek (continued)***

	Riparian Vegetation Characteristics (continued)						
Reach	**Buffer Width (ft)**	**Con/Dec (% of reach)**	**Woody Shrub (% of reach)**	**Bare ground/ disturbed (% of reach)**	**Grass/ Sedge (% of reach)**	**Impervious/ Urban (% of reach)**	**Combined Unstable/Eroding Banks (% of reach)**
BIG29	20	10	30	0	50	10	11
BIG31	50	0	50	0	45	5	11
BIG22b	25	15	35	5	45	0	10
BIG25	5	15	10	10	65	0	8
BIG27	30	10	30	0	40	20	7
BIG35	50	10	35	5	40	10	7
BIG24	40	30	30	10	30	0	6
BIG26	0	10	0	0	0	90	4
BIG34	40	10	45	0	45	0	3
BIG28	25	10	20	0	45	25	0
Averages Quartile 4	*29*	*12*	*29*	*3*	*41*	*16*	*7*

4.2 Characteristics of Reference Reaches

Vegetation and Channel Reference Reaches were identified for Big Spring Creek to provide a gauge for forming restoration targets. As was discussed in Section 3.1.1 and 3.1.2, reference reaches are those that were classified as Lightly or Not Impacted in the vegetation condition assessment and Lightly Impacted in the channel condition assessment. The reference reaches occur throughout the Middle and Upper regions of Big Spring Creek, but are absent from the lower third of the stream. A summary of the average characteristics of the reference reaches is presented for vegetation and channel conditions in Table 4-2 and 4-3, respectively.

Table 4-2 ***Vegetation Reference Reaches - Big Spring Creek***

Location on Big Spring Cr.	**Reach**	**Coniferous/Deciduous (%)**	**Woody Shrub (%)**	**Degraded Riparian Vegetation (%)**
Middle	BIG22a	40	30	11
Middle	BIG22b	15	35	20
Upper	BIG31	0	50	21
Upper	BIG34	10	45	0
Upper	BIG35	10	35	13
	averages	*15*	*39*	*13*
	TARGET	15% tree + 39% shrub = **54% tree/shrub types**		**Degraded Riparian Vegetation ≤ 13%**

Table 4-3 ***Channel Reference Reaches - Big Spring Creek***

Location on Big Spring Cr.	Reach	Channelization (%)	Unstable Banks (%)	Severely Eroding Banks (%)
Upper	BIG29	10	2	9
Upper	BIG27	0	0	7
Upper	BIG30	0	13	6
Middle	BIG22a	0	11	7
Middle	BIG17	0	6	12
Upper	BIG33	0	7	7
Middle	BIG24	0	3	3
Upper	BIG32	0	6	7
Upper	BIG31	0	10	1
Middle	BIG22b	0	4	6
	averages	1	6	7
	TARGET	**Channelized ≤ 1%**	6% unstable + 7% severely eroding = **Eroding Banks ≤ 13%**	

4.3 Comparison of Reference Reaches with Highly Degraded Reaches

The target conditions derived in Tables 4-2 and 4-3 above were compared to the conditions in the most degraded reaches on Big Spring Creek. For Big Spring Creek, the "most degraded" reaches were defined to be those in which the vegetation condition and/or the channel condition were rated as Highly Impacted. These represent reaches of Big Spring Creek that appear to be in the greatest need of restoration and where the largest potential reductions in sediment loading could be achieved. Table 4-4 summarizes the most degraded reaches and describes their land use characteristics. Table 4-5 compares the most degraded reaches to reference conditions.

Table 4-4 ***"Most Degraded" Reaches – Big Spring Creek***

Reach	Location on Big Spring Cr.	Vegetation Impact Category	Channel Impact Category	Land Use Characteristics
BIG1	Lower	Highly Impacted	Highly Impacted	confluence w/Judith, livestock grazing
BIG3	Lower	Highly Impacted	Highly Impacted	livestock grazing, agr field 25' from LB road 80' from RB, vehicle access on RB
BIG5	Lower	Highly Impacted	Highly Impacted	livestock grazing, agr field 30' RB 2-track 25' RB, concentrated stock access point (3)
BIG6	Lower	Highly Impacted	Highly Impacted	livestock grazing, agr field <10' RB road 40' RB, pullout from road to RB concentrated stock access point (4)
BIG7	Lower	Highly Impacted	Highly Impacted	livestock grazing, agr field <10' LB concentrated stock access point (2)
BIG10	Lower	Highly Impacted	Highly Impacted	Spring Creek Colony farm operation Bridge, road/2-track 25' RB/LB concentrated stock access point (1) , agr field to bank edge, RB
BIG11	Lower	Highly Impacted	Highly Impacted	livestock grazing, agr fields <25', RB (2) vehicle fjord (2), road within 25', RB

Table 4-4 ***"Most Degraded" Reaches – Big Spring Creek (continued)***

Reach	Location on Big Spring Cr.	Vegetation Impact Category	Channel Impact Category	Land Use Characteristics
BIG18	Middle	Highly Impacted	Highly Impacted	ag. operation w/livestock grazing potential solid waste dumping over RB at ranch road/2-track to bank edge RB, bridges (2) intermittent stream joins RB, erosion upstream of confluence at RR bridge
BIG19	Middle	Highly Impacted	Highly Impacted	RR within 100' of 30% of reach, RB
BIG23	Middle	Highly Impacted	Highly Impacted	several small ranches riprap along majority of reach, RB/LB agr field to bank edge for most of RB
BIG25	Upper	Highly Impacted	Highly Impacted	Wastewater Treatment Plant LB, bridge, riprap majority of reach is lawn or agr field within 15',RB/LB
BIG26	Upper	Highly Impacted	Highly Impacted	residential and commercial urban landuse, majority of reach is channelized and concrete
BIG8	Lower	Highly Impacted	Moderately Impacted	roads to bank edge, RB/LB, bridge fields to bank edge, RB/LB (4)
BIG12	Lower	Highly Impacted	Moderately Impacted	livestock grazing agr fields to bank edge RB/LB (4), concentrated stock access point (1)
BIG13	Middle	Highly Impacted	Moderately Impacted	livestock grazing, agr field <50', LB (2) concentrated stock access points (5) bridges (2)
BIG20	Middle	Highly Impacted	Moderately Impacted	ranch operation w/livestock grazing agr fields to bank edge (7), RB/LB, concentrated stock access (2), bridge
BIG28	Upper	Moderately Impacted	Highly Impacted	confluence w/Casino Cr channelized between roads 80% of reach bridges (2)

LB = left bank
RB = right bank

Table 4-5 ***Comparison of Most Degraded Reaches with Target Conditions – Big Spring Creek***

	Target Variable	*Target Value (%)*	BIG1	BIG3	BIG5	BIG6	BIG7	BIG10	BIG11	BIG18	BIG19	BIG23	BIG25	BIG26	BIG8	BIG12	BIG13	BIG20	BIG28
Vegetation	**Tree/shrub Types**	*≥ 54*	20	25	25	35	20	45	30	40	35	40	25	10	30	35	65	55	30
	Degraded Riparian Vegetation	*≤ 13*	96	61	92	51	93	76	62	75	69	64	98	100	62	60	54	55	19
Channel	**Channelized**	*≤ 1*	0	0	0	0	0	0	43	24	0	17	98	97	0	0	0	26	79
	Eroding Banks	*≤ 13*	69	58	60	84	70	74	29	52	72	13	8	4	52	58	41	25	0

4.4 Restoration Focus Areas

4.4.1 Previous Restoration Activities

In 1995, the NRCS conducted several restoration projects on privately owned and state land on Big Spring Creek. Table 4-6 describes the restoration projects that were detailed in the NRCS study. There was no information available regarding the success of these projects or describing whether the riparian management was continued past the 1995 study.

Table 4-6 ***1995 NRCS Restoration Projects***

Reach	Owner	Riparian Fencing (ft)	Channel Improved* (ft)	Stream/Riparian Improved* (ft)	Off-site Watering Locations Provided	Comments
BIG16	Don Jenni	None	100	2,300	One	Continue willow plantings
BIG20	Sam Weidner	7,915	None	5,940	One	Complete
BIG24	Emmet Butcher	3,300	None	4,620	One	Complete
BIG28	MT FWP	4,800	3,950	5,600	None	None
BIG33	George Hamilton	None	110	720	None	Conservation Easement on unit
BIG31	Ron Isackson	None	None	570	None	Complete

*No information was provided as to the improvement technique.

4.4.2 Restoration Priorities

For each of the "most degraded" reaches of Big Spring Creek described in Section 4.3, this section summarizes the major impacts observed during the air photo assessment. Because of their heavily impacted condition, these reaches represent the areas most likely in need of restoration.

BIG1 – This reach begins at the confluence of the Judith River and Big Spring Creek. The primary impact was to riparian vegetation; 96% of the riparian vegetation community was degraded and less than half the target value for tree/shrub types was observed. 69% of the channel was unstable or eroding, over five times the reference value for Big Spring Creek.

BIG3 – The channel and riparian impacts were similar but slightly less than the near downstream reach, BIG1 (above). The impacts to riparian vegetation and the channel in this reach were similar; 61% of the vegetation was degraded and 58% of the channel was degraded by evidence of grazing, agricultural fields to the bank edge and vehicle access across the stream. Less than half of the tree/shrub cover target was observed on this reach.

BIG5 – This reach is similar in characteristics to the downstream reaches BIG1 and BIG3 (above). The primary impact was to riparian vegetation; 92% of the riparian vegetation community was impacted by evidence of grazing, agricultural fields and dirt roads within 30 feet of the bank edge and concentrated stock access points. Less than half the target value for tree/shrub types was observed. 60% of the channel was unstable or eroding, over four times the reference value for Big Spring Creek.

BIG6 – BIG6 had a higher tree/shrub cover and nearly half the degraded riparian vegetation of the reaches listed above but a significantly higher (84%) amount of unstable or eroding banks. The reach was impacted by evidence of grazing, agricultural fields and dirt roads within 40 feet of the bank edge and concentrated stock access points.

BIG7 – With the exception of BIG6, this reach is similar in characteristics to the downstream reaches listed above. The primary impact was to riparian vegetation; 93% of the riparian vegetation community was impacted by evidence of grazing, agricultural fields within 10 feet of the bank edge and concentrated stock access points. Less than half the target value for tree/shrub types was observed. 70% of the channel was unstable or eroding, over five times the reference value for Big Spring Creek.

BIG10 - The impacts to riparian vegetation and the channel in this reach were similar; 76% of the vegetation was degraded and 74% of the channel was degraded. However, the tree/shrub percentage was within 10% of the target. The impacts were primarily due to the Spring Creek Colony farm located on the reach; roads and agricultural fields were observed within 10 feet of the bank edge. Evidence of grazing and concentrated stock access points were observed. Less than half of the tree/shrub cover target was observed on this reach.

BIG11 – The primary channel impacts to this reach were a result of channelization: 43% of the reach was channelized. 29% of the channel was unstable or eroding, which is within 16% of the target value. The tree/shrub cover was approximately 25% less than the target value, and 62% of the riparian vegetation on the reach was degraded. Evidence of grazing, roads and agricultural fields were observed within 25 feet of the bank. Restructuring of the channelized portions of the reach to a more sinuous condition will aid in reducing stream flow velocities.

BIG18 – Channel impacts included 24% channelization of the reach and 52% unstable or eroding banks. 75% of the vegetation was degraded and 40% tree/shrub cover was observed. Evidence of grazing, roads to the bank edge and the dumping of solid waste (riprap?) over the bank edge was observed associated with an agricultural operation. Restructuring of the channelized portions of the reach to a more sinuous condition will aid in reducing stream flow velocities.

BIG19 - The impacts to riparian vegetation and the channel in this reach were similar; 69% of the vegetation was degraded and 72% of the channel was degraded. The tree/shrub percentage was 35%. Railroad tracks ran approximately 100 feet from the reach. Enhancing the tree and woody shrub community where there is potential would aid in erosion reduction. Bank stabilization is recommended where possible.

BIG23 – The channel condition was relatively good; the percentage of unstable or eroding banks was at the target value and a small amount of the reach was channelized (17%). However, 22% of the reach was stabilized with riprap (Table 3-2). The primary impacts to the reach were to the riparian vegetation: 64% of the riparian vegetation was degraded. The tree/shrub cover was within 15% of the target. Several small ranches were located on the reach.

BIG25 and *BIG26* – These two reaches run through the city of Lewistown. Nearly all of each reach has little to no riparian vegetation and is completely channelized. Where possible, restoring some sinuosity to the stream and installing flow-reducing structures would reduce flow velocities that may cause erosion downstream. Establishing riparian communities within the new stream bends would aid in restoring some riparian function to these reaches.

BIG8 - The impacts to riparian vegetation and the channel in this reach were similar; 62% of the vegetation was degraded and 52% of the channel was degraded. Roads and agricultural fields were observed to the bank edge. Approximately 25% less than the tree/shrub cover target was observed on this reach.

BIG12 - The impacts to riparian vegetation and the channel in this reach were similar; 60% of the vegetation was degraded and 58% of the channel was degraded. Evidence of livestock

grazing, concentrated stock access points and roads and agricultural fields to the bank edge were observed. Approximately 20% less than the tree/shrub cover target was observed on this reach.

BIG13 – This reach had a higher percentage of tree/shrub cover (65%) and lower amounts of degraded riparian vegetation and channel erosion than its adjacent downstream reach BIG12 (above). The tree/shrub cover is above the target value. Roads within 50 feet of the stream and evidence of livestock grazing was observed.

BIG20 – The tree/shrub cover on this reach was above the target value. 55% of the vegetation was degraded. 25% of the reach was unstable or eroding; however, 26% of the reach had been channelized. A ranch operation with evidence of grazing, concentrated stock access points and roads to the bank edge was observed.

According to the 1995 NRCS data, one off-site watering location, 7,915 feet of riparian fencing was installed in 1995 and 5,940 feet of the stream/riparian area was improved by the private landowner. No description of the improvements was provided.

BIG28 – The primary impact to this reach is the high degree of channelization: 79% of the reach is channelized between roads. The percentage of tree/shrub cover is 25% less than the target value.

According to the 1995 NRCS data, the Montana Fish, Wildlife and Parks installed 4,800 feet of riparian fencing, improved 3,959 feet of the channel and 5,600 feet of the stream/riparian area in 1995. No description of the improvements was provided.

5.0 CONCLUSIONS

Impacts to riparian vegetation appeared to be the greatest potential source of sediment input to the stream. The primary sources of vegetation impacts were related to land use: agriculture and grazing appeared to have had significant impacts to riparian communities on the lower and upper portions of Big Spring Creek while the urban landscape appeared to have replaced the riparian zone in and around Lewistown. Channelization was observed mostly in the urban portion of Big Spring Creek. These channelized areas will have a greater influence on sediment generation downstream, where higher stream velocities will result in increased bank erosion.

On the majority of the reaches, both the vegetation condition and the channel condition were classified as Highly and Moderately Impacted.

Select riparian characteristics were compared to the total percentage of unstable and eroding banks in each reach in order to provide a quantitative estimate of the correlation between riparian vegetation and bank stability. Few if any connections between vegetation condition and bank stability were obvious from the comparison, suggesting a more complicated set of circumstances controls bank stability on Big Spring Creek.

In general, Big Spring Creek was significantly impacted, with 34% of the banks in either unstable (22%) or severely eroding (12%) condition and nearly half of the riparian vegetation (47%) in degraded condition. The 12% of the stream that has been channelized will complicate restoration efforts, as such "hard" impacts are difficult and expensive to re-naturalize and can have systemic effects on sediment production.

Table 5-1 ***Summary of Degradation Statistics***

Degraded Riparian Vegetation	Riprap	Channelization	Unstable Banks	Severely Eroding Banks
47%	2%	12%	22%	12%

The air photo assessment that was conducted for this report was not at a scale that allows for detailed site-specific restoration recommendations. However, the following general recommendations could guide restoration efforts, particularly in those reaches identified in Section 4.3 as "most degraded" and thus most in need of restoration:

- Restructuring of the channelized portions of the reach to a more sinuous condition to aid in reducing stream flow velocities;
- Providing at least a 50 foot vegetation buffer between Beaver Creek and fields/roads;
- Improving proper riparian function by providing off-site watering locations coupled with riparian fencing;
- Enhancing the tree and woody shrub community where there is potential to aid in erosion reduction or maintenance of bank stability; and
- Mechanical bank stabilization where possible