Middle Fork West Fork Gallatin River Restoration Project Plan



June 28, 2019

MIDDLE FORK WEST FORK GALLATIN RIVER RESTORATION PROJECT PLAN

by



Jeff Dunn, Upper Missouri / Yellowstone Project Manager 321 E. Main Street, Suite 411 Bozeman, Montana 59715

Prepared in partnership with



32 Market Place, Suite 6 | PO Box 160513 Big Sky, MT 59716

June 28, 2019

TABLE OF CONTENTS

Table of Contents	i
List of Tables	i
List of Figures	i
Attachments	ii
Introduction	1
Problem Description	1
Project Location and Impairment Cause Addressed	2
Project 1 - Upper Middle Fork West Fork Road Sediment BMPs	4
Project 2 - Upper Middle Fork West Fork Riparian Buffer	7
Project 3 - Middle Fork West Fork Restoration downstream of Lake Levinsky	10
Project 4 - Middle Fork West Fork Restoration in Lone Moose Meadows	14
Project 5 - Middle Fork West Fork Restoration in Aspen Groves/Antler Ridge	17
Future Opportunities in the Middle Fork West Fork Gallatin River Watershed	21
References	22

LIST OF TABLES

Table 1. Middle Fork West Fork Gallatin River TMDL Percent Reductions	2
Table 2. Middle Fork West Fork Gallatin River Project Impairment Addressed	2
Table 3. Project 1 Road Crossings	5
Table 4. 2008 Stream Channel Survey Data Summary for Monitoring Site MFWF04-01	10
Table 5. 2008 Stream Channel Survey Data Summary for Monitoring Sites MFWF09-01 and 02	18

LIST OF FIGURES

Figure 1. Project Area Overview	3
Figure 2. Project 1 Road Crossings	6
Figure 3. Project 2 Existing Conditions along Lake Levinsky	8
Figure 4. Project 2 Riparian Buffer Enhancement Areas	9
Figure 5. Project 3 Existing Channel Conditions within Project Reach	12
Figure 6. Project 3 Existing Conditions within Restored Channel Location	12
Figure 7. Project 3 Potential Natural Conditions Observed Downstream of Project Reach	12
Figure 8. Project 3 Channel Restoration Conceptual Design	13
Figure 9. Project 4 Degraded Riparian Conditions in Monitoring Reach MFWF07-02	15
Figure 10. Project 4 Degraded Riparian Conditions in Monitoring Reach MFWF08-01	15
Figure 11. Project 4 Potential Natural Conditions Observed in the North Fork West Fork Gallatin Rive	er.15

Figure 12. Project 4 Riparian Buffer Enhancement and Large Woody Debris Placement Conceptu	ial Design
	16
Figure 13. Streambank Erosion along Former Logging Road and Current Trail	19
Figure 14. Streambank Erosion and Culvert along Former Logging Road and Current Trail	19
Figure 15. Project 5 Reach Overview and Historic Channel Location to be Restored	19
Error! Bookmark not	defined.
Figure 16. Project 5 Channel Restoration and Riparian Buffer Enhancement Conceptual Design	20

ATTACHMENTS

Attachment A – Project 1 Road Sediment Reduction Sites Attachment B – Projects 3 and 5 Conceptual Design Drawings

INTRODUCTION

The *Middle Fork West Fork Gallatin River Restoration Plan* examines water quality improvement projects for the Middle Fork West Fork Gallatin River in five discreet project areas extending from the headwaters on Lone Mountain downstream to the confluence with the North Fork West Fork Gallatin River. Projects include:

- Project 1 Upper Middle Fork West Fork Road Sediment BMPs
- Project 2 Upper Middle Fork West Fork Riparian Buffer Enhancement around Lake Levinsky
- Project 3 Middle Fork West Fork Restoration downstream of Lake Levinsky
- Project 4 Middle Fork West Fork Restoration in Lone Moose Meadows
- Project 5 Middle Fork West Fork Restoration in Aspen Groves/Antler Ridge

The *Middle Fork West Fork Gallatin River Restoration Plan* provides a foundation for an application to the Montana Department of Environmental Quality's (DEQ) 319 grant program to address identified water quality impairments and improve conditions so that the Middle Fork West Fork Gallatin River meets water quality standards and fully supports the aquatic life and primary contact recreation beneficial uses, which are currently only partially supported. The *Middle Fork West Fork Gallatin River Restoration Plan* provides a holistic approach for addressing water quality impairments within the Middle Fork West Fork Gallatin River watershed, while also promoting natural stream and riparian processes. Additional opportunities for watershed improvements are discussed within the "future opportunities" section at the end of this report.

PROBLEM DESCRIPTION

The Middle Fork West Fork Gallatin River is a tributary to the West Fork Gallatin River flowing approximately 6 miles from its headwaters on Lone Mountain to its confluence with the North Fork West Fork Gallatin River. The Middle Fork West Fork Gallatin River watershed is effectively divided into "upper" and "lower" segments by Lake Levinsky, which is a man-made impoundment in the Mountain Village that provides water storage for snowmaking at Big Sky Resort. The 2008 303(d) List of Impaired Waterbodies identified solids (suspended/bedload), alteration in stream-side or littoral vegetation covers, nitrate/nitrite, and fecal coliform as causes for impairment in the Middle Fork West Fork Gallatin River, which impact the aquatic life, cold water fishery, and primary contact recreation beneficial uses (DEQ 2010). In 2010, *The West Fork Gallatin River Watershed Total Maximum Daily Loads (TMDLs) and Framework Watershed Water Quality Improvement Plan* (DEQ 2010) provided TMDLs for sediment, nitrate+nitrite (NO³+NO²) and *E. coli* in the Middle Fork West Fork Gallatin River.

Pollutants identified in the 2010 TMDL document leading to water quality impairments in the Middle Fork West Fork Gallatin River include sediment, nutrients, and pathogens. Excess sediment is contributed from roads, resort development, recreation, and historic riparian vegetation removal. Sediment impairments, including the non-pollutant "alteration in stream-side or littoral vegetation covers" impairment, are described in the TMDL document as excess fine sediment in riffles and pool tails and low residual pool depths upstream of Lake Levinsky and decreased pool and large woody debris frequency downstream of Lake Levinsky. Excess nutrients (nitrate+nitrite) are identified in the TMDL document as derived from residential and resort land and vegetation clearing, residential and commercial landscape and maintenance and management, and sewer or service line failures or leaks. The TMDL document indicates that controlling and limiting nitrate+nitrite from lands in the developed and residential areas upstream of Lake Levinsky are the focus of nutrient load reductions. Excess pathogens (*E. coli*) are identified in the TMDL document as derived from domestic pets, geese and waterfowl, wildlife, and refuse and runoff from streets, parking lots and other impervious surfaces in the developed area, along with sewer line failures or leaks, particularly downstream of Lake Levinsky. Percent reductions in pollutant loading necessary to meet water quality standards and restore full support of beneficial uses are presented in **Table 1**.

Pollutant	Stream	Percent	Anthropogenic Source Categories
	Segment	Reduction	
Sediment	entire length	29%	road crossings, traction sand, streambank erosion,
			upland erosion, point sources
Nitrate+nitrite	upper	33%	residential and resort landscape management and
	lower	0%	maintenance, on-site septic systems
E. coli	entire length	55%	wastewater, residential and recreational land uses

Table 1. Middle Fork West Fork Gallatin River TMDL Percent Reductions

In 2012, the Blue Water Task Force, which is now the Gallatin River Task Force (Task Force), prepared the *Upper Gallatin Watershed Restoration Plan* (BWTF 2012), which outlines a restoration strategy for addressing the identified water quality impairments in the West Fork Gallatin River watershed. In 2018, the Task Force, in partnership with a diverse group of stakeholders comprising the Big Sky Sustainable Water Solutions Forum, completed the *Big Sky Area Sustainable Watershed Stewardship Plan* (Dunn et al. 2018). The Watershed Stewardship Plan identifies action items for sustaining the ecological health of the river systems, water supply and availability, and wastewater treatment and reuse. The Task Force also recently completed the *Big Sky Area Wetland and Riparian Mapping* (Dunn and Pettit 2018) report, which identifies wetland and riparian restoration and conservation priorities based on natural resource and conservation values, along with wetland and riparian areas with a high potential for impacts from infrastructure and development.

PROJECT LOCATION AND IMPAIRMENT CAUSE ADDRESSED

The five proposed projects on the Middle Fork West Fork Gallatin River are within the West Fork Gallatin River HUC12 (100200080202) in the Upper Gallatin TMDL Planning Area in Madison (Projects 1, 2 and 3) and Gallatin (Projects 4 and 5) counties. Projects address sediment, nutrient and pathogen inputs, with specific project areas presented in **Figure 1** and the water quality impairment cause addressed presented in **Table 2**. In addition, Projects 1, 2, 3 and 5 are located within wetland and riparian priority areas identified in the 2018 *Big Sky Area Wetland and Riparian Mapping* report (**Figure 1**).

Project	Impairment Cause Addressed	Latitude	Longitude
1	Sediment, (E. coli, nitrate+nitrite)	45.29192	-111.40438
2	Nitrate+nitrite, (sediment, E. coli)	45.28904	-111.39657
3	Sediment, alteration in stream-side or littoral vegetation covers	45.28729	-111.39264
4	Sediment, alteration in stream-side or littoral vegetation covers	45.27927	-111.36258
5	Sediment, alteration in stream-side or littoral vegetation covers	45.26795	-111.33333

Table 2. Middle Fork West Fork Gallatin River Project Impairment Addressed

Parentheses indicate secondary benefits of the project



Figure 1. Project Area Overview

PROJECT 1 - UPPER MIDDLE FORK WEST FORK ROAD SEDIMENT BMPs

Project 1 Description:

Project 1 addresses sediment inputs from the road network within the headwaters of the Middle Fork West Fork Gallatin River watershed, with additional potential to reduce nutrient and pathogen inputs. Sediment contributions addressed in Project 1 include runoff from unpaved roads, along with traction sand inputs from both paved and unpaved roads. Project 1 sites include road crossings and near-stream road segments on the Middle Fork West Fork Gallatin River and its tributary streams in the headwaters of the Middle Fork West Fork Gallatin River watershed upstream of Lake Levinsky in the Big Sky Resort base area. Project 1 involves implementation of Best Management Practices (BMPs) by installation of barriers to sediment contributions and recontouring road shoulders where possible. A summary of Project 1 sites is provided in **Table 3** and **Figure 2**, with photographs of each site presented in **Attachment A – Road Sediment Reduction Sites**.

Project 1 Goal and Objectives:

The goal of Project 1 is to reduce sediment loading to streams at road crossings and near-stream road segments in the headwaters of the Middle Fork West Fork Gallatin River watershed upstream of Lake Levinsky. To attain this goal, the following objectives will be accomplished: 1) install and maintain BMPs at 16 road crossings and near-stream road segments on the Middle Fork West Fork Gallatin River (4 sites) and its tributaries (12 sites) upstream of Lake Levinsky (**Table 3** and **Figure 2**).

Project 1 Partners:

Potential Project 1 partners include the Gallatin River Task Force, Trout Unlimited, Big Sky Resort, Moonlight Basin, Montana Department of Transportation, Madison County, and private landowners.

Project 1 Methods:

To address sediment inputs at road crossings, coir wattles will be installed, and the road shoulder will be recontoured where possible. Sites will be maintained annually, and long-term solutions will be developed where possible to reduce the risk of sediment inputs due to culvert failures, enhance fish passage, and improve connectivity within the upper Middle Fork West Fork Gallatin River watershed.

Project 1 Ownership and Access:

Ownership is primarily Big Sky Resort LLC / Boyne Resorts Inc. and Moonlight Basin, along with the Montana Department of Transportation and private landowners (Quam Jay M, Harbaugh Darla L Trust). (**Table 3**). Access is provided by adjacent roadways.

Site	Stream	Road Name	Road	Ownership / Responsibility	Latitude	Longitude
			Surface			
MFX-01	tributary	Turkey Leg Road	Gravel	Big Sky Resort LLC	45.29021	-111.39948
MFX-02	Middle Fork	Sitting Bull Road	Paved	Big Sky Resort LLC	45.29211	-111.39796
MFX-03	tributary	Sitting Bull Road	Gravel	Big Sky Resort LLC	45.29030	-111.40294
MFX-04	tributary	Rising Bull Road	Paved	Big Sky Resort LLC / Boyne Properties Inc	45.29176	-111.40469
MFX-05	tributary	unnamed	Gravel	Big Sky Resort LLC	45.29011	-111.40097
MFX-06	tributary	Lone Mountain Trail (HWY64)	Paved	Montana Department of Transportation	45.29224	-111.39460
MFX-07	tributary	White Otter Road	Paved	Quam Jay M / Harbaugh Darla L Trust	45.29474	-111.40415
MFX-08	Middle Fork	White Otter Chair Lift Access	Gravel	Big Sky Resort LLC	45.29405	-111.40513
MFX-09	tributary	Rising Bull Road	Gravel	Big Sky Resort LLC	45.29745	-111.41301
MFX-10	Middle Fork	Rising Bull Road	Gravel	Boyne Properties Inc	45.29400	-111.41309
MFX-11	tributary	Mountain Loop Road	Paved	MB MT Acquisition LLC	45.29918	-111.41557
MFX-12	tributary	Mountain Loop Road	Paved	MB MT Acquisition LLC	45.29707	-111.41735
MFX-13	Middle Fork	Mountain Loop Road	Paved	MB MT Acquisition LLC	45.29408	-111.41632
MFX-14	tributary	Big Sky Resort Road	Paved	Big Sky Resort LLC	45.28449	-111.39906
MFX-15	tributary	parking lot	Gravel	Big Sky Resort LLC	45.29021	-111.39700
MFX-16	tributary	Lone Mountain Trail (HWY64)	Paved	Montana Department of Transportation	45.29580	-111.40402

Table 3. Project 1 Road Crossings



Figure 2. Project 1 Road Crossings

PROJECT 2 - UPPER MIDDLE FORK WEST FORK RIPARIAN BUFFER

Project 2 Description:

Project 2 addresses nutrient inputs along the margin of Lake Levinsky, with additional potential to reduce sediment and pathogen inputs. Project 2 entails planting riparian shrubs and conifers to enhance the riparian buffer along Lake Levinsky, which is an impoundment on the Middle Fork West Fork Gallatin River. Riparian buffer enhancement will filter surface and subsurface runoff from adjacent areas. Project 2 specifies 0.43 acres of riparian buffer enhancement along Lake Levinsky at five sites (**Figures 3** and **4**).

Project 2 Goal and Objectives:

The goal of Project 2 is to reduce nutrient loading to Lake Levinsky, which is an impoundment on the Middle Fork West Fork Gallatin River. To attain this goal, the following objectives will be accomplished: 1) install riparian shrubs and conifers at five sites totaling 0.43 acres.

Project 2 Partners:

Potential project partners include the Gallatin River Task Force, Trout Unlimited, Big Sky Resort, and Montana Department of Transportation, along with homeowners in the Lake Condominiums.

Project 2 Methods:

To address nutrient inputs, riparian shrubs and conifers will be planted to enhance the riparian buffer.

Project 2 Ownership and Access:

Ownership is primarily Big Sky Resort LLC and Big Sky Montana Inc. and access is provided by adjacent roadways.



Figure 3. Project 2 Existing Conditions along Lake Levinsky



Figure 4. Project 2 Riparian Buffer Enhancement Areas

PROJECT 3 - MIDDLE FORK WEST FORK RESTORATION DOWNSTREAM OF LAKE LEVINSKY

Project 3 Description:

Project 3 addresses sediment impairments, including "alteration in stream-side or littoral vegetation covers", in the Middle Fork West Fork Gallatin River by improving in-stream habitat in a channelized reach downstream of Lake Levinsky. Project 3 entails stream channel restoration and floodplain reconnection along approximately 420 feet of stream channel as depicted in **Figures 5** through **8** and **Attachment B – Projects 3 and 5 Conceptual Design Drawings**.

Project 3 Goal and Objectives:

The goal of Project 3 is to address sediment impairments by improving in-stream habitat within a channelized reach downstream of Lake Levinsky. To attain this goal, the following objectives will be accomplished: 1) approximately 420 feet of stream will be restored to a natural meandering riffle-pool sequence with increased floodplain connectivity and 2) develop wetland features and natural water storage within the existing channel.

Project 3 Partners:

Potential project partners include the Gallatin River Task Force, Trout Unlimited, and Big Sky Resort.

Project 3 Methods:

To address sediment and "alteration in stream-side or littoral vegetation covers" impairments, bioengineering techniques will be used to restore a natural meandering riffle-pool sequence with increased floodplain connectivity, including wetland creation and natural water storage features. Restoration will utilize native materials harvested on-site and appropriate to the landscape setting. Channel data collected within the project reach at monitoring site MFWF04-01 during the 2008 sediment and habitat assessment conducted by DEQ and the Task Force as presented in the *Upper Gallatin Base Parameter Report* (PBS&J 2009a) will provide a starting point for channel design (**Table 4**).

Reach ID	Bankfull Channel Width (Feet)	Cross-Sectional Area (Square Feet)	Bankfull Mean Depth (Feet)	Width / Depth Ratio	Field Slope (Percent)	GIS Calculated Sinuosity	Riffle Pebble Count D50 (mm)	Mean Residual Pool Depth (Feet)	Number of Pools per 1000 Feet	Total Number of LWD per 1000 Feet
MFWF04-01	17.8	20.1	1.1	15.7	3.5	1.14	61	1.1	15	100
MFWF04-01	16.0	21.0	1.3	12.2	3.5	1.14	27			
MFWF04-01	21.2	19.8	0.9	22.7	3.5	1.14	55			

Table 4. 2008 Stream Channel Survey Data Summary for Monitoring Site MFWF04-01

Project 3 Ownership and Access:

Ownership is primarily Big Sky Resort LLC, along with private landowners (Cliffhanger #9 LLC, Behm's Big Dog Lodge LLC). The site can be accessed from the downstream side of the dam at Lake Levinsky.



Figure 5. Project 3 Existing Channel Conditions within Project Reach



Figure 6. Project 3 Existing Conditions within Restored Channel Location



Figure 7. Project 3 Potential Natural Conditions Observed Downstream of Project Reach



Figure 8. Project 3 Channel Restoration Conceptual Design

PROJECT 4 - MIDDLE FORK WEST FORK RESTORATION IN LONE MOOSE MEADOWS

Project 4 Description:

Project 4 addresses sediment impairments, including "alteration in stream-side or littoral vegetation cover", in the Middle Fork West Fork Gallatin River by reducing streambank erosion, enhancing the riparian buffer, and improving in-stream habitat through the addition of large woody debris along approximately 1.3 miles of a historically logged reach. Project 4 entails riparian shrub and conifer plantings in historically logged areas along the channel, along with large woody debris placement as depicted in **Figures 9** through **12**.

Project 4 Goal and Objectives:

The goal of Project 4 is to address sediment impairments by enhancing the riparian buffer and improving in-stream habitat within a historically logged reach of the Middle Fork West Fork Gallatin River. To attain this goal, the following objectives will be accomplished: 1) riparian shrub and conifer plantings in historically logged areas within 50 feet of the channel margin and 2) large woody debris additions, including approximately six large woody debris clusters, along with the addition of individual trees. Riparian shrubs and conifers will be planted in open areas within 50 feet of the channel margin to reduce streambank erosion, increase streamside shading, and restore natural rates of large woody debris recruitment. Approximately 1.3 miles of stream will be addressed by Project 4.

Project 4 Partners:

Potential Project 4 partners include the Gallatin River Task Force, Trout Unlimited, and the Lone Moose Meadow Home Owners Association (HOA).

Project 4 Methods:

To address sediment and "alteration in stream-side or littoral vegetation covers" impairments, riparian shrubs and conifers will be planted along the channel margin and adjacent areas and large woody debris will be added along approximately 1.3 miles of stream, including large woody debris clusters and the addition of individual trees. Large woody debris will be obtained from development-related clearing the Big Sky area and from on-site as opportunities arise. Large woody debris targets presented in the 2010 TMDL document, along with data and observations from reference reaches in the North Fork West Fork Gallatin River (**Figure 11**), will provide a starting point for project design. Riparian plantings will include shrubs along the channel margin and conifers within 50 feet of the channel margin and will be targeted to enhance areas currently lacking natural regeneration post-logging.

Project 4 Ownership and Access:

Ownership is primarily Lone Moose Meadows and access is provided by adjacent roadways.



Figure 9. Project 4 Degraded Riparian Conditions in Monitoring Reach MFWF07-02



Figure 10. Project 4 Degraded Riparian Conditions in Monitoring Reach MFWF08-01



Figure 11. Project 4 Potential Natural Conditions Observed in the North Fork West Fork Gallatin River



Figure 12. Project 4 Riparian Buffer Enhancement and Large Woody Debris Placement Conceptual Design

PROJECT 5 - MIDDLE FORK WEST FORK RESTORATION IN ASPEN GROVES/ANTLER RIDGE

Project 5 Description:

Project 5 addresses sediment impairments, including "alteration in stream-side or littoral vegetation covers", in the Middle Fork West Fork Gallatin River by reducing streambank erosion and improving instream habitat. Project 5 entails channel relocation away from a large eroding streambank and restoration into a historic channel within the center of the meadow. Within the project reach, a large streambank is eroding along the toe of an abandoned logging road that has been converted to a hiking and biking trail that is located within designated parkland in the Big Sky Area. There is silt fence hanging from the top of the streambank into the channel, indicating previous efforts to reduce sediment contributions at the site. The project reach was evaluated during the 2008 sediment and habitat assessment conducted by DEQ and the Task Force and streambank erosion was determined to contribute 26.2 tons/year (PBS&J 2009b). In addition, the channel along the eroding streambank is a continuous riffle lacking diverse in-stream habitat. Project 5 will restore approximately 540 feet of channel into the center of the meadow and will be accompanied by riparian plantings, wetland creation, and side channel-reconnection as depicted in Figures 13 through 16. This project is anticipated to increase the water level within the meadow through floodplain reconnection and wetland creation, which will enhance the potential for natural water storage. In addition, improvements to the trail and bridge crossing could be performed, which will enhance user safety and reduce long-term impacts to the stream channel and riparian corridor.

Project 5 Goal and Objectives:

The goal of Project 5 is to address sediment impairments by reducing sediment loading from streambank erosion and improving in-stream habitat. To attain this goal, the following objectives will be accomplished: 1) relocate the channel away from a large eroding streambank and restore the channel into a historic channel in the center of the meadow, totaling approximately 540 feet of restored channel, 2) enhance the riparian buffer, totaling approximately 1 acre, and 3) develop wetland features and natural water storage within existing channel.

Project 5 Partners:

Potential Project 5 partners include the Gallatin River Task Force, Trout Unlimited, Antler Ridge HOA, and Aspen Groves HOA.

Project 5 Methods:

To address sediment and "alteration in stream-side or littoral vegetation covers" impairments, bioengineering techniques will be used to restore a natural meandering riffle-pool sequence with increased floodplain connectivity. Restoration will utilize native materials appropriate to the landscape setting. Channel data collected within the project reach at monitoring site MFWF09-01 and immediately downstream in MFWF09-02 during the 2008 sediment and habitat assessment conducted by DEQ and the Task Force as presented in the *Upper Gallatin Base Parameter Report* (PBS&J 2009a) will provide a starting point for restoration design (**Table 5**).

Reach ID	Bankfull Channel Width (Feet)	Cross-Sectional Area (Square Feet)	Bankfull Mean Depth (Feet)	Width / Depth Ratio	Field Slope (Percent)	GIS Calculated Sinuosity	Riffle Pebble Count D50 (mm)	Mean Residual Pool Depth (Feet)	Number of Pools per 1000 Feet	Total Number of LWD per 1000 Feet
MFWF09-02	25.7	32.0	1.2	20.7	1.2	1.29	28	1.9	9	15
MFWF09-02	20.2	29.8	1.5	13.7	1.2	1.29				
MFWF09-02	28.5	36.4	1.3	22.3	1.2	1.29	69			
MFWF09-02	20.8	30.7	1.5	14.1	1.2	1.29				
MFWF09-02	31.8	40.8	1.3	24.8	1.2	1.29	51			
MFWF09-01	18.6	24.9	1.3	13.9	2.3	1.24	73	1.3	4	34
MFWF09-01	19.1	28.1	1.5	13.0	2.3	1.24				
MFWF09-01	24.3	34.3	1.4	17.2	2.3	1.24	47			
MFWF09-01	28.4	29.6	1.0	27.3	2.3	1.24				
MFWF09-01	22.9	30.3	1.3	17.3	2.3	1.24	76			

Table 5. 2008 Stream Channel Survey Data Summary for Monitoring Sites MFWF09-01 and 02

Project 5 Ownership and Access:

Ownership is Aspen Groves Development Corp and Antler Ridge Homeowners Assoc Inc, with access on abandoned logging roads that have been converted to a trail system that includes several private landowners (Olson John L and Marilyn J, Anderson Aileen &, Shnider Robert and Amy, and Hogan Jedediah K and Elizabeth A). The project is located within designated parklands in the Big Sky area.



Figure 13. Streambank Erosion along Former Logging Road and Current Trail



Figure 14. Streambank Erosion and Culvert along Former Logging Road and Current Trail



Figure 15. Project 5 Reach Overview and Historic Channel Location to be Restored



Figure 16. Project 5 Channel Restoration and Riparian Buffer Enhancement Conceptual Design

FUTURE OPPORTUNITIES IN THE MIDDLE FORK WEST FORK GALLATIN RIVER WATERSHED

- 1) Identify road crossing sites in Project 1 that may benefit from culvert removal and replacement with structures that facilitate fish passage to enhance connectivity.
- 2) Map and evaluate unassessed road and trail crossings on Big Sky Resort ski runs.
- 3) Address Low Dog Road (aka "Poop Chute") crossing at the base of Thunder Wolf chair lift.
- 4) Identify areas for wetland and riparian enhancement and the creation of natural water storage features on Big Sky Resort ski runs.
- 5) Evaluate opportunity to restore native Westslope Cutthroat Trout in the upper Middle Fork West Fork Gallatin River upstream of Lake Levinsky.
- 6) Improve stormwater management during construction activities and post-construction
- 7) Convert to making snow with treated wastewater effluent instead of water from the Middle Fork West Fork Gallatin River.
- 8) Examine the potential to convert Lake Levinsky into a lined storage pond to store treated wastewater effluent for use during snowmaking and restore the Middle Fork West Fork to a naturally flowing stream around the storage pond.
- 9) Identify additional opportunities for wetland and riparian conservation and restoration for priority sites and priority areas identified in the 2018 *Big Sky Area Wetland and Riparian Mapping* report.

REFERENCES

Blue Water Task Force, 2012. *Upper Gallatin River Watershed Restoration Plan*, prepared by the Blue Water Task Force Inc., Big Sky, MT.

Dunn, J., Filipovich K., Ingman, G., Benn, T., and Collins, Z., 2018. *Big Sky Area Sustainable Watershed Stewardship Plan.* Prepared for Gallatin River Task Force and Big Sky Sustainable Water Solutions Forum.

Dunn, J., Pettit M., 2018. *Big Sky Area Wetland and Riparian Mapping: Restoration and Conservation Opportunities*. Prepared for Gallatin River Task Force.

Montana Department of Environmental Quality, 2010. *The West Fork Gallatin River Watershed Total Maximum Daily Loads (TMDLs) and Framework Watershed Water Quality Improvement Plan,* prepared by the Montana Department of Environmental Quality, MO5-TMDL-01A-F.

PBS&J, 2009a. *Base Parameter Report: Upper Gallatin TMDL Planning Area.* Prepare for Montana Department of Environmental Quality.

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