M08-TMDL-01A

# UPPER JEFFERSON RIVER TRIBUTARY SEDIMENT TMDLS AND FRAMEWORK WATER QUALITY IMPROVEMENT PLAN

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**Montana Department of Environmental Quality**
P.O. Box 200901
Helena, MT 59620-0901

Banning Starr, Project Manager

Darrin Kron, Project Manager

**Significant Contributors**
Jefferson River Watershed Council

**Cooperators**
Montana Fish, Wildlife, and Parks
Trout Unlimited

# ERRATA SHEET FOR THE "UPPER JEFFERSON RIVER TRIBUTARY SEDIMENT TMDLS AND FRAMEWORK WATER QUALITY IMPROVEMENT PLAN"

This TMDL was approved by EPA on September 22, 2009. Several copies were printed and spiral bound for distribution, or sent electronically on compact disks. The original version has a minor change that is explained and corrected on this errata sheet. If you have a bound copy, please note the correction listed below or simply print out the errata sheet and insert it in your copy of the TMDL. If you have a compact disk please add this errata sheet to your disk or download the updated version from our website.

Appropriate corrections have already been made in the downloadable version of the TMDL located on our website at: http://deq.mt.gov/wqinfo/TMDL/finalReports.mcpx

The following table contains corrections to the TMDL. The first column cites the page and paragraph where there is a text error. The second column contains the original text that was in error. The third column contains the new text that has been corrected for the "Upper Jefferson River Tributary Sediment TMDLs and Framework Water Quality Improvement Plan" document.

| **Location in the TMDL** | **Original Text** | **Corrected Text** |
|---|---|---|
| Page 15, Section 1.2, Table 1-1., Row Big Pipestone Creek, Headwaters to mouth (Jefferson River) | Big Pipestone Creek, Headwaters to mouth (Jefferson River) | Remove this row from the table. |
| Page 24, Section 3.1, Table 3-1, Whitetail Creek, Water Body # column | MT41D003_050 | MT41G002_140 |
| Page 32, Section 5.2, Table 5-1, Whitetail Creek, Water Body # column | MT41D003_050 | MT41G002_140 |
| Page 75, Section 5.5, Table 5-35, Whitetail Creek, Water Body # column | MT41D003_050 | MT41G002_140 |

# TABLE OF CONTENTS

Executive Summary ... 9
Section 1.0 Introduction ... 11
1.1 Background ... 11
1.2 303(d) List Summary and TMDLs Written ... 12
1.3 Document Description ... 15
Section 2.0 Watershed Characterization ... 17
2.1 Physical Characteristics ... 17
2.1.1 Location ... 17
2.1.2 Climate ... 17
2.1.3 Hydrology ... 17
2.1.4 Geology, Soils, and Stream Morphology ... 17
2.2 Social Characteristics ... 18
2.2.1 Land Ownership ... 18
2.2.2 Land Use and Land Cover ... 18
2.2.3 Population ... 18
2.3 Fish and Aquatic Life ... 19
Section 3.0 Application of Montana's Water Quality Standards for TMDL Development ... 21
3.1 Upper Jefferson Watershed Stream Classifications and Designated Beneficial Uses ... 21
3.2 Water Quality Standards ... 22
3.2.1 Sediment Standards ... 23
Section 4.0 Description of TMDL Components ... 25
4.1 Establishing and Evaluating Targets ... 25
4.2 Quantifying Pollutant Sources ... 25
4.3 Determining Allocations ... 26
4.4 Margin of Safety ... 27
Section 5.0 Sediment ... 29
5.1 Mechanism of Effects of Excess Sediment on Beneficial Uses ... 29
5.2 Stream Segments of Concern ... 29
5.3 Information Sources and Assessment Methods ... 30
5.3.1 Sediment Loading due to Point Sources ... 31
5.3.2 Modeled Upland Erosion and Riparian Buffering Capacity ... 32
5.3.3 Unpaved Road Sediment Assessment ... 33
5.3.4 Sediment Loading due to Gully Wash and Rill Erosion along Interstate 90 ... 33
5.3.5 Eroding Streambank Sediment Assessment ... 34
5.3.6 Uncertainty ... 34
5.4 Water Quality Targets and Comparison to Existing Conditions ... 35
5.4.1 Water Quality Targets ... 35
5.4.2 Existing Condition and Comparison to Water Quality Targets ... 45
5.5 TMDL Development Summary ... 72
5.6 Source Quantification ... 73
5.6.1 Upland Erosion ... 73
5.6.2 Unpaved Roads ... 74
5.6.3 Streambank Erosion ... 75
5.6.4 Source Assessment Summary ... 76
5.7 TMDL and Allocations ... 76

5.7.1 Big Pipestone Creek ........ 78
5.7.2 Cherry Creek ........ 79
5.7.3 Fish Creek ........ 80
5.7.4 Hells Canyon Creek ........ 82
5.7.5 Little Pipestone Creek ........ 83
5.7.6 Whitetail Creek ........ 84
5.8 Seasonality and Margin of Safety ........ 85
5.8.1 Seasonality ........ 86
5.8.2 Margin of Safety ........ 86
5.8.3 Uncertainty and Adaptive Management ........ 87
Section 6.0 Framework for Water Quality Restoration ........ 89
6.1 Summary of Jefferson Restoration Strategy ........ 89
6.2 Watershed Restoration Goals ........ 89
6.3 Framework Watershed Management Recommendations ........ 90
6.3.1 Sediment Restoration Approaches ........ 90
6.4 Restoration Approaches by Source ........ 104
6.4.1 General Grazing Management BMP Recommendations ........ 105
6.4.2 Unpaved Roads BMPs ........ 108
6.4.3 Sediment Loading Due to Gully Wash and Rill Erosion along Interstate 90 ........ 108
6.4.4 Forestry and Timber Harvest ........ 109
6.4.5 Fire Suppression, Conifer Encroachment, Water Yield and Soil Erosion ........ 109
6.4.6 Beaver Populations and Sediment Yields ........ 112
6.5 Watershed Restoration Summary ........ 112
Section 7.0 Monitoring Strategy and Adaptive Management ........ 115
7.1 Introduction ........ 115
7.2 Adaptive Management Approach ........ 115
7.3 Future Monitoring Guidance ........ 115
7.3.1 Strengthening Source Assessment Prior to Restoration Work ........ 116
7.3.2 Impairment Status Monitoring and Recommended Future Assessments ........ 116
7.3.3 Effectiveness Monitoring for Restoration Activities ........ 117
Section 8.0 Public Involvement ........ 123
Section 9.0 References Cited ........ 125

## APPENDIXS

Appendix A – Watershed Characterization Report Jefferson River Water Quality Restoration Planning Areas
Appendix B – Regulatory Framework and Reference Condition Approach
Appendix C – 2004 Aerial Photo Review and Field Source Assessment, Upper Jefferson River Watershed
Appendix D – Upland USLE Based Sediment Model, Sediment Contribution From Hillslope Erosion For Tributaries of the Upper Jefferson TMDL Planning Area
Appendix E – USLE Generated Upland Erosion Corrected for Existing and Potential Riparian Health
Appendix F – Unpaved Road Sediment Assessment, Upper Jefferson River TMDL Planning Area

Appendix G – Streambank Erosion Source Assessment, Upper Jefferson River Water Quality Restoration Planning Area
Appendix H – Total Maximum Daily Loads

# TABLE OF TABLES

Table 1-1. 2006 303(d) Listed Water Bodies, Impairment Causes, and Impaired Beneficial Uses in the Upper Jefferson River TPA. ........ 13
Table 3-1. Tributary Water Bodies in the Upper Jefferson River TPA from the 2006 303(d) List and their Associated Level of Beneficial Use-Support. ........ 22
Table 3-2. Applicable Rules for Sediment Related Pollutants ........ 23
Table 5-1. Water Body Segments with Sediment Listings and Possible Sediment-related Listings on the 2006 303(d) List ........ 30
Table 5-2. Estimated Average Annual TSS Storm Water Load for the Washington Group International, Inc Mining Facility ........ 32
Table 5-3. Targets and Supplemental Indicators for Sediment in Tributary Stream of the Upper Jefferson TPA ........ 35
Table 5-4. Beaverhead-Deerlodge National Forest Reference Dataset 75th Percentiles for Individual Rosgen Stream Types. ........ 38
Table 5-5. Descriptive Statistics for the Helena National Forest McNeil Core Dataset ........ 40
Table 5-6. Big Pipestone Creek Sediment Data Compared with Targets* ........ 47
Table 5-7. Big Pipestone Creek Sediment Data Compared to Supplemental Indicators. ........ 47
Table 5-8. 2005 Greenline Survey data for Big Pipestone Creek. ........ 48
Table 5-9. Cherry Creek Sediment Data Compared to Targets*. ........ 51
Table 5-10. Cherry Creek Sediment Data Compared with Supplemental Indicators ........ 51
Table 5-11. 2005 Greenline Survey Data for Cherry Creek ........ 51
Table 5-12. Biological Metrics for Cherry Creek ........ 52
Table 5-13. Fish Creek Sediment Data Compared to Targets*. ........ 55
Table 5-14. Fish Creek Sediment Data Compared to Supplemental Indicators. ........ 55
Table 5-15. 2005 Greenline Survey Data for Fish Creek ........ 56
Table 5-16. Biological Metrics for Fish Creek ........ 56
Table 5-17. Fitz Creek Sediment Data Compared with Targets* ........ 58
Table 5-18. Fitz Creek Sediment Data Compared with Supplemental Indicators ........ 58
Table 5-19. 2005 Greenline Survey Data for Fitz Creek ........ 59
Table 5-20. Halfway Creek Sediment Data Compared to Targets* ........ 61
Table 5-21. Halfway Creek Sediment Data Compared to Supplemental Indicators. ........ 61
Table 5-22. 2005 Greenline Survey Data for Halfway Creek ........ 62
Table 5-23. Biological Metrics for Halfway Creek ........ 62
Table 5-24. Hells Canyon Creek Sediment Data Compared to Targets*. ........ 64
Table 5-25. Hells Canyon Creek Sediment Data Compared to Supplemental Indicators. ........ 64
Table 5-26. 2005 Greenline Survey Data for Hells Canyon Creek ........ 65
Table 5-27. Little Pipestone Creek Sediment Data Compared to Targets*. ........ 67
Table 5-28. Little Pipestone Creek Sediment Data Compared to Supplemental Indicators. ........ 67
Table 5-29. 2005 Greenline Survey Data for Little Pipestone Creek ........ 67
Table 5-30. Biological Metrics for Little Pipestone Creek ........ 68
Table 5-31. Whitetail Creek Sediment Data Compared to Targets*. ........ 70
Table 5-32. Whitetail Creek Sediment Data Compared to Supplemental Indicators. ........ 71
Table 5-33. 2005 Greenline Survey Data for Whitetail Creek ........ 71
Table 5-34. Biological Metrics for Whitetail Creek ........ 71
Table 5-35. Summary of TMDL development determinations ........ 73
Table 5-36. Sediment Source Assessment, Allocations and TMDL for Big Pipestone Creek ........ 79

Table 5-37. Sediment Source Assessment, Allocations and TMDL for Cherry Creek ................ 80
Table 5-38. Sediment Source Assessment, Allocations and TMDL for Fish Creek .................... 81
Table 5-39. Sediment Source Assessment, Allocations and TMDL for Hells Canyon Creek ..... 82
Table 5-40. Sediment Source Assessment, Allocations and TMDL for Little Pipestone Creek .. 84
Table 5-41. Sediment Source Assessment, Allocations and TMDL for Whitetail Creek ............ 85
Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed ........ 92
Table 6-2: General Grazing BMPs and Management Techniques (from NRCS 2001 and DNRC 1999). ........ 105
Table 7-1. Monitoring Recommendations for Road BMPs ........ 118
Table 7-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern ........ 120

# TABLE OF FIGURES

Figure 4-1. Schematic example of TMDL development. ... 26
Figure 4-2. Schematic diagram of TMDL and allocations. ... 27
Figure 5-1. Percent fines <6.4 mm as represented by four major geomorphic groups of the Helena National Forest McNeil core dataset ... 39
Figure 5-2. Existing Annual Sediment Load (tons/year) from Upland Erosion by 303(d) Listed Watershed within the Upper Jefferson TPA ... 74
Figure 5-3. Existing Annual Sediment Load (tons/year) from Unpaved Roads in 303(d) Listed Tributary Watersheds within the Upper Jefferson TPA ... 75
Figure 5-4. Existing Annual Sediment Load (tons/year) from Streambank Erosion by 303(d) Listed Tributary Watersheds within the Upper Jefferson TPA ... 76

# EXECUTIVE SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality improvement plan for six impaired tributaries to the Upper Jefferson River near Whitehall, Montana, including Big Pipestone, Little Pipestone, Cherry, Fish, Hells Canyon, and Whitetail creeks. The plan was developed by the Montana Department of Environmental Quality (DEQ).

The Montana Water Quality Act requires DEQ to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. TMDLs are the maximum amount of a pollutant a water body can receive and still meet water quality standards, or the level of reduction in pollutant loading that is needed to meet water quality standards. The goal of TMDLs is to eventually attain and maintain water quality standards in all of Montana's streams and lakes, and to improve water quality to levels that support all state-designated beneficial water uses.

The Upper Jefferson River TMDL Planning Area (TPA) is located in Madison, Silverbow, and Jefferson counties and includes the Jefferson River and its tributaries from Twin Bridges to the Boulder River confluence near Whitehall. The tributaries originate in the Tobacco Root Mountains, located in the southern portion of the watershed, and the Highland Mountains to the north. The watershed drainage area encompasses about 469,994 acres, with land ownership consisting of federal, state, and private lands.

The state of Montana has developed water quality standards per Clean Water Act direction. DEQ has performed assessments determining that a number of tributaries do not meet these standards. The scope of the TMDLs in this document address sediment related problems. The DEQ recognizes there are other pollutant listings for this TPA; however, this document only addresses sediment.

Sediment was identified as a cause of impairment of aquatic life and coldwater fisheries in Big Pipestone, Little Pipestone, Cherry, Fish, Fitz, Halfway, Hells Canyon, and Whitetail creeks. Sediment impacted beneficial water uses in these streams by altering aquatic insect communities, reducing fish spawning success, and increasing turbidity. Water quality restoration goals for sediment in these stream segments were established on the basis of fine sediment levels in trout spawning areas and the stability of streambanks. DEQ believes that once these water quality goals are met, all water uses currently impacted by sediment will be restored.

Sediment loads were quantified for natural background conditions and for the following sources: bank erosion, hillslope erosion, and unpaved roads. The most significant sources included streambank and upland erosion as influenced by agricultural activities as well as reduced sediment trapping efficiency of the vegetated riparian buffer. The Upper Jefferson Watershed sediment TMDLs indicate that reductions in sediment loads ranging from 24% to 55% will result in meeting the water quality restoration goals.

Recommended strategies for achieving the pollutant reduction goals of the Upper Jefferson River Watershed TMDLs are also presented in this plan. They include best management practices (BMPs) for building and maintaining roads, timber harvesting, and suburban development as well as expanding riparian buffer areas and using other land, soil, and water conservation practices that improve the condition of stream channels and associated riparian vegetation.

Implementation of most measures described in this plan will be based on voluntary cooperation by watershed stakeholders, and proposed actions will not conflict with water rights or private property rights. Flexible adaptive management approaches may become necessary as more knowledge is gained through implementation and future monitoring. The plan includes an effectiveness monitoring strategy designed to track future progress toward meeting TMDL objectives and goals, and to help refine the plan during its implementation.

# SECTION 1.0
# INTRODUCTION

## 1.1 Background

This document, *The Upper Jefferson River TMDLs and Framework Watershed Water Quality Improvement Plan*, describes the Montana Department of Environmental Quality's (DEQ) present understanding of sediment related water quality problems in tributary streams of the Upper Jefferson River TPA (**Figures 1 & 2 in Appendix A**) and presents a general framework for resolving them. Guidance for completing the plan is contained in the Montana Water Quality Act and the federal Clean Water Act.

In 1972 Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act. Its goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Clean Water Act requires each state to set water quality standards to protect designated beneficial water uses and to monitor the attainment of those uses. Fish and aquatic life, wildlife, recreation, agriculture, industrial, and drinking water are all types of beneficial uses. Streams and lakes (also referred to as water bodies) that do not meet the established standards are called "impaired waters." These waters are identified on the 303(d) list, named after Section 303(d) of the Clean Water Act, which mandates the monitoring, assessment, and listing of water quality limited water bodies. The 303(d) list is contained within a biennial integrated water quality report. (See **Table 1-1** for a list of waters identified on the 2006 303(d) List as having impairments in the Upper Jefferson River TPA, their impaired uses and probable impairment causes.)

Both Montana state law (Section 75-5-703 of the Montana Water Quality Act) and section 303(d) of the federal Clean Water Act require the development of total maximum daily loads (TMDLs) for impaired waters where a measureable pollutant (e.g., sediment, nutrients, metals, or temperature) is the cause of the impairment. A TMDL is a loading capacity and refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards.

The development of TMDLs and water quality improvement strategies in Montana includes several steps that must be completed for each impaired water body and for each contributing pollutant (or "pollutant/water body combination"). These steps include:

- Characterizing the existing water body conditions and comparing these conditions to water quality standards. Measurable targets are defined as numeric values and set to help evaluate the stream's condition in relation to the standards.
- Quantifying the magnitude of pollutant contribution from sources.
- Establishing allowable loading limits (or total maximum daily loads) for each pollutant
- Comparing the current pollutant load to the loading capacity (or maximum loading limit/TMDL) of the particular water body.
- Determining the allowable loads or the necessary load reduction for each source (called "pollutant allocations").

In Montana restoration strategies and recommendations are also incorporated to help facilitate TMDL implementation.

In some cases the TMDLs may not be capable of fully restoring the designated beneficial uses without the addition of other restoration measures. For example, impairment causes such as streamflow alterations or dewatering, habitat degradation, and streambank or stream channel alterations may prevent a water body from fully attaining its beneficial uses even after TMDLs have been implemented. These are referred to as "pollution" problems, as opposed to impairments caused by any type of discrete "pollutant," such as sediment or metals. TMDLs, *per se*, are not intended to address water use support problems that are not directly associated with specific pollutants. However, many water quality restoration plans (**Section 6.1**) describe strategies that consider and address habitat, streamflow, and other conditions that may impair beneficial uses, in addition to problems caused by more conventional water pollutants. The desired goal of any well designed water quality improvement strategy is to enable restoration of impaired waters such that they support all designated beneficial uses and achieve and maintain full water quality standards by using comprehensive restoration approaches.

## 1.2 303(d) List Summary and TMDLs Written

As per federal court order, by 2012 DEQ must address all pollutant/water body combinations appearing on the 2006 303(d) List and which were also identified on the 1996 303(d) List. Eight tributary stream segments on the 2006 303(d) List were listed as impaired in the Upper Jefferson TPA. Water bodies can become impaired from pollution (e.g., flow alterations and habitat degradation) and from pollutants (e.g., nutrients, sediment, and metals). However, because only pollutants are associated with a load, the EPA restricts TMDL development to pollutants. Pollution is commonly—but not always—associated with a pollutant, and a TMDL may be written (but is not required) for a water body that is only on the 303(d) list for pollution. Based on the 2006 303(d) List and a review of existing data for tributary streams of the Upper Jefferson TPA, 6 TMDLs were written for sediment within 8 water body segments, all of which were listed for pollution (**Table 1-1**).

The causes and sources of sediment related water quality impairments within tributary streams of the Upper Jefferson TPA vary from stream to stream. Listings include a mix of pollutant-related impairment from sediment and pollution-related impairment from substrate alterations, alterations in stream-side or littoral vegetative cover, and low-flow alterations. The scope of the TMDLs in this document address sediment related problems. DEQ recognizes there are other pollutant listings for this TPA; however, this document addresses only sediment. Pollutant-related listings other than sediment will be addressed within a timeframe identified in Montana's law (MCA 75-5-703). A review of the relevant existing data will be provided for stream segments on the 2006 303(d) List in **Sections 5.4.2**.

**Table 1-1. 2006 303(d) Listed Water Bodies, Impairment Causes, and Impaired Beneficial Uses in the Upper Jefferson River TPA.**

| Water body & Location Description | Water Body ID | Impairment Cause | Pollutant Category | Impaired Uses |
|---|---|---|---|---|
| **BIG PIPESTONE CREEK,** headwaters to mouth (Jefferson River) | MT41G002_010 | Suspended Solids | **Sediment*** | Aquatic Life, Cold Water Fishery, Industrial |
| **BIG PIPESTONE CREEK,** headwaters to mouth (Jefferson River) | MT41G002_010 | Habitat Alterations | Not a Pollutant | Aquatic Life, Cold Water Fishery |
| **BIG PIPESTONE CREEK,** headwaters to mouth (Jefferson River) | MT41G002_010 | Thermal Alterations | Temperature | Aquatic Life, Cold Water Fishery |
| **BIG PIPESTONE CREEK,** headwaters to mouth (Jefferson River) | MT41G002_010 | Phosphorus (Total), Nitrogen (Total) | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| **CHERRY CREEK,** headwaters to mouth (Jefferson River) | MT41G002_110 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |
| **CHERRY CREEK,** headwaters to mouth (Jefferson River) | MT41G002_110 | Low flow alterations | Not a Pollutant | Aquatic Life Cold Water Fishery Primary Contact Recreation |
| **CHERRY CREEK,** headwaters to mouth (Jefferson River) | MT41G002_110 | Zinc | Metals | Aquatic Life Cold Water Fishery |
| **CHERRY CREEK,** headwaters to mouth (Jefferson River) | MT41G002_110 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **FISH CREEK,** headwaters to mouth (Jefferson River) | MT41G002_100 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **FISH CREEK,** headwaters to mouth (Jefferson River) | MT41G002_100 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |

**Table 1-1. 2006 303(d) Listed Water Bodies, Impairment Causes, and Impaired Beneficial Uses in the Upper Jefferson River TPA.**

| **Water body & Location Description** | **Water Body ID** | **Impairment Cause** | **Pollutant Category** | **Impaired Uses** |
|---|---|---|---|---|
| **FISH CREEK,** headwaters to mouth (Jefferson River) | MT41G002_100 | Low flow alterations | Not a Pollutant | Aquatic Life Cold Water Fishery Primary Contact Recreation |
| **FITZ CREEK,** headwaters to mouth (Little Whitetail Creek) | MT41G002_160 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **FITZ CREEK,** headwaters to mouth (Little Whitetail Creek) | MT41G002_160 | Phosphorus (Total) | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| **FITZ CREEK,** headwaters to mouth (Little Whitetail Creek) | MT41G002_160 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |
| **HALFWAY CREEK,** headwaters to mouth (Big Pipestone Creek | MT41G002_020 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **HALFWAY CREEK,** headwaters to mouth (Big Pipestone Creek | MT41G002_020 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |
| **HELLS CANYON CREEK,** headwaters to mouth (Jefferson River) | MT41G002_030 | Low flow alterations | Not a Pollutant | Aquatic Life Cold Water Fishery Primary Contact Recreation |
| **HELLS CANYON CREEK,** headwaters to mouth (Jefferson River) | MT41G002_030 | Physical substrate habitat alterations | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **HELLS CANYON CREEK,** headwaters to mouth (Jefferson River) | MT41G002_030 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |
| **LITTLE PIPESTONE CREEK,** headwaters to mouth (Big Pipestone Creek) | MT41G002_040 | Phosphorus (Total), Nitrogen (Total) | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |

**Table 1-1. 2006 303(d) Listed Water Bodies, Impairment Causes, and Impaired Beneficial Uses in the Upper Jefferson River TPA.**

| Water body & Location Description | Water Body ID | Impairment Cause | Pollutant Category | Impaired Uses |
|---|---|---|---|---|
| **LITTLE PIPESTONE CREEK,** headwaters to mouth (Big Pipestone Creek) | MT41G002_040 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **LITTLE PIPESTONE CREEK,** headwaters to mouth (Big Pipestone Creek) | MT41G002_040 | Siltation, Sedimentation | **Sediment*** | Aquatic Life, Cold Water Fishery |
| **WHITETAIL CREEK,** headwaters to mouth (Jefferson river) | MT41G002_140 | Alteration in stream-side or littoral vegetative covers | Not a Pollutant | Aquatic Life Cold Water Fishery |
| **WHITETAIL CREEK,** headwaters to mouth (Jefferson river) | MT41G002_140 | Aluminum, Copper, Silver, Lead | Metals | Aquatic Life Cold Water Fishery |
| **WHITETAIL CREEK,** headwaters to mouth (Jefferson river) | MT41G002_140 | Ammonia, Nitrate/Nitrite, Phosphorus, Total Kjehldahl Nitrogen, Chlorophyll-a | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| **WHITETAIL CREEK,** headwaters to mouth (Jefferson river) | MT41G002_140 | Low flow alterations | Not a Pollutant | Aquatic Life Cold Water Fishery Primary Contact Recreation |

* This document only addresses the pollutant categories in bold.

All 303(d) listing probable causes shown in **bold** in **Table 1-1** are associated with sediment pollutants and will be addressed within this document. Although TMDLs address pollutant loading, implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some pollution impairments in the listed water bodies above.

## 1.3 Document Description

Sediment has been shown to impair some designated uses of tributary streams of the Upper Jefferson River watershed, including aquatic life and coldwater fisheries (See **Table 1-1**). **Table 1-1** provides a summary of identified impairments for the Upper Jefferson River TPA based on the 2006 Integrated Report. DEQ recognizes there are other pollutant listings for the TPA; however, this document only addresses sediment. Because TMDLs are completed for each pollutant/water body combination, one framework water quality improvement plan, such as this, is likely to contain several TMDLs.

The document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy as well as a discussion on public involvement. The main body of the document provides a summary of the TMDL components. Additional technical details are found in the Appendices. The document is organized as follows:

- Watershed Characterization: **Section 2.0**
- Application of Montana's Water Quality Standards for TMDL Development: **Section 3.0**
- Description of TMDL Components: **Section 4.0**
- Sediment – Comparison of Existing Data to Water Quality Targets, Sources and Loads, and TMDLs and Allocations: **Section 5.0**
- Restoration Objectives and Implementation Plan: **Section 6.0**
- Effectiveness Monitoring: **Section 7.0**
- Stakeholder and Public Comments: **Section 8.0**

The Appendices include:

Appendix A: Watershed Characterization Report
Appendix B: Regulatory Framework and Reference Condition Approach
Appendix C: Aerial Photo Review and Field Source Assessment
Appendix D: Sediment Contribution from Hillslope Erosion
Appendix E: Upland Sediment Loading Corrected for Existing and Potential Riparian Buffering Capacity
Appendix F: Sediment Contribution from Roads
Appendix G: Sediment Contribution from Streambank Erosion
Appendix H: Daily TMDLs
Appendix I: Response to Public Comments

# SECTION 2.0
# WATERSHED CHARACTERIZATION

This section includes a summary of the physical and social characteristics of the Upper Jefferson River watershed excerpted from the *Watershed Characterization Report for the Jefferson River Water Quality Restoration Planning Areas*. The entire watershed characterization report, including associated maps, is contained in **Appendix A**.

## 2.1 Physical Characteristics

### 2.1.1 Location

The Upper Jefferson watershed TMDL planning area encompasses approximately 734 square miles of land in Jefferson and Madison counties, beginning at the Jefferson River's point of origin near Twin Bridges and extending to its confluence with the Boulder River near Whitehall. The watershed area includes a dozen or more tributary streams that drain portions of the Tobacco Root Mountains to the south and the Highland Mountains to the north. Land ownership includes a mix of federal, state, and private.

### 2.1.2 Climate

The average precipitation ranges from 10 inches/year in the valley to 18 inches/year at higher elevations, while average snowfall ranges from 9 inches/year in the valley to 85.8 inches/year at higher elevations. May and June are consistently the wettest months of the year and winter precipitation is dominated by snowfall. Temperature patterns reveal that July is the hottest month and January is the coldest throughout the watershed. Summertime highs are typically in the high 70s Fahrenheit to low 80s F, and winter lows fall to approximately 11 degrees F.

### 2.1.3 Hydrology

Streamflows are at their highest between May and June, which also see the greatest amount of precipitation and snowmelt runoff. Streamflows begin to decline in late June or early July and reach minimum flow levels in September, as many streams go dry. This decrease in streamflow correlates with a dwindling water supply and increasing water demands for irrigation and other uses. About 42,000 acres, (9% of the total Upper Jefferson River watershed area) is irrigated. Streamflows begin to rebound in October and November when irrigation ends and fall storms supplement baseflow levels.

### 2.1.4 Geology, Soils, and Stream Morphology

The majority of soils in the Upper Jefferson watershed are moderately susceptible to erosion and produce moderate amounts of runoff. The areas of land draining to Big Pipestone, Little Pipestone, Halfway, Whitetail, and Fitz creeks is dominated by the granitic Boulder Batholith, which is nutrient-poor and highly erodible, contributing to a naturally high sediment supply in these streams.

Many tributary streams have been historically straightened, or channelized, to accommodate a variety of land uses and/or transportation networks. These alterations can have significant effects on sediment transport dynamics of streams and may affect stability of streambanks.

## 2.2 Social Characteristics

### 2.2.1 Land Ownership

Private land dominates the Upper Jefferson watershed, with 44.7% in private ownership. U.S. Forest Service lands account for 38.6% of the area, while the U.S. Bureau of Land Management controls another 11.5%, and the state owns 4.7% (including water). The remaining minor portion falls under U.S. Fish and Wildlife Service designation.

### 2.2.2 Land Use and Land Cover

Evergreen forest (national and other forested lands) is the dominant land use at higher elevations in the watershed, comprising 40.83% of the watershed area. Grass rangelands comprise 37.76% of the land area, while crop and pasturelands make up 11.86%. Brush rangeland and mixed rangeland total an additional combined 5.79% of the land area.

Land cover is dominated by a combination of grassland types (40.03%). A mix of several forest types, including Douglas-fir, mixed xeric forest, lodgepole pine, and mixed subalpine and whitebark pine, accounts for 38.6% of the land cover in the watershed. Sagebrush accounts for 6.6%, dry and irrigated agricultural lands 4.61%, and montane parklands and subalpine meadows 3.22% of the watershed. The remaining 7% of land area consists of minor amounts of 19 different vegetation types.

### 2.2.3 Population

The main towns in the Upper Jefferson River watershed include Twin Bridges in the south and Whitehall in the north. Twin Bridges' population increased from 374 in 1990 to 400 in 2000, while Whitehall had a slight decrease in population from 1,067 in 1990 to 1,044 in 2000. Twenty-four percent of the combined labor force of both towns work in construction, extraction, and maintenance occupations, while 23% work in management and professional occupations. Sales and office occupations employ 19%. Service occupations employ 14% of workers, and production, transportation, and material moving industries employ 13%. Seven percent of workers in Twin Bridges and Whitehall are employed in farming, fisheries, and forestry occupations.

## 2.3 Fish and Aquatic Life

Two fish species occurring within the Upper Jefferson River watershed, the Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) and the Montana arctic grayling (*Thymallus arcticus montanus*), are listed by the state as species of special concern. Westslope cutthroat trout are thought to occur in five streams, including four that appear on the 303(d) list. These include Halfway Creek, Fish Creek, Cherry Creek, and Hells Canyon Creek. Genetically pure populations of Westslope cutthroat trout are thought to be limited to Halfway and Fish creeks. The present distribution of Montana fluvial arctic grayling in the Upper Jefferson watershed is not well known. However, grayling may be present in the Jefferson River mainstem as a result of an attempt to reestablish a population in the lower Beaverhead River upstream of the confluence of the Beaverhead and Big Hole rivers.

# SECTION 3.0
# APPLICATION OF MONTANA'S WATER QUALITY STANDARDS FOR TMDL DEVELOPMENT

The goal of the federal Clean Water Act is to ensure that the quality of all surface waters is capable of supporting all designated uses. Water quality standards also form the basis for impairment determinations for Montana's 303(d) list, TMDL water quality improvement goals, formation of TMDLs and allocations, and standards attainment evaluations. The Montana water quality standards include four main parts: 1) stream classifications and designated uses, 2) numeric and narrative water quality criteria designed to protect the designated uses, 3) non-degradation provisions for existing high quality waters, and 4) prohibitions of various practices that degrade water quality. The components applicable to this document are reviewed briefly below. More detailed descriptions of the Montana water quality standards that apply to the Upper Jefferson TPA can be found in **Appendix B**.

## 3.1 Upper Jefferson Watershed Stream Classifications and Designated Beneficial Uses

Classification is the designation of a single use, or group of uses, to a water body based on the potential of the water body to support those uses. All Montana waters are classified for multiple beneficial uses. All streams and lakes within the Upper Jefferson watershed are classified B-1, which specifies that all of the following uses must be supported: drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. On the 2006 303(d) List, 8 water body segments are listed as not supporting one or more beneficial uses (**Table 3-1**).

While some of the Upper Jefferson watershed streams might not actually be used for a specific purpose (e.g., drinking water supply), the quality of the water must be maintained at a level that can support that use to the best extent possible based on a stream's natural potential. More detailed descriptions of Montana's surface water classifications and designated beneficial uses are provided in **Section B.2 of Appendix B**.

**Table 3-1. Tributary Water Bodies in the Upper Jefferson River TPA from the 2006 303(d) List and their Associated Level of Beneficial Use-Support.**

| Water body & Stream Description | Water body # | Use Class | Year | Aquatic Life | Coldwater Fishery | Drinking Water | Contact Recreation | Agriculture | Industry |
|---|---|---|---|---|---|---|---|---|---|
| **Big Pipestone Creek**, from headwaters to mouth (Jefferson River) | MT41D001_020 | B-1 | 2006 | P | P | F | P | F | P |
| **Cherry Creek**, from headwaters to mouth (Jefferson River) | MT41D002_090 | B-1 | 2006 | N | N | F | N | F | F |
| **Fish Creek**, from headwaters to mouth (Jefferson River) | MT41D003_070 | B-1 | 2006 | N | N | F | N | F | F |
| **Fitz Creek**, from headwaters to mouth (Whitetail Creek) | MT41D002_030 | B-1 | 2006 | N | N | F | N | F | F |
| **Halfway Creek**, from headwaters to mouth (Big Pipestone Creek) | MT41D003_130 | B-1 | 2006 | P | P | F | F | F | F |
| **Hells Canyon Creek**, from headwaters to mouth (Jefferson River) | MT41D003_030 | B-1 | 2006 | P | P | F | P | F | F |
| **Little Pipestone Creek**, from headwaters to mouth (Big Pipestone Creek) | MT41D003_220 | B-1 | 2006 | P | P | F | F | F | F |
| **Whitetail Creek**, from headwaters to mouth (Jefferson River)** | MT41G002_140 | B-1 | 2006 | P | P | F | P | F | F |

F = Full Support, P = Partial Support, N = Not Supported, T = Threatened, X = Not Assessed (Lacking Sufficient Credible Data)

## 3.2 Water Quality Standards

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria that are designed to protect the designated uses. For the sediment

TMDL development process in the Upper Jefferson River TPA, only the narrative standards are applicable.

Narrative standards have been developed for substances or conditions where sufficient data on the long and/or short-term effects do not exist or for pollutants whose effects must be assessed on a site-specific basis. Narrative standards describe either the allowable condition or an allowable increase of a pollutant over “naturally occurring” conditions or pollutant levels. DEQ uses a reference condition (naturally occurring condition) to determine whether or not narrative standards are being achieved.

Reference condition is defined as the condition a water body could attain if all reasonable land, soil, and water conservation practices were put in place. Reasonable land, soil, and water conservation practices usually include, but are not limited to, best management practices (BMPs).

The specific sediment narrative water quality standards that apply to the Upper Jefferson River watershed are summarized below. More detailed descriptions of Montana’s surface water standards are provided in **Section B.2 of Appendix B**.

### 3.2.1 Sediment Standards

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in **Table 3-2**. The relevant narrative criteria do not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. In other words, water quality goals should aim for condition in which any increases in sediment above naturally occurring levels are not harmful, detrimental, or injurious to beneficial uses (see definitions in **Table 3-2**).

**Table 3-2. Applicable Rules for Sediment Related Pollutants**

| Rule(s) | Standard |
|---|---|
| 17.30.622(3) & 17.30.623(2) | No person may violate the following specific water quality standards for waters classified A-1 or B-1. |
| 17.30.602(19) | “Naturally occurring” means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971, are natural. |
| 17.30.602(24) | “Reasonable land, soil, and water conservation practices” refers methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities. |

**Table 3-2. Applicable Rules for Sediment Related Pollutants**

| Rule(s) | Standard |
|---|---|
| 17.30.622(3)(f) & 17.30.623(2)(f) | No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife. |
| 17.30.622(3)(d) | No increase above naturally occurring turbidity or suspended sediment is allowed in A-1 except as permitted in 75-5-318, MCA. |
| 17.30.623(2)(d) | The maximum allowable increase above naturally occurring turbidity is 5 NTU for B-1 except as permitted in 75-5-318, MCA. |
| 17.30.637(1)(a & d) | State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life. |

# SECTION 4.0
# DESCRIPTION OF TMDL COMPONENTS

A TMDL is basically a loading capacity for a particular water body and refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards. A TMDL is also a reduction in pollutant loading resulting in attainment of water quality standards. More specifically, a TMDL is the sum of waste load allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background sources. In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. The allowable pollutant load must ensure that the water body will be able to attain and maintain water quality standards regardless of seasonal variations in water quality conditions, streamflows, and pollutant loading. TMDLs are expressed by the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

Section 5 includes all 303(d) listings specific to sediment, the source assessment process for that pollutant, relevant water quality targets, a comparison of existing conditions to targets, quantification of loading from identified sources, TMDLs, and allocations to sources. The major components that figured into TMDL development are described below.

## 4.1 Establishing and Evaluating Targets

Because loading capacity is evaluated in terms of meeting water quality standards, quantitative water quality targets and supplemental indicators are developed to help assess the condition of the water body relative to the applicable standard(s) and to help determine successful TMDL implementation. This document outlines water quality targets for sediment, the pollutant of concern, in tributary streams of the Upper Jefferson TPA. TMDL water quality targets help translate the numeric or narrative water quality standards for the pollutant of concern. For pollutants with established numeric water quality standards, the numeric values are used as TMDL water quality targets. For pollutants with only narrative standards, such as sediment, the water quality targets help to further interpret the narrative standard and provide an improved understanding of impairment conditions. Water quality targets typically include a suite of instream measures that link directly to the impacted beneficial use(s) and applicable water quality standard(s). The water quality targets help define the desired stream conditions and are used to provide benchmarks to evaluate overall success of restoration activities.

## 4.2 Quantifying Pollutant Sources

All significant pollutant sources, including natural background loading, are quantified so that the relative pollutant contributions can be determined. Because water quality impacts can vary throughout the year, often source assessments must evaluate the seasonal nature and ultimate fate of the pollutant loading. The source assessment usually helps further define the extent of the problem by putting human-caused loading into context with natural background loading.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Most other pollutant sources, typically referred to as nonpoint sources, are quantified by source categories, such as unpaved roads, and/or by land uses, such as crop production or forestry. These source categories or land uses can be further divided by ownership such as federal, state, or private. Alternatively, a sub-watershed (or tributaries) approach can be used whereby most or all sources are combined for quantification purposes.

The source assessments are performed at a watershed scale because all potentially significant sources of the water quality problems must be evaluated. The source quantification approaches may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading (40CFR Section 130.2(I)). Montana TMDL development often includes a combination of approaches, depending on the level of desired certainty for setting allocations and guiding implementation activities.

**Figure 4-1** is a schematic diagram illustrating how numerous sources contribute to the existing load and how a TMDL is determined by comparing the existing load to that which will meet standards.

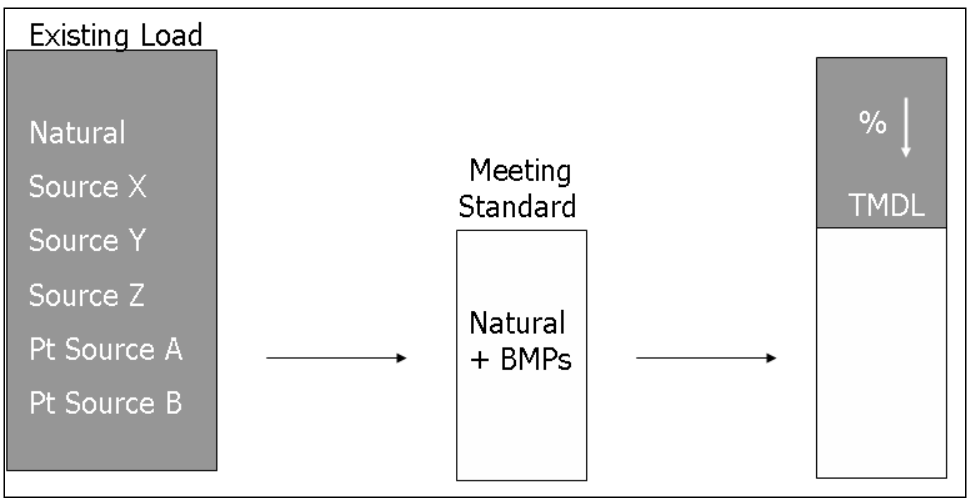


**Figure 4-1. Schematic example of TMDL development.**

## 4.3 Determining Allocations

Once the loading capacity (i.e., TMDL) is determined, that total must be divided, or allocated, among the contributing sources. Allocations are determined by quantifying feasible and achievable load reductions associated with the application of reasonable land, soil, and water conservation practices. Reasonable land, soil, and water conservation practices generally include BMPs, but additional conservation practices may be required to achieve compliance with water quality standards and restore beneficial uses. **Figure 4-2** contains a schematic diagram of how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Under the current regulatory framework for development of TMDLs, flexibility is allowed for specifying allocations in that “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.” Allocations are typically expressed as a number, a percent reduction (from the current load), or as a surrogate measure, such as a percent increase in canopy density for temperature TMDLs.

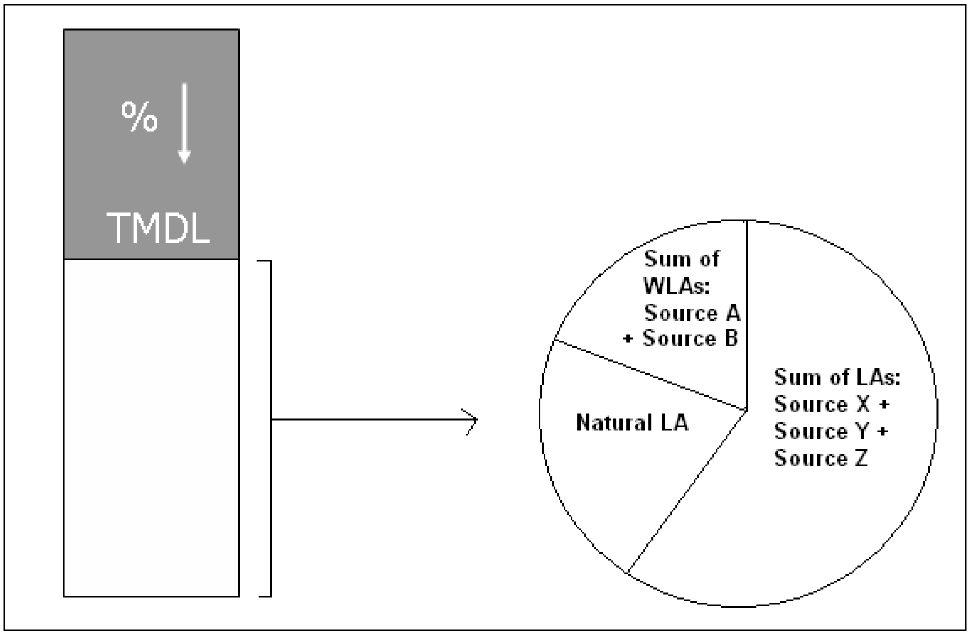


**Figure 4-2. Schematic diagram of TMDL and allocations.**

## 4.4 Margin of Safety

Incorporating a margin of safety (MOS) is a required component of TMDL development. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to sustain conditions that will support beneficial uses. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (EPA, 1999). The TMDLs within this document incorporate an implicit MOS in a variety of ways that are discussed in greater detail in **Section 5.8.**

# SECTION 5.0
# SEDIMENT

This portion of the document focuses on sediment as an identified cause of water quality impairments in the Upper Jefferson TPA. It describes: 1) the mechanisms by which sediment impairs beneficial uses of those streams, 2) the specific stream segments of concern, 3) the available data pertaining to sediment impairments in the watershed, 4) the various contributing sources of sediment based on recent studies, and 5) the sediment TMDLs and allocations.

## 5.1 Mechanism of Effects of Excess Sediment on Beneficial Uses

Weathering and erosion of land and transport of sediment to and by streams are important natural phenomena that help build and maintain streambanks and floodplains. However, excessive erosion, or the absence of natural sediment barriers and filters such as riparian vegetation, woody debris, beaver dams, and overhanging vegetation, can lead to high levels of suspended sediment and sediment deposits in areas not naturally containing high levels of fine sediment.

Uncharacteristically high amounts of sediment in streams can impair habitat for aquatic life and coldwater fisheries as well as beneficial uses for recreation and drinking water. Excess suspended sediment can increase filtration costs for water treatment facilities, decrease recreational use potential, and impair aesthetic values. Fish and other aquatic life are typically the most sensitive to excess sediment. High levels of suspended sediment can reduce light penetration through water, which may limit growth of algae and aquatic plants. This decline in primary producers could result in a decline in aquatic insect populations, which may also be affected if deposited sediment obscures food, habitat, hiding places, and nesting sites. Excess sediment can also impair biological processes and reproductive success of individual aquatic organisms by clogging gills and causing abrasive damage, reducing spawning sites, and smothering eggs or hatchlings. An accumulation of fine sediment on stream bottoms can also reduce water flow through gravels harboring incubating eggs, hinder the emergence of newly hatched fish, deplete the oxygen supply to embryos, and cause metabolic wastes to accumulate around embryos, killing them.

## 5.2 Stream Segments of Concern

A total of eight tributary water body segments in the Upper Jefferson TPA appeared on the 2006 Montana 303(d) List due to sediment impairments (**Table 5-1**). These include Big Pipestone, Little Pipestone, Cherry, Fish, Fitz, Halfway, Hells Canyon, and Whitetail creeks. Pollutant listing causes include sedimentation/siltation and suspended solids. As shown in **Table 5-1**, many of the water bodies with sediment impairments are also listed for habitat and flow alterations, which are forms of pollution frequently associated with sediment impairment. TMDLs are limited to pollutants, but implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some pollution impairments.

**Table 5-1. Water Body Segments with Sediment Listings and Possible Sediment-related Listings on the 2006 303(d) List**

| Stream Segment | Water Body # | Sediment and Potentially Related Causes of Impairment |
|---|---|---|
| **Big Pipestone Creek,** from headwaters to mouth (Jefferson River) | MT41D001_020 | Suspended solids & physical substrate habitat alterations* |
| **Cherry Creek**, from headwaters to mouth (Jefferson River) | MT41D002_090 | Sedimentation / siltation, Physical substrate habitat alterations* & flow alterations* |
| **Fish Creek,** from headwaters to mouth (Jefferson River) | MT41D003_070 | Sedimentation/ siltation, physical substrate habitat alterations* & flow alterations* |
| **Fitz Creek,** from headwaters to mouth (Whitetail Creek) | MT41D002_030 | Sedimentation/ siltation & physical substrate habitat alterations* |
| **Halfway Creek,** from headwaters to mouth (Big Pipestone Creek) | MT41D003_130 | Sedimentation/ siltation & physical substrate habitat alterations* |
| **Hells Canyon Creek,** from headwaters to mouth (Jefferson River) | MT41D003_030 | Sedimentation/ siltation, physical substrate habitat alterations* & flow alterations* |
| **Little Pipestone Creek,** from headwaters to mouth (Big Pipestone Creek) | MT41D003_220 | Sedimentation/ siltation & physical substrate habitat alterations* |
| **Whitetail Creek,** from headwaters to mouth (Jefferson River) | MT41G002_140 | Sedimentation/ siltation, physical substrate habitat alterations* & flow alterations* |

*Form of pollution frequently linked to sediment impairment.

## 5.3 Information Sources and Assessment Methods

Sources used to develop the TMDL components include information from DEQ assessment files used to make impairment determinations and data collected and/or obtained during the TMDL development process. Physical, biological, and habitat data were collected by DEQ on most water bodies between 1999 and 2003. Additionally, field measurements of channel morphology and riparian and instream habitat parameters were collected in 2004 and 2005 from 20 reaches on 11 water bodies to aid in TMDL development. The focus of the 2005 Upper Jefferson River TPA Sediment and Stream Morphology Project was to apply the 2004 aerial photo interpretation results and preliminary pollution source assessment to direct physical sampling for suspected and confirmed sediment-impaired stream segments in the upper Jefferson Watershed (DEQ, 2005a & DEQ, 2006). Water quality monitoring and assessments were intended to characterize instream sediment conditions and bank erosion for 303(d) listed stream segments in the Upper Jefferson watershed. The field parameters assessed in 2005 include standard measures of stream channel morphology, stream habitat, riparian vegetation, and near-stream land use. The aerial and field assessments are described in more detail in the *Upper Jefferson River Water Quality Monitoring*

*Project Quality Assurance Project Plan* (DEQ, 2005b). Field parameters are briefly described in Section 5.4, and summaries of all field data are contained in the 2005 and 2006 monitoring summary reports (DEQ, 2005a & DEQ, 2006).

Significant sediment sources identified within the Upper Jefferson TPA that were assessed for the purposes of TMDL development include:

- point sources
- upland erosion and riparian health
- unpaved roads
- gully and rill erosion from I-90
- streambank erosion

For each impaired water body segment, sediment loads from each source category were estimated based on field surveys, watershed modeling, and load extrapolation techniques (described below). Additional details about the source assessment approach are contained in the *Upper Jefferson River Water Quality Monitoring Project Quality Assurance Project Plan* (DEQ, 2004). The complete methods and results for source assessments for upland erosion, unpaved roads, and streambank erosion are located in **Appendices D, E, F,** and **G.**

### 5.3.1 Sediment Loading due to Point Sources

Point sources of sediment in the tributaries of the Upper Jefferson TPA evaluated in this assessment include the town of Whitehall's domestic wastewater treatment facility's municipal permit (Permit # MT0020133) and the Washington Group International, Inc., storm water permit (Permit # MTR300007).

Whitehall has a wastewater treatment lagoon facility that is permitted to continuously discharge into Big Pipestone Creek. The Town's Montana Pollutant Discharge Elimination System (MPDES) permit was renewed March 1, 2009. This permit set the Average Monthly Limitation for Total Suspended Solids (TSS) at 94 lb/day, or 17.1 tons/year, for effluent discharged from this facility. This number represents the maximum amount of TSS that the facility could discharge and remain in compliance with the MPDES permit. If the conservative approach is taken and 100% of this TSS is considered to be sediment then this waste load represents <0.15% of the overall sediment yield quantified for the Big Pipestone Creek watershed (**Table 5-36**). Facility discharge monitoring reports were then used to calculate the existing load of TSS discharged from the facility. The facility's actual annual average TSS load contribution was calculated using monthly TSS and discharge measurements from 1998-2007 (n=93). The average TSS contribution from this source was 6 tons/year, discharging directly to Big Pipestone Creek. Again, if the conservative approach is taken and 100% of this TSS is considered to be sediment then this waste load represents <0.05% of the overall sediment yield assessed in the Big Pipestone Creek watershed. As such, the waste load allocation for the Town of Whitehall domestic waste water treatment facility will be set at 17.1 tons/year, equivalent to the MPDES permit limit.

The Washington Group International, Inc., has a MPDES storm water permit covered under the general permit for storm water discharges associated with mining and with oil and gas activities.

This permit regulates the direct discharge of storm water draining the facility and its grounds. Based upon a review of this permit and associated materials within the permitting file, no discharges have ever been recorded at this facility. The fact that no discharge has been reported, and in conjunction with the current use of sediment BMPs on site, this facility is deemed an insignificant source of sediment within the Big Pipestone watershed. That being said per State and Federal TMDL law, all permitted point source discharges of the TMDL pollutant, including storm water, must have a waste load allocation developed within the framework of the TMDL. As such an estimation of this load allocation was undertaken and is presented below.

This assessment utilized the average annual precipitation of the Upper Jefferson watershed, the acres of land disturbed by this activity and the target concentration of 100mg/l TSS, to calculate a worst case scenario average annual TSS load if all water were to run off from the site. The 100 mg/l TSS concentration was taken from Attachment B, Monitoring Parameter Benchmark Concentrations, within the general storm water permit. If this benchmark is met, a facility represents little potential for water quality concern. This level of TSS represents a target concentration for a facility to achieve through the implementation of appropriate best management practices. That being said current implemented BMPs at the facility are probably reducing concentrations much lowers then this value and very little water exits the site as surface runoff. The total average annual TSS storm water waste load allocation calculated for this facility is 7.3 tons/year (**Table 5-2).**

**Table 5-2. Estimated Average Annual TSS Storm Water Load for the Washington Group International, Inc Mining Facility**

| Acres Disturbed (acres) | Average Annual Precipitation (inches) | Target Concentration (mg/l) | TSS (tons/year) |
|---|---|---|---|
| 45 | 14.5 | 100 | 7.3 |

This waste load represents <0.06% the overall sediment yield assessed in the Big Pipestone Creek watershed. As discussed above, this load estimate is based on a worse case modeled scenario where the conditions of the general storm water are all satisfied. Therefore, meeting the conditions of the existing general storm water permit will satisfy this waste load allocation.

## 5.3.2 Modeled Upland Erosion and Riparian Buffering Capacity

Upland sediment loading due to hillslope erosion was modeled using the Universal Soil Loss Equation (USLE). Sediment delivery to the stream was predicted using a sediment delivery ratio. The USLE results are useful for source assessment as well as for determining allocations for human-caused upland erosion. This model provided an estimate of existing sediment loading from upland sources and an estimate of potential sediment loading reductions by applying best management practices (BMPs). Because the plant canopy and type of tillage practices can influence erosion, potential load reductions are calculated by adjusting factors within the model associated with land management and cropping practices (C-factors). Additional information on the upland erosion modeling can be found in *Sediment Contribution from Hillslope Erosion* (**Appendix D**).

The Upland USLE-based modeling effort did not, however, take into account the effect that vegetated riparian buffers have on reducing the upland sediment load delivered to streams. Because of this, a secondary effort was undertaken to qualify existing and potential riparian health and its associated effect on existing and potential upland sediment loads to the 303(d) listed tributaries of the Upper Jefferson TMDL Planning Area (TPA); it is presented in *USLE Based Upland Sediment Loading Corrected for Existing and Potential Riparian Buffering Capacity* (**Appendix E**).

Supplemental to the modeling scenarios developed for the upland USLE model, this secondary effort provides an additional assessment of the existing sediment loading from modeled upland sources routed through the existing riparian buffer condition. In addition it provides for an assessment of potential sediment loading reductions gained through BMPs, to those activities whose actions within the near-stream riparian environment have the potential to affect the buffering capacity (i.e., sediment reduction efficiency) of the vegetated riparian buffer.

The sediment load allocation strategy for upland erosion sources provides for a potential decrease in loading through BMPs in upland land uses, as well as those land management activities that have the potential to affect the overall heath and/or buffering capacity of the vegetated riparian buffer. A more detailed description of the assessment can be found in *Sediment Contribution from Hillslope Erosion* (DEQ, 2007) (**Appendix D**) and *USLE Based Upland Sediment Loading Corrected for Existing and Potential Riparian Buffering Capacity* (**Appendix E**).

### 5.3.3 Unpaved Road Sediment Assessment

Sediment loading from unpaved roads was assessed using GIS, field data collection, and sediment modeling. Each identified unpaved road crossing and near-stream road segment was assigned attributes for road name, surface type, road ownership, stream name, subwatershed, and landscape type (i.e., mountain, foothill, or valley). Sixty crossings and 23 near-stream segments representing the range of conditions within the watershed were field assessed in 2006, and sediment loading was estimated using the Water Erosion Prediction Project Methodology (WEPP:Road). The average sediment contribution from unpaved road crossings and near-stream road segments were extrapolated to all unpaved roads in the watershed based on landscape type. To address sediment from unpaved roads in the TMDLs and allocations that follow in **Section 5.6**, the WEPP:Roads analysis was also run using BMPs to reduce the road contributing length. A more detailed description of this assessment can be found in *Unpaved Road Sediment Assessment* (DEQ, 2007) (**Appendix F**).

### 5.3.4 Sediment Loading due to Gully Wash and Rill Erosion along Interstate 90

The transport and input of gully wash and rill erosion was assessed along Homestake Creek, tributary to Big Pipestone Creek, adjacent to Interstate 90 (I-90). In his student thesis titled *Hydrology, Water Quality, and Sediment transport Rates in the Pipestone Creek Watershed, Jefferson County, Montana*, Berger (2004) attempted to semi-quantify the volume of sediment produced from sources associated with I-90. He estimated that the approximate volume of sediment entering Homestake Creek from I-90 sources was roughly 500 cubic feet or 21 tons (assuming a bulk density of 1.44 tons/cubic yard). However, he also stated that due to the high rates of bedload transport in the stream, it is likely that this total was significantly underestimated. Berger's study noted that these sediment inputs were dominated by four large sources that were traced to uncontrolled runoff from I-90 and subsequent gullying and rill erosion of steep hillslopes leading down to Homestake Creek.

In the TMDLs and allocations that follow, a 10% reduction in the human-caused sediment load from I-90 sources is proposed. The Montana Department of Transportation will explore alternatives for diverting road runoff from sensitive areas and capturing sediment. Additionally, BMPs may be used to prevent delivery of road materials, including gully wash, rill erosion, and road traction sanding, to Homestake Creek. BMPs could include planting vegetation buffers, routing flows away from streams, and creating sediment traps. Loading from gully wash and rill erosion will be considered in developing sediment loads, allocations, and potential reductions. Road traction sanding also has the potential to produce a sediment load. Though not included in this allocation strategy, it is recommended that road traction sanding be evaluated through adaptive management and monitoring.

### 5.3.5 Eroding Streambank Sediment Assessment

Sediment loading from eroding streambanks was assessed by performing Bank Erosion Hazard Index (BEHI) measurements and evaluating the Near Bank Stress (NBS) (Rosgen 1996, 2004) along monitoring reaches in 2005. BEHI scores were determined at each eroding streambank based on the following parameters: bank height, bankfull height, root depth, root density, bank angle, and surface protection. In addition to BEHI data collection, the source of streambank erosion was evaluated based on observed human-caused disturbances and the surrounding land-use practices based on the following near-stream source categories:

- transportation
- riparian grazing
- cropland
- mining
- silviculture
- irrigation-shifts in stream energy
- natural sources
- other

Streambank erosion data from the 2005 monitoring was extrapolated to the stream reach, stream segment, and watershed scales. The potential for sediment load reduction at the stream segment scale was estimated as a percent reduction that could be achieved if all eroding streambanks could be reduced to a moderate BEHI score. A more detailed description of this assessment can be found in *Streambank Erosion Source Assessment,* which is included as **Appendix G**.

### 5.3.6 Uncertainty

A degree of uncertainty is inherent in any study of watershed processes related to sediment. Sediment limitations in many streams in the Upper Jefferson TPA relate to a fine sediment fraction found on the stream bottom, while sediment modeling used in the Upper Jefferson TPA examined all sediment sizes. In general, roads and uplands produce mostly fine sediment loads, while streambank erosion can produce all sediment sizes. Because sediment source modeling may under- or over-estimate natural inputs due to selection of sediment monitoring sections and the extrapolation methods used, model results are not an accurate account of sediment production within each watershed. Instead, source assessment model results are used as a tool to estimate sediment loads and make general comparisons of sediment loads from various sources. Due to the uncertainty with modeling, this TMDL document will include a monitoring and adaptive management plan (Section 7) to account for such uncertainties in the source assessment results.

## 5.4 Water Quality Targets and Comparison to Existing Conditions

This section summarizes water quality targets and compares them with available data for the tributary stream segments of concern in the Upper Jefferson TPA (**Table 5-1**). Although placement on the 303(d) list indicates impaired water quality, a comparison of water quality targets with existing data helps define the level of impairment and guide the development of TMDL allocations. It also establishes a starting point from which to measure future water quality restoration success.

### 5.4.1 Water Quality Targets

For the tributary streams of the Upper Jefferson TPA, a suite of water quality targets and supplemental indicators are presented to assess the effect of sediment derived from human-caused sources on beneficial use support. Water quality targets and supplemental indicators for sediment impairments include measures of the width/depth ratio, entrenchment ratio, percent of fine sediment on the stream bed and in pool tail-outs, eroding banks, residual pool depths, pool frequency, large woody debris frequency, riparian condition, and biological metrics. Future surveys should document stable (if meeting criterion) or improving trends. The proposed water quality targets and supplemental indicators for sediment impairments are summarized in **Table 5-3** and are described in detail in the sections that follow. If the results are consistent with the existing impairment determinations, a TMDL will be provided. Site-specific conditions such as recent wildfires, natural conditions, and flow alterations within a watershed may warrant the selection of unique indicator values that differ slightly from those presented below, or special interpretation of the data relative to the proposed sediment indicator values.

**Table 5-3. Targets and Supplemental Indicators for Sediment in Tributary Stream of the Upper Jefferson TPA**

| Water Quality Targets | Proposed Criterion |
|---|---|
| Percentage of fine surface sediment <6mm based on the reach composite pebble count. | Comparable with reference values based on Rosgen Stream type. [a] |
| Percentage of fine surface sediment <2mm based on the reach **average** riffle pebble counts. | The reach average value must not exceed 20%. This target shall not apply to low gradient E type streams with natural silt or sand substrates. Future surveys should document stable or improving trends. |

**Table 5-3. Targets and Supplemental Indicators for Sediment in Tributary Stream of the Upper Jefferson TPA**

| **Water Quality Targets** | **Proposed Criterion** |
|---|---|
| Percentage of subsurface fines < 6.4 mm size class, expressed as a **reach** average, in McNeil core samples collected in trout spawning gravel beds. | The reach average value must not exceed 30%. [b] Future surveys should document stable or improving trends. |
| Percentage of subsurface fines < 0.85 mm size class, expressed as a reach **average**, in McNeil core samples collected in trout spawning gravel beds. | The reach average value must not exceed 10%. Future surveys should document stable or improving trends. |
| Width/depth ratio, expressed as a reach **median** from channel cross-section measurements. | Comparable with reference values. [a] |
| Entrenchment ratio, expressed as a reach **median** from channel cross-section measurements. | Comparable with reference values. [a] This target only applies to B, C, and E stream types. An entrenchment ratio >5 will be considered to meet the water quality target for C channels and >3.7 for E channels. |
| Supplemental Indicators | Proposed Criterion |
| BEHI hazard rating, expressed as a reach **average**. | Comparable with reference values based on Rosgen Stream type. [a] |
| Percentage of eroding banks, based on the sum of both left and right bank lengths per reach. | Non-eroding banks for at least 85% of reach for A, E, B, and C type streams. Future surveys should document stable or improving trends. |
| Proper Functioning Condition (PFC) riparian assessment. | "Proper Functioning Condition" or "Functional-at Risk" with an upward trend and the intent of reaching "Proper Functioning Condition". |
| Anthropogenic sediment sources. | No significant sources identified based on field and aerial surveys. |
| Macroinvertebrates | Mountain MMI > 63<br>Valley MMI > 48<br>0.80 < RIVPACS < 1.2 |
| Pool frequency and average residual pool depth per reach. | Until appropriate reference conditions are identified, 2005 inventory values shall provide benchmarks for future surveys. Future surveys should document stable or improving trends. |
| Greenline survey. | ≥ 49% understory shrub cover |

[a] Based on the Beaverhead-Deerlodge National Forest channel morphology dataset and applies only to Jefferson River tributary streams.
[b] Based on the Helena National Forest McNeil Core dataset.

Several of the water quality targets for sediment in the Upper Jefferson TPA are based on regional reference data. Note: DEQ defines "reference" as the condition of a water body capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, reference condition reflects a water body's greatest potential for water quality given historic and current land use activities. Water bodies used to determine reference conditions are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. In addition, this reference condition approach is not an effort to "turn back the clock" to conditions that may have existed before human settlement but is intended to accommodate natural variations due to climate, bedrock, soils, hydrology, and other natural physiochemical differences when establishing threshold values for sediment indicators. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology due to human activity.

**Channel Morphology and Substrate Measurements**

The channel morphology dataset compiled by Pete Bengeyfield of the U.S. Forest Service was used to develop several water quality targets in the Upper Jefferson TPA. This dataset includes regional reference data derived from the Beaverhead-Deerlodge National Forest and the Greater Yellowstone Area and includes nearly 300 surveys in the Big Hole watershed and more than 650 surveys in the south zone of the Beaverhead-Deerlodge National Forest between 1991 and 2002.

The Beaverhead-Deerlodge National Forest channel morphology surveys were compiled into a channel morphology reference dataset based on approximately 200 reference sites. Approximately 70 of the reference sites were from the Greater Yellowstone Area, while the remaining sites were surveyed within the Beaverhead-Deerlodge National Forest. Streams described as “reference” were not necessarily in pristine watersheds, though the streams had to be stable and in “proper functioning condition.” Streams that shifted a Level I Rosgen classification value (e.g., E to C) were reported as “non-functioning” and were not included in the reference dataset (Bengeyfield, 2004). The entire reference dataset is available upon request from the Beaverhead-Deerlodge National Forest and has been provided to DEQ.

Water quality targets for the percent of fine sediment are <6mm, channel width/depth ratio, entrenchment ratio, and the Bank Erosion Hazard Index (BEHI) rating are based on the Beaverhead-Deerlodge National Forest channel morphology reference dataset. The 75th percentile was calculated from the reference dataset and will be used as a basis for sediment water quality targets (**Table 5-4**). Since the water quality target depends on the stream type, the term “comparable to reference values” should be interpreted as “less than or equal to” the 75th percentile for the percent surface fines, width/depth ratio, and BEHI. “Comparable to reference values” should be interpreted as “greater than or equal to” the 75th percentile for the entrenchment ratio and sinuosity. In essence, lower values for surface fine sediment, width/depth ratio, and BEHI rating are more desirable and suggest support of the coldwater fishery and aquatic life beneficial uses. In general, higher values are desirable for the entrenchment ratio and sinuosity, though entrenchment ratio indicators will not be applied to streams that are naturally A types, since these stream types, by definition, are entrenched. In addition, no fine sediment indicators will be applied to streams that are naturally E5 or E6 types, since these stream types naturally have high amounts of fine sediment.

**Table 5-4. Beaverhead-Deerlodge National Forest Reference Dataset 75th Percentiles for Individual Rosgen Stream Types.**

| **Parameter** | **A** | **B3** | **B4** | **B** | **C3** | **C4** | **C** | **E3** | **E4** | **E5** | **Ea** | **E** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % surface fines < 6mm | 24 | 12 | 25 | 20 | 14 | 29 | 29 | 20 | 38 | NA | 40 | 44 |
| Width/Depth Ratio | 10 | 15 | 17 | 16 | 31 | 20 | 23 | 10 | 7 | 4 | 7 | 7 |
| Entrenchment Ratio | NA | 1.8 | 1.9 | 1.8 | 5.1 | 5.1 | 5.1 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| Sinuosity | 1.1 | 1.2 | 1.3 | 1.2 | 1.3 | 1.7 | 1.5 | 1.3 | 1.8 | 1.9 | 1.4 | 1.7 |
| Reach Average BEHI | 24.2 | 27.1 | 31.7 | 29.7 | 26.9 | 26.5 | 26.5 | 26.3 | 24.2 | 22.0 | 22.7 | 23.6 |

Reference values for the percent of fine subsurface sediment measured with a McNeil core sampler are based on an extensive dataset acquired from the Helena National Forest, as well as existing TMDL standards adopted within other Montana watersheds (Lake Helena, Upper Flathead, and Deep Creek TPAs). The Helena National Forest lies immediately to the north of the Upper Jefferson watershed and displays many similar terrain features, in particular, granite-dominated watersheds of the Boulder Batholith. Since 1986 the Helena National Forest has been collecting McNeil core data from spawning gravel beds in streams supporting salmonid fisheries. Their dataset is available upon request from the forest and has been provided to DEQ.

More than 500 McNeil cores have been collected from salmonid fishery streams located within various land types and geologies. In an attempt to discern patterns of subsurface percent fines by geologies, specifically that of granite-dominated watersheds, the Helena National Forest dataset was broken into four major geomorphic groups: alluvial (n = 80), glacio-fluvial (alluvial outwash, n = 232), granitic (n = 49), and belt (metasediments, n = 153) land types (**Figure 5-1**). Box plots of the data groups reveal that percent fines among the four geomorphic groups are fairly normally distributed and have similar mean values. A one-way ANOVA (analysis of variance) test confirms this observation (significance value = 0.445) and, thus, the proposed water quality indicators have been chosen independently of watershed geology.

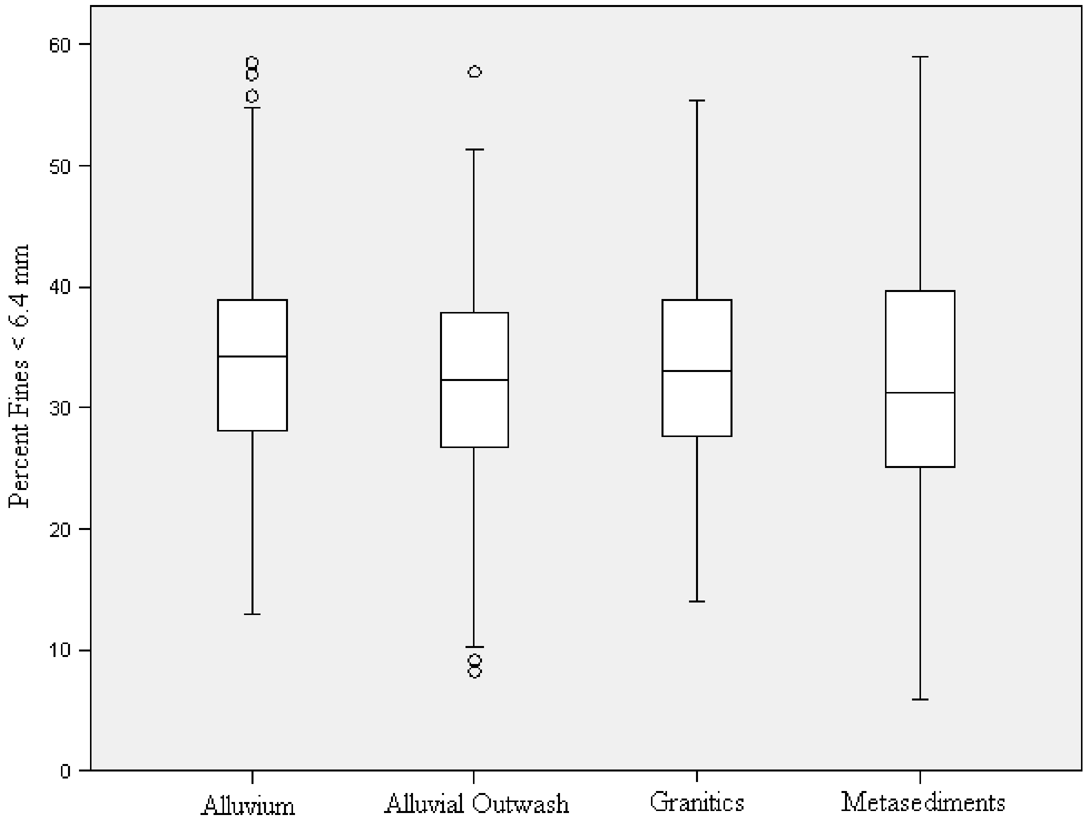


**Figure 5-1. Percent fines <6.4 mm as represented by four major geomorphic groups of the Helena National Forest McNeil core dataset**

The proposed McNeil core water quality indicators within spawning gravels are not to exceed 30% fines < 6.4 mm and no more than 10% < 0.85 mm. 30% fines < 6.4 mm reflects a value midway between the median and the 25$^{th}$ percentile of the Helena National Forest McNeil core dataset (**Table 5-5**). This indicator also reflects agreement with other sediment TMDLs approved by the state of Montana and the EPA: the Deep Creek and Upper Flathead TMDLs. The water quality indicator for percent fines < 0.85 mm is based on literature compiled by the state of Idaho for development of sediment TMDLs (Rowe et al., 2003 and Reylea 2000).

**Table 5-5. Descriptive Statistics for the Helena National Forest McNeil Core Dataset**

| | |
|---|---|
| Mean | 32.52 |
| Standard Error | 0.43 |
| Median | 32.33 |
| 25th Percentile | 26.44 |
| Mode | N/A |
| Standard Deviation | 9.72 |
| Sample Variance | 94.47 |
| Kurtosis | 0.10 |
| Skewness | 0.09 |
| Range | 53.19 |
| Minimum | 5.87 |
| Maximum | 59.07 |
| Count | 514 |
| 95 % Confidence Level | 0.84 |

**Surface Fine Sediment**

The percent of surface fines less than 6mm and 2mm is a measurement of the fine sediment on the surface of a stream bed. Increases in fine sediment have been linked to land management activities, and research has shown a statistically significant inverse relation between the amount of fine sediment <6.4 mm in spawning beds and successful salmonid fry emergence (Reiser and Bjornn 1979, Chapman and McLeod 1987, Weaver and Fraley 1991, McHenry et al. 1994, and Rowe et al. 2003). In addition, changes in macroinvertebrate communities have been shown to occur as fine sediments (<2 mm) increase above 20% coverage by area (Reylea et al. 2000). Thus, the amount of fine sediment on the streambed is directly linked to the support of the coldwater fishery and aquatic life beneficial uses.

During the 2005 stream channel assessments, surface fines data from the Upper Jefferson TPA was collected using a modified version of the Wolman pebble count technique. Data collected using this method tends to be highly variable, and the percent of fine sediment tends to be underestimated due to human bias. To reduce this variability, a total of three separate pebble counts were collected in each reach, with two pebble counts performed in riffles and one “composite” pebble count performed proportionally to the bed features present (e.g., pools and riffles). The modified composite pebble count was used for assigning a Rosgen stream classification and is the basis for the percent fines <6mm target. The other two pebble counts are the basis for assessing fine sediment levels present in riffles.

The water quality target for the percent of fine sediment on the streambed is based on departure of the percent of substrate <6mm beyond the reference range for the appropriate stream type based on the “composite” pebble count. Although the Beaverhead-Deerlodge National Forest Reference Dataset is based on the “zigzag” pebble count method, comparisons with 2005 Upper Jefferson reach composite pebble count datasets are reasonable. A second water quality target of ≤ 20% of the substrate <2mm in riffles will be used based on the requirements of aquatic macroinvertebrates (Bollman 2004, Reylea et. al. 2000). Departure from reference condition will apply when the reach average riffle pebble count value <2mm exceeds 20%. Fine sediment targets shall not apply to low gradient E type streams with natural sand (E5) or silt (E6) substrates. Future surveys should document stable (if meeting criterion) or improving trends.

McNeil core samples were collected during the 2005 survey in trout spawning habitat (generally pool tail-outs) from select reaches of the Jefferson River (3 sites), Hells Canyon Creek (2 sites), Fish Creek (1 site), Big Pipestone Creek (1 site), and Whitetail Creek (headwaters also known as Little Whitetail Creek, 1 site). Six cores were collected from each survey reach to adequately represent spawning habitat conditions. Sampling protocols were based on Intermountain West spawning redd studies and reflect practices used by the Helena National Forest. The proposed McNeil core water quality indicators within spawning gravels are not to exceed 30% fines < 6.4 mm and no more than 10% < 0.85 mm. Future surveys should document stable (if meeting criterion) or improving trends.

Watershed geology has a strong influence on substrate size distribution. For example, granitic watersheds often exhibit a natural bimodal size distribution. Several of the tributaries of the Upper Jefferson Watershed listed as impaired due to sediment are located in watersheds with granitic geologies. Therefore, watershed geology will be considered when evaluating the relationship between management actions and the percent of surface fine sediment. This is particularly true in the case of the highly erosive granitic geology, the Boulder Batholith (TKb), that is found along some portion of all of the 303(d) listed tributary streams, except for Fitz Creek and Dry Boulder Creek.

**Width/Depth Ratio and Entrenchment Ratio**

The width/depth ratio and the entrenchment ratio are fundamental aspects of channel morphology. Each provides a measure of channel stability as well as an indication of the ability of a stream to transport and naturally sort sediment into a heterogeneous composition of fish habitat features (e.g., riffles, pools, and near-bank zones). Changes in both the width/depth ratio and entrenchment ratio can be used as indicators of change in the relative balance between the sediment load and the transport capacity of the stream channel. As the width/depth ratio increases, streams become wider and shallower, suggesting an excess coarse sediment load (MacDonald et al. 1991). As sediment accumulates, the depth of the stream channel decreases, which is compensated for by an increase in channel width as the stream attempts to regain a balance between sediment load and transport capacity. Conversely, a decrease in the entrenchment ratio signals a loss of access to the floodplain. Low entrenchment ratios signify that stream energy is concentrated in-channel during flood events versus having energy dissipation on the floodplain. Accelerated bank erosion and an increased sediment supply often accompany an increase in the width/depth ratio and/or a decrease in the entrenchment ratio (Knighton 1998, Rowe et al. 2003, Rosgen 1996).

The 75th percentiles of entrenchment ratios for C and E channels in the reference dataset range from 3.7 to 15.9 (**Table 5-4**). Although a higher entrenchment ratio is more desirable, if a channel is not entrenched, having an even higher ratio does not indicate a problem and is not a reasonable target. Rosgen and Silvey (1996) define a slightly entrenched C or E channel as having an entrenchment ratio greater than 2.2. Although this number is a generalization based on channel type data collected throughout the United States, and is not as applicable as regional reference data, it provides a frame of reference for an unentrenched channel. The smallest reference entrenchment ratio for a C channel is 5.1; for an E channel 3.7. These numbers will be used as the entrenchment ratio target for C and E channels. A departure of the width/depth ratio and entrenchment ratio beyond the reference range for the appropriate stream type will be used as a water quality target for sediment impairments (**Table 5-4**).

**Bank Erosion Hazard Index (BEHI)**

Stream flows, sediment loads, riparian vegetation, and streambank material all influence bank stability, which, in turn, influences sediment contribution to the stream. The Bank Erosion Hazard Index (BEHI) is a composite metric of streambank characteristics that affect overall bank integrity and is determined based on bank height, bankfull height, rooting depth, bank angle, surface protection, and bank materials/composition (Rosgen 1996). Measurements for each metric are combined to produce an overall score or “rating” of bank erosion potential. Low BEHI values indicate a low potential for bank erosion. A bank erosion hazard index beyond the reference range for the appropriate stream type will be used as a supplemental indicator for sediment impairments.

The percent of eroding streambanks within a survey reach will be applied as a supplemental indicator for sediment impairments. Since streambank erosion is a natural process, this indicator will be used with caution. For example, just because eroding banks are present does not necessarily mean the erosion is human-induced or that there is an instream sediment problem. Additional information, such as observed bank trampling, removal of stabilizing vegetation, or increased water yield from timber harvest, will be considered. Departure from reference condition will apply when the percent of eroding banks within a survey reach exceeds 15% for A, B, C, and E type streams. These values are based on least impacted stream surveys in the Ruby Watershed, which, along with the Big Hole and Beaverhead rivers, is one of the three forks of the Jefferson River. Future surveys should document stable or improving trends.

## 5.4.1.2 Other Sediment Related Measures

**Residual Pool Depths**

Pools, like riffles, are important components of aquatic habitat. Excessive levels of sediment can lead to pool infilling and subsequent loss of habitat. Pools provide refuge for fish and are particularly crucial during summer low flows, when water temperatures are high, or in winter when low flows can cause freezing in some parts of the stream. Residual pool depth measurements quantify pool depth relative to the depth of the riffle crest. When performed over time, or compared with established reference conditions, this measure can be used to identify pool infilling and potential habitat loss. At this time, insufficient reference data are available to recommend specific water quality indicators for residual pool depths. Until appropriate reference conditions are identified, the 2005 inventory values will serve as benchmarks for future surveys, with the stipulation that future surveys document stable or improving trends.

**Pool Frequency**

Pool frequency varies based on the type of channel and the size of the stream. Pool-riffle channels (generally C, E, and some F types), step-pool channels (generally B type), and cascades (A type) are generally expected to have high pool frequencies (Montgomery and Buffington 1997). In general, a pool frequency of at least two pools for each meander wavelength would be expected under natural conditions in meandering stream channels (C and E types), while step-pool channels (B types) would be expected to have more pools. At this time, insufficient reference data are available to recommend specific water quality indicators for pool frequency. Until appropriate reference conditions are identified, the 2005 inventory values will serve as benchmarks for future surveys with the stipulation that future surveys document stable or improving trends.

**Large Woody Debris**

Large woody debris plays a significant role in the creation of pools, especially in smaller stream channels. In a study conducted in northwestern Montana, Hauer et al. (1999) observed that single pieces of large woody debris situated perpendicular to the stream channel, or large woody debris aggregates, form the majority of pools. In the Middle and Lower Big Hole TPA riparian shrubs (e.g., willows, alders) were often responsible for pool formation, especially along valley streams. At this time, insufficient reference data are available to recommend specific water quality indicators for the amount of large woody debris. Until appropriate reference conditions are identified, the 2005 inventory values will serve as benchmarks for future surveys with the stipulation that future surveys document stable or improving trends.

**Greenline Measurements**

Interactions between the stream channel and streambank vegetation are vital components in the support of the beneficial uses of coldwater fish and aquatic life. Riparian vegetation provides food for aquatic organisms and supplies large woody debris that influences sediment storage and channel morphology. Vegetation can provide shading, cover, and habitat for fish. Vegetation holds streambank soils together, and the presence or lack of certain types of vegetation can significantly influence bank erosion rates. During assessments conducted in 2005, ground cover, understory vegetation, and overstory vegetation were cataloged at 10-foot intervals along the greenline at the bankfull channel margin along both sides of the stream channel for each survey reach. The percent of understory shrub cover is of particular interest in valley bottom streams historically dominated by willows and other riparian shrubs.

Based on the median understory shrub cover of 49% in reference reaches in the Upper Big Hole TPA, a supplemental indicator of ≥ 49% understory shrub cover is established for the Upper Jefferson TPA. The understory shrub cover will be applied in situations were riparian shrubs are a significant component of the streamside vegetation, such as in meadow areas. This supplemental indicator will not be applied in areas where dense conifer canopies and large substrate naturally limit the development of riparian shrubs.

**Proper Functioning Conditions Assessments**

The Proper Functioning Condition (PFC) method is a qualitative method for assessing the physical functioning of riparian-wetland areas (Prichard 1998). The hydrologic processes, riparian vegetation characteristics, and erosion/deposition capacities of streams were evaluated using the PFC method for each stream reach assessed in 2005. Each reach was rated as being in “proper functioning condition” (PFC), “functional – at risk” (FAR), or “non-functioning” (NF). Based on these assessments, a supplemental indicator of either “proper functioning condition” or “functional – at risk” with an upward trend with the intent of attaining “proper functioning condition” is established for the Upper Jefferson TPA.

**Macroinvertebrates**

Siltation exerts a direct influence on benthic macroinvertebrates assemblages through several mechanisms, including limiting the amount of preferred habitat for some taxa by filling in interstices, that is, spaces between gravel. In other cases, fine sediment limits attachment sites for taxa that affix to substrate particles. Macroinvertebrate assemblages respond predictably to siltation with a shift in natural or expected taxa to a prevalence of sediment-tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessment scores are an assessment of the macroinvertebrate assemblage at a site and are used by DEQ to evaluate impairment condition and beneficial use support. The advantage to these bioindicators is that they provide a measure of support of associated aquatic life, an established beneficial use of Montana's waters.

In 2006 DEQ adopted impairment thresholds for bioassessment scores based on two separate methodologies. The Multi-Metric Index (MMI) method assesses biologic integrity of a sample based on a battery of individual biometrics. The River Invertebrate Prediction and Classification System (RIVPACS) method uses a probabilistic model based on the taxa assemblage that would be expected at a similar reference site. Based on these tools, DEQ adopted bioassessment thresholds that reflected conditions that supported a diverse and biologically unimpaired macroinvertebrate assemblage and, therefore, a direct indication of beneficial use support for aquatic life.

The MMI is based on the different ecoregions within Montana. Three MMIs are used to represent the various Montana ecoregions: mountain, low valley, and plains. Each region has specific bioassessment threshold criteria that represent full support of macroinvertebrates. The Upper Jefferson watershed falls within both mountain and low valley regions. The MMI score is based upon the average of a variety of individual metric scores. The metric scores measure predictable attributes of benthic macroinvertebrate communities to make inferences regarding aquatic life condition when pollution or pollutants affect stream systems and instream biota. For the MMI, individual metric scores are averaged to obtain the final score, which ranges between 0 and 100. The impairment thresholds are 63 and 48 for the mountain and low valley indices, respectively. These values are established as supplemental indicators for sediment impairments in the Upper Jefferson TPA. The impairment threshold (10th percentile of the reference dataset) represents the point where DEQ believed macroinvertebrates were affected by some kind of impairment (e.g., loss of sensitive taxa).

The RIVPACS model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled. The RIVPACS model provides a single dimensionless ratio to infer the health of the macroinvertebrate community. This ratio is referred to as the Observed/Expected (O/E) value. Used in combination, the results suggest strong evidence that a water body is either supporting or not supporting its aquatic life uses for invertebrates. The RIVPACS impairment threshold for all Montana streams is any O/E value <0.8. However, the RIVPACS model has a bidirectional response to nutrient impairment. Some stressors cause macroinvertebrate populations to decrease right away (e.g., metals contamination), which causes the score to decrease below the impairment threshold of 0.8. Nutrient enrichment may actually increase the macroinvertebrate population diversity before eventually falling below 0.8. An upper limit was set to flag these situations. The 90th percentile of the reference dataset was selected (1.2) to account for these situations, and any value above this score is defined as impaired unless specific circumstances can justify otherwise. However, RIVPACS scores >1.0 are considered unimpaired for all other stressor types. A supplemental indicator value RIVPACS score of >0.80 and <1.2 is established for sediment impairments in the Upper Jefferson TPA. A score of greater than 1.2 does not necessarily indicate a problem, but, when combined with other data, may indicate nutrient or metal impacts.

**Human-caused Sediment Sources**
The presence of human-caused sediment sources does not always result in sediment impairment of a beneficial use. When there are no significant identified manmade sources of sediment within the watershed of a 303(d) listed steam, no TMDL will be prepared, since Montana's narrative criteria for sediment cannot be exceeded in the absence of human causes. Human-induced and natural sediment sources will be evaluated using recently collected data in comparison with the reference dataset, along with field observations and watershed scale source assessment information from aerial imagery and GIS data layers.

## 5.4.2 Existing Condition and Comparison to Water Quality Targets

This section includes existing data, a comparison of existing data with water quality targets and supplemental indicators, and a TMDL development determination for each 303(d) sediment listed water body in **Table 5-1**. All water bodies do not have data for all targets and supplemental indicators; all available relevant data are included in this section.

### 5.4.2.1 Big Pipestone Creek

Big Pipestone Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. In addition, this stream segment was listed for habitat alterations and other manmade substrate alterations that are forms of pollution commonly linked to sediment impairment. Big Pipestone Creek forms at the outlet of Delmoe Lake on the Beaverhead-Deerlodge National Forest and flows for approximately 20 miles to where it meets Whitetail Creek.

**Physical Condition and Sediment Sources**
The channel forms of Big Pipestone Creek above I-90 are predominantly controlled by landform structure, as well as reservoir releases from Delmoe Lake. The prominent landform geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. Narrow valley bottoms dominated by granitic boulders (Rosgen B-type reaches) are found, as well as less confined valley bottom areas (Rosgen C-type reaches). Delmoe Lake releases have greatly increased the flow of the creek in this area. During the 2004 aerial assessment, various pollution sources observed in the upper portions of the watershed were related to the operation of Delmoe Lake Dam and from unpaved roads and trails (**Appendix C**, **Figure 2-7**).

A perched culvert on Big Pipestone Creek at the I-90 road crossing was viewed during an additional DEQ field survey in March 2006. When I-90 was built, the valley created by Big Pipestone Creek was filled with boulders and a large culvert was installed through the ballast.

However, the culvert was installed approximately 20 feet above the streambed and is functional only during extreme runoff events. Under normal conditions all of the water in Big Pipestone Creek drains through the subsurface boulder fills under I-90 to continue on course. The culvert appears to act as a trap for many of the fine sediments transported by the creek, as indicated by a large depositional zone extending well above the culvert (north side of I-90). It is possible that this trap prevents many fine sediments from being transported to the valley bottom segment of the creek and affects the sediment transport capacity of the creek below the culvert. Should the culvert be brought to the proper grade for surface flow, more fine sediments could be transported to and deposited within the valley reaches.

Below I-90 the channel forms within Big Pipestone Creek are controlled by historical and current land use activities. As noted in the 2004 aerial assessment, the predominant valley type (VIII) in this area would typically result in an unconfined Rosgen stream type (C or E). Yet water level alterations for flow diversions, as well as channelization, have resulted in stream types out of balance with the valley type. In some instances, during the aerial assessment, Rosgen stream type could not be discerned due to the presence of a constructed versus a natural alluvial channel. In addition, extreme headcutting was noted in the lowermost reach of the watershed and more than likely cause or contributed to the observed channelization. During the 2004 assessment numerous pollution sources observed along Big Pipestone Creek below I-90 were related to agriculture. During the field source assessment, grazing impacts (trampled banks, overwidened channel, channel braids) and stream channel alterations were observed in most of the reaches. In general, stream condition deteriorated heading downstream (**Appendix C, Figure 2-8**).

In September 1994 DEQ performed a stream reach assessment at an upper and lower site within the Big Pipestone Creek drainage. Qualitative data collected suggested moderate habitat impairments to instream and riparian health. Identified sources of sediment include mining, unpaved roads, and riparian grazing. Other information taken from DEQ's files include historic assessments that identified the effects of irrigation infrastructure and hydromodification on instream sediment production and channel modifications, particularly extensive headcutting in the lower portions of the watershed.

In 2005 DEQ performed two focused assessments in the upper portions of the watershed above I-90. These survey sites were located 5 (BIGP5) and 11 (BIGP12) miles below the Delmoe Lake outlet. The lowermost 2005 survey site on Big Pipestone Creek (BIGP15) was located about 18 miles below the Delmoe Lake outlet (DEQ 2006)

In addition to the 2005 inventory, two channel surveys were conducted by the Beaverhead-Deerlodge National Forest on upper Big Pipestone Creek (above the I-90 crossing), which corresponds with portions of Reaches 1 (BIGP1-FS01) and 5 (BIGP5-FS99) delineated during the 2004 source assessment. BIGP1-FS01, inventoried in 2001, is located approximately one-half-mile below the Delmoe Lake outlet. BIGP5-FS99, inventoried in 1999, is the same site that was inventoried in 2005, BIGP5 (DEQ 2006).

**Comparison to Water Quality Targets**

The existing data in comparison with the targets and supplemental indicators for Big Pipestone Creek are summarized in **Tables 5-6, 5-7**, and **5-8**.

**Table 5-6. Big Pipestone Creek Sediment Data Compared with Targets***

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | Composite % < 6mm (mean) | Riffle %<2mm (mean) | % <0.85 mm | % <6.4 mm | Width / Depth Ratio (median) | Entrenchment Ratio (median) | E | P |
| BIGP1-FS01 | 8% | NA*** | NA | NA | 11.3 | **1.4******** | F4 | B4 |
| BIGP5-FS99 | 75% | NA | NA | NA | 9.7 | **1.7******** | B5 c | C5 |
| BIGP5 | **40%** | 15% | **17%** | **39%** | 15.8 | **1.6** | B4 | B4 |
| BIGP12 | **51%** | **38%** | NA | NA | **10.8** | **3.0** | C4 | E4 |
| BIGP15 | **89%** | **49%** | NA | NA | 12.0 | 9.7 | C5 | C4 |

*Bolded values represent departure from water targets based on Rosgen Level II potential.
** E = Existing Stream Type & P = Potential Stream Type.
***NA = data not available
**** Forest Service Data based upon a single measure of entrenchment.

**Table 5-7. Big Pipestone Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| BIGP1-FS01 | NA | NA | NA | **NF** | NA | NA | NA |
| BIGP5-FS99 | NA | NA | NA | FAR | NA | NA | NA |
| BIGP5 | **33.3** | **High** | 97.6 | FAR | 0.95 | 88 | 300 |
| BIGP12 | **38.8** | **High** | 85.9 | FAR | 0.6 | 70 | 23 |
| BIGP15 | **32.7** | **High** | **56.4** | FAR | 1.23 | 105 | 100 |

*Bolded values represent departure from the water quality indicators.

**Table 5-8. 2005 Greenline Survey data for Big Pipestone Creek.**

| **Ground Cover** | **BIGP5** | **BIGP12** | **BIGP15** |
|---|---|---|---|
| Rock/Root | 34% | 23% | 5% |
| Riprap | 0 | 2% | 0 |
| Bare Ground | 6% | 17% | 10% |
| Herbaceous | 53% | 46% | 79% |
| Wetland | 8% | 13% | 7% |
| **Understory** | **BIGP5** | **BIGP12** | **BIGP15** |
| Deciduous | 77% | 46% | 41% |
| Coniferous | 0 | 0 | 0 |
| Mixed | 6% | 0 | 0 |
| **Overstory** | **BIGP5** | **BIGP12** | **BIGP15** |
| Deciduous | 0 | 0 | 12% |
| Coniferous | 13% | 0 | 0 |
| Mixed | 0 | 0 | 0 |

*Bolded values represent departure from the water quality indicators.

For the survey sites along Big Pipestone Creek above I-90, the composite surface fines value <6 mm at BIGP5 was 60% greater than the defined reference mean for B4 streams, and the values for both classes of percent fines in McNeil core samples were elevated against the target values. The percentage of subsurface fines <6.4 mm at BIGP5 was 29% greater than the defined reference mean, while the percentage of fine fines (<0.85 mm) was 70% greater. The 2005 McNeil core data have computed a reach averaged geometric mean subsurface particle size equivalent to fine gravels (6.8 mm). Measures of subsurface sediment include more fine particles than a surface sediment evaluation (pebble count). The entrenchment ratio values for BIGP1-FS01, BIGP5-FS99, and BIGP5 were believed to have been different from reference due to hydromodification associated with Delmoe Lake operations, suggesting that access to the floodplain has been reduced. At both sites the 2005 Proper Functioning Condition assessment rated the reaches as functional at risk (FAR), with no apparent trend. Negative ratings were mostly due to channel form and riparian alterations believed to be caused by flow withdrawals and grazing practices. Human-caused bank erosion was observed at both these sites and was primarily influenced by riparian grazing and irrigation shifts in stream energy directly related to dam operations. Under the assumption that Delmoe Lake operations were following reasonable land, soil, and water conservation practices, the entrenchment ratio values and PFC ratings will not be considered a violation of proposed reference conditions.

For the survey sites along Big Pipestone Creek below I-90 (BIGP12 and BIGP15), the water quality indicator values for surface sediments were not within reference. The percentage of surface fines <2 mm at BIGP12 was 89% greater than the defined reference mean, while the percentage of composite surface fines <6 mm was anywhere from 34% (E4) to 76% (C4) greater, depending on Rosgen stream type. At BIGP15, the percentage of surface fines <2 mm was 147% greater than the defined reference mean, while the percentage of surface fines <6 mm was 208% (C4) greater. The entrenchment ratios were 81% (E4) lower than expected, suggesting that access to the floodplain has been reduced. In this location excess fine sediment was noted and the Proper Functioning Condition assessment rated the reach as functional at risk (FAR), with no apparent trend. Negative ratings were mostly due to channel form and riparian alterations believed to be caused by flow modifications, upstream channelization, cropping (past), and grazing practices. This is further supported by the exceedences of the understory riparian vegetation supplemental indicator at BIG12 and BIG15. Human-influenced bank erosion was observed and primarily influenced by riparian grazing and cropping. The Properly Functioning Conditions (PFC) ratings were not considered exceedences of the proposed reference conditions, given that trends were not discernable.

Streambank erosion in all reaches did not meet the supplemental indicator value for bank erosion. However, the percent of reach with non-eroding banks was meeting the supplemental indicator value of ≥ 85% in the uppermost two monitoring sections, though it was below the criteria in the lower monitoring section, with a value of 56%.

**Summary and TMDL Development Determination**
Based on the data reviewed for Big Pipestone Creek, instream habitats for aquatic life and coldwater fisheries beneficial uses are likely impacted and affected by sediment. In the upper portion of the watershed, fine surface and subsurface sediments are accumulating in macroinvertebrate and fish spawning habitats. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this subwatershed. The exceedence of the fines reference value (<0.85 mm) supports this conclusion.

In the Jefferson valley reaches of Big Pipestone Creek fine surface sediments appear to be accumulating in riffles, and pool habitat is also likely affected. As noted during the 2005 field assessment and in historic data, hydromodification related to irrigation withdrawals is likely affecting sediment transport and channel morphology. In addition, the 2004 source assessment reveals that additional active human-induced sediment sources are present.

Elevated surface fines in riffles can harm aquatic insects, while high fines in spawning gravels can disrupt and even prevent trout reproduction. Limited pool habitat may also be of concern for some reaches of the creek. Lower than expected entrenchment ratios could equate to increased sediment loading from streambanks. Bank erosion did appear to be problematic in the Jefferson valley survey reaches of Big Pipestone Creek. During the 2005 inventory many sediment sources were present, such as road/trail inputs, riparian grazing, and severe channel modifications (channelization/headcutting) that were related to human activities.

These results indicate an increased sediment supply and a decreased capacity to transport sediment, particularly in the lower part of Big Pipestone Creek. Available sediment and habitat data suggest that fine sediment deposition within Big Pipestone Creek is likely impacting fish spawning and rearing habitat and the aquatic macroinvertebrate assemblages that support the fishery. The primary human-caused sources of sediment within the watershed include rangeland and near-stream grazing, bank erosion, and unpaved and paved roads. This information supports the 303(d) listing, and a sediment TMDL will be completed for Big Pipestone Creek.

### 5.4.2.2 Cherry Creek

Cherry Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. In addition, this stream segment was listed for habitat alterations, which is a form of pollution commonly linked to sediment impairment. Cherry Creek originates at Little Cherry Creek Spring on the Beaverhead-Deerlodge National Forest. It flows for approximately 7 miles to where it meets the Jefferson River. During the summer irrigation season, landowners reported that the stream goes dry on the lower alluvial fan before reaching the Jefferson River.

**Physical Condition and Sediment Sources**

Cherry Creek's channel forms are primarily controlled by landform structure. The prominent geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. The stream headwaters occur on relatively steep slopes (A-type), moving toward more moderate slopes downstream. The valley bottom is fairly confined (B-type reaches) until exiting the canyon to the alluvial fan (B and Eb reaches) (**Appendix C, Figure 2-13**). Within Cherry Creek many of the pollution sources observed during the 2004 aerial review and field assessments were related to riparian grazing and unpaved roads. In the upper reaches of the creek, the source of flow alterations from water diversions was taken from a GIS layer that located water rights claims. In addition, some impacts from abandoned mine lands were noted. Silviculture activities were also noted in the headwaters. Grazing impacts observed in the field were more detrimental in lower portions of the watershed. Sediment input from unpaved roads was fairly minimal. Loss of riparian habitat was associated with development in the floodplain (roads, crops, housing).

In 2003 DEQ conducted water quality assessments at two locations within the watershed, using DEQ reassessment protocols. The upper site (DEQ Upper) was located approximately 6.5 miles from the mouth, and the lower site (DEQ Lower) was located about 1 mile upstream of Montana Highway 41. This assessment provided the majority of data used for updates to the water body's listing status in 2006. In addition to the 2003 DEQ data, in 2005 DEQ performed a sediment and stream morphology assessment at one location within the Cherry Creek watershed. This site (CHRY6) was located about 6 miles below the headwaters (DEQ 2006).

**Biological Data**

In 2003 DEQ collected macroinvertebrate samples at two sites on Cherry Creek. The bioassessment scores are presented in **Table 5-12**.

**Comparison with Water Quality Targets**

Comparisons of existing data with the targets and supplemental indicators for Big Pipestone Creek are summarized in **Tables 5-9, 5-10, 5-11**, and **5-12**.

**Table 5-9. Cherry Creek Sediment Data Compared to Targets*.**

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | Composite % < 6mm (mean) | Riffle % <2mm (mean) | % <0.85 mm | % <6.4 mm | Width / Depth Ratio (median) | Entrenchment Ratio (median) | E | P |
| DEQ Upper | **43%** | **41%** | NA*** | NA | NA | NA | NA | B4 |
| DEQ Lower | 77% | **69%** | NA | NA | NA | NA | NA | B5 |
| CHRY6 | 62% | 28% | NA | NA | **4.4** | 3.8 | E5b /B5 | E5b/ B5 |

*Bolded values represent departure from water targets based on Rosgen Level II potential.
** E = Existing Stream Type & P = Potential Stream Type.
***NA = data not available

**Table 5-10. Cherry Creek Sediment Data Compared with Supplemental Indicators**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| CHRY6 | **30.9** | **High** | 96.9 | FAR | 0.54 | 129 | 6 |

*Bolded values represent departure from the water quality indicators.

**Table 5-11. 2005 Greenline Survey Data for Cherry Creek**

| **Ground Cover** | **CHRY6** |
|---|---|
| Rock/Root | 18% |
| Riprap | 2% |
| Bare Ground | 32% |
| Herbaceous | 48% |
| Wetland | 2% |
| **Understory** | **CHRY6** |
| Deciduous | 61% |
| Coniferous | 0 |
| Mixed | 1% |
| **Overstory** | **CHRY6** |
| Deciduous | 1% |
| Coniferous | 0 |
| Mixed | 0 |

**Table 5-12. Biological Metrics for Cherry Creek**
Bolded text failed to meet the target (Mountain MMI ≥ 63, Low Valley ≥ 48, and RIVPAC ≥ 0.80)

| **Station ID** | **Date** | **Class** | **Mountain Index** | **RIVPACS O/E** |
|---|---|---|---|---|
| M08CHRYC01 | 10/12/2003 | Mountains | 84 | 1.17 |
| M08CHRYC02 | 10/12/2003 | Low Valley | 55 | 0.89 |

Many of the selected sediment water quality indicator values were not within reference for the survey sites on Cherry Creek. Surface fine sediment targets of <2mm and <6mm were not met at both the 2003 DEQ Upper and DEQ Lower sites. Information taken from the DEQ files regarding the lower assessment site stated:

The channel is actively downcutting. About 40 percent of streambanks show signs of lateral cutting. Sediment load is high; Cattle and sheep (including an on-channel confined feeding operation) and roads contribute to the elevated sediment load. (Maps and 1995 orthophotos indicate that most roads are situated in adjoining drainages, and that this drainage is only lightly-roaded, mostly in the lower reaches.) Early-seral woody species are reduced by livestock (cattle and sheep) browsing. Irrigation diversions are present, and reduce flow volume. PFC rating is "Functioning At Risk." MT DEQ supplement questions: Habitat types are reduced, little structure present. Spawning extensively reduces due to deposition and storage of fines in the substrate. The stream is a losing reach and the channel is dewatered for hay field irrigation (dry channel below this site). No structures are present to prevent fish entrainment to the numerous irrigation ditches. The overall rating is "At Risk" (DEQ Waterbody Assessment Files).

At the 2005 site no percent fines reference values were applied to the E5 stream type. However, the W/D slightly exceeded reference condition in comparison with the 75th percentile of reference E5 stream types. Again, both the E5 and B5 stream types have naturally elevated percent fines. The 2005 Proper Functioning Condition assessment rated the assessment reach as functional at risk (FAR), with an upward trend, given channel and riparian area recovery from historic land use. Negative ratings were mostly due to riparian and channel alterations stemming from historic land use (orchard operation) and riparian grazing.

At the 2005 inventory site, 3% of the survey reach was measured as having actively eroding banks. BEHI metrics for the eroding banks were rated as having moderate to high potentials for erosion. An overall BEHI rating for the reach was judged to be moderate. Sources contributing to the total reach calculated sediment load from bank erosion were historic land use (orchard operations), riparian grazing, and natural sources. That being said, the percent of non-eroding streambanks supplemental target was not exceeded at 97%.

Macroinvertebrate data collected in October 2003 met select supplemental targets for the mountain (>63) and valley (>48) MMI scores. The RIVPACS values met selected target levels; however, the lowermost site was near the target value.

**Summary and TMDL Development Determination**
Based on the data reviewed for Cherry Creek, instream habitats for aquatic life and coldwater fisheries beneficial uses may be negatively affected by sediment. Fine surface sediments are accumulating in riffles and, potentially, pool habitat is also being affected. Elevated surface fines in riffles can harm aquatic insects. A W/D above the expected values would also support a conclusion of sediment impairment. However, the strength of this target alone in these stream types does not provide overwhelming justification.

In addition to the target comparison information above, significant sediment sources related to current and historic human activities are present, such as riparian grazing and channel modifications (historic land use, rip rap, etc.). DEQ's Waterbody Assessment files reported that the streambanks were visually eroding. The main cause of the sediment problem seemed to be caused livestock trampling.

In addition, sediment source assessment results, presented in **Section 5.5**, document significant controllable human-derived sediment source contributions from unpaved roads, streambanks, and other upland sediment sources.

Available sediment and habitat data suggest that fine sediment deposition within Cherry Creek is likely impacting fish spawning and rearing habitat and the aquatic macroinvertebrate assemblages that support the fishery. In addition, there are significant controllable human-caused sources. The primary human sources of sediment within the watershed include rangeland and near-stream grazing and bank erosion. This information supports the 303(d) listing, and a sediment TMDL will be completed for Cherry Creek.

## 5.4.2.3 Fish Creek

Fish Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment was listed for alteration in stream-side or littoral vegetative covers, which are forms of pollution commonly linked to sediment impairment. Fish Creek originates in the Highland Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 20 miles to where it meets the Jefferson Canal, one of the major irrigation canals in the Jefferson valley. Due to irrigation water withdrawals and natural losses to the alluvial fan, the creek goes dry for much of the year before reaching the Jefferson Canal.

**Physical Condition and Sediment Sources**
The channel forms of Fish Creek within the Highland Mountains are predominantly controlled by landform structure, as well as historical land uses (**Appendix C, Figure 2-19**). The upper reaches have been affected by faulting and glaciation, and more recently by placer mining and logging activities. Before entering the Jefferson valley, the Boulder Batholith geology has weathered into narrow valley bottom sections (B-type reaches), as well as less confined valley bottom areas (C-type reaches). During the 2004 aerial photo review and associated field surveys, many pollution sources observed along upper Fish Creek were related to placer mining, riparian grazing, and unpaved roads. In many instances the sources of flow alterations from water diversions and impacts from abandoned mines were taken from GIS layers that located water rights claims and abandoned mines. The GIS-identified sources have generally not been field

verified. Tree harvesting before 1983 have occurred upslope from and adjacent to Fish Creek. Harmful effects from this impact were not observed in the field (DEQ 2005).

Many of the channel forms of Fish Creek in the Jefferson Valley are controlled by landform structure and historical and current land use activities (**Appendix C, Figure 2-20**). Channel form on the alluvial fan tended to be more unconfined than expected (C-type versus B-type). Fish Creek typically goes dry before entering Fish Creek Canal. The area near the canal was not classified due to the fact that it is part of a major irrigation canal system in the Jefferson valley and probably carries flow from the Jefferson River rather than Fish Creek. Many pollution sources observed on the aerial photographs during the 2004 assessment for lower Fish Creek were related to agricultural operations (irrigation diversions, cropping, and loss of riparian area). During the field source assessment, active beaver dams were observed. Discussions with local landowners revealed that dewatering of the creek results in isolation of a genetically pure Westslope cutthroat trout population, which apparently thrives in the reaches above the alluvial fan.

In 2003 DEQ conducted water quality assessments at two locations within the watershed (DEQ Upper and DEQ Lower), using DEQ reassessment protocols. This assessment provided the majority of data used for updates to the water body's listing status in 2006. In 2005 DEQ performed a focused sediment and stream morphology assessment at three locations within the Fish Creek watershed. These sites were located approximately 3.5 (FISH5), 6 (FISH8), and 14 (FISH14) miles below the headwaters (DEQ 2006). In addition to the 2005 inventory, one channel survey was completed by the Beaverhead-Deerlodge National Forest in 2001 (FISH6-FS-01). This site was located approximately 4.5 miles from the headwaters. At this location a shift in Rosgen stream type from E4 to B4 was noted and attributed to grazing, roads, and placer mining. (DEQ 2006).

**Biological Data**
In 2003 DEQ collected macroinvertebrate samples at two sites on Fish Creek. The bioassessment scores are presented in **Table 5-16**.

**Comparison to Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Fish Creek are summarized in **Tables 5-13, 5-14, 5-15**, and **5-16**.

**Table 5-13. Fish Creek Sediment Data Compared to Targets*.**

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | Composite % < 6mm (mean) | Riffle %<2mm (mean) | % <0.85 mm | % <6.4 mm | Width / Depth Ratio (median) | Entrenchment Ratio (median) | E | P |
| DEQ Upper | **36%** | **22%** | NA | NA | NA | NA | | B4/C4 |
| DEQ Lower | **73%** | **73%** | NA | NA | NA | NA | | B4/C4 |
| FISH5 | 5% | 3% | NA | NA | 12.8 | **1.4** | B3 | B3 |
| FISH6-FS01 | 14% | NA | NA | NA | **15.9** | **1.8***** | B4 | E4 |
| FISH8 | 13% | 12% | 9% | **31%** | 17.2 | **4.3** | C4b | C4b |
| FISH14 | 18% | 5% | NA | NA | 12.9 | **1.5** | B4c | C4 |

*Bolded values represent departure from water targets based on Rosgen Level II potential.
** E = Existing Stream Type & P = Potential Stream Type.
***NA = data not available
**** Forest Service Data based upon a single measure of entrenchment.

**Table 5-14. Fish Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| FISH5 | **31.6** | **High** | 98.6 | PFC | 0.59 | 100 | 65 |
| FISH6- FS01 | NA | NA | NA | **NF** | NA | NA | NA |
| FISH8 | 0 | Very Low | 0 | PFC | 0.94 | 100 | 65 |
| FISH14 | **32.4** | **High** | 90.2 | FAR | 1.15 | 76 | 100 |

*Bolded values represent departure from the water quality indicators.

**Table 5-15. 2005 Greenline Survey Data for Fish Creek**

| **Ground Cover** | **FISH5** | **FISH8** | **FISH14** |
|---|---|---|---|
| Rock/Root | NA | NA | 39% |
| Riprap | 0 | 0 | 0 |
| Bare Ground | 13% | 8% | 7% |
| Herbaceous | 23% | 89% | 56% |
| Wetland | 65% | 3% | 0 |
| **Understory** | **FISH5** | **FISH8** | **FISH14** |
| Deciduous | 13% | 18% | 73% |
| Coniferous | 19% | 7% | 1% |
| Mixed | 5% | 1% | 1% |
| **Overstory** | **FISH5** | **FISH8** | **FISH14** |
| Deciduous | 0 | 0 | 0 |
| Coniferous | 41% | 44% | 0 |
| Mixed | 0 | 0 | 39% |

**Table 5-16. Biological Metrics for Fish Creek**
Bolded text failed to meet the target (Mountain MMI ≥ 63, Low Valley ≥ 48, and RIVPAC ≥ 0.80)

| **Station ID** | **Date** | **Class** | **Mountain Index** | **RIVPACS O/E** |
|---|---|---|---|---|
| M08FISHC01 | 10/13/2003 | Mountains | 80 | 0.96 |
| M08FISHC02 | 10/13/2003 | Low Valley | 71 | 0.88 |

The 2003 reassessment of Fish Creek (DEQ Upper and DEQ Lower) showed riffle substrate percent fines smaller than 6 mm, increased from 36% at the Upper site and 73% at the Lower site. Also, the percentage of fine particles smaller than 2 mm increased from 22% at the Upper site to 73% at the Lower site. Rosgen stream type was not estimated. However, assuming either a B4 or C4 stream type typical of this area, percent fines <6 mm and <2 mm both exceed the target value. Other qualitative information associated with this sampling event noted excess sediment production from trampled banks and human activities exacerbating the highly erosive geology.

The assessment data collected in 2005 by DEQ revealed that most of the selected sediment water quality targets and indicator values were judged to be within reference for the survey sites along Fish Creek. However, the entrenchment ratios differed from reference for all the survey sites, suggesting that access to the floodplain has been reduced and the potential for bank erosion has increased. The shift in Rosgen stream type from E4 to B4 that was documented at FISH6- FS01 supports the conclusion that surface fines may be a problem due to the increased entrenchment. With a potential Rosgen stream type of E4, the W/D at FISH6- FS01 was greater than reference, while the entrenchment ratio was less. The 2001 PFC rating for this section of Fish Creek was also considered different from proposed reference conditions. At FISH8, the values for the percent fines <6.4mm in McNeil core samples were slightly elevated (3%) against the target value, while the percentage of fines (<0.85 mm) was 7% less. Additionally, the 2005 BEHI survey at FISH5 and FISH14 indicates that bank erosion was greater than expected for reference and primarily attributable to human sources. That being said, the total percent of non-eroding banks per site was greater then the selected target value of 85%.

Macroinvertebrate data collected in October 2003 met select supplemental targets for the mountain (>63) and valley (>48) MMI scores, as well as supplemental RIVPACS values.

Summary and TMDL Development Determination
Based on the data reviewed for Fish Creek, instream habitats for aquatic life and coldwater fisheries beneficial uses are likely impacted and affected by sediment. Elevated fines in riffles are apparent in the 2003 assessment data and may be affecting instream macroinvertebrate habitat. Fine surface sediments are accumulating in riffles and, potentially, pool habitat is also being affected. Greater than expected W/D and lower than expected entrenchment ratios could equate to increased sediment loading from streambanks. Bank erosion did appear to be a problem at two of the four inventory sites. In addition, significant controllable human-derived sediment source contributions from unpaved roads, streambanks, and other upland sediment sources are documented. This information supports the 303(d) listing, and a sediment TMDL will be completed for Fish Creek.

## 5.4.2.4. Fitz Creek

Fitz Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment was listed for alteration in stream-side or littoral vegetative covers, which are forms of pollution commonly linked to sediment impairment. Fitz Creek forms in the Bull Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 5 miles to where it meets Little Whitetail Creek. For much of the year the creek goes dry on the alluvial fan before reaching Whitetail Creek.

**Physical Condition and Sediment Sources**
The channel forms of Fitz Creek are primarily controlled by landform structures. The stream headwaters occur on relatively steep slopes (A-type), moving toward more moderate slopes downstream. The valley bottom is fairly confined (B-type reaches) along the canyon and alluvial fan sections until entering the floodplain of Little Whitetail Creek (**Appendix C, Figure 2-25**). Most of the pollution sources observed on the aerial photos were related to flow alterations and unpaved roads. In many instances, the source of flow alterations from water diversions was taken from a GIS layer and was not field verified. Grazing was observed along much of the lower reaches of the stream, but the impacts were fairly minimal due to the lack of water. During the 2004 field source assessment the stream was observed as naturally going dry at the head of the alluvial fan. On the alluvial fan the stream goes distributary and probably does not carry flow, except during spring runoff and intense rainfall events. These characteristics are typical for streams on alluvial fans in arid environments.

In 2003 DEQ conducted a water quality assessment at one location within the watershed approximately 1.5 miles upstream from the mouth. This assessment provided the majority of data used for updates to the water body's listing status in 2006. Qualitative data showed significant grazing impacts, and photos show areas of compacted soils, barren of vegetation adjacent to the channel, with a narrow band of grass along the streambanks. The channel and riparian is hoof-pugged (DEQ Waterbody Assessment Files).

In 2005 DEQ performed a sediment and stream morphology assessment at one location within the Fitz Creek watershed. This site (FITZ4) was located about 2.8 miles below the headwaters (DEQ, 2006)

**Comparison with Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Big Pipestone Creek are summarized in **Tables 5-17, 5-18** and **5-19**.

**Table 5-17. Fitz Creek Sediment Data Compared with Targets***

| **Reach ID** | **Pebble Count** | | **McNeil Core** | | **Cross Section** | | **Rosgen Level II**** | |
|---|---|---|---|---|---|---|---|---|
| | **Composite % < 6mm (mean)** | **Riffle % <2mm (mean)** | **% <0.85 mm** | **% <6.4 mm** | **Width / Depth Ratio (median)** | **Entrenchment Ratio (median)** | **E** | **P** |
| FITZ4 | 23% | 19% | NA | NA | **8.0** | 1.7 | E4a/ B4a | E4a/ B4a |

*Bolded values represent departure from water targets based on Rosgen Level II potential.
** E = Existing Stream Type & P = Potential Stream Type.
***NA = data not available

**Table 5-18. Fitz Creek Sediment Data Compared with Supplemental Indicators**

| **Reach ID** | **BEHI Score (mean)** | **BEHI Adjective Rating** | **% Non-Eroding Banks** | **P.F. Condition** | **Residual Pool Depth (mean)** | **Pool Frequency (#/mile)** | **Large Woody Debris Frequency (#/mile)** |
|---|---|---|---|---|---|---|---|
| FITZ4 | **36.1** | **High** | 99.7 | FAR | 0.33 | 65 | 47 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.

**Table 5-19. 2005 Greenline Survey Data for Fitz Creek**

| **Ground Cover** | **FITZ4** |
|---|---|
| Rock/Root | 43% |
| Riprap | |
| Bare Ground | 1% |
| Herbaceous | 57% |
| Wetland | |
| **Understory** | **FITZ4** |
| Deciduous | 52% |
| Coniferous | 2% |
| Mixed | 4% |
| **Overstory** | **FITZ4** |
| Deciduous | 14% |
| Coniferous | 43% |
| Mixed | |

Most indicator values were judged to be within reference for the survey site on Fitz Creek. However, the water quality indicator values for W/D and entrenchment ratio may have exceeded reference condition by 14% and 80%, respectively, in comparison with the 75th percentile of reference EA stream types.

The bank erosion hazard index at this site did not meet reference condition, with an average condition rated as high. However, the total percent of non-eroding banks met the supplemental indicator criteria of > 85%. The 2005 inventory measured < 1% of the total survey length as having eroding banks.

Other relevant information taken from DEQ's Waterbody Assessment files includes data generated from the 2003 reassessment of Fitz Creek. The 2003 information suggests that human sources of sediment are present:

The stream is of small scale and is a losing reach below the sampling site. The riparian is not functioning here as a result of heavy livestock impacts. Willows and sedges are removed by livestock, and the soils adjacent to the narrow riparian are trampled, compacted, and mostly devoid of vegetation. The expected willow/sedge community has converted to grass and some forbs as a consequence of livestock grazing. Field photos indicate that fine particles comprise a significant portion of the channel substrate. As thoroughly trampled as this channel appears, it is reasonable to think that the supply and storage of fine sediment is elevated (DEQ Waterbody Assessment Files).

**Summary and TMDL Development Determination**
Available sediment and habitat data suggest that fine sediment deposition within Fitz Creek could be potentially impairing the coldwater fishery and aquatic life beneficial uses. However, more data is necessary to adequately determine if instream habitats for aquatic life and coldwater fisheries beneficial uses are negatively affected by sediment. No sediment TMDL will be prepared for Fitz at this time, and additional monitoring is recommended to evaluate the extent of

naturally occurring fine sediment, the significance of human sources, and impacts to beneficial uses.

### 5.4.2.5. Halfway Creek

Halfway Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment was listed for alteration in stream-side or littoral vegetative covers, which are forms of pollution commonly linked to sediment impairment. Halfway Creek forms in Halfway Park on the Beaverhead-Deerlodge National Forest. It flows for approximately 8 miles to where it meets Big Pipestone Creek.

**Physical Condition and Sediment Sources**
The channel forms of Halfway Creek are predominantly controlled by landform structure. Halfway Park, the headwater area, is a broad wetland meadow with fairly gentle slopes. Channel form here is thought to be E-type. Once the stream leaves Halfway Park, the gradient steepens (A-type) and flow is confined to the canyon. Below the canyon the Boulder Batholith geology has weathered into less confined valley bottom sections (Ea and Eb-type reaches), as well as narrow valley bottom areas (B-type reaches) (**Appendix C, Figure 2-28**). The 2004 aerial assessment documented various sediment sources, including water diversions and impacts from abandoned mines and the loss of riparian habitat associated with road development and grazing. Many pollution sources observed along Halfway Creek were related to riparian grazing and unpaved roads and trails (overwidened channel, bank erosion, loss of vegetation). During the field source assessment, the channel condition appeared to degrade heading downstream.

In 2003 DEQ conducted a water quality assessment at one location within the watershed (DEQ-03) using DEQ reassessment protocols. This assessment provided the majority of data used for updates to the water body’s listing status in 2006. In 2005 DEQ performed a sediment and stream morphology assessment at one location within the Halfway Creek watershed. The site (HWFY7) was located about 5 miles below the headwaters. In addition to the DEQ inventories, two channel surveys were completed by the Beaverhead-Deerlodge National Forest (HFWY1-FS01 and HFWY7-FS01). This information is provided below. (DEQ, 2006).

**Biological Data**
In 2003 DEQ collected macroinvertebrate samples at one site on Halfway Creek. The bioassessment scores are presented in **Table 5-23**.

**Comparison with Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Halfway Creek are summarized in **Tables 5-20, 5-21, 5-22**, and **5-23**.

**Table 5-20. Halfway Creek Sediment Data Compared to Targets***

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | Composite % < 6mm (mean) | Riffle %<2mm (mean) | % <0.85mm | % <6.4 mm | Width / Depth Ratio (median) | Entrenchment Ratio (median) | E | P |
| DEQ-03 | 98% | 97% | NA | NA | NA | NA | NA | B4/ E4 |
| HFWY1-FS01 | 100% | NA | NA | NA | 4.1 | **3.4***** | E6 | E5 |
| HFWY7-FS01 | 88% | NA | NA | NA | **12.3** | **1.5***** | B5 | E5 |
| HFWY7 | **54%** | 20% | NA | NA | **13.5** | **1.6** | B4c | E4 |

*Bolded values represent departure from water targets based on Rosgen Level II potential.
** E = Existing Stream Type & P = Potential Stream Type.
***NA = data not available
*** Forest Service Data based upon a single measure of entrenchment.

**Table 5-21. Halfway Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| HFWY1-FS01 | N/A | N/A | N/A | FAR | N/A | N/A | N/A |
| HFWY7-FS01 | N/A | N/A | N/A | **NF** | N/A | N/A | N/A |
| HFWY7 | **41.8** | **Very High** | 92.8 | FAR | 0.55 | 135 | 164 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.

**Table 5-22. 2005 Greenline Survey Data for Halfway Creek**

| **Ground Cover** | **HFWY7** |
|---|---|
| Rock/Root | 17% |
| Riprap | |
| Bare Ground | 22% |
| Herbaceous | 62% |
| Wetland | |
| **Understory** | **HFWY7** |
| Deciduous | 66% |
| Coniferous | 2% |
| Mixed | 6% |
| **Overstory** | **HFWY7** |
| Deciduous | |
| Coniferous | 6% |
| Mixed | 1% |

**Table 5-23. Biological Metrics for Halfway Creek**
Bolded text failed to meet the target (Mountain MMI ≥ 63, Low Valley ≥ 48, and RIVPAC ≥ 0.80)

| **Station ID** | **Date** | **Class** | **Mountain Index** | **RIVPACS O/E** |
|---|---|---|---|---|
| M08HFWYC01 | 10/14/2003 | Low Valley | 64.6 | 1.09 |

DEQ data generated from the 2003 reassessment of Halfway Creek reported riffle substrate < 6 mm at 98% and the percentage of fine particles < 2 mm at 97%. Rosgen stream type was not estimated for this data collection effort. However, assuming either a B4 or E4 stream type typical of this area, percent fines <6 mm and <2 mm both exceed target values. Conversely, macroinvertebrate samples taken at this location met target metrics.

At the uppermost survey site (HFWY1-FS01), the shift in Rosgen stream type from E5 to E6 suggests that increased deposition of surface fines are a problem. With a potential Rosgen stream type of E5, the W/D at HFWY1-FS01 was slightly greater than reference, while the entrenchment ratio was slightly less than expected. Measures above the expected W/D and below the expected entrenchment ratio suggests potential sediment problems; however, these comparisons alone do not lend overwhelming support of the sediment listing.

The water quality indicator value for composite surface sediments <6mm in Reach 7 was not within reference at the 2005 survey site, and possibly exceeded reference condition in 2001 along lower Halfway Creek (HFWY7 and HFWY7-FS01). In 2005 the percentage of composite surface fines <6 mm at HFWY7 was anywhere from 42% (E4) to 116% (B4) above reference depending on Rosgen stream type. The entrenchment ratios for both surveys in Reach 7 were less than expected for reference E and B type streams. The 2005 PFC rating for this section of Halfway Creek was also considered different from proposed reference conditions. The 2005 BEHI survey indicates that bank erosion was greater than expected for potential reference and primarily attributable to human sources; however, the percent eroding banks target was met.

Macroinvertebrate data collected in October 2003 met select supplemental targets for the mountain and valley MMI scores, as well as supplemental RIVPACS values.

**Summary and TMDL Development Determination**

Fine surface sediments appear to be accumulating in riffles, and pool habitat may also be affected. However, natural levels of elevated fines in this area are common due to the highly erosive parent geology. That being said, a greater than expected W/D and lower than expected entrenchment ratios could equate to increased sediment loading from streambanks. Bank erosion did appear to be a problem within the 2005 survey reach (HFWY7). During the 2005 inventory many sediment sources related to human activities were documented, such as riparian grazing, roads/trails, and channel modifications (suspected beaver dam removal and placer mining).

Although some of the percent fines targets were not met, elevated fine sediment is likely naturally occurring. No sediment TMDL will be prepared for Halfway Creek at this time, and additional monitoring is recommended to evaluate the extent of naturally occurring fine sediment, the significance of human sources, and impacts to beneficial uses.

## 5.4.2.6. Hells Canyon Creek

Hells Canyon Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment is also listed for physical substrate habitat alterations, which are a form of pollution commonly linked to sediment impairment. Hells Canyon Creek forms in the Highland Mountains on the Beaverhead-Deerlodge National Forest. It flows for approximately 13 miles to where it meets the Jefferson River.

**Physical Condition and Sediment Sources**

The channel forms of Hells Canyon Creek are predominantly controlled by landform structure, as well as historic and current land uses. The prominent landform geology, the Boulder Batholith, has resulted in valley bottom formation along weathered joints. The stream headwaters arise from steep slopes (A-type), changing to more moderate slopes downstream. The canyon valley bottom alternates between confined (B-type) and unconfined sections (C-type). Remnants of beaver dams were observed in the lower portions of the stream. The removal of beaver dams may have altered channel form (straightened, incised), and that channel type would probably have naturally trended towards an E-type in these areas (**Appendix C, Figure 2-31**). The 2004 aerial assessment documented various sediment sources, including riparian grazing and unpaved roads. The sources of flow alterations from water diversions and impacts from abandoned mines were taken from GIS layers that located water rights claims and abandoned mines. The GIS-identified sources were not field verified. Silviculture harvests occurred before 1983 upslope from and adjacent to Hells Canyon Creek. Harmful effects from this impact were not observed in the field. Loss of riparian habitat was generally associated with road development and grazing.

In 2005 DEQ performed a sediment and stream morphology assessment at two locations within the Hells Canyon Creek watershed. These assessment sites were located about 3 miles (HELLC3) and 6 miles (HELLC6) below the headwaters. In addition to the 2005 inventory, two channel surveys was completed by the Beaverhead-Deerlodge National Forest in 1998 (HELLC4-FS98 and HELLC6-FS98) (DEQ, 2006).

**Comparison with Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Hells Canyon Creek are summarized in **Tables 5-24, 5-25**, and **5-26**.

**Table 5-24. Hells Canyon Creek Sediment Data Compared to Targets*.**

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | **Composite % < 6mm (mean)** | **Riffle %<2mm (mean)** | **% <0.85 mm** | **% <6.4 mm** | **Width / Depth Ratio (median)** | **Entrenchment Ratio (median)** | **E** | **P** |
| HELLC3 | 24% | 21% | NA | NA | 7.3 | 2.3 | B4a | B4a |
| HELLC4-FS98 | **33%** | NA | NA | NA | 18.9 | **2.5** | C4b/B4 | C4 |
| HELLC6 | 21% | 11% | **16%** | **40%** | 13.0 | **1.6** | B4c | E4 or C4 |
| HELLC6-FS98 | **29%** | NA | NA | NA | 14.2 | **2.4** | C4b | C4 |
| HELLC9 | NA | NA | 10% | **34%** | NA | NA | NA | NA |

*Bolded text values represent departure from the water quality indicators for potential Rosgen stream type.
** E = Existing Stream Type & P = Potential Stream Type.
*** Forest Service Data based upon a single measure of entrenchment.

**Table 5-25. Hells Canyon Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| HELLC3 | **31.36** | **High** | 91.6 | PFC | 0.75 | 76 | 276 |
| HELLC4-FS98 | NA | NA | NA | FAR | NA | NA | NA |
| HELLC6 | **43.7** | **Very High** | 99.3 | **FAR** | 0.85 | 88 | 0 |
| HELLC6-FS98 | NA | NA | NA | FAR | NA | NA | NA |
| HELLC9 | NA | NA | NA | NA | NA | NA | NA |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.

**Table 5-26. 2005 Greenline Survey Data for Hells Canyon Creek**

| **Ground Cover** | **HELLC3** | **HELLC6** |
|---|---|---|
| Riprap | | 3% |
| Bare Ground | 18% | 11% |
| Herbaceous | 13% | 73% |
| Wetland | 70% | 14% |
| **Understory** | **HELLC3** | **HELLC6** |
| Deciduous | 16% | 26% |
| Coniferous | 23% | |
| Mixed | 14% | |
| **Overstory** | **HELLC3** | **HELLC6** |
| Deciduous | 11% | |
| Coniferous | 42% | |
| Mixed | 14% | |

Many of the selected sediment water quality indicator values were judged to be outside of reference or at the threshold for the survey sites along Hells Canyon Creek. The percentage of surface fines <2 mm at HELLC3 was 6% greater than the defined reference mean. The percentage of composite surface fines <6 mm at HELLC4-FS98 was anywhere from 14% (C4) to 32% (B4) greater, depending on Rosgen stream type. The W/D at HELLC4-FS98 was less than reference C4 type streams, while the entrenchment ratio was 82% less than expected for reference C4 type streams. At HELLC6 the entrenchment ratio was 16% less than expected and 89% less then the potential C4 stream type. The percentage of subsurface fines <6.4 mm for HELLC6 was 33% greater than the defined reference mean, while the percentage of fines (<0.85 mm) was 60% greater. The PFC rating at HELLC6 was also considered a violation of proposed reference conditions, due to the potential downward trend given current and historical management activities. Composite surface fines <6 mm at HELLC6-FS98 were at the threshold for reference, while the entrenchment ratio was 82% less than expected for reference. At HELLC9 the percentage of subsurface fines <6.4 mm for this site was 13% greater than the defined reference mean, while the percentage of fines (<0.85 mm) was at the threshold for the defined reference value.

**Summary and TMDL Development Determination**

Based on the data reviewed for Hells Canyon Creek, instream habitats for aquatic life and coldwater fisheries beneficial uses are likely impacted and affected by sediment. Fine surface sediments appear to be accumulating in riffles, and pool habitat may also be affected. Elevated surface fines in riffles can harm aquatic insects. In addition, subsurface sediments appear to be accumulating in fish spawning habitats. High fines in spawning gravels can disrupt and even prevent trout reproduction. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this subwatershed. During the 2004 and 2005 assessments many sediment sources related to human activities were documented, such as road inputs, riparian grazing, and channel modifications (suspected beaver dam removal, rip-rap, and historic logging alterations). This information supports the 303(d) listing, and a sediment TMDL will be completed for Big Pipestone Creek.

### 5.4.2.7. Little Pipestone Creek

Little Pipestone Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment is also listed for alteration in stream-side or littoral vegetative covers, which are forms of pollution commonly linked to sediment impairment. Little Pipestone Creek originates on the Continental Divide in the Beaverhead-Deerlodge National Forest. It flows for approximately 16 miles to where it meets Big Pipestone Creek.

**Physical Condition and Sediment Sources**
The channel forms of Upper Little Pipestone Creek are predominantly controlled by landform structure, as well as historical and current land use activities. The uppermost portion of the headwaters area consists of flooded wet meadows that transition into a flowing stream. There were ponded areas from earthen dams and some areas of multiple threads with E-type channel characteristics. The upper reaches of the stream are affected by channelization between Montana Highway 2 and the railway. Channel forms in these confined areas were characteristic of E- and mostly G-type streams (**Appendix C, Figure 2-34**). The Boulder Batholith is the prominent geology of the upper reaches. Many pollution sources observed along Upper Little Pipestone Creek were related to roads and riparian grazing. In many instances, the sources of flow alterations from water diversions and impacts from abandoned mines were taken from GIS layers that located water rights claims and abandoned mines. The GIS-identified sources were not field verified, except in the uppermost reaches of the stream where earthen dams were observed obstructing the channel.

The channel forms of Lower Little Pipestone Creek are also predominantly controlled by landform structure and historical and current land use activities. The predominant valley type (VIII) would typically result in an unconfined stream type (C or E), yet channel alterations have resulted in stream types out of balance with the valley type (**Appendix C, Figure 2-35**). Active beaver dams were observed on the creek above Montana Highway 41. Many pollution sources observed along Lower Little Pipestone Creek were related to agricultural operations and rural housing development. Alterations for irrigation diversions were also observed. During the field source assessment, grazing impacts and flow alterations were observed, and in general, stream condition deteriorates in a downstream direction.

In 2005 DEQ performed a sediment and stream morphology assessment at two locations within the Little Pipestone Creek watershed. These sites, LTLP6 and LTLP9, were located about 7.5 and 12 miles below the headwaters. In addition to the 2005 inventory, one channel survey was completed by the Beaverhead-Deerlodge National Forest in 2001 (LTLP3-FS01) (DEQ, 2006).

**Biological Data**
In 2003 DEQ collected macroinvertebrate samples at two sites on Little Pipestone Creek. The bioassessment scores are presented in **Table 5-30**.

**Comparison with Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Little Pipestone Creek are summarized in **Tables 5-27, 5-28, 5-29**, and **5-30**.

**Table 5-27. Little Pipestone Creek Sediment Data Compared to Targets*.**

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | Composite % < 6mm (mean) | Riffle %<2mm (mean) | % <0.85 mm | % <6.4 mm | Width / Depth Ratio (median) | Entrenchment Ratio (median) | E | P |
| LTLP3 -FS01 | **60%** | NA | NA | NA | 6.9 | **1.1** | G4c | E4 |
| LTLP6 | **52%** | **23%** | NA | NA | 10.7 | **1.4** | B4a | B4a |
| LTLP9 | **46%** | **23%** | NA | NA | **8.2** | **2.4** | E4 | E4 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.
** E = Existing Stream Type & P = Potential Stream Type.
*** Forest Service Data based upon a single measure of entrenchment.

**Table 5-28. Little Pipestone Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| LTLP3-FS01 | NA | NA | NA | NF | NA | NA | NA |
| LTLP6 | **29.8** | **High** | 98.2 | FAR | 0.86 | 186 | 182 |
| LTLP9 | **35.8** | **High** | 85.9 | FAR | 0.86 | 100 | 76 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.

**Table 5-29. 2005 Greenline Survey Data for Little Pipestone Creek**

| **Ground Cover** | **LTLP6** | **LTLP9** |
|---|---|---|
| Rock/Root | 41% | 17% |
| Riprap | 2% | 1% |
| Bare Ground | 3% | 27% |
| Herbaceous | 28% | 38% |
| Wetland | 27% | 18% |
| **Understory** | **LTLP6** | **LTLP9** |
| Deciduous | 89% | 31% |
| Coniferous | 2% | 8% |
| Mixed | 2% | 4% |
| **Overstory** | **LTLP6** | **LTLP9** |
| Deciduous | 9% | 40% |
| Coniferous | 20% | 1% |
| Mixed | 7% | 1% |

**Table 5-30. Biological Metrics for Little Pipestone Creek**
Bolded text failed to meet the target (Mountain MMI ≥ 63, Low Valley ≥ 48, and RIVPAC ≥ 0.80)

| Station ID | Date | Class | Mountain Index | RIVPACS O/E |
|---|---|---|---|---|
| M08LTPSC04 | 7/17/2000 | Mountains | **62** | **0.76** |
| M08LTPSC05 | 7/17/2000 | Mountains | **52** | 0.88 |

At the uppermost survey site (LTLP3-FS01), the shift in Rosgen stream type from E4 to G4c may support the conclusion that surface fines are a problem. With a potential Rosgen stream type of E4, the entrenchment ratio at LTLP3-FS01 was 93% less than expected. Beaverhead-Deerlodge National Forest reference data are not available for G type streams, but the percent of surface fines <6mm composite count has exceeded the E4 value. A lower than expected entrenchment ratio and high composite surface fines value support the conclusion of sediment impairment. Additionally, the PFC evaluation rated the reach as non-functional.

The 2005 data for Little Pipestone Creek reveal that the water quality indicator values for surface sediments and many of the channel morphology measures were not within reference. The percentage of surface fines <2 mm at LTLP6 was 16% greater than the defined reference mean, while the percentage of composite surface fines <6 mm was 108% greater. At LTLP6 the reach median entrenchment ratio was 26% less than expected. At LTLP9 the percentage of surface fines <2 mm was 15% greater than the defined reference mean, while the percentage of composite surface fines <6 mm was 21% greater. The W/D ratio was 17% greater than expected and the entrenchment ratio was 85% less than expected at LTLP9. The PFC ratings were not considered exceedences of the reference conditions, given that trends were either not discernable (LTLP6) or appeared to be improving (LTLP9). Additionally, the BEHI survey at LTLP9 indicates that bank erosion was greater than expected and primarily attributable to human-induced, although potentially historic sources.

Macroinvertebrate data collected in July 2003 were slightly below supplemental targets for the mountain (>63) MMI scores, though the supplemental RIVPACS values were met.

**Summary and TMDL Development Determination**

The results for Little Pipestone Creek indicate an increased sediment supply and a decreased capacity to transport sediment. Available sediment and habitat data suggest that fine sediment deposition is likely impacting fish spawning and rearing habitat and the aquatic macroinvertebrate assemblages that support the fishery. The primary human sources of sediment within the watershed include rangeland and near-stream grazing, bank erosion, and unpaved and paved roads. This information supports the 303(d) listing, and a sediment TMDL will be completed for Little Pipestone Creek.

### 5.4.2.8. Whitetail Creek

Whitetail Creek was listed as impaired due to sedimentation/siltation on the 2006 303(d) List. This stream segment is also listed for alteration in stream-side or littoral vegetative covers, which are forms of pollution commonly linked to sediment impairment. Whitetail Creek forms at the outlet of Whitetail Reservoir on the Beaverhead-Deerlodge National Forest. It flows for approximately 23 miles to where it meets the Jefferson Slough, a former channel of the Jefferson River.

**Physical Condition and Sediment Sources**

The channel forms of Upper Whitetail Creek are predominantly controlled by landform structure and flow releases from Whitetail Reservoir. The landform geology of this area includes the Boulder Batholith, while intrusive volcanic rocks are also apparent. The headwaters arise in Whitetail Park at the outlet of Whitetail Reservoir (C-type), then the stream flows through a steep, narrow canyon (A-type). The canyon gradient lessens and valley bottom openings alternate between relatively confined (B-type reaches) and unconfined areas (C-type reaches) (**Appendix C, Figure 2-40**). Sediment sources noted during the 2004 aerial and pollution source assessment include impacts from riparian grazing and unpaved roads. Impacts due to water diversions and mining activities were noted but not field verified.

The channel forms of Lower Whitetail Creek are controlled by landform and historical and current land use activities. The predominant valley type (VIII) would typically result in an unconfined stream type (C or E). Yet alterations for flow diversions and possibly removal of beaver dams have resulted in sections with channel types out of balance with the valley type. After the confluence with Little Whitetail Creek, sinuosity greatly increases, and the stream was thought to exhibit an E-type channel (**Appendix C, Figure 2-41**). Active beaver dams were observed in the lowermost reaches of Whitetail Creek. There was also a notable difference in beaver management along the stream, depending on individual landowner, with beaver dams concentrated in some areas and totally absent in others. It is possible that active beaver dams, as well as beaver dam removal, have resulted in diverse channel forms, such as braided sections and incised sections. Within the lower portions of the creek many pollution sources were observed during the 2004 aerial and pollution source assessment. These sources were primarily related to agricultural operations. During the field source assessment, grazing impacts were observed in all of the field surveyed reaches. In addition, irrigation diversion impacts were also noted.

In 2004 DEQ conducted a water quality assessment at two locations within the watershed. This assessment provided the majority of data used for updates to the water body's listing status in 2006. Other qualitative information relevant to excess sediment production was noted in the file at these locations and includes trampled banks and the influence of human activities exacerbating the highly erosive geology.

In 2005 DEQ performed sediment and stream morphology assessments at three locations within the Whitetail Creek watershed. These sites, WHTL5, WHTL14, and WHTL16, were located approximately 5, 12, and 19.5 miles below the outlet of Whitetail Reservoir. In addition to the 2005 inventory, two channel surveys were completed by the Beaverhead-Deerlodge National

Forest in 1999 and 2001 (WHTL4-FS01 and WHTL11-FS99)( DEQ, 2006). These sites were located approximately 3 and 10 miles below the outlet of Whitetail Reservoir.

**Biological Data**
In 2003 DEQ collected macroinvertebrate samples at two sites on Whitetail Creek. The bioassessment scores are presented in **Table 5-34**.

**Comparison with Water Quality Targets**
The existing data in comparison with the targets and supplemental indicators for Whitetail Creek are summarized in **Tables 5-31, 5-32, 5-33**, and **5-34**.

**Table 5-31. Whitetail Creek Sediment Data Compared to Targets*.**

| Reach ID | Pebble Count | | McNeil Core | | Cross Section | | Rosgen Level II** | |
|---|---|---|---|---|---|---|---|---|
| | **Composite % < 6mm (mean)** | **Riffle %<2mm (mean)** | **% <0.85 mm** | **% <6.4 mm** | **Width / Depth Ratio (median)** | **Entrenchment Ratio (median)** | **E** | **P** |
| DEQ Upper | **54%** | **53%** | NA | NA | **NA** | **NA** | NA | B4/ C4 |
| DEQ Lower | **80%** | **77%** | NA | NA | **NA** | **NA** | NA | B4/ C4 |
| WHTL4-FS01 | **62%** | NA | NA | NA | **17.0** | **1.8*** ** | B5c | E5 |
| WHTL5 | **40%** | 19% | **25.0%** | **71.4%** | **15.8** | **1.6** | B4c | E4 or C4 |
| WHTL11-FS99 | **44%** | NA | NA | NA | 10.6 | **1.7*** ** | B4c | C4 |
| WHTL14 | 28% | 9% | NA | NA | 10.8 | **1.8** | B4c | C4 |
| WHTL16 | **40%** | **35%** | NA | NA | **22.3** | **1.2** | F4 | E4 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.
** E = Existing Stream Type & P = Potential Stream Type.
*** Forest Service Data based upon a single measure of entrenchment.

**Table 5-32. Whitetail Creek Sediment Data Compared to Supplemental Indicators.**

| Reach ID | BEHI Score (mean) | BEHI Adjective Rating | % Non-Eroding Banks | P.F. Condition | Residual Pool Depth (mean) | Pool Frequency (#/mile) | Large Woody Debris Frequency (#/mile) |
|---|---|---|---|---|---|---|---|
| WHTL4-FS01 | NA | NA | NA | FAR | NA | NA | NA |
| WHTL5 | **30.7** | **High** | **58.4** | FAR | 1.01 | 88 | 117 |
| WHTL11-FS99 | NA | NA | NA | **NF** | NA | NA | NA |
| WHTL14 | **30.9** | **High** | 87.2 | FAR | 0.75 | 70 | 123 |
| WHTL16 | **33.3** | **High** | 87.3 | **NF** | 0.96 | 65 | 6 |

*Bolded values represent departure from the water quality indicators for potential Rosgen stream type.

**Table 5-33. 2005 Greenline Survey Data for Whitetail Creek**

| **Ground Cover** | **WHTL5** | **WHTL14** | **WHTL16** |
|---|---|---|---|
| Rock/Root | 31% | 18% | 7% |
| Riprap | 0 | 0 | 8% |
| Bare Ground | 46% | 12% | 13% |
| Herbaceous | 25% | 71% | 71% |
| Wetland | 0 | 0 | 2% |
| **Understory** | **WHTL5** | **WHTL14** | **WHTL16** |
| Deciduous | 35% | 35% | 41% |
| Coniferous | 8% | 7% | 0 |
| Mixed | 6% | 2% | 0 |
| **Overstory** | **WHTL5** | **WHTL14** | **WHTL16** |
| Deciduous | 0 | 49% | 0 |
| Coniferous | 31% | 0 | 0 |
| Mixed | 31% | 18% | 7% |

**Table 5-34. Biological Metrics for Whitetail Creek**
Bolded text failed to meet the target (Mountain MMI ≥ 63, Low Valley ≥ 48, and RIVPAC ≥ 0.80)

| Station ID | Date | Class | Mountain Index | RIVPACS O/E |
|---|---|---|---|---|
| M08WHITC01 | 6/9/2004 | Mountains | 63 | 1.00 |
| M08WHITC02 | 6/9/2004 | Mountains | 32.2 | 1.13 |

The 2004 DEQ reassessment data reported riffle substrate percent fines smaller than 6 mm as 54% at the upper site to 80% at the lower site. The percentage of fine particles smaller than 2 mm increased from 53% at the upper site, to 77% at the lower assessment site. Rosgen stream type was not estimated for this data collection effort. However, assuming either a B4 or C4 stream type typical of this area, percent fines <6 mm and <2 mm both exceed the target value.

For the survey sites along Upper Whitetail Creek (Little Whitetail Creek, WHTL4-FS01, WHTL5, and WHTL11-FS99), the composite surface fines values <6 mm were elevated against the target values. At WHTL14 the composite surface fines were just below (3%) target values for a potential Rosgen stream type of C4, but exceeded the target values by 12% for its existing stream type B4. At WHTL5 the percentage of subsurface fines in McNeil core samples <6.4 mm was 138% greater than the defined reference mean, while the percentage of fine fines (<0.85 mm) was 150% greater. The reach median W/D at WHTL5 was slightly below the 75th percentile of reference B4 and C4 type streams, yet exceeded the target for E4. The PFC rating was indicative of a downward trend. Bank erosion also appeared to be a problem at WHTL5.

The entrenchment ratio values for most of the Upper Whitetail Creek survey sites were believed to have been different from reference due to hydromodification associated with Whitetail Reservoir operations. Under the assumption that reservoir operations were following reasonable land, soil, and water conservation practices, the entrenchment ratio values will not be considered a violation of proposed reference conditions.

At the lowermost survey site on Whitetail Creek (WHTL16), the PFC rating was not within reference conditions. The PFC assessment rated the reach as NF. Given a potential Rosgen stream type of E4, the percentage of composite surface fines <6 mm, the W/D, the entrenchment ratio, and the BEHI rating were not within reference. Pool infilling may also be occurring at WHTL16.

One of the two macroinvertebrate samples collected in June 2004 exceeded supplemental target values for the Mountain Index, and the second sample was near the target value.

**Summary and TMDL Development Determination**

These results indicate an increased sediment supply and a decreased capacity to transport sediment within the Whitetail Creek watershed. Available sediment and habitat data suggest that fine sediment deposition is likely impacting fish spawning and rearing habitat and the aquatic macroinvertebrate assemblages that support the fishery. The primary human sources of sediment within the watershed include rangeland and near-stream grazing, bank erosion, and unpaved roads. This information supports the 303(d) listing, and a sediment TMDL will be completed for Whitetail Creek.

## 5.5 TMDL Development Summary

Based on the comparison of existing conditions to water quality targets, 6 sediment TMDLs will be developed in the tributary streams of the Upper Jefferson TPA. **Table 5-35** summarizes the sediment TMDL development determinations and corresponds to **Table 1-1**, which contains the TMDL development status for all listed water body segments on the 2006 303(d) List. Water body segments with a TMDL development determination of “No” are recommended for additional review and/or monitoring and may require TMDL development in the future.

**Table 5-35. Summary of TMDL development determinations**

| Stream Segment | Water Body # | TMDL Development Determination (Y/N) |
|---|---|---|
| **Big Pipestone Creek**, from headwaters to mouth (Jefferson River) | MT41D001_020 | Y |
| **Cherry Creek**, from headwaters to mouth (Jefferson River) | MT41D002_090 | Y |
| **Fish Creek**, from headwaters to mouth (Jefferson River) | MT41D003_070 | Y |
| **Fitz Creek**, from headwaters to mouth (Whitetail Creek) | MT41D002_030 | N |
| **Halfway Creek**, from headwaters to mouth (Big Pipestone Creek) | MT41D003_130 | N |
| **Hells Canyon Creek**, from headwaters to mouth (Jefferson River) | MT41D003_030 | Y |
| **Little Pipestone Creek**, from headwaters to mouth (Big Pipestone Creek) | MT41D003_220 | Y |
| **Whitetail Creek**, from headwaters to mouth (Jefferson River) | MT41G002_140 | Y |

## 5.6 Source Quantification

This section summarizes the current sediment load estimates from three broad source categories: unpaved road erosion, stream bank erosion, and hillslope erosion. EPA sediment TMDL development guidance for source assessments state that the basic source assessment procedure includes compiling an inventory of all sources of sediment to the water body and using one or more methods to determine the relative magnitude of source loading, focusing on the primary and controllable sources of loading (EPA 1999). Additionally, regulations allow that loadings "may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (Water quality planning and management, 40 CFR § 130.2(G)). The source assessment conducted for this TMDL evaluated loading from the primary sediment sources using standard DEQ methods. But the sediment loads presented herein represent relative loading estimates within each source category, and, as no calibration has been conducted, should not be considered as actual loading values. Rather, relative estimates provide the basis for percent reductions in loads for each source category. Until better information is available, and the linkage between loading and instream conditions becomes clearer, the loading estimates presented here should be considered as an evaluation of the relative contribution from sources and areas that will be further refined in the future through adaptive management

### 5.6.1 Upland Erosion

Based on source assessment, hillslope erosion contributes approximately 7,300 tons per year to sediment listed tributary streams in the Upper Jefferson TPA. This assessment indicates that rangeland grazing on the "grasslands/herbaceous" and "shrubland" cover types is the most significant contributor to accelerated hillslope erosion within these tributary watersheds. Sediment loads due to hillslope erosion range from 85 tons/year in Halfway Creek watershed to 2,852 tons/year in the Whitetail Creek watershed. Since this assessment was conducted at the watershed scale, it is expected that larger watersheds will have greater sediment loads. Sediment loads normalized to watershed area are included in **Appendix D** and **E**. A significant portion of the sediment load due to hillslope erosion is contributed by natural sources. **Figure 5-2** contains annual sediment loads from upland erosion in 303(d) listed watersheds. **Appendix D** and **E** contain additional information about sediment loads from upland erosion in the Upper Jefferson TPA by subwatershed, including all 6th code HUCs in the TPA.

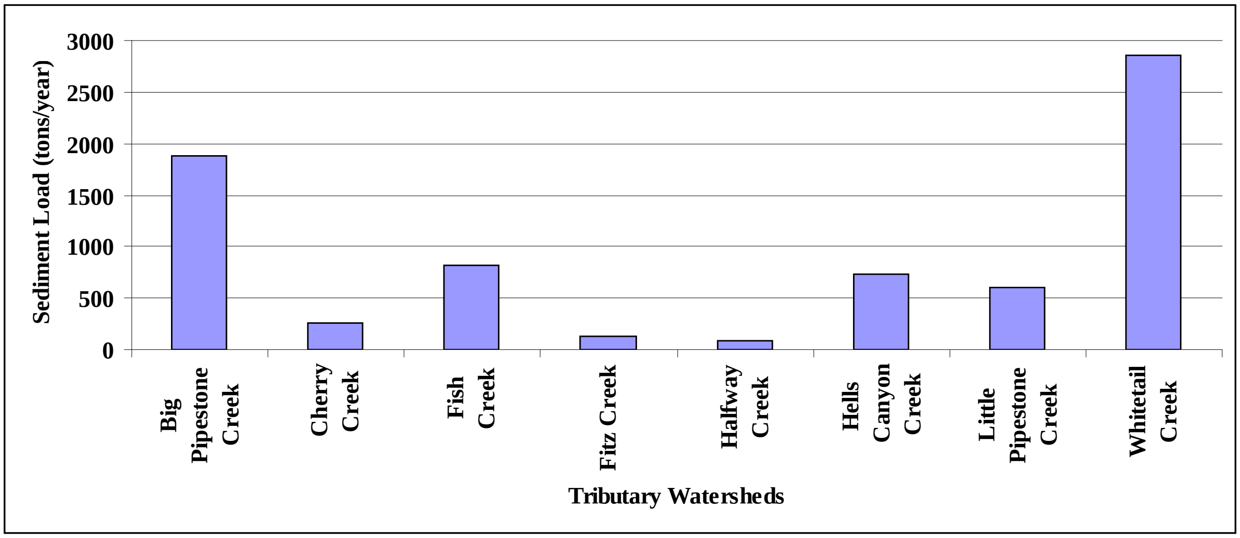


**Figure 5-2. Existing Annual Sediment Load (tons/year) from Upland Erosion by 303(d) Listed Watershed within the Upper Jefferson TPA**

## 5.6.2 Unpaved Roads

Based on the source assessment, unpaved roads are estimated to contribute 342 tons of sediment per year to sediment listed tributary streams in the Upper Jefferson TPA. Sediment loads due to unpaved roads range from 8 tons/year in the Halfway Creek watershed to 102 tons/year in the Big Pipestone Creek watershed. Factors influencing sediment loads from unpaved roads at the watershed scale include the overall road density within the watershed and the configuration of the road network, along with factors related to road construction and maintenance. **Figure 5-3** contains annual sediment loads from unpaved roads in 303(d) sediment listed watersheds. **Appendix F** contains additional information about sediment loads from unpaved roads in the Upper Jefferson TPA by subwatershed, including all that were assessed.

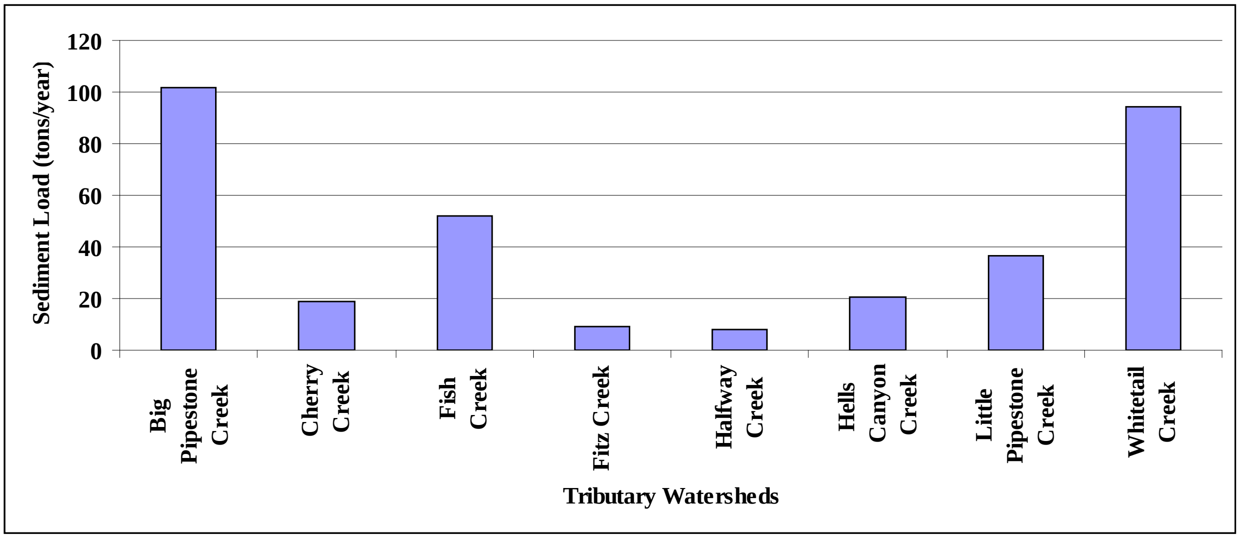


**Figure 5-3. Existing Annual Sediment Load (tons/year) from Unpaved Roads in 303(d) Listed Tributary Watersheds within the Upper Jefferson TPA**

### 5.6.3 Streambank Erosion

Based on the source assessment, streambank erosion contributes an estimated 20,745 tons of sediment per year to the Upper Jefferson TPA. Sediment loads due to streambank erosion range from 80 tons/year in the Fitz Creek watershed to 9,397 tons per year in the Big Pipestone Creek watershed. Within sediment listed tributary streams of the Upper Jefferson TPA, on average 46% of the sediment load due to streambank erosion is due to natural sources, while 54% is attributable to human sources. Significant sources of streambank erosion include riparian grazing (23%), irrigation shifts in stream energy (14%), transportation (6%), and cropping (5%). **Figure 5-4** contains annual sediment loads from eroding stream banks within 303(d) sediment listed watersheds. **Appendix G** contains additional information about sediment loads from eroding streambanks in the Upper Jefferson TPA by subwatershed, including all that were assessed.

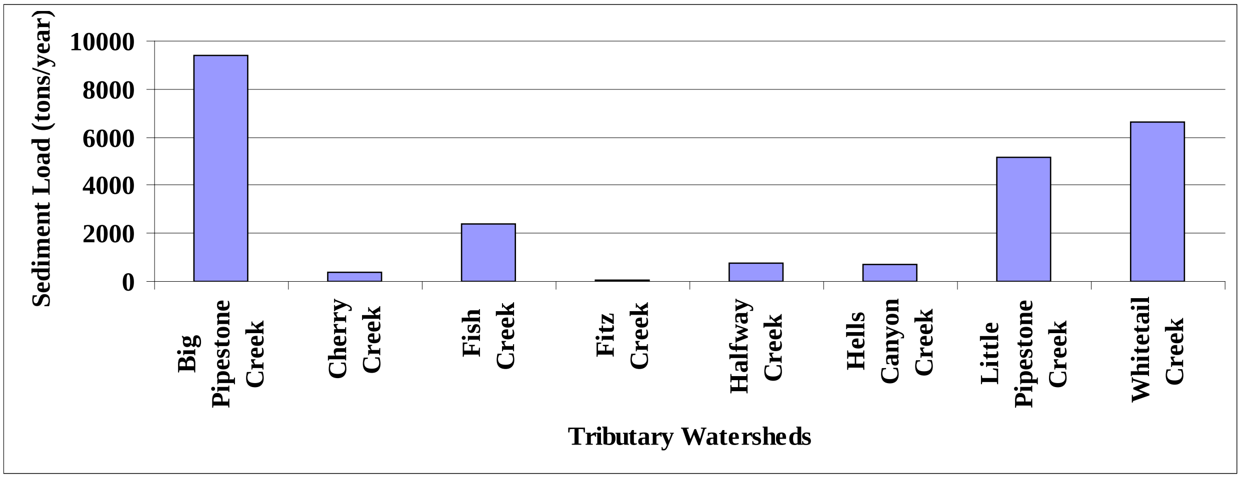


**Figure 5-4. Existing Annual Sediment Load (tons/year) from Streambank Erosion by 303(d) Listed Tributary Watersheds within the Upper Jefferson TPA**

### 5.6.4 Source Assessment Summary

The estimated annual sediment load from all identified sources within 2006 303(d) sediment listed tributary streams within the Upper Jefferson TPA is 28,434 tons. Each source type has different seasonal loading rates, and the relative percentage from each source category does not necessarily indicate its importance as a loading source. Additionally, the different source assessment methodologies introduce differing levels of uncertainty, as discussed in **Sections 5.3.6** and **5.8.3**. However, the modeling results for each source category, and the ability to proportionally reduce loading with the application of improved management practices (**Appendices D, E, F** and **G**), provide an adequate tool to evaluate the relative importance of loading sources (e.g., subwatersheds and/or source types) and to focus water quality restoration activities for this TMDL analysis.

## 5.7 TMDL and Allocations

The sediment TMDL process for the Upper Jefferson TPA will adhere to the TMDL loading function discussed in Section 4 but use a percent reduction in loading allocated among sources and an inherent margin of safety. A percent-reduction approach is used because there is uncertainty associated with the loads derived from the source assessment. Using the estimated sediment loads creates a rigid perception that the loads are absolutely conclusive. The percent-reduction TMDL approach constructs a plan that can be more easily understood for restoration planning. The TMDLs for sediment are stated as an overall percentage of the average annual sediment load that can be achieved by the sum of each individual allocation to a source. The sediment TMDLs use a percent-reduction allocation strategy based on estimates of BMP performances in the watershed.

Because there are no significant point sources, and sediment generally has a cumulative effect on beneficial uses, an annual expression of the TMDLs was determined as the most appropriate timescale to facilitate TMDL implementation. EPA encourages TMDLs to be expressed in the most applicable timescale but also requires TMDLs to be presented as daily loads (Grumbles 2006); daily loads are provided in **Appendix H**.

The percent-reduction allocations are based on the modeled BMP scenarios for each major source type (e.g., unpaved roads, upland erosion, and streambank erosion) and reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. Sediment loading reductions are expected to be achieved through a combination of BMPs, and the most appropriate BMPs will vary by site. The allocation for roads was determined by assuming a reduction in the contributing length to 100 feet from each side of road crossings and 100 feet for near-stream roads. This is not a formal goal but an example of how reductions can be achieved. The Beaverhead-Deerlodge National Forest (BDNF) reference dataset indicates that a moderate BEHI score (20-29.5) can be expected on reference streams with the following stream types: A, C, (C3, C4), and E (E3, E4, E5, Ea) (Bengeyfield, 2004). Streams classified as B types are on the border of moderate and high (30.0-39.5) BEHI categories, with B3 streams falling into the moderate category and B4 streams falling into the high category. Based on the BDNF reference dataset, it was determined that functioning streams in the Upper Jefferson TPA would tend to have a moderate BEHI score. Therefore, the potential reduction associated with streambank erosion was derived by reducing the BEHI score for all assessed streambanks that exceeded the moderate category to a moderate BEHI score.

For streambanks with a moderate or lower BEHI score, no adjustment was made, and the resulting allocation is a 0% reduction. Often bank erosion sources are the result of historical land management activities that are not easily mitigated through changes in current management. Also, they can be costly to restore and damage is sometimes irreversible. Therefore, although the sediment load associated with bank erosion is presented in separate source categories (e.g., transportation, grazing, cropland), the allocation is presented as a percent reduction expected collectively from human sources. Streambank stability and erosion rates are largely a factor of the health of vegetation near the stream, and the reduction in bank erosion risk and sediment loading is expected to be achieved by applying BMPs within the riparian zone. Sediment load reductions at the watershed scale are based on the assumption that the same sources that affect a listed stream segment affect other streams within the watershed and that a similar percent sediment load reduction can be achieved by applying BMPs throughout the watershed.

Allocations for upland sediment sources were derived by modeling the reduction in sediment loads that will occur by increasing ground cover through the implementation of upland BMPs. In addition, further allocations were developed to account for the additional reduction in sediment loads that will occur by increasing the sediment trapping efficiency (i.e., health) of the vegetated riparian buffer through the implementation of riparian BMPs. This secondary allocation is focused on those sources that affect the overall health of the vegetated riparian buffer. Examples include providing off-site watering sources, limiting livestock access to streams, applying conservation tillage and precision farming, and establishing or enhancing riparian buffers. The allocation to these sources includes both present and past influences and is not meant to represent only current management practices. Many of the restoration practices that address current land use will reduce pollutant loads that are influenced from historic land uses. A significant portion of the remaining upland sediment loads after BMPs is also a component of the natural upland load. However, the assessment methodology did not differentiate between sediment loads with all reasonable BMPs and natural loads. Additional information regarding BMPs for all source categories is contained in **Sections 6** and **7**.

### 5.7.1 Big Pipestone Creek

Big Pipestone Creek was listed as impaired due to sedimentation and siltation on the 2006 303(d) List. Sediment sources within the watershed include roads, streambank erosion, and upland erosion. Human sources of sediment to Big Pipestone Creek identified during this assessment include municipal and storm water point sources, roads/transportation, grazing, cropping, mining, irrigation shifts in stream energy, silviculture and “other,” which refers to historical channel obstructions from historic mining.

The current annual sediment load is estimated at 11,402 tons/year, with an estimated 31% of the sediment load due to natural sources and 69% of the sediment load due to human sources (**Table 5-36**).

By applying BMPs, the sediment load to the Big Pipestone Creek watershed could be reduced to 6,181 tons/year. To achieve this reduction, a 62% sediment load reduction is allocated to unpaved roads, and a 10% reduction is allocated to gully wash and rill erosion from I-90. Streambank erosion is allocated a 67% reduction, while upland sediment sources are allocated a 59% reduction from grazing, a 91% reduction from croplands, and an additional 45% reduction from silviculture activities and other sources. Traditional upland BMPs and associated reductions were not allocated to silviculture activities and natural sources. However, their 45% reduction represents additional reductions in upland sediment sources gained through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the reductions from other upland sources. For more information see **Appendix E**. This 45% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Big Pipestone Creek is expressed as a 46% reduction in the total average annual sediment load.

**Table 5-36. Sediment Source Assessment, Allocations and TMDL for Big Pipestone Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Potential Estimated Sediment Load BMPs (Tons/Year) | Sediment Load Allocations (% reduction) |
|---|---|---|---|---|
| Point Sources | Town of Whitehall WWTP | 6 | 17.1 | 0%* |
| | Conda Mining, Inc | 0 | 7.3 | 0%* |
| Roads | Unpaved Roads All Ownership | 102 | 39 | 62% |
| | I-90 | 21 | 19 | 10% |
| Streambank Erosion** | Transportation | 961 | 317 | 67% |
| | Riparian Grazing | 1926 | 636 | 67% |
| | Cropland | 975 | 322 | 67% |
| | Mining | 27 | 9 | 67% |
| | Irrigation | 1377 | 454 | 67% |
| | Other Human Caused Sources | 839 | 277 | 67% |
| | Natural Sources | 3291 | 3291 | 0% |
| Upland Sediment Sources** | Grazing | 1547 | 633 | 59% |
| | Crops | 46 | 4 | 91% |
| | Silviculture | 2 | 1 | 45%*** |
| | Other**** | 282 | 155 | 45%*** |
| Total Sediment Load | | 11402 | 6181 | **46% = TMDL** |

*This Waste Load Allocation actually represents a percent increase from the existing load. TSS load allocations will be managed by following MPDES permit requirements.
**A significant portion of bank erosion, grazing lands, cropland and other loads have a "natural load" component incorporated into them.
***The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
****Defined as areas with little or no human activity bounded by riparian areas where human activities are "allowing" a higher loading than what could be achieved via riparian improvements.

## 5.7.2 Cherry Creek

Cherry Creek was listed as impaired due to sedimentation and siltation on the 2006 303(d) List. Sediment sources within the Cherry Creek watershed include roads, streambank erosion, and upland erosion. Human sources of sediment identified during this assessment include roads/transportation, grazing, cropping, and irrigation shifts in stream energy.

The current estimated annual sediment load is 627 tons/year, with an estimated 30% from natural sources and 70% from human sources (**Table 5-37**). By applying BMPs, the sediment load could be reduced to 357 tons/year. To achieve this reduction, a 71% sediment load reduction is allocated to roads, while a 67% reduction is allocated to streambank erosion. Upland sediment sources are allocated a 55% reduction from grazing, a 62% reduction from croplands, and an additional 41% reduction in loading from other sources. Traditional upland BMPs and associated reductions were not allocated to other sources. However, their 41% reduction represents additional reductions in upland sediment sources gained through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the allocations from other upland sources. For more information see **Appendix E**. This 41% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Cherry Creek is expressed as a 43% reduction in the total average annual sediment load.

**Table 5-37. Sediment Source Assessment, Allocations and TMDL for Cherry Creek**

| **Sediment Sources** | | **Current Estimated Load (Tons/Year)** | **Potential Estimated Sediment Load with BMPs (Tons/Year)** | **Sediment Load Allocations (% reduction)** |
|---|---|---|---|---|
| Roads | All Ownership | 19 | 6 | 71% |
| Streambank Erosion* | Transportation | 9 | 3 | 67% |
| | Riparian Grazing | 85 | 28 | 67% |
| | Irrigation | 87 | 29 | 67% |
| | Natural Sources | 175 | 175 | 0% |
| Upland Sediment Sources* | Grazing | 234 | 106 | 55% |
| | Crops | 0.3 | 0.1 | 62% |
| | Other*** | 18 | 11 | 41%** |
| Total Sediment Load | | 627 | 357 | **43% = TMDL** |

*A significant portion of bank erosion, grazing lands, cropland and other loads have a “natural load” component incorporated into them.
**The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
***Defined as areas with little or no human activity bounded by riparian areas where human activities are “allowing” a higher loading than what could be achieved via riparian improvements.

## 5.7.3 Fish Creek

Fish Creek was listed as impaired due to sedimentation on the 2006 303(d) List. Sediment sources within the Fish Creek watershed include roads, streambank erosion, and upland erosion. Human sources of sediment identified during this assessment include roads/transportation, grazing, cropping, mining, irrigation shifts in stream energy, silviculture, and “other,” which refers to the influence of channel obstructions.

The current estimated annual sediment load is 3,264 tons/year, with an estimated 36% from natural sources and 64% from human sources (**Table 5-38**). By applying BMPs, the sediment load can be reduced to 2,077 tons/year. To achieve this reduction a 52% sediment load reduction is allocated to roads, while a 54% reduction is allocated to streambank erosion. Upland sediment sources are allocated a 56% reduction from grazing, a 73% reduction from croplands, and an additional 40% reduction in loading from silviculture activities and other sources. Traditional upland BMPs and associated reductions were not allocated to silviculture activities and other sources. However, their 40% reduction represents additional reductions in upland sediment sources through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the reductions from other upland sources. For more information see **Appendix E**. This 40% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Fish Creek is expressed as a 36% reduction in the total average annual sediment load.

**Table 5-38. Sediment Source Assessment, Allocations and TMDL for Fish Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Potential Estimated Sediment Load BMPs (Tons/Year) | Sediment Load Allocations (% reduction) |
|---|---|---|---|---|
| Roads | All Ownership | 52 | 25 | 52% |
| Streambank Erosion* | Transportation | 241 | 111 | 54% |
| | Riparian Grazing | 494 | 227 | 54% |
| | Cropland | 213 | 98 | 54% |
| | Mining | 5 | 2 | 54% |
| | Irrigation | 363 | 167 | 54% |
| | Other | 24 | 11 | 54% |
| | Natural Sources | 1055 | 1055 | 0% |
| Upland Sediment Sources* | Grazing | 690 | 306 | 56% |
| | Crops | 3 | 1 | 73% |
| | Silviculture | 2 | 1 | 40%** |
| | Other*** | 122 | 72 | 40%** |
| Total Sediment Load | | 3264 | 2077 | **36% = TMDL** |

*A significant portion of bank erosion, grazing lands, cropland and other loads have a “natural load” component incorporated into them.
**The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
***Defined as areas with little or no human activity bounded by riparian areas where human activities are “allowing” a higher loading than what could be achieved via riparian improvements.

## 5.7.4 Hells Canyon Creek

Hells Canyon Creek was listed as impaired due to sedimentation and siltation on the 2006 303(d) List. Sediment sources within the Hells Canyon Creek watershed include roads, streambank erosion, and upland erosion. Human sources of sediment identified during this assessment include roads/transportation, grazing, irrigation shifts in stream energy and “other,” which refers to channel incision.

The current estimated annual sediment load is 1,473 tons/year, with an estimated 32% from natural sources and 68% from human sources (**Table 5-39**). By applying BMPs, the sediment load can be reduced to 947 tons/year. To achieve this reduction, a 38% sediment load reduction is allocated to roads, while a 67% reduction is allocated to streambank erosion. Upland sediment sources are allocated a 44% reduction from grazing and an additional 29% reduction in loading from other upland sources. Traditional upland BMPs and associated reductions were not allocated to other upland sources. However, the 29% reduction represents additional reductions in upland sediment sources through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the reductions from other upland sources. For more information see **Appendix E**. This 29% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Hells Canyon Creek is expressed as a 36% reduction in the total average annual sediment load.

**Table 5-39. Sediment Source Assessment, Allocations and TMDL for Hells Canyon Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Potential Estimated Sediment Load BMPs (Tons/Year) | Sediment Load Allocations (% reduction) |
|---|---|---|---|---|
| Roads | All Ownership | 21 | 13 | 38% |
| Streambank Erosion* | Transportation | 19 | 6 | 67% |
| | Riparian Grazing | 223 | 74 | 67% |
| | Irrigation | 45 | 15 | 67% |
| | Other | 20 | 6 | 67% |
| | Natural Sources | 421 | 421 | 0% |
| Upland Sediment Sources* | Grazing | 668 | 371 | 44% |
| | Other *** | 57 | 41 | 29%** |
| Total Sediment Load | | 1473 | 947 | **36% = TMDL** |

*A significant portion of bank erosion, grazing lands, cropland and other loads have a “natural load” component incorporated into them.
**The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
***Defined as areas with little or no human activity bounded by riparian areas where human activities are “allowing” a higher loading than what could be achieved via riparian improvements.

### 5.7.5 Little Pipestone Creek

Little Pipestone Creek was listed as impaired due to sedimentation and siltation on the 2006 303(d) List. Sediment sources within the Little Pipestone Creek watershed include roads, streambank erosion, and upland erosion. Human sources of sediment identified during this assessment include roads/transportation, grazing, cropping, irrigation shifts in stream energy, silviculture and “other,” which refers to the influence of upstream channelization and flow modifications.

The current estimated annual sediment load is 5,812 tons/year, with an estimated 35% from natural sources and 65% from human sources (**Table 5-40**). By applying BMPs, the sediment load can be reduced to 3,461 tons/year. To achieve this reduction, a 40% sediment load reduction is allocated to roads, while a 61% reduction is allocated to streambank erosion. Upland sediment sources are allocated a 63% reduction from grazing, an 83% reduction from croplands, and an additional 51% reduction in loading from silviculture activities and other sources. Traditional upland BMPs and associated reductions were not allocated to silviculture activities and other sources. However, their 51% reduction represents additional reductions in upland sediment sources through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the reductions from other upland sources. For more information see **Appendix E**. This 51% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Little Pipestone Creek is expressed as a 41% reduction in the total average annual sediment load.

**Table 5-40. Sediment Source Assessment, Allocations and TMDL for Little Pipestone Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Potential Estimated Sediment Load BMPs (Tons/Year) | Sediment Load Allocations (% reduction) |
|---|---|---|---|---|
| Roads | All Ownership | 37 | 22 | 40% |
| Streambank Erosion* | Transportation | 646 | 252 | 61% |
| | Riparian Grazing | 839 | 327 | 61% |
| | Cropland | 594 | 232 | 61% |
| | Irrigation | 442 | 172 | 61% |
| | Other | 708 | 276 | 61% |
| | Natural Sources | 1947 | 1947 | N/A |
| Upland Sediment Sources* | Grazing | 534 | 197 | 63% |
| | Crops | 1.50 | 0.25 | 83% |
| | Silviculture | 0.39 | 0.19 | 51%** |
| | Other*** | 73 | 35 | 51%** |
| Total Sediment Load | | 5821 | 3461 | **41% = TMDL** |

*A significant portion of bank erosion, grazing lands, cropland and other loads have a "natural load" component incorporated into them.
**The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
***Defined as areas with little or no human activity bounded by riparian areas where human activities are "allowing" a higher loading than what could be achieved via riparian improvements.

## 5.7.6 Whitetail Creek

Whitetail Creek was listed as impaired due to sedimentation on the 2006 303(d) List. Sediment sources include roads, streambank erosion, and upland erosion. Human sources of sediment to Whitetail Creek identified during this assessment include roads/transportation, grazing, irrigation shifts in stream energy, silviculture and "other," which refers to channel incision.

The current estimated annual sediment load is 9,569 tons/year, with an estimated 23% from natural sources and 77% from human sources (**Table 5-41**). By applying BMPs, the sediment load can be reduced to 5,293 tons/year. To achieve this reduction, a 66% sediment load reduction is allocated to roads, while a 57% reduction is allocated to streambank erosion. Upland sediment sources are allocated a 55% reduction from grazing, a 93% reduction from croplands, and an additional 42% reduction in loading from silviculture activities and other sources. Traditional upland BMPs and associated reductions were not allocated to silviculture activities and other sources. However, their 42% reduction represents additional reductions in upland sediment sources through improved riparian health and increased riparian buffering capacity. Though not explicitly apparent, this reduction is also included within the reductions from other upland sources. For more information see **Appendix E**. This 42% reduction is allocated to those activities that influence the health and buffering capacity of the vegetated riparian buffer.

The total maximum daily sediment load for Whitetail Creek is expressed as a 45% reduction in the total average annual sediment load.

**Table 5-41. Sediment Source Assessment, Allocations and TMDL for Whitetail Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Potential Estimated Sediment Load BMPs (Tons/Year) | Sediment Load Allocations (% reduction) |
|---|---|---|---|---|
| Roads | All Ownership | 94 | 32 | 66% |
| Streambank Erosion* | Transportation | 500 | 215 | 57% |
| | Riparian Grazing | 1650 | 710 | 57% |
| | Cropland | 887 | 382 | 57% |
| | Irrigation | 1358 | 584 | 57% |
| | Other | 251 | 108 | 57% |
| | Natural Sources | 1977 | 1977 | 0% |
| Upland Sediment Sources* | Grazing | 2490 | 1122 | 55% |
| | Crops | 90 | 6 | 93% |
| | Silviculture | 2.14 | 1.25 | 42%** |
| | Other **** | 270 | 158 | 42%** |
| Total Sediment Load | | 9569 | 5293 | **45% = TMDL** |

*A significant portion of bank erosion, grazing lands, cropland and other loads have a "natural load" component incorporated into them.
**The load reduction derived solely by increasing the health and sediment buffering capacity of the vegetated riparian buffer.
***Defined as areas with little or no human activity bounded by riparian areas where human activities are "allowing" a higher loading than what could be achieved via riparian improvements.

## 5.8 Seasonality and Margin of Safety

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and to ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes seasonality and margin of safety in the Upper Jefferson TPA tributary sediment TMDL development process.

### 5.8.1 Seasonality

The seasonality of sediment impact to aquatic life is taken into consideration in the analysis within this document. Sediment loading varies considerably with season. For example, sediment delivery increases during spring when snowmelt delivers sediment from upland sources and the resulting higher flows scour streambanks. However, these higher flows also scour fines from streambeds and sort sediment sizes, resulting in a temporary decrease in the proportion of deposited fines in critical areas for fish spawning and insect growth. While fish are most susceptible to fine sediment deposition seasonally during spawning, fine sediment may affect aquatic insects throughout the year. Because both fall and spring spawning salmonids reside in the Upper Jefferson TPA, streambed conditions need to support spawning through all seasons. Additionally, reduction in pool habitat, by either fine or coarse sediment, alters the quantity and quality of adult fish habitat and can, therefore, affect the adult fish population throughout the year. Thus, sediment targets are not set for a particular season, and source characterization is geared toward identifying average annual loads. Annual loads are appropriate because the impacts of delivered sediment are a long-term impact—once sediment enters the stream network, it may take years for sediment loads to move through a watershed. Although an annual expression of the TMDLs was determined as the most appropriate timescale to facilitate TMDL implementation, to meet EPA requirements daily loads are provided in **Appendix H**.

### 5.8.2 Margin of Safety

Incorporating a margin of safety (MOS) is a required component of TMDL development. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to sustain conditions that will support beneficial uses. MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (EPA, 1999). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to help verify beneficial use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during target development (see **Section 5.4.1**).
- By using supplemental indicators, including biological indicators, to help verify beneficial use support determinations and assess standards attainment after TMDL implementation. Conservative assumptions were used during supplemental indicator development (see **Section 5.4.1**).
- By using standards, targets, and TMDLs that address both coarse and fine sediment delivery.
- By using supplemental indicators that act as an early warning method to identify pollutant-loading threats, which may not otherwise be identified, if targets are not met. Conservative assumptions were used for the source assessment process, including erosion rates, sediment delivery ratio, and BMP effectiveness (see **Appendices D, E, F** and **G**).
- By considering seasonality (discussed above).
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, targets, modeling assumptions, and restoration strategies to

further reduce uncertainties associated with TMDL development (discussed below and in **Section 6** and **7**).
- By using naturally occurring sediment loads as described in ARM 17.30.602(17) (see **Appendix B**) to establish the TMDLs and allocations. This includes an allocation process that addresses all known human sediment causing activities, not just the significant sources.

### 5.8.3 Uncertainty and Adaptive Management

A degree of uncertainty is inherent in any study of watershed processes related to sediment. The assessment methods and targets used in this study to characterize impairment and measure future restoration are each associated with a degree of uncertainty. This TMDL document will include a monitoring and adaptive management plan to account for uncertainties in the field methods, targets, and supplemental indicators. For the purpose of this document, adaptive management relies on continued monitoring of water quality and stream habitat conditions, continued assessment of impacts from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fish respond to changes in water quality and stream habitat conditions. Adaptive management addresses important considerations, such as feasibility and uncertainty in establishing targets. For example, despite implementation of all restoration activities (**Section 6**), the attainment of targets may not be feasible due to natural disturbances, such as forest fires, flood events, or landslides.

The targets established in the document are meant to apply under median conditions of natural background and natural disturbance. The goal is to ensure that management activities achieve loading approximate to the TMDLs within a reasonable timeframe and prevent significant excess loading during recovery from significant natural events. Additionally, the natural potential of some streams could preclude achievement of some targets. For instance, natural geologic and other conditions may contribute sediment at levels that cause a deviation from numeric targets associated with sediment. Conversely, some targets may be underestimates of the potential of a given stream and it may be appropriate to apply more protective targets upon further evaluations. Supplemental indicators are used to help with these determinations. In these circumstances, it is important to recognize that the adaptive management approach provides the flexibility to refine targets and supplemental indicators as necessary to ensure protection of the resource and to adapt to new information concerning target achievability.

Sediment limitations in many streams in the Upper Jefferson TPA relate to a fine sediment fraction found on the stream bottom, while sediment modeling employed in the Upper Jefferson TPA examined all sediment sizes. In general, roads and upland sources produce mostly fine sediment loads, while streambank erosion can produce all sizes of sediment. Because sediment source modeling may under- or over-estimate natural inputs due to selection of sediment monitoring sections and the extrapolation methods used, model results should not be taken as an absolutely accurate account of sediment production within each watershed. Instead, source assessment model results should be considered used as a tool to estimate sediment loads and make general comparisons of sediment loads from various sources.

Cumulatively, the source assessment methodologies address average sediment source conditions over long timeframes. Sediment production from both natural and human sources is driven by storm events. Pulses of sediment are produced periodically, not uniformly, through time. Separately, each source assessments methodology introduces different levels of uncertainty. For example, the road erosion method focuses on sediment production and sediment delivery locations from yearly precipitation events. The analysis did not include an evaluation of road culvert failures, which tend to add additional sediment loading during large flood events and would, therefore, increase the average yearly sediment loading if calculated over a longer time period. Road loading also tends to focus in upper areas of watersheds where there is often limited hillslope or bank erosion loading. The bank erosion method focuses on both sediment production and sediment delivery and also incorporates large flow events via the method used to identify bank area and retreat rates. Therefore, a significant portion of the bank erosion load is based on large flow events versus typical yearly loading. The hillslope erosion model focuses primarily on sediment production across the landscape during typical rainfall years. Sediment delivery is partially incorporated based on distance to stream (**Appendix C**). The significant filtering role of near-stream vegetated buffers (riparian areas) was incorporated into the hillslope analysis (**Appendix E**), resulting in proportionally reduced modeled sediment loads from hillslope erosion relative to the average health of the vegetated riparian buffer throughout the watershed.

Because the sediment standards relate to a water body's greatest potential for water quality given current and historic land use activities where all reasonable land, soil, and water conservation practices have been applied and resulting conditions are not harmful, detrimental, or injurious to beneficial uses, the percent-reduction allocations are based on the modeled upland and riparian BMP scenarios for each major source type. The allocations reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. However, if new information becomes available regarding the feasibility or effectiveness of BMPs, adaptive management allows for the refinement of TMDLs and allocations.

Additionally, as part of this adaptive management approach, shifts in the amount or intensity of land use activities should be tracked and incorporated into the source assessment to determine if allocations need to be revised. Cumulative impacts from multiple projects must also be considered. This approach will help track the recovery of the system and the impacts, or lack of impacts, from ongoing management activities in the watershed. Under these circumstances, additional targets and other types of water quality goals may need to be developed to address new stressors to the system, depending on the nature of the activity.

Undersized culverts are also a potential sediment source but were not assessed within the scope of this project. The risk of culvert failure is related to the frequency and size of storm events. Total failure can result in a large sediment pulse, but for undersized culverts, even smaller events can flush excess instream sediment downstream and cause culverts to become barriers to fish passage. Due to the uncertainty associated with sediment source assessment modeling, **Section 7** includes a monitoring and adaptive management plan to account for uncertainties in the source assessment results.

# SECTION 6.0
# FRAMEWORK FOR WATER QUALITY RESTORATION

## 6.1 Summary of Jefferson Restoration Strategy

This section provides a framework strategy for water quality restoration in the tributary streams of the Upper Jefferson River watershed, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document. This section identifies which activities will contribute the most reduction in pollutants for each TMDL. Limited information about spatial application of each restoration activity will be provided.

This section should assist stakeholders in developing a more detailed adaptive Watershed Restoration Plan (WRP) in the future. The locally developed Watershed Restoration Plan will likely provide more detailed information about restoration goals and spatial considerations. The WRP may also encompass more broad goals than this framework includes. The to-be-developed WRP would serve as a locally organized “road map” for watershed activities, sequences of projects, prioritizing of projects, and funding sources for achieving local watershed goals, including water quality improvements. Within this plan, the local stakeholders would identify and prioritize streams, tasks, resources, and schedules for applying Best Management Practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, stakeholders could adapt and revise this strategy based on new information and ongoing improvements.

## 6.2 Watershed Restoration Goals

The following are general water quality goals provided in this TMDL document:

Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within tributary streams of the Upper Jefferson River TMDL Planning Area (TPA) by improving sediment water quality conditions. This technical guidance is provided by the TMDL components in the document.
Identify a framework watershed restoration approach for activities that will attain sediment water quality standards in water bodies with TMDLs.
Assess watershed restoration activities to address significant pollutant sources. Costs and benefits are both generally considered, although this analysis is not detailed. General spatial guidance will be provided for restoration activities.

A Watershed Restoration Plan (WRP) is a locally derived plan that can be more dynamic than the TMDL document. It can be refined as activities progress and address a much wider variety of goals than those included in this TMDL document. The following are key suggested elements for this stakeholder derived Watershed Restoration Plan (WRP):

Implement Best Management Practices (BMPs) to protect water conditions so that all streams in the watershed maintain good quality, with an emphasis on waters with completed TMDLs.

Develop more detailed cost-benefit and spatial considerations for water quality improvement projects.
Develop an approach for future BMP installments and efficiency results tracking.
Provide information and education to reach out to stakeholders about approaches to restoration, its benefits, and funding assistance.
Include other watershed health goals as needed.

Specific water quality goals are detailed in **Section 5**. The targets are the basis for long-term effectiveness monitoring for achieving the above water quality goals (**Section 7**). These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses for Upper Jefferson tributary waters. **Section 7** identifies a general approach to the monitoring recommendations designed to track post-implementation water quality conditions and restoration successes.

## 6.3 Framework Watershed Management Recommendations

Sediment TMDLs were completed for six tributary watersheds. The most important restoration approach for reducing sediment loading in the Upper Jefferson River TPA is streamside riparian restoration and long-term riparian zone management. Channel restoration might be necessary where riparian vegetation has been altered and/or irrigation systems have had a negative impact. Other sediment restoration actions would include controlling erosion from unpaved roads near streams and improving management of the I-90 corridor.

### 6.3.1 Sediment Restoration Approaches

Restoring riparian vegetation and long-term riparian area management are essential practices that must be implemented across the watershed to achieve the sediment TMDLs. Using native riparian vegetation (particularly woody plants) is recommended because these species have the best root mass to hold streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian vegetation captures sediment from upland runoff. During flooding, sediment can deposit more heavily in healthy riparian zones because the vegetation slows water flow, allowing sediments to filter out before reaching the stream.

Most of the sediment TMDLs identify eroding banks due to human influences as the primary sediment source (**Table 6-1**). Riparian restoration will address bank erosion and include channel restoration in areas that have been heavily impacted. Livestock grazing in riparian areas is the predominant cause of riparian and stream channel degradation in the Upper Jefferson watershed. In numerous areas hay production encroaches into riparian zones, negatively impacting riparian vegetation. **Table 6-1** provides a summary of load reductions along with ranked sources and possible BMPs associated with each source. The table also identifies general spatial guidance for each watershed with a sediment TMDL. Also see **Appendix E, Figure E-3** for spatial considerations when contemplating riparian vegetation improvement projects.

Erosion from uplands due to human influences tends to be the second most predominant source of sediment identified in the TMDLs. The restoration objective is to improve riparian vegetation so that it captures more sediment and prevents it from reaching the stream. Thus, as stated above, restoring riparian vegetation and implementing a long-term riparian management plan are key factors in reducing sediment.

On average, erosion from unpaved and paved roads is the third most controllable sediment source in the Upper Jefferson watershed. Restoration efforts should be designed to divert water from roads and ditches before it enters the stream. Diverted water can be routed through natural healthy vegetation, which filters out sediment before it can enter streams. Sediment from roads, as well as rill and gully wash erosion, may cause significant localized impacts in some stream reaches, even though, at a watershed scale, it may be a small to moderate source. Sediment from culvert failure and culvert-caused scour were not noted by the TMDL source assessment but should be considered in restoration efforts.

All of these BMPs are considered reasonable restoration approaches due to their benefit and generally low costs. Riparian protection/restoration and road erosion control are standard BMPs identified by NRCS and are not overly expensive. Many riparian areas could benefit from more active grazing management (possibly with some additional fencing) and would typically recover naturally. Active riparian vegetation planting, along with bank sloping, may be slightly more costly but still reasonable and relatively cost effective. When restoration is needed due to altered stream channels, costs increase and projects should be assessed on a case-by-case basis.

Historic placer mining, as well as irrigation infrastructure, may have localized impacts that affect sediment production within the watershed. If found, such sediment sources that can be restored at reasonable costs could be prioritized into the watershed restoration plan. Any other unknown sediment sources could also be incorporated into the restoration plan, while considering cost and sediment reduction benefits.

Through application of locally appropriate BMPs, sediment loads in individual streams can be reduced between 36% and 46% (**Table 6-1**).

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| Big Pipestone Creek | 11,402 | 46% | 1 | Eroding Banks needing sustainable riparian zone vegetative condition, Reduction in irrigation infrastructure effects | Riparian grazing management, Riparian willow vegetation restoration, Move haying from riparian green line, Irrigation infrastructure mitigation | Eroding banks with insufficient riparian cover occur along significant but intermittent reaches of both the lower and upper portions of the creek. Some riparian areas are managed well and others need riparian restoration work. Riparian health appears to be fair in upper portions of the watershed while health markedly declines to a mix of fair and poor in the lower portions. Tributaries should also be addressed to reduce sediment loads to Big Pipestone Creek.<br><br>In both the lower and upper portions of the watershed, effects from Irrigation infrastructure are apparent. |
| | | | 2 | Upland Sediment from grazing, | Riparian grazing management, Provide filter strips along streams | |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| | | | | | | Spatial considerations are provided in **Appendix E** & **G** |
| | | | 3 | Paved and Unpaved roads | Road maintenance and runoff BMPs | Road maintenance BMPs should occur on I-90 and many unpaved road crossings. Spatial considerations are provided in **Appendix C** & **F**. |
| Cherry Creek | 627 | 43% | 1 | Upland Sediment from grazing | Riparian grazing management, Provide filter strips along streams | A few improvements could be achieved in upper Cherry Creek but riparian management appears to be good to fair along the upper/middle of the watershed. Grazing related impacts were noted in the area just downstream of public lands on private property. There may also be some effects from irrigation infrastructure.<br><br>Green line degradation in the floodplain and the loss of riparian |
| | | | 2 | Eroding Banks needing sustainable riparian zone vegetative condition | Riparian grazing management, Riparian willow vegetation restoration | |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| | | | | | | habitat is much more prevalent in the lowest segments of the watershed.<br><br>Much of grazing effects occur on private lands. |
| Fish Creek | 3,264 | 36% | 1 | Eroding Banks needing sustainable riparian zone vegetative condition | Riparian grazing management, Riparian willow vegetation restoration in grazed and cropped areas | Eroding banks with insufficient riparian cover occur along significant but intermittent reaches of both the lower and upper portions of the creek. Some riparian areas are managed well and others need riparian restoration work. Riparian health appears to be fair in upper portions of the watershed with a few heavily impacted areas of poor health.<br><br>The lower portions of the watershed exhibit Good, Fair and Poor riparian condition and impacts are |
| | | | 2 | Upland Sediment from grazing and hay production | Riparian grazing and cropping management, Provide filter strips along streams | |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| | | | | | | primarily associated with grazing and haying within the riparian zone.<br><br>In the upper portions of the watershed effects from placer mining including channelization and degraded riparian health are apparent.<br><br>Spatial considerations are provided in **Appendix E** & **G** |
| | | | 3 | Unpaved roads | Road maintenance and runoff BMPS | Road maintenance should occur on many unpaved road crossings.<br><br>Spatial considerations are provided in **Appendix C** & **F**. |
| Hells Canyon Creek | 1,473 | 36% | 1 | Eroding Banks needing sustainable riparian zone vegetative condition | Riparian grazing management, Riparian willow vegetation restoration in grazed and cropped areas | Eroding banks with insufficient riparian cover occur along significant but intermittent reaches of both the lower and upper portions of the |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| | | | 2 | Upland Sediment from grazing and hay production | Riparian grazing and cropping management, Provide filter strips along streams | creek. Some riparian areas are managed well and others need riparian restoration work. Riparian health appears to be fair in upper portions of the watershed with a few heavily impacted areas of poor health.<br><br>The lower portions of the watershed exhibit Good, Fair and Poor riparian condition and impacts are primarily associated with grazing and haying within the riparian zone.<br><br>In the upper portions of the watershed effects from placer mining including channelization and degraded riparian health are apparent.<br><br>Spatial considerations are |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| **Name of Water body** | **Current Sediment Loads** | **TMDL Sediment Load Reduction (% of total load)** | **Source and Restoration Rank** | **Ranked Controllable Sources** | **Ranked BMP Type** | **Spatial concerns** |
|---|---|---|---|---|---|---|
| | | | | | | provided in **Appendix E** & **G** |
| | | | 3 | Unpaved roads | Road maintenance and runoff BMPS | Road maintenance should occur on many unpaved road crossings.<br><br>Spatial considerations are provided in **Appendix C** & **F**. |
| Little Pipestone Creek | 5,821 | 41% | 1 | Eroding Banks needing sustainable riparian zone vegetative condition, | Riparian grazing management, Riparian willow vegetation restoration, Move haying from riparian green line | Eroding banks with insufficient riparian cover occur along significant but intermittent reaches of both the lower and upper portions of the creek. Some riparian areas are managed well and others need riparian restoration work. Riparian health appears to be fair in upper portions of the watershed while health markedly declines to a mix of fair and poor in the lower portions. Tributaries should also addressed to reduce sediment loads to Little |
| | | | 2 | Upland Sediment from grazing, | Riparian grazing management, Provide filter strips along streams | |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| **Name of Water body** | **Current Sediment Loads** | **TMDL Sediment Load Reduction (% of total load)** | **Source and Restoration Rank** | **Ranked Controllable Sources** | **Ranked BMP Type** | **Spatial concerns** |
|---|---|---|---|---|---|---|
| | | | | | | Pipestone Creek.<br><br>In both the lower and upper portions of the watershed effects from Irrigation infrastructure are apparent. Spatial considerations are provided in **Appendix E** & **G** |
| | | | 3 | Paved and Unpaved roads | Road maintenance and runoff BMPS | Road maintenance should occur on unpaved road crossings and road wash sources. Spatial considerations are provided in **Appendix C** & **F**. |
| Whitetail Creek | 9.569 | 45% | 1 | Eroding Banks needing sustainable riparian zone vegetative condition, | Riparian grazing management, Riparian willow vegetation restoration, Move haying from riparian green line | Eroding banks with insufficient riparian cover occur along significant but intermittent reaches of both the upper and lower portions of the creek. Some |

**Table 6-1. Summary of Sediment Load Reductions and Ranked Restoration Strategy by Watershed**

| Name of Water body | Current Sediment Loads | TMDL Sediment Load Reduction (% of total load) | Source and Restoration Rank | Ranked Controllable Sources | Ranked BMP Type | Spatial concerns |
|---|---|---|---|---|---|---|
| | | | 2 | Upland Sediment from grazing, | Riparian grazing management, Provide filter strips along streams | riparian areas are managed well and others need riparian restoration work. Riparian health appears to be fair in upper portions of the watershed while health markedly declines to poor in the lower portions. Tributaries should also be addressed to reduce sediment loads to Little Pipestone Creek.<br><br>In both the lower and upper portions of the watershed effects from Irrigation infrastructure are apparent.<br><br>Spatial considerations are provided in **Appendix F** & **G** |

## 6.3.1.1 Big Pipestone Creek

The current sediment load for Big Pipestone Creek is estimated at 11,402 tons per year; the TMDL sediment load reduction is 46% (**Section 5.7.1**). Restoration strategies for this watershed vary from a most-aggressive approach involving significant channel work to simply continuing with existing BMPs (**Table 6-1**).

Because of the obvious differences in land use, cover, ownership, and pollutant source types, for the purposes of this section, Big Pipestone Creek was broken into two restoration segments: Upper Big Pipestone Creek, extending from the Delmoe Lake outlet to the I-90 crossing, and Lower Big Pipestone Creek, extending from the I-90 crossing downstream to the confluence with the Jefferson River.

Within the upper portion of Big Pipestone Creek land ownership is primarily under the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM). The dominant riparian cover along Big Pipestone Creek above I-90 is mixed coniferous forest with upland shrubs (**Appendix C, Figure 2-9**). The relative health category assigned to all of the upper reaches was: "Fair. Vegetation appears healthy but some disturbance is present." (**Appendix E, Figure E-3**). Many pollution sources along Big Pipestone Creek above I-90 were related to operations at Delmoe Lake Dam and to unpaved roads and trails. Sediment from paved and unpaved roads, as well as sediment from ATV/motorcycle trails, is impacting upper Big Pipestone Creek. Restoration priorities in the upper portions of the watershed should focus primarily on road and trail sources and secondarily upland grazing and riparian management.

A French drain on Big Pipestone Creek at the I-90 road crossing separates the upper and lower portions of the watershed. The drain traps many of the fine sediments transported by the creek as indicated by a large depositional zone extending well above the culvert (north side of I-90). It is likely that this trap prevents substantial amounts of fine sediments from reaching the valley bottom segment of the creek and affects the sediment transport capacity of the creek below I-90. The creek must flow under I-90, subsurface, to continue on course. Should the drain be brought to the proper grade for surface flow, it is possible that more fine sediments would be transported and deposited to the valley reaches. Thus, restoration efforts should include more research into addressing the incorrectly aligned drain and future maintenance. Before action is taken to remove or change the connectivity of the upper and lower portions of the watershed, it is recommended that Montana Fish, Wildlife and Parks be contacted regarding Westslope cutthroat trout populations and whether the existing barrier is protecting some populations.

Land ownership is primarily private in the lower portions of Big Pipestone Creek. The dominant riparian cover along Big Pipestone Creek below I-90 had been herbaceous; however, agricultural grasses and forbs are now grown in the riparian corridor and almost all woody vegetation is absent (**Appendix C, Figure 2-10**). The typical health category describing the various reaches of the stream in the lower valley was "Fair. Vegetation appears healthy, but some disturbance is present" and "Poor" due to notable disturbance (**Appendix E, Figure E-3**).

Many pollution sources along lower Big Pipestone Creek come from agricultural operations in the riparian zone. During the field source assessment, grazing impacts (trampled banks, over-widened channel, channel braids) were observed in all of the surveyed reaches. In addition, channel alterations for irrigation diversions were observed in many places. In general, stream condition deteriorates heading downstream to the mouth. Just above Whitehall, the Jefferson Ditch water has caused severe incisement of the stream channel, which has subsequently headcut upstream due to poor riparian vegetation conditions. Restoration priorities in the lower watershed should focus primarily on reducing bank erosion and managing riparian areas, including impacts from grazing and hay production. Irrigation effects on bank erosion, stream channelization, and incisement are significant; however, the cost of restoring such structures and associated channel impacts are often high. Thus, with regards to irrigation infrastructure, restoration planning should include a cost-benefit analysis to help guide prioritization in addressing these problems.

## 6.3.1.2 Cherry Creek

The current sediment load for Cherry Creek is estimated at 627 (see **Table 6-1**) tons per year; the TMDL sediment load reduction is 43% (**Section 5.7.2**). Restoration strategies for this watershed vary from riparian grazing management to simply continuing existing BMPs (**Table 6-1**)

Landownership in Cherry Creek is primarily private, except for a small portion of USFS land in the headwaters. The dominant riparian cover in the headwaters was mixed coniferous forest with upland shrubs (**Appendix C, Figure 2-14**). The relative riparian health category assigned to this reach was "Excellent. Vegetation appears to be vigorous, with various age classes present (little or no disturbance)" (**Appendix E, Figure E-3**). No significant sources of sediment were noted in the headwaters section.

The dominant riparian cover along the canyon sections of Cherry Creek was mixed coniferous, with some areas of dominantly deciduous forest (**Appendix C, Figure 2-14**). The relative health category was "Fair. Vegetation appears healthy, but some disturbance is present" (**Appendix, E Figure E-3**). In the canyon area—just downstream of public lands—on private lands streambank erosion and significant impacts to the riparian vegetation were noted. For this area restoration activities should primarily focus on improving the health of the vegetated riparian buffer by implementing grazing BMPs.

The dominant riparian cover along the alluvial fan portion of Cherry Creek was herbaceous, where grasses or forbs were being grown into the riparian zone; almost no woody vegetation was present (**Appendix C, Figure 2-14**). The relative health category was "Fair" to "Poor" due to notable disturbance (**Appendix E, Figure E-3**). In addition to minor impacts to the stream from riparian grazing, agricultural practices and development within the floodplain have significantly reduced the riparian buffering capacity. Restoration priorities within the alluvial fan of Cherry Creek should primarily focus on protecting and enhancing the vegetated riparian buffer around agricultural areas and mitigating the impacts of development in the floodplain.

## 6.3.1.3 Fish Creek

The current sediment load for Fish Creek is estimated at 3,264 tons per year; the TMDL sediment load reduction is 36% (**Section 5.7.3**). Restoration strategies for this watershed vary from a most-aggressive approach involving significant channel work to simply continuing existing BMPs (**Table 6-1**).

Because of the differences in land use, cover, and pollutant source types, for the purposes of this section Fish Creek was broken into two restoration segments: Upper Fish Creek, extending from the headwaters in the highland mountains to the Jefferson Valley floor, and Lower Fish Creek, extending from the lower boundary of the upper segment downstream to its confluence with the Jefferson Canal.

Within the upper portion of Fish Creek, land ownership is primarily USFS, BLM, and private. The dominant riparian cover along upper Fish Creek, within the Highland Mountains, is mixed coniferous forest with upland shrubs (**Appendix C, Figure 2-21**). Healthy riparian vegetation is virtually absent in some reaches and could probably be attributed to many sources (grazing, placer mining, roads). The relative health categories in the upper reaches vary from “Excellent” to “Poor,” depending on the amount of visible disturbance (**Appendix E, Figure E-3**). In the headwaters portion of Upper Fish Creek various sources of sediment were observed and relate to riparian grazing, unpaved roads, and historic mining. The effects of placer mining and channelization have modified the channel form and altered riparian vegetation. Sediment from unpaved roads and bank erosion (stemming from road encroachment) were observed at numerous locations on both public and private lands. Silvicultural activities were also noted as a potential source; however, harmful effects from these activities were not observed in the field. Restoration priorities for the Upper Fish Creek watershed should focus primarily on revegetating the impacted riparian buffer by managing grazing and mitigating historic mining impacts. Mine mitigation and cleanup often take extensive channel work at an exorbitant expense; therefore, more research is recommended to determine the costs and benefits. The second restoration strategy should focus on controlling erosion from obvious unpaved road delivery sites.

The dominant riparian plants along Lower Fish Creek in the Jefferson valley were wetland species (**Appendix C, Figure 2-22**). The relative health category of most of the valley reaches was “Fair”; however, reaches of “Excellent” and “Poor” are also apparent, depending on the amount of visible disturbance (**Appendix E ,Figure E-3**). Within Lower Fish Creek, sediment sources came from agricultural operations and related bank erosion and alterations to riparian vegetation. The lowermost portions of the stream are chronically dewatered, and discussions with local landowners revealed that dewatering has isolated a population of Westslope cutthroat trout in the upper portions of the watershed. Restoration priorities within Lower Fish Creek should focus on revegetating degraded riparian environments to reduce bank erosion and trap sediment from upland agricultural sources.

## 6.3.1.4 Hells Canyon Creek

The current sediment load for Hells Canyon Creek is estimated at 1,473 tons per year; the TMDL sediment load reduction is 36% (**Section 5.7.4**). Restoration strategies for this watershed vary from a most-aggressive approach involving eroding bank restoration to simply continuing existing BMPs (**Table 6-1**).

Landownership within Hells Canyon Creek is predominantly USFS and BLM, with a small track of private land adjacent to the stream near the mouth. Riparian cover along Hells Canyon Creek alternated between mixed coniferous forest with upland shrubs (confined valley bottom areas), wetlands (less confined valley bottom areas), and mixed coniferous with some areas of dominantly deciduous  forests located in the alluvial fan portion of the watershed (**Appendix C**, **Figure 2-32**). The relative health categories of reaches varied between “Excellent” and “Fair.” One reach was delineated as having “Poor” riparian health due to bare ground associated with a road failure that occurred sometime after 1983 (**Appendix E, Figure E-3**). Within Hells Canyon Creek, sources of sediment include bank erosion, riparian grazing, and unpaved road /recreation-related sources. One stream reach within the Hell's Canyon Creek Riparian Project area is fenced off from grazing. Field observations noted a significant reduction in vegetative health and streambank condition outside of the project area. Restoration strategies should focus primarily on revegetating degraded riparian zones to reduce bank erosion and capture sediment from grazing activities. Additional measures include evaluating bank stabilization needs for the road failure noted above and reducing sediment from unpaved roads and trails.

### 6.3.1.5 Little Pipestone Creek

The current sediment load for Little Pipestone Creek is estimated at 5,821 tons per year; the TMDL sediment load reduction is 41% (**Section 5.7.5**). Restoration strategies vary from a most-aggressive approach involving eroding bank stabilization to simply continuing existing BMPs (**Table 6-1**).

Because of the differences in land use, cover, and pollutant source types, for the purposes of this section, Little Pipestone Creek was broken into two restoration segments: Upper Little Pipestone Creek, extending from the headwaters in the highland mountains to the Jefferson Valley, and Lower Little Pipestone Creek, extending from the lower boundary of the upper segment downstream to its confluence with Big Pipestone Creek.

Landownership within Upper Little Pipestone Creek is mostly private with a portion of USFS land in the headwaters. Riparian cover is variable (**Appendix C, Figure 2-36**). The relative health category of the riparian vegetation regressed from "Excellent" to "Poor" heading downstream (**Appendix E, Figure E-3**). Areas of poor riparian health in Upper Little Pipestone are related primarily to highway encroachment and near-stream grazing. Watershed sediment sources come from roads, rill and gully erosion, and bank erosion from road encroachment. Some grazing-related sources were present with impacts to riparian health. Restoration priorities should focus primarily on road and trail sources and secondarily upland grazing and riparian management.

Landownership within Lower Little Pipestone Creek is completely private. Riparian vegetative cover along Lower Little Pipestone Creek ranges from predominantly deciduous, to wetlands, to herbaceous (**Appendix C, Figure 2-37**). The relative health category of the lower reaches regressed from "Fair" to "Poor" heading downstream (**Appendix E, Figure E-3**). Areas of "Poor" riparian health were related to agricultural operations, including hay production and near-stream grazing. Bank erosion, channel incisement, riparian degradation, and grazing-related sources were observed in the valley reaches surveyed. Sediment sources came from agricultural operations and their effects on bank erosion and riparian vegetation. Restoration priorities should focus on revegetating degraded riparian environments to reduce bank erosion and trap sediment from upland agricultural sources.

### 6.3.1.6 Whitetail Creek

The current sediment load for Whitetail Creek is estimated at 9,569 tons per year; the TMDL sediment load reduction is 45% (**Section 5.7.6**). Restoration strategies for this watershed vary from a most-aggressive approach involving significant riparian improvements to simply continuing existing BMPs (**Table 6-1**).

Because of the differences in land use, cover, and pollutant source types, for the purposes of this section, Whitetail Creek was broken into two restoration segments: Upper Whitetail Creek, extending from the headwaters to the Jefferson valley, and Lower Whitetail Creek, extending from the lower boundary of the upper segment downstream to its confluence with the Jefferson Slough, a former channel of the Jefferson River.

Landownership in Upper Whitetail Creek is primarily USFS with two small tracts managed by BLM and the state. Riparian cover is mixed coniferous forest with upland shrubs, wetlands (less confined valley bottom areas), and deciduous forest (**Appendix C, Figure 2-42**). Buffer widths were generally limited by valley bottom width and the availability of moisture. The relative health categories assigned to all of the upper reaches was either “Excellent” or “Fair,” depending on visible disturbance. Most of the pollution sources observed in the field along Upper Whitetail Creek were related to riparian grazing, its effects on bank erosion and riparian health, and unpaved roads and/or trail crossings.

Landownership is predominately private. Riparian cover along Lower Whitetail Creek consists of herbaceous and wetland types (**Appendix C, Figure 2-43**). The relative health category of most of the lower reaches was “Poor” primarily due to agricultural activities, including irrigated crops and near-stream grazing (**Appendix E, Figure E-3**). Though small in area, residential development in and around the town of Whitehall has also negatively affected riparian health. During the field source assessment, grazing impacts were observed in all of the surveyed reaches. The sources observed varied locally and according to the property owner’s use of the land, such as confined feedlots, removal of riparian vegetation, and small grazing pastures.

Restoration strategies in both the upper and lower segments of Whitetail Creek should primarily focus on revegetating degraded riparian environments to reduce bank erosion and trap sediment from upland agricultural sources.

## 6.4 Restoration Approaches by Source

For the major sources of human-caused pollutant loads in the Upper Jefferson watershed, general management recommendations are outlined below. Applying ongoing BMPs is the core of the sediment reduction strategy but only forms a part of the restoration strategy. Restoration might also address other current pollution-causing uses and management practices. In some cases, efforts beyond implementing new BMPs may be required to address key sediment sources. In these cases, BMPs are usually identified as a first effort followed by an adaptive management approach to determine if further restoration activities are necessary to achieve water quality standards. Monitoring is also an important part of the restoration process. Monitoring recommendations are outlined in **Section 7**.

## 6.4.1 General Grazing Management BMP Recommendations

Improving riparian habitat, streambank erosion, and channel condition by implementing grazing BMPs are documented in the literature (Mosley et al., 1997). The restoration strategy for reducing impacts of grazing on water quality and riparian and channel condition includes implementing multiple BMPs prescribed on a site-specific basis. BMPs are most effective as part of a management strategy that focuses on critical areas within the watershed, i.e. those areas contributing the largest pollutant loads or sites that are susceptible to impacts from grazing. These riparian BMPs promote properly functioning riparian communities and reduce damage to streambanks. BMPs include managing the timing, intensity, and duration of grazing; establishing and maintaining preferred deep-rooted woody cover; developing infrastructure such as fences and hardened crossings; and managing feeding areas, salt licks, and water availability. In combination, these integrated approaches promote vegetative vigor and protect near-stream soils. BMPs should be determined on a site-specific basis that incorporates the landowner's production needs and associated logistics, while promoting sediment/riparian allocations and targets.

Some general grazing management recommendations and BMPs to address grazing sources of pollutants and pollution are listed below (**Table 6-2**). Implementing BMPs is voluntary. However, other planning partners, including the Jefferson Watershed Coordination Council and NRCS, will be instrumental in involving individual landowners, developing site-specific plans, and obtaining funding.

**Table 6-2: General Grazing BMPs and Management Techniques (from NRCS 2001 and DNRC 1999).**

| BMP and Management Techniques | Pollutants Addressed |
|---|---|
| Design a grazing management plan and determine the intensity, frequency, duration, and season of grazing to promote desirable plant communities and productivity of key forage species. In this case, native riparian species. | Sediment, temperature, nutrients |
| Encourage the growth of woody species (willow, alder, etc.) along the streambank, which will limit animal access to the stream and provide root support to the bank. | Sediment, nutrients, temperature |
| Establish riparian buffer strips of sufficient width and plant composition to filter and take up nutrients and sediment from concentrated animal feeding operations. | Sediment, nutrients, |
| Create riparian buffer area protection grazing exclosures through fencing. | Sediment, temperature, nutrients |
| Maintain adequate vegetative cover to prevent accelerated soil erosion, protect streambanks, and filter sediments. Set target grazing use levels to maintain both herbaceous and woody plants. | Sediment |
| Ensure adequate residual vegetative cover and regrowth and rest periods. Periodically rest or defer riparian pastures during the critical growth period of plant species. | Sediment, nutrients |

**Table 6-2: General Grazing BMPs and Management Techniques (from NRCS 2001 and DNRC 1999).**

| BMP and Management Techniques | Pollutants Addressed |
|---|---|
| Alternate a location's season of use from year to year. Early spring use can cause trampling and compaction damage when soils and streambanks are wet. If possible, develop riparian pastures to be managed as a separate unit through fencing. | Sediment, nutrients |
| Provide off-site, high quality water sources. | Sediment, nutrients |
| Periodically rotate feed and mineral sites and generally keep them in uplands. | Sediment, nutrients |
| Place salt and minerals in uplands, away from water sources (ideally ¼ mile from water to encourage upland grazing). | Sediment, nutrients, temperature |
| Monitor livestock forage use and adjust strategy accordingly. | Sediment, nutrients, temperature |
| Create hardened stream crossings. | Sediment |

## 6.4.1.1 Animal Feeding Operations

Because they generate significant amounts of manure and wastewater, animal feeding operations (AFOs) can pose a number of risks to water quality and public health. To minimize the impacts, as well as spreading animal waste on land, the U.S. Department of Agriculture (USDA) and Environmental Protection Agency (EPA) released the Unified National Strategy for AFOs in 1999 (NRCS 2005). It encourages AFO operators of any size to voluntarily develop and implement site specific Comprehensive Nutrient Management Plans (CNMPs) by 2009. The CNMP document details manure storage and handling systems, surface runoff control measures, mortality management, chemical handling, manure application rates, schedules to meet crop nutrient needs, land management practices, and other options for manure disposal. An AFO that exhibits certain criteria is referred to as Concentrated Animal Feeding Operation (CAFO) and, in addition, may be required to obtain a Montana Pollution Discharge Elimination System (MPDES) permit as a point source. Montana's AFO compliance strategy is based on federal law and has voluntary as well as regulatory components. If voluntary efforts can eliminate discharges to state waters, no direct regulation is necessary through a permit in some cases. Operators of AFOs may take advantage of effective low cost practices to reduce potential runoff to state waters, which additionally increase property values and productivity. Properly installed vegetative filter strips, in conjunction with other practices to reduce waste loads and runoff volume, are effective at trapping sediment and reducing transport of nutrients and pathogens to surface waters; removal rates approach 90% (NRCS 2005). Other installations might include clean water diversions, roof gutters, berms, sediment traps, fencing, structures for temporary manure storage, shaping, and grading. Animal health and productivity also benefits when clean alternative water sources are installed to prevent contamination of surface water. Studies have shown benefits in red meat and milk production of 10% to 20% when good quality drinking water is substituted for contaminated surface water.

Financial and technical assistance for achieving voluntary AFO and CAFO compliance are available from conservation districts and NRCS field offices. Voluntary participation may help prevent a more rigid regulatory program from being implemented by the Montana Nonpoint Source Management Plan for Montana livestock operators in the future.

Further information is available from DEQ's Web site: http://www.deq.mt.gov/wqinfo/mpdes/cafo.asp.

Montana's NPS pollution control strategies for addressing AFOs are summarized below:
Work with producers to prevent NPS pollution from AFOs.
Promote use of State Revolving Fund for implementing AFO BMPs.
Collaborate with MSU Extension Service, NRCS, and agriculture organizations in providing resources and training in whole farm planning to farmers, ranchers, conservation districts, watershed groups, and other resource agencies.
Encourage inspectors to refer farmers and ranchers with potential nonpoint source discharges to DEQ watershed protection staff for assistance with locating funding sources and grant opportunities for BMPs that meet their needs. (This is in addition to funds available through NRCS and the Farm Bill).
Develop early intervention of education and outreach programs for small farms and ranches that have the potential to discharge nonpoint source pollutants from animal management activities. This includes assistance from DEQ Permitting Division (internal), as well as external entities (DNRC, local watershed groups, conservation districts, MSU Extension).

## 6.4.1.2 Riparian Vegetation Restoration

Reduced riparian vegetative cover is a principal cause of water quality and habitat degradation in the Upper Jefferson watershed. Although implementing grazing, irrigation, and agricultural BMPs would promote recovery of riparian communities, the severity of the impairment suggests that natural recovery rates may be insufficient in many reaches to meet conservation goals in a timely manner to protect native fish populations and aquatic life. All areas that are actively restored with vegetation must have a reasonable approach to protecting the invested effort from further degradation from livestock or hay production.

Riparian planting will be necessary to achieve some stream targets within a desirable period. Factors influencing appropriate riparian restoration would include the severity of degradation, site-potential for various species, and the availability of local sources as transplant materials. In general, riparian plantings would promote the establishment of functioning stands of native species (grasses and willows). The following recommended restoration measures would help stabilize the soil, decrease sediment reaching the streams, and increase nutrient absorption from overland runoff.

Harvest and transplant locally available sod mats with dense root mass to immediately promote bank stability and capture nutrients and sediments.
Transplant mature shrubs, particularly willows (*Salix* sp.), to rapidly restore instream habitat and water quality by providing overhead cover and stream shading, as well as uptake of nutrients.
Seed with native graminoids (grasses and sedges) and forbs, a low cost activity where lower bank shear stresses would be unlikely to cause erosion.

Plant willows by "sprigging" to expedite vegetative recovery; sprigging involves clipping willow shoots from nearby sources and transplanting them in the vicinity where needed.

### 6.4.1.3 Streambank/Floodplain Restoration BMPs

Bank erosion from willow removal and livestock grazing are a major source of sediment. Reductions in streamside willows appeared to have resulted in some overly wide and shallow channel segments. Over-widened channels can cause fine sediment to accumulate in pools because of reduced sediment transport efficiencies.  Thus, stream channels might have fewer or lower quality pools with increased sediments. Over-widened channels increase sediment concentrations and water temperatures, reducing aquatic habitat quality.

These general restoration activities focus on enhancing suitable instream habitat for native fishes and speeding up recovery for stream channels, bank erosion, and riparian vegetation shading. They would assist in meeting sediment TMDL targets in stream reaches that have historically been heavily altered by grazing, channeling, mining, transportation, or haying. Actual restoration activities would be determined on a site-by-site basis and depend on the relationships among shrub cover, width-to-depth ratios, eroding banks, and pool frequency.

## 6.4.2 Unpaved Roads BMPs

Road sediment reduction represents the estimated sediment load that would remain once all contributing road treads, cut slopes, and fill slopes were reduced to the maximum of 200 feet. These measurements were selected as an example to illustrate the potential for sediment reduction by using BMPs and are not a formal goal at every crossing. For example, many road crossings in mountainous settings can easily have a contributing length shorter than 200 feet, while others may not be able to meet a 200-foot milestone. Reducing sediment loading from the road system as called for in the TMDLs may occur through a variety of methods at the discretion of local land managers and restoration specialists.

Assessments should occur for roads within watersheds that have timber harvesting or other major land management operations. The information gathered will give timely feedback to land managers about the impact their activities could have on water quality and achieving TMDL targets and allocations. This feedback mechanism is intended to keep sediment load calculations current and avoid new road impacts that go undetected for a long periods.

## 6.4.3 Sediment Loading Due to Gully Wash and Rill Erosion along Interstate 90

The input and transport of gully wash and rill erosion was assessed along Homestake Creek, tributary to Big Pipestone Creek, adjacent to I-90. The assessment was presented in a thesis submitted to Montana Tech by student Aaron Berger and titled *Hydrology, Water Quality, and Sediment transport Rates in the Pipestone Creek Watershed, Jefferson County, Montana* (Berger 2004). It attempted to semi-quantify the volume of sediment produced from sources associated with I-90. Berger estimated that the approximate volume of sediment entering Homestake Creek from I-90 was roughly 500 cubic feet, or 21 tons (assuming a bulk density of 1.44 tons/cubic yard). However, due to the high rates of bedload transport in the stream, it is likely that this total was significantly underestimated. Berger also noted that the sediment inputs were dominated by four large sources that were traced to uncontrolled runoff from I-90 and subsequent gullying and rill erosion of steep hillslopes leading down to Homestake Creek.

In the TMDLs and allocations that follow, a 10% reduction in human-caused sediment load from I-90 sources is proposed. The Montana Department of Transportation will explore alternatives for diverting road runoff from sensitive areas and capturing sediment. Additionally, BMPs may be used to prevent road materials from entering Homestake Creek, such as gully wash, rill erosion, and road traction sanding. BMPs may include vegetation buffers, routing flows away from streams, and the creation of sediment catching structures. Loading from gully wash and rill erosion will be considered in developing sediment loads, allocations, and potential reductions. Road traction sanding also has the potential to produce a sediment load. Though not included in this allocation strategy, road traction sanding should be evaluated through adaptive management and monitoring.

### 6.4.4 Forestry and Timber Harvest

Currently, timber harvest is not significantly affecting sediment production in the Upper Jefferson TPA, but harvesting will likely continue in the future within the national forest and on private land. Future harvest activities should be conducted by all landowners and contractors according to Forestry BMPs for Montana (MSU Extension Service 2001) and the Montana SMZ Law (77-5-301 through 307 MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e., within 50 feet of a water body), the riparian protection principles behind the law can be applied to numerous land management activities (i.e., timber harvest for personal use, agriculture, development). Before harvesting on private land, landowners or operators are required to notify the Montana DNRC, who are responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular forestry BMP training sessions for private landowners.

Timber harvest should not increase the peak water yield by more than 10%. If a natural disturbance, such as a forest fire, increases peak water yield, the increase should be accounted for as part of timber harvest management.

### 6.4.5 Fire Suppression, Conifer Encroachment, Water Yield and Soil Erosion

The anthropogenic management of the forested uplands within the Upper Jefferson River watershed has substantially affected the structure of the forest community and its interrelations with riparian function, water yield and soil erosion. There exists considerable debate about both the extent and nature of human-caused changes in the forest landscape, and the need and means to address those changes. Though not explicitly addressed within the TMDL and allocations section of this document, this discussion is included as an additional tool for the prioritization of riparian restoration strategies. In focusing on issues relating to forest alteration and restoration in central western Montana, this section is a modest attempt to identify how long term management of fire suppression in forested uplands has the potential to affect water yields and sediment production. In addition this section introduces some basic restoration strategies that could be implemented to offset such affects.

Many upland portions of the Upper Jefferson watershed are experiencing a substantial increase in the density of conifer species. Rangeland grazing and fire suppression has contributed to the increase in conifer woodlands and a reduction in open grasslands. The density of trees, and the aerial extent of these communities, is evidenced by historic photos and the age structure of these woodlands. These trees effectively out-compete other shrub and herbaceous species resulting in decreased and/or inconsistent water yields, and increased soil erosion. The deep, tap roots of conifers are much less effective in retaining soil than the fibrous, surface roots of herbaceous species. As conifer woodlands continue to increase, and as the rill and gully erosion areas continue to expand and become connected, these communities will be an increasing upland source of sediment into tributary streams of the Upper Jefferson River watershed, particularly in large storm events that generate overland flow.

In addition to upland areas, riparian communities along stream corridors in many montane rangeland watersheds have been disrupted by encroaching conifers which can cause changes in riparian corridor functions. Native riparian vegetation, such as aspen overstory, and herbaceous and shrub understory, provides crucial sediment filtering and channel protection that is significantly reduced when conifers come to dominate riparian vegetation. Studies have shown that soil loss or erosion can be elevated by up to 10 times in juniper-encroached areas in comparison with native vegetation providing natural vegetative protection (DeBoodt, et. al., 2005). In addition to effects on soil erosivity, conifer encroachment effects watershed function through the loss of plant and animal diversity, as well as hydrologic changes such as reduced stream flow.

The potential hydrologic effects conifer encroachment can be significant in small first order intermittent or ephemeral drainages. Successional conifer encroachment in drainages can cease water yield during the summer from seeps and springs in the upper headwaters regions of watersheds. A conifer tree has a higher transpiration rate than a similar aspen tree; hence more water is drawn from the soil from a conifer stand than aspen stand. This reduction in flow can reduce the overall acreage available for upland grazing and may focus grazing into smaller ranges, posing a potential greater threat on those waterbodies with greater flow. Such instances could greatly effect sediment production in these streams by reducing riparian buffering and increasing bank erosion via trampling. Furthermore, the lack of aspen and flowing water has the potential to eliminate the most suitable beaver habitat in the area. Beavers are discussed in the next section.

Of the approximately 470,000 acres in the upper Jefferson watershed, approximately 3.1 percent (14,700 acres) of the watershed is classified as riparian vegetation, and conifers (mostly junipers) dominate this riparian vegetation on approximately 22 percent (3,300 acres) of the watersheds' riparian acres.

While knowledge of historical conditions will be useful, even essential, in guiding restoration efforts, attempts to strictly recreate conditions of the past will often be neither desirable nor feasible. Knowledge of historic conditions can help clarify the types and extent of changes that have occurred in ecosystems and help inform the identification of management objectives and restoration priorities. However, climates are now different than at any historic time, and will be different in the future (Millar and Woolfenden 1999). Species have been irrevocably added and subtracted, and the modern human imprint cannot be entirely eliminated. While past fire regimes may be more accurately estimated than forest structure and composition, as Agee (1998b) points out, "the natural fire regimes of the past are not the regimes of the present, nor will they be the regimes of the future." Nonetheless, careful determinations of past conditions can be an essential part of deciding what needs to be done now and in the future. Restoration planning needs to recognize that historic and/or “natural” conditions may or may not be appropriate for today or successfully maintained.

In the upper Jefferson area, exclusion of periodic intense fires has supported conifer expansion and encroachment into riparian areas. Ongoing livestock and wildlife grazing have enhanced the effects of this invasion. Effective watershed restoration tools to restore functioning native overstory and understory vegetation in riparian corridors include: 1. moderate intensity fires (eliminating most conifers and stimulate native vegetation regrowth), 2. conifer removal (chainsawing conifers, leaving tree slash to protect bare ground, and shelter regrowth), and 3. conifer reduction (light fire/slashing followed by planting of native vegetation). It should be noted that all the restoration tools above should take a proactive approach to controlling other invasive non-native weeds.

Prior to the implementation of such restoration activities within the upper Jefferson watershed further studies will need to be done to evaluate the tradeoffs of riparian restoration via harvest and/or prescribed fire. In addition, in some areas conifers represent the natural occurring dominant riparian vegetation. In these areas conifers are critical to shade and stream geomorphology, and are protected via the Montana’s Stream Side Zone law. Therefore, the restoration strategies presented here only apply to those areas that under natural conditions would be different and in no way advocates riparian harvest in areas where mature conifers are the natural stream side vegetation (although prescribed burning in such areas may be appropriate in a case by case basis).

Every effort should be made to apply these tools thoughtfully, in ways and in locations where they will have the highest prospects for success and the lowest likelihood of unintended consequences. Based on current knowledge, it appears that the most credible efforts will:

- Be part of comprehensive ecosystem and watershed restoration that addresses roads, livestock grazing, invasive exotic species, off-road vehicles, etc;
- Consider landscape context, including watershed condition and populations, as well as habitats, of fish and wildlife;
- Address causes of degradation, not just symptoms;
- Provide timber only as a by-product of primary restoration objectives;
- Avoid construction of new roads;

### 6.4.6 Beaver Populations and Sediment Yields

Historic heavy trapping of beavers has likely had a dramatic effect on sediment yields in the watershed. Before the removal of beavers, many streams had a series of catchments that moderated flow, with smaller unincised multiple channels and frequent flooding. Now many streams have an increased channel capacity, with incised wider channels and are no longer connected to the floodplain. This results in more bank erosion because high flows scour streambanks to a greater extent instead of flowing onto the floodplain. Parker (1986, as cited in Olson and Hubert, 1994) reported water below beaver complexes had 50% to 77% lower total suspended solids (TSS) than water above complexes.

Beavers are still trapped in the Jefferson watershed. Trapping is often in response to complaints about detrimental beaver activity in lower reaches of tributaries or irrigation ditches, where they plug culverts or ditches and cut down trees that are valued for shade. Trappers still remove beavers from headwaters streams, as well, for recreation and pelts. Beavers are re-establishing themselves where habitat is adequate, but much of the area that potentially could support beaver populations currently does not have adequate woody riparian vegetation to support beavers.

Management of headwaters areas should include improving beaver habitat. Long-term management could include maintenance of headwaters protection areas and managing beaver populations re-established in areas currently lacking the beaver complexes to trap sediment, reduce peak flows, and increase summer low flows.

## 6.5 Watershed Restoration Summary

The most important restoration efforts for implementation in tributary streams of the Upper Jefferson watershed will be to protect, restore, and enhance riparian vegetation. Restoring riparian areas will provide the greatest sediment load reductions. A tiered approach for restoring stream channels and adjacent riparian vegetation should consider the existing conditions of the stream channel and adjacent vegetation. In non-conifer dominated areas, the restoration goals should focus on restoring natural shrub cover on streambanks to reference levels that are provided by the sediment TMDL riparian vegetation targets. In areas with little to no shrub vegetation within non-conifer dominated riparian zones, active natural shrub reintroduction should occur. In areas where stream channels are unnaturally stable or streambanks are eroding excessively, active restoration approaches, such as channel design, bank sloping, seeding, and shrub planting, may be needed.

All riparian areas should be protected against excessive hoof sheer, over-grazing, and especially over-browsing. In many cases where riparian areas are heavily impacted, protection may need a several years of rest with careful rotation schedules thereafter. In areas meeting riparian, stream channel, and other targets, these protections should continue with active grazing and hay management. Active riparian grazing management is important for long-term health of riparian zones. Management following restoration in these zones should include keeping browsing to a minimum once shrub health has increased. These areas should be used during specific seasons that promote grazing and not browsing. Grazing of riparian areas should occur in a shorter time window and only when sufficient forage is available. Grazing systems should be dynamic and based upon measures of browsing, hoof sheer, and stubble height only after sufficient shrubs have been allowed to recover. Weed management should also be a dynamic component of managing riparian areas as they recover.

# SECTION 7.0
# MONITORING STRATEGY AND ADAPTIVE MANAGEMENT

## 7.1 Introduction

The monitoring strategy discussed in this section is an important component of watershed restoration, a requirement of TMDL development under Montana's TMDL law, and the foundation of the adaptive management approach. While targets and allocations are calculated using the best available data, the data are only an estimate of a complex ecological system. The MOS is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate. Some field procedures have been revised since data collection for TMDL development, and all future monitoring should adhere to standard DEQ protocols. Where applicable, analytical detection limits must be below the numeric standard.

The monitoring strategy presented in this section provides a starting point for the development of more detailed and specific planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet aforementioned goals. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on stakeholder priorities for restoration and funding opportunities.

## 7.2 Adaptive Management Approach

An adaptive management approach is recommended to control costs and meet the water quality standards to support all beneficial uses. This approach works in cooperation with the monitoring strategy, and as new information is collected, it allows for adjustments to restoration goals or pollutant targets, TMDLs, and/or allocations, as necessary.

## 7.3 Future Monitoring Guidance

The objectives for future monitoring in the Upper Jefferson watershed include: 1) strengthening the spatial understanding of sources for future restoration work, which will also strengthen source assessment analysis for future TMDL review, 2) investigating weak links in the existing conditions assessments if needed, 3) identifying streams that should be investigated further because of indications that sediment TMDLs may be needed, and 4) tracking restoration projects as they are implemented and assessing their effectiveness.

### 7.3.1 Strengthening Source Assessment Prior to Restoration Work

Sediment TMDLs have been developed for six water body segments in the Upper Jefferson TPA. Since data was collected for the sediment source assessment, DEQ has modified several aspects of the procedure, including standardizing procedures for selecting representative sediment/habitat sampling sites. These modifications, as well as others identified by DEQ, should be considered during follow-up monitoring. Strengthening source assessments should also include assessment of future sources as they arise. The extent of monitoring should be consistent with the extent of potential impacts. In addition, monitoring can vary from basic BMP compliance inspections to establishing baseline conditions and measuring target parameters below the project area both before and after project completion. Cumulative impacts from multiple projects must also be considered. This approach will help track the recovery of the system and the impacts, or lack of impacts, from ongoing management activities in the watershed. Therefore, additional targets and other water quality goals may need to be developed to address new stressors to the system. If new sources do occur, the new data should be used to update TMDL allocations.

Many parts of the watershed have naturally erosive geology. Although human-caused sources exacerbate erosion, additional monitoring is recommended to gain a better understanding of natural sediment loading from streambank retreat (erosion) rates. These watersheds include the Big Pipestone, Little Pipestone, Hells Canyon, Cherry, Fish, and Whitetail creeks. Streambank retreat rates are part of the equation for calculating sediment loading from near-stream sediment sources for sediment TMDLs and allocation. The current sediment TMDLs are calculated using literature values for streambank retreat rates. Measuring streambank retreat rates on water bodies within the Upper Jefferson TPA would be useful to verify or revise the current TMDLs and would also be useful for completing or revising sediment TMDLs in other watersheds throughout Montana in similar settings. Bank retreat rates can be determined by installing bank pins at different positions on the streambank at several transects across a range of landscapes and stability ratings. Bank erosion is documented after high flows and throughout the year for several years to capture retreat rates under a range of flow conditions.

Sediment from both paved and unpaved roads is significant throughout the tributary watersheds of the Upper Jefferson TPA. Though the paved road assessment focused solely on the influence of the I-90 corridor, future monitoring should expand to include source assessment monitoring along Little Pipestone Creek and MT State Highway 2.

### 7.3.2 Impairment Status Monitoring and Recommended Future Assessments

The Montana Department of Environmental Quality (DEQ) is the lead agency for developing and conducting impairment status monitoring. Other agencies or entities may work closely with DEQ to provide compatible data if interest arises. Impairment determinations are conducted by the state but can use data collected from other sources. The information in this section provides general guidance for future impairment status monitoring.

Sediment TMDLs were not completed in Fitz Creek and Halfway Creek even though controllable human-caused sources were present because sediment conditions in the stream could not be clearly linked to aquatic life impacts. Further stream bottom content and pool measurements should occur to verify this. Monitoring should follow all DEQ recommended Standard Operating Procedures for sediment and habitat assessments.

DEQ is currently considering overall biological health and also sediment related metrics for periphyton assessments. The new metrics may provide additional relevant information relating to beneficial uses and should be considered during future TMDL reviews.

Currently, Homestake Creek, tributary to Big Pipestone Creek, is not listed as impaired by sediment. However, source assessment data suggests that significant human-caused sources are present. Though sediment TMDLs were developed for Big Pipestone Creek at the watershed scale, hence incorporating its tributaries into the TMDL and allocations, future impairment monitoring and evaluation is recommended specifically for Homestake Creek.

### 7.3.3 Effectiveness Monitoring for Restoration Activities

The following recommendations are categorized by the type of restoration practice to which they apply.

#### 7.3.3.1 Road BMPs

Monitoring road sediment delivery is necessary to determine if BMPs are effective, to determine which are most effective, and to determine which practices or sites require modification to achieve water quality goals. Effectiveness monitoring should be initiated before implementing BMPs at treatment sites.

Monitoring actual sediment routing is difficult or prohibitively expensive. It is likely that budget constraints will influence the number of monitored sites. Once specific restoration projects are identified, a detailed monitoring study design should be developed. To overcome environmental variances, monitoring at specific locations should continue for a period of two to three years after BMPs are initiated.

Specific types of monitoring for separate issues and improvements are listed in **Table 7-1**.

**Table 7-1. Monitoring Recommendations for Road BMPs**

| **Road Issue from Section 10.0 (Restoration)** | **Restoration Recommendation** | **Monitoring Recommendation** | **Recommended Methodology** |
|---|---|---|---|
| Ditch Relief Combined with Stream Crossings | Re-engineer & rebuild roads to completely disconnect inboard ditches from stream crossings. Techniques may include:<br>Ditch relief culverts<br>Rolling dips<br>Water Bars<br>Outsloped roads<br>Catch basins<br>Raised road grade near stream crossing | Place silt trap directly upslope of tributary crossing to determine mass of sediment routed to that point<br>Rapid inventory to document improvements and condition | Sediment yield monitoring based on existing literature/USFS methods<br>Revised Washington Forest Practices Board methodology |
| Ditch Relief Culverts | Consider eliminating the inboard ditch and outsloping the road or provide rolling dips<br>When maintaining/ cleaning ditch, do not disturb toe of cutslope<br>Install culverts with proper slope and angle following Montana road BMPs<br>Armor culvert outlets<br>Construct stable catch basins<br>Vegetate cutslopes above ditch<br>Increase vegetation or install slash filters, provide infiltration galleries where culvert outlets are near a stream | Rapid inventory to document improvements and condition<br>Silt traps below any ditch relief culvert outlets close to stream | Revised Washington Forest Practices Board methodology<br>Sediment yield monitoring based on existing literature/USFS methods |

**Table 7-1. Monitoring Recommendations for Road BMPs**

| Road Issue from Section 10.0 (Restoration) | Restoration Recommendation | Monitoring Recommendation | Recommended Methodology |
|---|---|---|---|
| Stream Crossings | Place culverts at streambed grade and at base of road fill<br>Armor and/or vegetate inlets and outlets<br>Use proper length and diameter of culvert to allow for flood flows and to extend beyond road fill | Repeat road crossing inventory after implementation<br>Fish passage and culvert condition inventory | Revised Washington Forest Practices Board methodology<br>Montana State (DNRC) culvert inventory methods |
| Road Maintenance | Avoid casting graded materials down the fill slope & grade soil to center of road, compact to re-crown<br>Avoid removing toe of cut slope<br>In some cases graded soil may have to be removed or road may have to be moved | Repeat road inventory after implementation<br>Monitor streambed fine sediment (grid or McNeil core) and sediment routing to stream (silt traps) below specific problem areas | Revised Washington Forest Practices Board methodology<br>Standard sediment monitoring methods in literature |
| Oversteepened Slopes/General Water Management | Where possible outslope road and eliminate inboard ditch<br>Place rolling dips and other water diverting techniques to improve drainage following Montana road BMPs<br>Avoid other disturbance to road, such as poor maintenance practices and grazing | Rapid inventory to document improvements and condition | Revised Washington Forest Practices Board methodology |

### 7.3.3.2 Agricultural BMPs

Grazing BMPs reduce grazing pressure along streambanks and riparian areas. Implementing BMPs may improve water quality, create narrower channels and cleaner substrates, and result in recovery of streambank and riparian vegetation. Effectiveness monitoring for grazing BMPs should be conducted over several years, making sure to start monitoring before BMPs are implemented. If possible, monitoring reaches should be established in pastures keeping the same management as well as in those that have changed. Where grazing management includes moving livestock according to riparian use level guidelines, it is important to monitor changes within the growing season as well as over several years. Monitoring recommendations to determine seasonal and long-term changes resulting from implementing grazing BMPs are outlined below in **Table 7-2**.

**Table 7-2. Effectiveness Monitoring Recommendations for Grazing BMPs by Restoration Concern**

| Recovery Concern | Monitoring Recommendations | Methodology or Source |
|---|---|---|
| Seasonal impacts on riparian area and streambanks | Seasonal monitoring during grazing season using riparian grazing use indicators<br>Streambank alteration<br>Riparian browse<br>Riparian stubble height at bank and "key area" | BDNF/BLM riparian standards (Bengeyfield and Svoboda, 1998) |
| Long-term riparian area recovery | Photo points<br>PFC/NRCS Riparian Assessment (every 5-10 yrs)<br>Vegetation Survey (transects perpendicular to stream and spanning immediate floodplain) every 5-10 years<br>Strip transects- Daubenmire 20cm x 50cm grid or point line transects | Harrelson et al., 1994; Bauer and Burton, 1993; NRCS, 2001 Stream Assessment Protocols |
| Streambank stability | Greenline including bare ground, bank stability, woody species regeneration (every 3-5 years) | Modified from Winward, 2000 |
| Channel stability | Cross-sectional area, with % fines/ embeddedness<br>Channel cross-section survey<br>Wolman pebble count<br>Grid or McNeil core sample | Rosgen, 1996; Harrelson et al., 1994 |
| Aquatic habitat condition | Aquatic macroinvertebrate sampling<br>Pool quality<br>R1/R4 aquatic habitat survey | DEQ biomonitoring protocols; Hankin and Reeves, 1988; USFS 1997 R1R4 protocols |
| General stream corridor condition | EMAP/Riparian Assessment (every 5-10 yrs) | NRCS 2001 Stream Assessment Protocols; U.S. EPA 2003. |

## 7.2.3.4 Other Restoration Activities

This TMDL assessment has revealed the importance of beavers to stream systems within the Upper Jefferson TPA. Beavers are important for managing water and sediment runoff and allowing recovery of riparian zones. Re-establishing populations in some areas may be an important tool for restoring natural channel dynamics and healthy riparian zones. Alternatively, beavers may cause problems by moving into irrigation networks and may need to be managed closely. Monitoring is needed to identify areas that can support beaver populations, define habitat requirements to determine potential reintroduction success, and determine positive and negative influences of beaver reintroduction on channel stability, fish habitat, water quality and quantity, riparian habitat, and aquatic and terrestrial wildlife. Specific monitoring needs will depend on the nature of reintroduction efforts and site-specific requirements.

### 7.2.3.5 Watershed-Scale Monitoring

As restoration activities are implemented, watershed-scale monitoring may be valuable in determining if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

Due to the natural high variability in water quality conditions, trends in water quality are difficult to define and even more difficult to relate directly to restoration or other changes in management. Improvements in water quality or aquatic habitat from restoration activities will most likely be evident in fine sediment deposition and channel substrate embeddedness, changes in channel cumulative width/depths, improvements in bank stability and riparian habitat, increases in instream flow, and changes in communities and distribution of fish and other bio-indicators. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budget and time constraints.

# SECTION 8.0
# PUBLIC INVOLVEMENT

Stakeholder and public involvement is a component of TMDL planning efforts supported by EPA guidelines and Montana State Law. Public comment on the Upper Jefferson River Tributary Sediment TMDLs involved two components. First, stakeholders and a technical advisory group (including private landowners, conservation groups, and agency representatives) were kept abreast of the TMDL process through periodic meetings, and were provided opportunities to review and comment on initial draft components of the TMDL document. The stakeholders and a technical advisory group also were allowed a stakeholder draft comment timeframe during which the completed draft document was posted on a website until the public comment draft was posted for the public comment period on DEQ's website. In addition, presentation about the draft TMDL document was provided to the following groups:

**Stakeholder and Technical Advisory Group Feedback – Whitehall, MT March 11th , 2009**
The second component of public involvement was a public comment period. This public review period was initiated on May 4th, 2008 and extended through July 6th, 2009. A public meeting on May 13th, 2009 in Whitehall, Montana provided an overview of the Upper Jefferson River Tributary Sediment TMDLs and Watershed Water Quality Planning Framework document. The meeting provided an opportunity to solicit public input and comments on the plan. This meeting and the opportunity to provide public comment on the draft document were advertised via a press release by DEQ and was included in a number of local newspapers. Copies of the main document were available at the Whitehall Post Office, Jefferson Valley Conservation District in Whitehall, the Whitehall Community Library, the State Library in Helena, and via the internet on DEQ's web page or via direct communication with the DEQ project manager.

DEQ receive did not receive any comments on the Upper Jefferson River tributary Sediment TMDL document during the public comment period.

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