Final -

Flathead – Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan

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ACRONYM LIST

Acronym	**Definition**
AFDM	Ash Free Dry Mass
AFO	Animal Feeding Operation
ARM	Administrative Rules of Montana
BMPs	Best Management Practices
BNSF	Burlington Northern and Santa Fe
CAFO	Concentrated (or Confined) Animal Feeding Operations
CFR	Code of Federal Regulations
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DMR	Discharge Monitoring Report
DNRC	Department of Natural Resources & Conservation (Montana)
DO	Dissolved Oxygen
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentives Program
FWP	Fish, Wildlife & Parks (Montana)
GIS	Geographic Information System
HBI	Hilsenhoff Biotic Index
HSPF	Hydrologic Simulation Program FORTRAN
HT	Holding Time
HUC	Hydrologic Unit Code
ID	Identification
INFISH	Inland Native Fish Strategy
IR	Integrated Report
LA	Load Allocation
LSPC	Loading Simulation Program C++ (HSPF)
LWD	Large Woody Debris
MCA	Montana Code Annotated
MDT	Montana Department of Transportation
MEANSS	Method for Estimating Attenuation of Nutrients from Septic Systems
MFISH	Montana Fisheries Information System
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
MSU	Montana State University
NAIP	National Agricultural Imagery Program
NHD	National Hydrography Dataset
NLCD	National Land Cover Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
PCB	PolyChlorinated Biphenyls
PIBO	PACFISH/INFISH Biological Opinion
QA	Quality Assurance
QC	Quality Control

Acronym	**Definition**
RSI	Riffle Stability Index
SAP	Sampling and Analysis Plan
SMZ	Streamside Management Zone
STORET	EPA STOrage and RETrieval database
SWMP	Storm Water Management Program (DEQ)
SWPPP	Storm Water Pollution Prevention Plan
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TPA	TMDL Planning Area
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
UUILT	Ultimate Upper Incipient Lethal Temperature
WEPP	Water Erosion Prediction Project
WLA	Wasteload Allocation
WRP	Watershed Restoration Plan
WWTP	Wastewater Treatment Plant

DOCUMENT SUMMARY

This document presents a total maximum daily load (TMDL) and water quality improvement plan for seven impaired tributaries to the Flathead River within the Flathead – Stillwater TMDL Planning Area, including Ashley, Haskill, Logan, Sheppard, and Spring creeks and the Stillwater and Whitefish rivers (see **Figure 1-1**).

The Montana Department of Environmental Quality (DEQ) develops TMDLs and submits them to the U.S. Environmental Protection Agency (EPA) for approval. 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. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. TMDLs provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses.

The Flathead-Stillwater TMDL Planning Area (TPA) is located in Flathead and Lincoln counties and includes the Whitefish River, Stillwater River, and Ashley Creek watersheds. The impaired tributaries originate in the Salish Mountains and Whitefish Range, located in the northern and western portions of the planning area. The TPA encompasses about 1,430 square miles, with federal, state, and private land ownership.

DEQ determined that seven tributaries, encompassing nine waterbody segments, within the Flathead – Stillwater TPA do not meet the applicable water quality standards. The scope of the TMDLs in this document addresses problems with nutrients, sediment, and temperature, and 18 TMDLs are included that address 23 pollutant impairments (**Table DS-1**).

Nutrients

Seven nutrient TMDLs are provided for two streams in Flathead-Stillwater TPA. These nutrient TMDLs are written for total nitrogen and total phosphorus impairments on three waterbody segments of Ashley Creek and the Spring Creek waterbody segment (**Table DS-1**). The nutrient TMDLs also address impairment for dissolved oxygen and nitrate on Ashley Creek and Spring Creek. Nutrient and/or biological data in these streams indicate nutrients are present in concentrations that can cause algal growth that harms recreation and aquatic life beneficial uses. Water quality restoration goals for nutrients were based on Montana's numeric nutrient criteria, measures of algal growth/density, and biological metrics for macroinvertebrates and periphyton. DEQ's water quality assessment methods for nutrient impairment are designed to evaluate the most sensitive use, thus ensuring protection of all designated uses. For streams in western Montana, the most sensitive uses assessed for nutrients are aquatic life and primary contact recreation.

Nutrient sources include: septic systems, point source discharges, urban areas, natural background, and agriculture. TMDL examples based on monitoring data indicate reductions between 17% and 91% are necessary. Meeting wasteload allocations and permit requirements for point source discharges and implementing the recommended best management plans (BMPs) for nonpoint sources discussed in this plan, are anticipated to achieve the reduction goals and meet the TMDLs.

Sediment

DEQ determined that sediment impairs aquatic life in Ashley, Haskill, Logan, and Sheppard creeks and the Stillwater River, and DEQ provides sediment TMDLs for seven waterbody segments (**Table DS-1**).

Fish Creek is on the 2014 303(d) List for sediment impairment, but data collected to support TMDL development indicate that it is no longer impaired for sediment and will be removed from the 303(d) list. For the five streams with sediment TMDLs, excess sediment is limiting their ability to support aquatic life. Water quality restoration goals for sediment were established on the basis of fine sediment levels in trout spawning areas and aquatic insect habitat, stream morphology and available in-stream habitat as it related to the effects of sediment, and the stability of streambanks. DEQ believes that once these water quality goals are met, all water uses currently affected by sediment will be restored. DEQ's water quality assessment methods for sediment impairment are designed to evaluate the most sensitive use, thus ensuring protection of all designated uses. For streams in western Montana, the most sensitive use assessed for sediment is aquatic life.

Sediment loads are quantified for natural background conditions and for the following sources: bank erosion, hillslope erosion, roads, and point sources. The most significant sources include: bank erosion, natural sources, and in some cases agriculture and urban areas. The Flathead-Stillwater TPA sediment TMDLs indicate that reductions in sediment loads ranging from 0.2% to 34% will satisfy the water quality restoration goals. Recommended strategies for achieving the sediment reduction goals are also presented in this plan. They include best management practices (BMPs) for building and maintaining roads, for harvesting timber, and for developing subdivisions. In addition, they includes BMPs for expanding riparian buffer areas and using other land, soil, and water conservation practices that improve stream channel conditions and associated riparian vegetation.

Temperature

DEQ determined that temperature impairs aquatic life in Ashley Creek and the Whitefish River, and DEQ provides a TMDL for each stream. Historic removal of riparian vegetation, which is important for regulating stream temperature by providing shade, is the primary cause of impairment. Water quality restoration goals focus on improving riparian shade; however, maintaining stable stream channel morphology and instream flow conditions during the hottest months of the summer are also important for meeting the TMDLs. DEQ believes that once these water quality goals are met, all water uses currently affected by temperature will be restored given all reasonable land, soil, and water conservation practices. DEQ's water quality assessment methods for temperature impairment are designed to evaluate the most sensitive use, thus ensuring protection of all designated uses. For streams in western Montana, the most sensitive uses assessed for temperature is aquatic life.

The Ashley Creek temperature model indicates that reductions in maximum daily water temperatures up to 10.8°F are necessary. The Whitefish River temperature model indicates that reductions in maximum daily water temperature up to 0.99°F are necessary. General strategies for achieving the instream water temperature reduction goals are also presented in this plan and include BMPs for managing riparian areas.

Water Quality Improvement Measures

Implementation of most water quality improvement measures described in this plan is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this document, and associated information, as a tool to guide local water quality improvement activities. Such activities can be documented within a watershed restoration plan consistent with DEQ and EPA recommendations.

A flexible approach to most nonpoint source TMDL implementation activities may be necessary as more knowledge is gained through implementation and future monitoring. The plan includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals and to help refine the plan during its implementation.

Most water quality improvement measures are based on voluntary measures. However, federal law requires that water quality discharge permits be consistent with the assumptions and requirements of wasteload allocations (WLAs) for streams with EPA-approved TMDLs. The Flathead-Stillwater TPA has permitted discharges to Ashley and Spring creeks and the Stillwater and Whitefish rivers. When these discharge permits are renewed, the WLAs contained within each permit must be consistent with the assumptions and requirements of the WLAs provided in this document.

Table DS-1. List of Impaired Waterbodies and their Impaired Uses in the Flathead-Stillwater TMDL Planning Area with Nutrient, Sediment, and Temperature TMDLs Contained in this Document

<table>
<tr><th>Waterbody & Location Description</th><th>TMDL Prepared</th><th>TMDL Pollutant Category</th><th>Impaired Use(s)</th></tr>
<tr><td rowspan="3">Ashley Creek,
Ashley Lake to Smith Lake</td><td>Total Nitrogen</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Temperature</td><td>Temperature</td><td>Aquatic Life</td></tr>
<tr><td rowspan="4">Ashley Creek,
Smith Lake to Kalispell Airport Road</td><td>Total Nitrogen</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Total Phosphorus</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Temperature</td><td>Temperature</td><td>Aquatic Life</td></tr>
<tr><td rowspan="4">Ashley Creek,
Kalispell Airport Road to mouth (Flathead River)</td><td>Total Nitrogen</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Total Phosphorus</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Temperature</td><td>Temperature</td><td>Aquatic Life</td></tr>
<tr><td>Haskill Creek,
Haskill Basin Pond to mouth (Whitefish River)</td><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Logan Creek,
Headwaters to Tally Lake</td><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Sheppard Creek,
Headwaters to mouth (Griffin Creek)</td><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td rowspan="2">Spring Creek,
Headwaters to mouth (Ashley Creek)</td><td>Total Nitrogen</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Total Phosphorus</td><td>Nutrients</td><td>Aquatic Life,
Primary Contact Recreation</td></tr>
<tr><td>Stillwater River,
Logan Creek to mouth</td><td>Sediment</td><td>Sediment</td><td>Aquatic Life</td></tr>
<tr><td>Whitefish River,
Whitefish Lake to mouth (Stillwater River)</td><td>Temperature</td><td>Temperature</td><td>Aquatic Life</td></tr>
</table>

1.0 PROJECT OVERVIEW

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for nutrients, sediment, and temperature problems in the Flathead-Stillwater TMDL Planning Area (TPA). This document also presents a general framework for resolving these problems. **Figure 1-1** below shows the nutrient, sediment, and temperature impaired waterbodies.

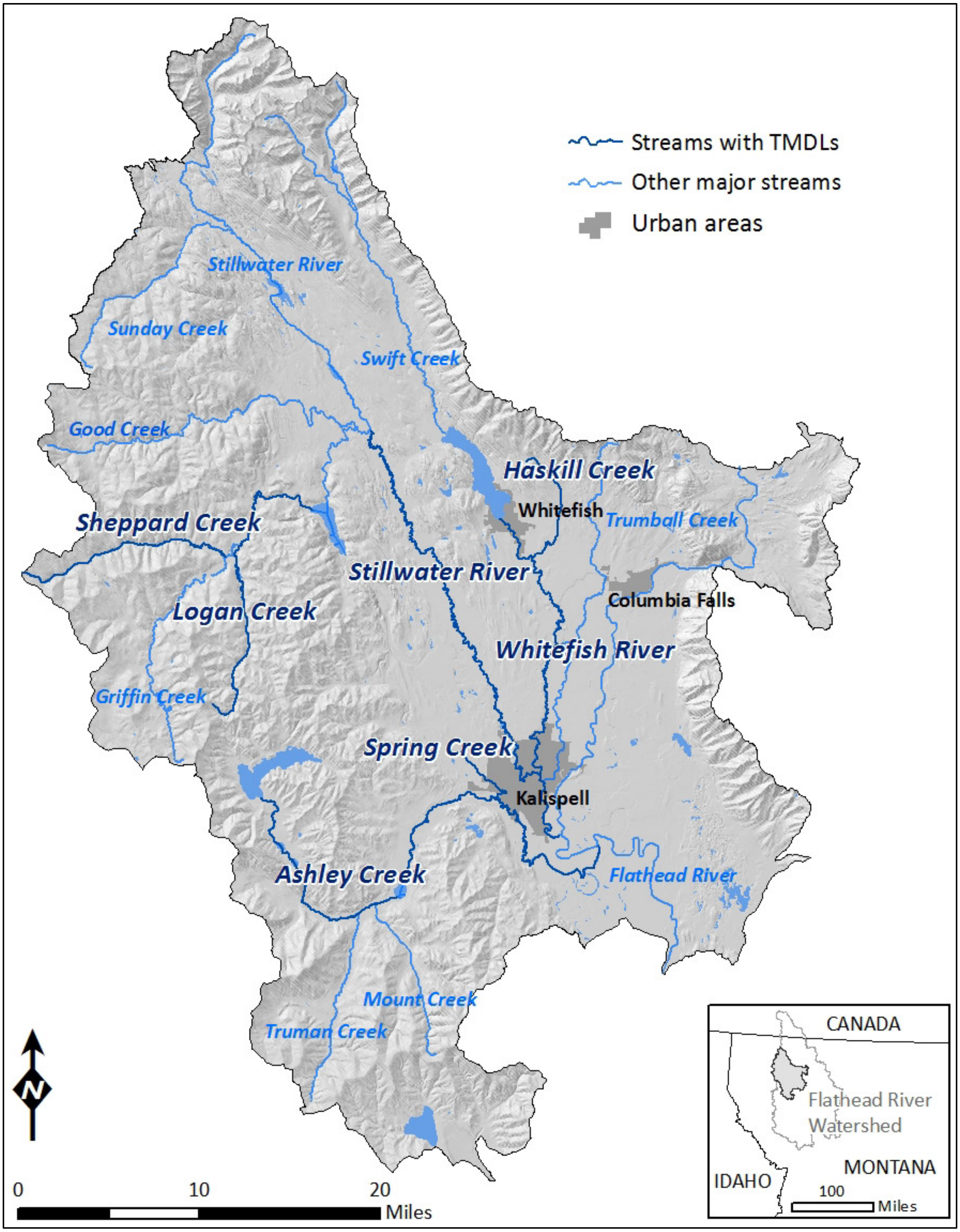


Figure 1-1. Nutrient, Sediment, and Temperature Impaired Waterbodies in the Flathead-Stillwater TMDL Planning Area

1.1 Why We Write TMDLs

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). The CWA's goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires each state to designate uses of their waters and to develop water quality standards to protect those uses.

Montana's water quality designated use classification system includes the following:

- fish and aquatic life
- wildlife
- recreation
- agriculture
- industry
- drinking water

Each waterbody in Montana has a set of designated uses from the list above. Montana has established water quality standards to protect these uses, and a waterbody that does not meet one or more standards is called an impaired water. Each state must monitor their waters to track if they are supporting their designated uses, and every two years the Montana Department of Environmental Quality (DEQ) prepares a Water Quality Integrated Report (IR) which lists all impaired waterbodies and their identified impairment causes. Impairment causes fall within two main categories: pollutant and non-pollutant.

Montana's biennial IR identifies all the state's impaired waterbody segments. The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL, whereas TMDLs are not required for non-pollutant causes of impairments. Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal CWA require the development of total maximum daily loads for all impaired waterbodies when water quality is impaired by a pollutant. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Developing TMDLs and water quality improvement strategies includes the following components, which are further defined in **Section 4.0**:

- Determining measurable target values to help evaluate the waterbody's condition in relation to the applicable water quality standards
- Quantifying the magnitude of pollutant contribution from their sources
- Determining the TMDL for each pollutant based on the allowable loading limits for each waterbody-pollutant combination
- Allocating the total allowable load (TMDL) into individual loads for each source

In Montana, restoration strategies and monitoring recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation (see **Sections 9.0** and **10.0** of this document).

Basically, developing a TMDL for an impaired waterbody is a problem-solving exercise: The problem is excess pollutant loading that impairs a designated use. The solution is developed by identifying the total acceptable pollutant load (the TMDL), identifying all the significant pollutant-contributing sources, and identifying where pollutant loading reductions should be applied to achieve the acceptable load.

1.2 Water Quality Impairments and TMDLs Addressed by this Document

Table 1-1 below lists all of the impairment causes from the "2014 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2014) that are addressed in this document (also see **Figures 5-1**, **6-1**, and **7-1** for maps of those waterbodies). Each pollutant impairment falls within a TMDL pollutant category (e.g., nutrients, sediment, or temperature), and this document is organized by those categories.

New data assessed during this project identified new sediment and temperature impairment causes for two waterbodies: Ashley and Haskill creeks. These impairment causes are identified in **Table 1-1** and noted as not being on the 2014 303(d) List (within the integrated report). Instead, these impairments will be documented within DEQ assessment files and incorporated into the 2016 IR.

TMDLs are completed for each waterbody – pollutant combination, and this document contains 18 TMDLs that address 23 pollutant impairments (**Table 1-1**). There are several non-pollutant types of impairment that are also addressed in this document. As noted above, TMDLs are not required for non-pollutants, although in many situations the solution to one or more pollutant problems will be consistent with, or equivalent to, the solution for one or more non-pollutant problems. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 8.0**. **Section 8** also provides some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document.

This document only addresses the impairments identified in **Table 1-1** below, and only includes waterbodies within the Flathead – Stillwater TMDL Planning Area. DEQ recognizes that there are other pollutant listings within the overall Flathead Lake watershed that have not been addressed via this project or previous TMDL projects in the watershed. This is because DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or a couple of specific pollutant types. **Section 8.0** provides tables of both pollutant and non-pollutant listings that have not been addressed in the Flathead Lake watershed, discusses future TMDL work to be completed, and includes information on previously completed TMDLs within the Flathead Lake watershed. Additionally, Flathead and Whitefish lakes are identified as impaired for sediment within the 2014 303(d) List. DEQ performed updated sediment water quality assessments for each lake and concluded that neither lake is impaired for sediment. Therefore, no sediment TMDLs are required for Flathead Lake or Whitefish Lake.

Table 1-1. Water Quality Impairment Causes for the Flathead-Stillwater TMDL Planning Area Addressed within this Document

Waterbody & Location Description [1]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status [2]	Included in 2014 Integrated Report [3]
Ashley Creek, Ashley Lake to Smith Lake	MT76O002_010	Alteration in stream-side or littoral vegetative covers	Not Applicable; Non-pollutant	Addressed by Sediment and Temperature TMDLs	Yes
		Chlorophyll-*a*	Not Applicable; Non-pollutant	Addressed by TN TMDL	Yes
		Nitrogen (Total)	Nutrients	TN TMDL completed	Yes
		Oxygen, Dissolved	Dissolved Oxygen	Addressed by TN TMDL	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	Yes
		Temperature, water	Temperature	Temperature TMDL completed	Yes
Ashley Creek, Smith Lake to Kalispell Airport Road	MT76O002_020	Nitrogen (Total)	Nutrients	TN TMDL completed	Yes
		Phosphorus (Total)	Nutrients	TP TMDL completed	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	No
		Temperature, water	Temperature	Temperature TMDL completed	No
Ashley Creek, Kalispell airport road to mouth (Flathead River)	MT76O002_030	Alteration in stream-side or littoral vegetative covers	Not Applicable; Non-pollutant	Addressed by Sediment and Temperature TMDLs	Yes
		Chlorophyll-*a*	Not Applicable; Non-pollutant	Addressed by TN and TP TMDLs	Yes
		Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	Addressed by TN TMDL	Yes
		Nitrogen (Total)	Nutrients	TN TMDL completed	Yes
		Oxygen, Dissolved	Dissolved Oxygen	Addressed by TN and TP TMDLs	Yes
		Phosphorus (Total)	Nutrients	TP TMDL completed	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	No
		Temperature, water	Temperature	Temperature TMDL completed	Yes
Haskill Creek, Haskill Basin Pond to mouth (Whitefish River)	MT76P003_070	Sedimentation/Siltation	Sediment	Sediment TMDL completed	No
Logan Creek, Headwaters to Tally Lake	MT76P001_030	Other flow regime alterations	Not Applicable; Non-pollutant	Addressed by sediment TMDL	Yes
		Physical substrate habitat alterations	Not Applicable; Non-pollutant	Addressed by sediment TMDL	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	Yes

Table 1-1. Water Quality Impairment Causes for the Flathead-Stillwater TMDL Planning Area Addressed within this Document

Waterbody & Location Description [1]	Waterbody ID	Impairment Cause	Pollutant Category	Impairment Cause Status [2]	Included in 2014 Integrated Report [3]
Sheppard Creek, Headwaters to mouth (Griffin Creek)	MT76P001_050	Alteration in stream-side or littoral vegetative covers	Not Applicable; Non-pollutant	Addressed by sediment TMDL	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	Yes
Spring Creek, Headwaters to mouth (Ashley Creek)	MT76O002_040	Nitrate/Nitrite (Nitrite + Nitrate as N)	Nutrients	Addressed by TN TMDL	Yes
		Nitrogen (Total)	Nutrients	TN TMDL completed	Yes
		Oxygen, Dissolved	Dissolved Oxygen	Addressed by TN and TP TMDLs	Yes
		Phosphorus (Total)	Nutrients	TP TMDL completed	Yes
Stillwater River, Logan Creek to mouth	MT76P001_010	Alteration in stream-side or littoral vegetative covers	Not Applicable; Non-pollutant	Addressed by sediment TMDL	Yes
		Sedimentation/Siltation	Sediment	Sediment TMDL completed	Yes
Whitefish River, Whitefish Lake to mouth (Stillwater River)	MT76P003_010	Temperature, water	Temperature	Temperature TMDL completed	Yes

[1] All waterbody segments within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset (NHD)
[2] TN = Total Nitrogen, TP = Total Phosphorus
[3] Impairment causes not in the "2014 Water Quality Integrated Report" were recently identified and will be included in the 2016 Integrated Report

1.3 What This Document Contains

This document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy. The TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices and attachments. In addition to this introductory section, this document includes:

Section 2.0 Flathead-Stillwater TMDL Planning Area Description:
Describes the physical characteristics and social profile of the planning area, which includes the Ashely Creek, Whitefish River, and Stillwater River watersheds.

Section 3.0 Montana Water Quality Standards
Discusses the water quality standards that apply to the waterbodies in the Flathead – Stillwater TMDL Planning Area.

Section 4.0 Defining TMDLs and Their Components
Defines the components of TMDLs and how each is developed.

Sections 5.0 – 7.0 Nutrients, Sediment, and Temperature TMDL Components (sequentially):
Each section includes (a) a discussion of the affected waterbodies and the pollutant's effect on designated beneficial uses, (b) the information sources and assessment methods used to evaluate stream health and pollutant source contributions, (c) water quality targets and existing water quality conditions, (d) the quantified pollutant loading from the identified sources, (e) the determined TMDL for each waterbody, (f) the allocations of the allowable pollutant load to the identified sources.

Section 8.0 Non-Pollutant Impairments, Previously Completed TMDLs, and Future TMDL Development:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in the plan might address some of these concerns. This section also provides recommendations for combating these problems and discusses previously completed TMDLs and potential future TMDL development work in the Flathead Lake watershed.

Section 9.0 Water Quality Improvement Plan:
Discusses water quality restoration objectives and a strategy to meet the identified objectives and TMDLs.

Section 10.0 Monitoring Strategy and Adaptive Management:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of the "Flathead – Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan."

Section 11.0 Stakeholder and Public Participation:
Describes other agencies and stakeholder groups who were involved with the development of this plan and the public participation process used to review the draft document. Addresses comments received during the public review period.

2.0 FLATHEAD-STILLWATER TMDL PLANNING AREA DESCRIPTION

This section includes a brief profile of the Flathead-Stillwater Total Maximum Daily Load (TMDL) Planning Area (TPA).

2.1 FLATHEAD-STILLWATER TPA DESCRIPTION

The following information provides a general description of the Flathead-Stillwater TMDL Planning Area including a discussion of location, topography, climate, surface water, population and land cover.

2.1.1 Location

The Flathead-Stillwater TPA encompasses approximately 1,430 square miles in northwestern Montana. The planning area is bounded in the north by the Whitefish Mountain Range, the east by the and Swan Mountain Range, in the west by the Upper Kootenai and Fisher River drainages, and in the south by Flathead Lake. Most of the planning area resides in Flathead County with Kalispell, MT being the largest population center. A small northern and western portion also extends into Lincoln County. The general TPA location is mapped in **Figure 2-1.**

2.1.2 Topography

Elevations in the Flathead-Stillwater TPA range from approximately 2,887 feet above sea level at the mouth of the Flathead River and the inlet of Flathead Lake, to approximately 7,450 feet atop the summit of Whitefish Mountain. Valley bottom elevations range from around 3,000 to 3,500 feet. Elevation is mapped on **Figure 2-2.**

2.1.3 Climate

Climate in the Flathead-Stillwater TPA varies greatly. Precipitation ranges from 15 inches per year in the central valley surrounding Kalispell to over 76 inches in the Whitefish and Swan Mountains. Precipitation trends closely follow elevation; significant moisture falls in the mountains and the quantity gradually decreases with elevation.

According to data provided by the Western Regional Climate Center for Kalispell, the average maximum temperature (82°F) occurs in July while the average minimum temperature (14°F) most often occurs in January. The average annual snowfall in Kalispell is 53 inches. Precipitation and temperature averages are mapped in **Figures 2-3** and **2-4**.

2.1.4 Surface Water

All surface water in the Flathead-Stillwater TPA drains into Flathead Lake through the Flathead River in the southern portion of the planning area. The Stillwater Watershed 4^{th} Code Hydrologic Unit (HUC 17010210) is completely contained within the TPA, as is a northern portion of the Flathead Lake Watershed (HUC 17010208). These waters are part of the larger Columbia River basin which eventually discharges into the Pacific Ocean. Surface hydrography is mapped in **Figure 2-5**.

The United States Geological Survey (USGS) has established numerous surface water monitoring and gaging stations in the planning area. As indicated in **Figure 2-5** and detailed in **Table 2-1**, five sites are actively recording continuous data as of August 2014. Data from these USGS gage stations show, as with most snowpack dominated systems, that stream flows most often peak during June and reach a minimum in October. Discharge is relatively constant from October through March, with runoff occurring from May to July.

Table 2-1. Active USGS Gage Stations in the Flathead-Stillwater TPA

Station ID	Station Description	Latitude	Longitude	Data Range*
12369000	Flathead River near Bigfork MT	48.092325	-114.115369	1969-present
12366500	Flathead River at Foys Bend nr Kalispell MT	48.154311	-114.248925	1909-present
12365700	Stillwater River at Lawrence Park, at Kalispell	48.21725	-114.313736	2004-present
12366080	Whitefish River nr mouth at Kalispell, MT	48.225928	-114.292661	2004-present
12363000	Flathead River at Columbia Falls MT	48.361633	-114.184425	1922-present

*Data not continuous for entire period of record

2.1.5 Population

The population of the Flathead-Stillwater TPA estimated using 2010 census block densities, is 82,400 people. This population is concentrated around the urban areas of Kalispell, Whitefish, and Columbia Falls. According to the U.S. Census Bureau, 20,972 people lived in Kalispell in 2013 while 6,649 lived in Whitefish and slightly fewer than 5,000 lived in Columbia Falls. Large tracts of land are also identified as uninhabited, mostly in the mountainous land managed by the U.S. Forest Service. Two major interstate highways bisect the planning area and have experienced focused development along their routes. U.S. Highway 93 connects Whitefish and Kalispell and continues north and south out of the TPA. U.S. Highway 2 runs in a general east-west fashion going through Columbia Falls. The Glacier Park International Airport, served by four major airlines, is situated eight miles northeast of Kalispell. Population density is mapped in **Figure 2-6**.

2.1.6 Land Cover

Land cover within the Flathead-Stillwater TPA is dominated by conifer forests. Human land uses, including various intensities of development, are common along the Flathead, Stillwater, and Whitefish River Valleys. Agricultural practices are also present in the valleys. Most land identified as recently disturbed relates to forest harvest, however, the extent of the 2007 Brush Creek fire in the Sheppard Creek watershed is also evident. Land cover is mapped in **Figure 2-7**.

2.2 Other Watershed Characterizations

Department of Environmental Quality (DEQ) has characterized portions of the Flathead-Stillwater TPA in other documents. These include characterizations for the Ashley Creek (Tetra Tech, Inc., 2014a), Haskill Creek (River Design Group, 2007a), Stillwater River (River Design Group, 2007b), and Whitefish River (PBS&J, 2006) watersheds. Additional information regarding climate, topography, population, etc., specific to each subwatershed, can be found in the documents.

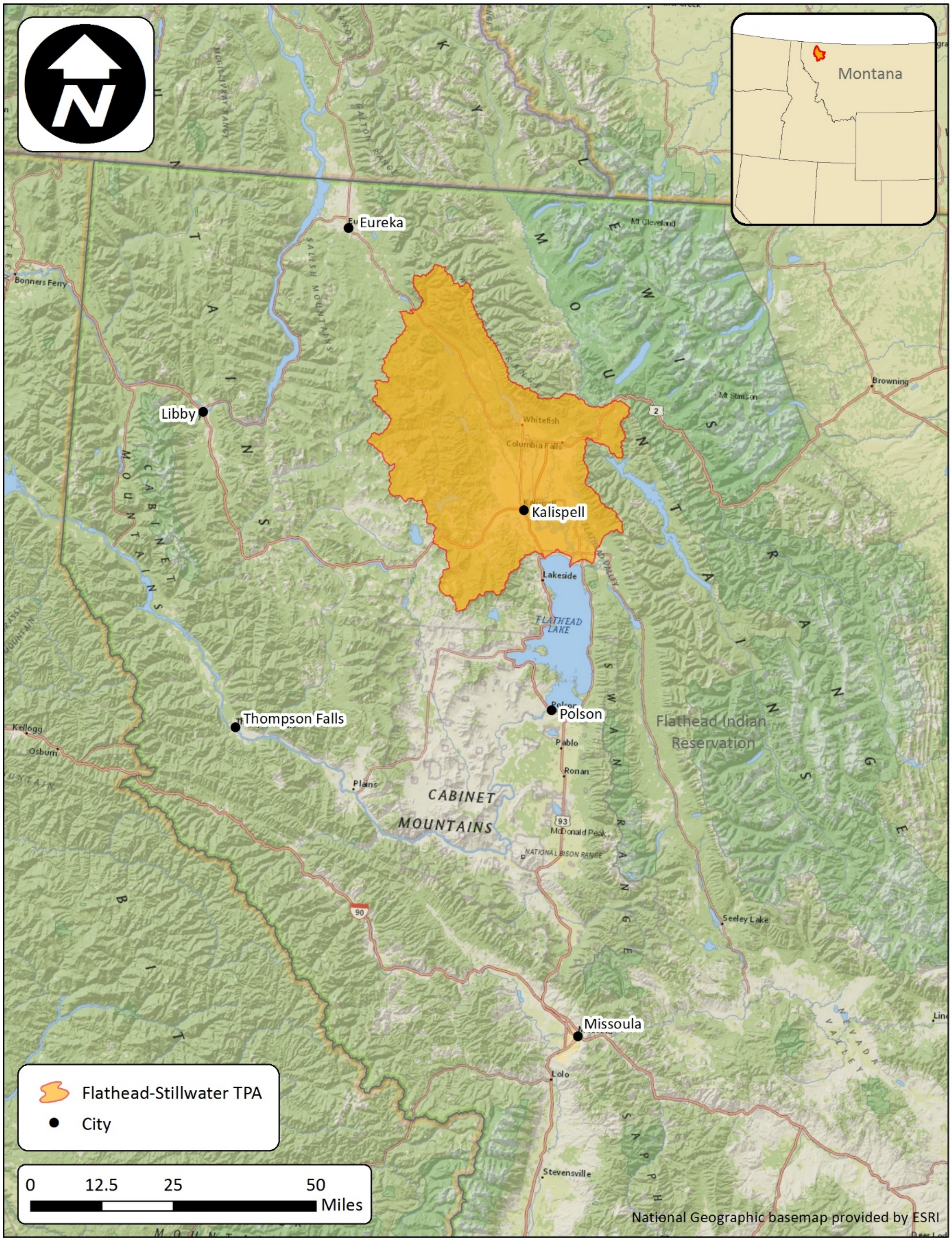


Figure 2-1. Location of the Flathead-Stillwater TMDL Planning Area

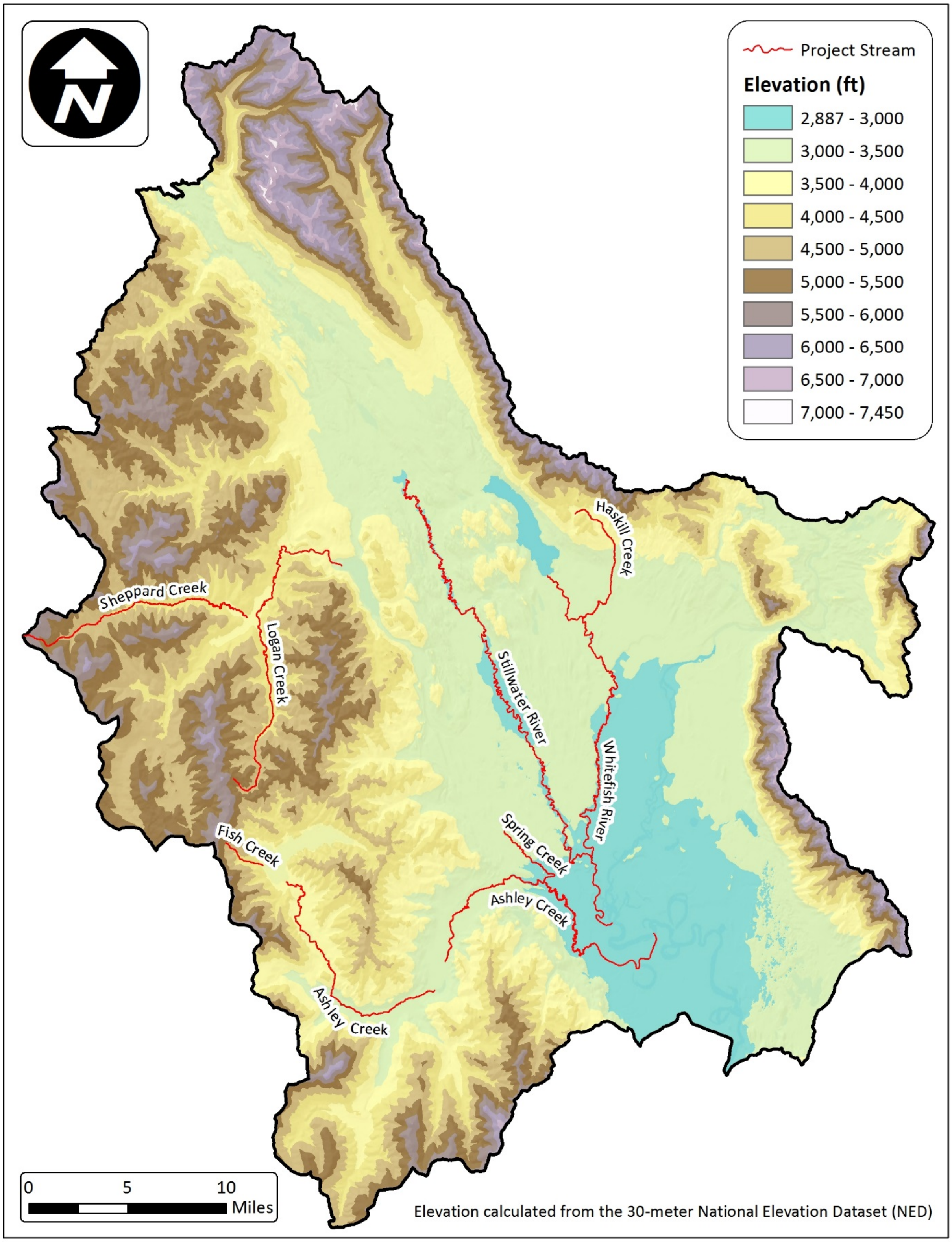


Figure 2-2. Topography of the Flathead-Stillwater TMDL Planning Area

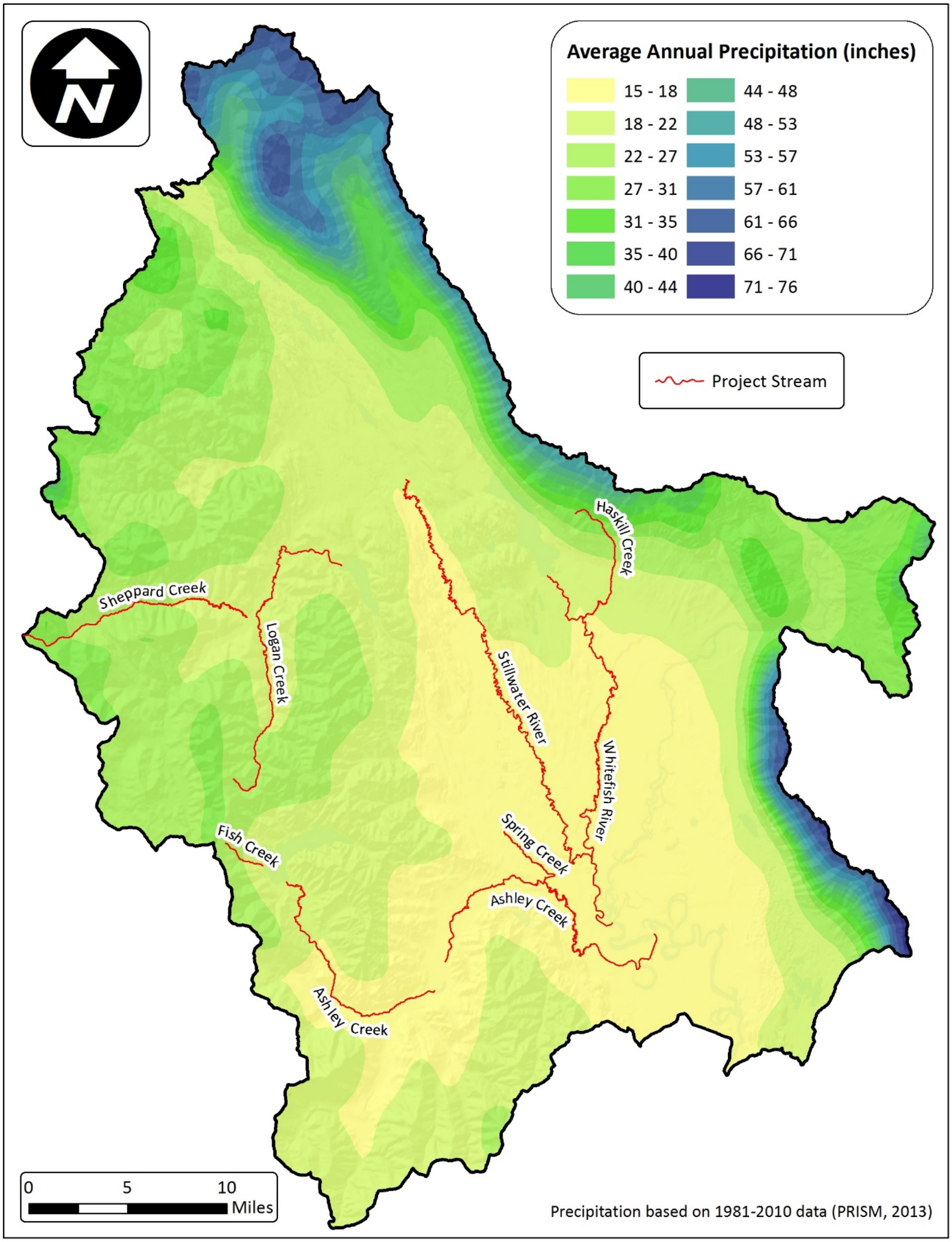


Figure 2-3. Average annual precipitation in the Flathead-Stillwater TMDL Planning Area

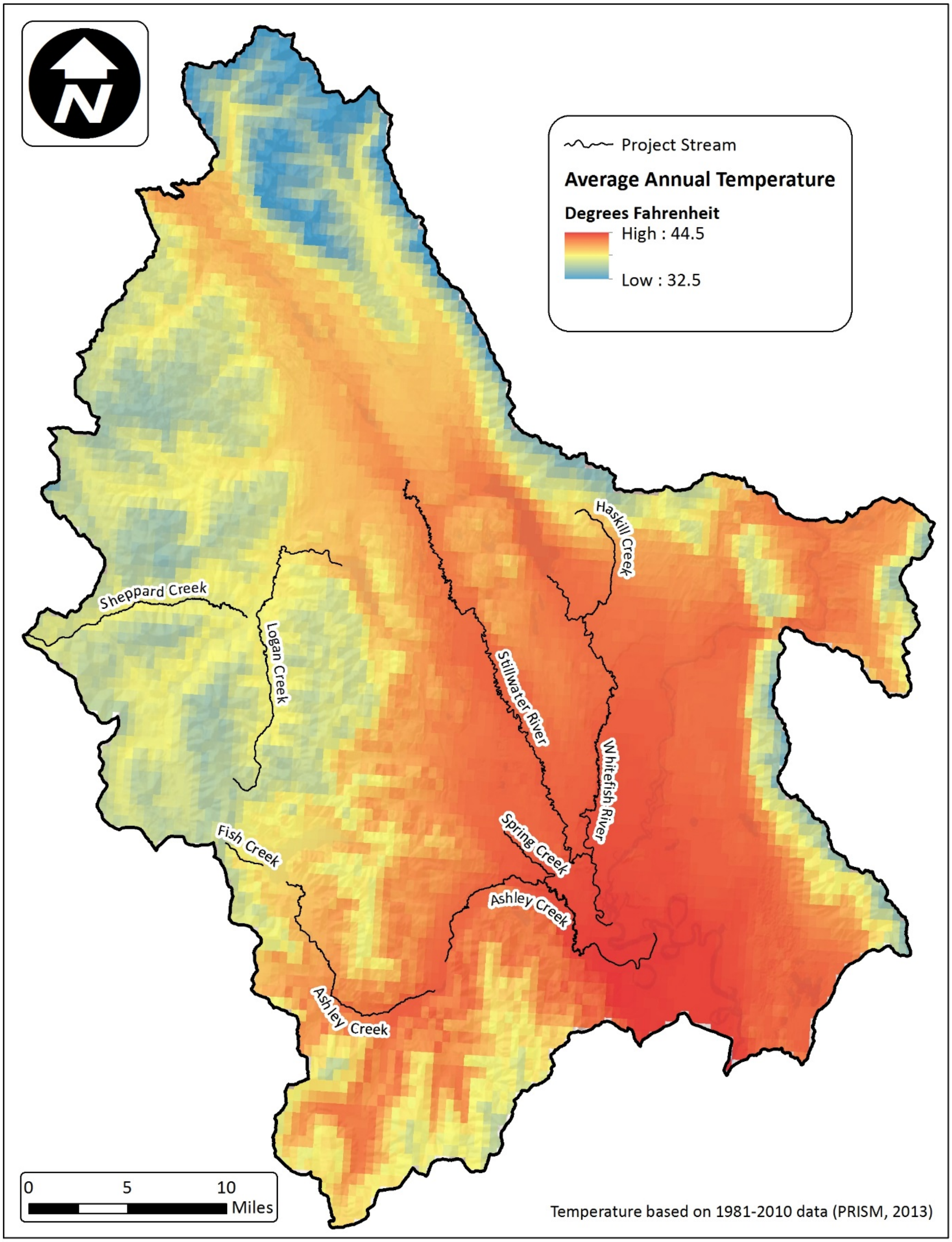


Figure 2-4. Average annual temperature in the Flathead-Stillwater TMDL Planning Area

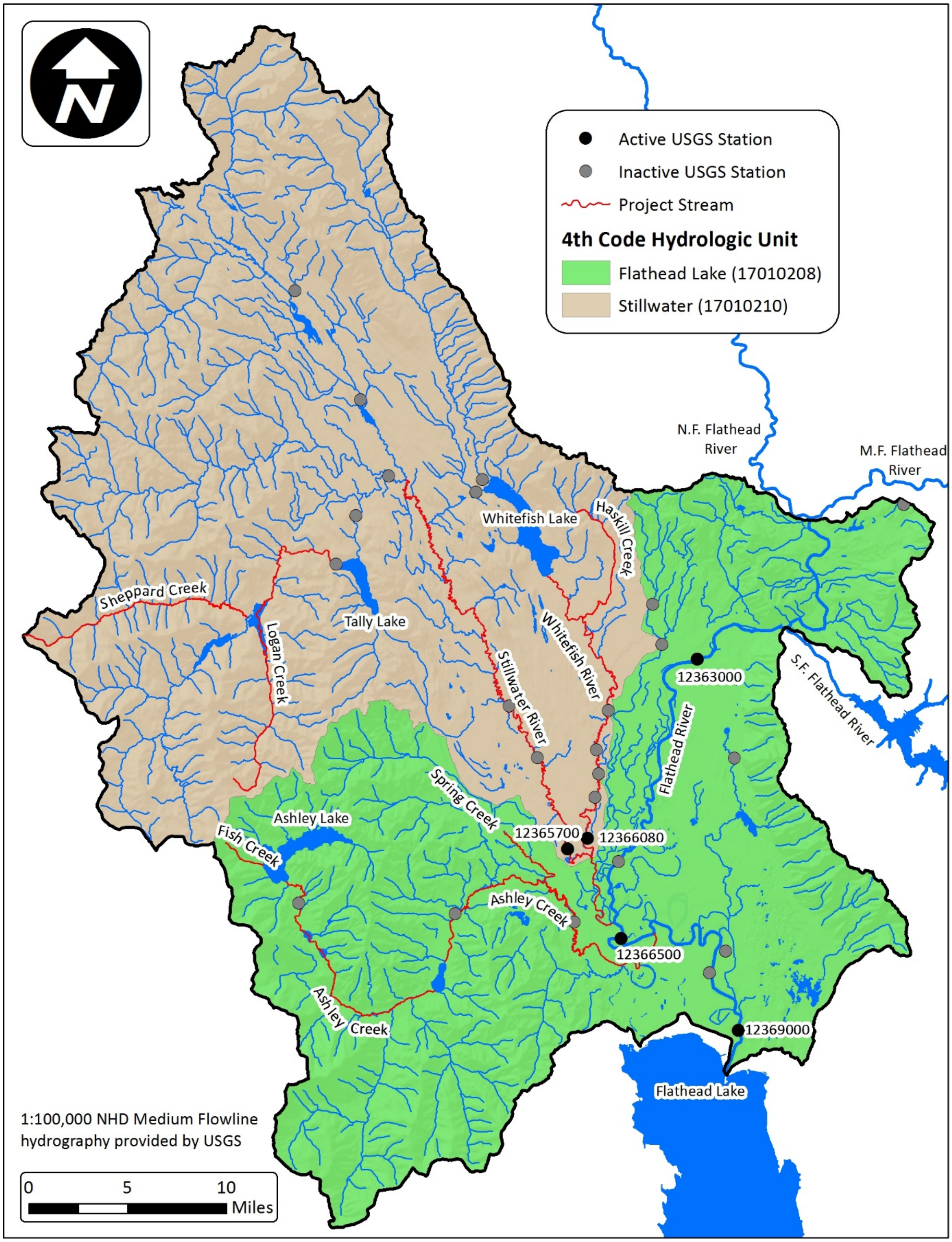


Figure 2-5. Surface water hydrography of the Flathead-Stillwater TMDL Planning Area

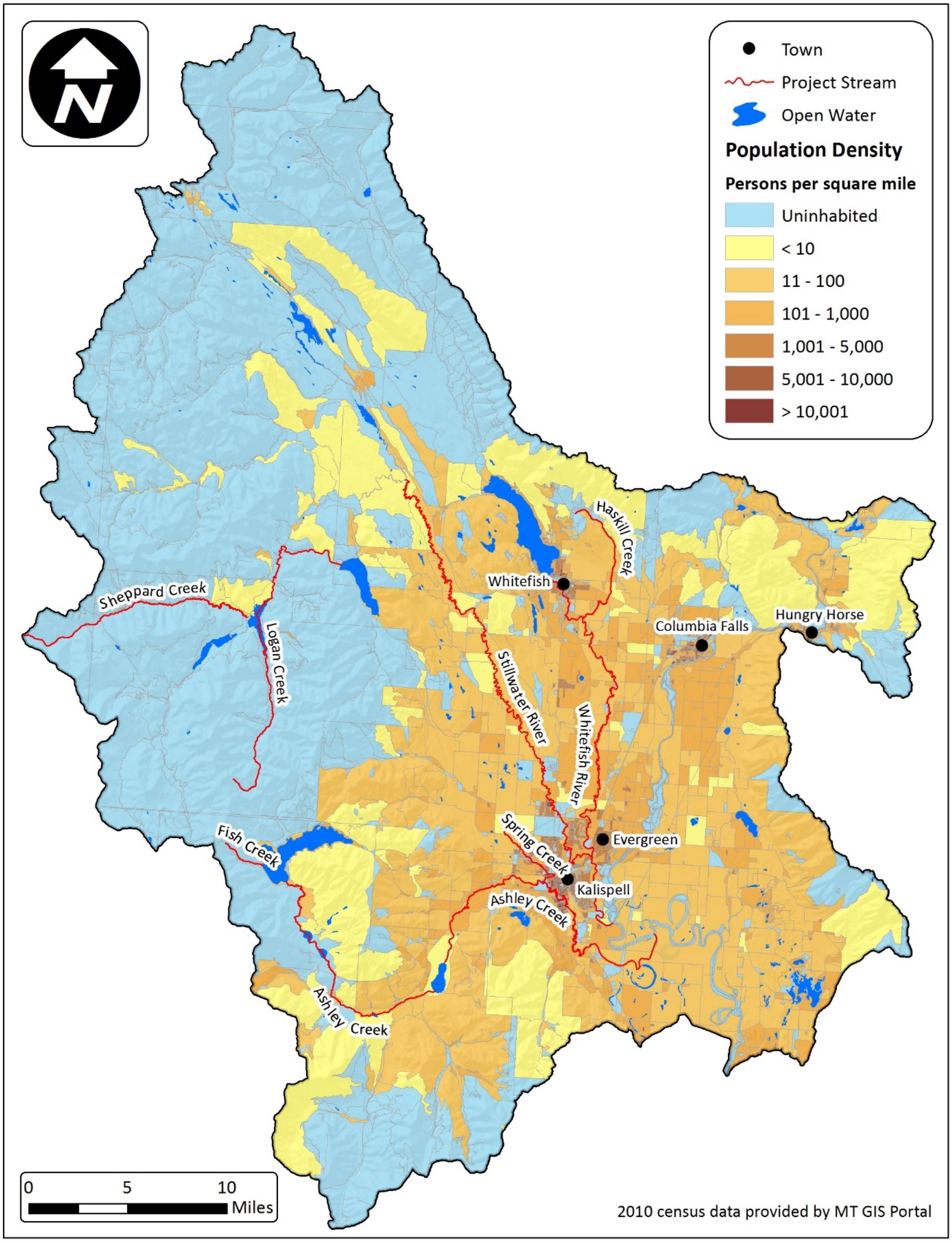


Figure 2-6. Population Density of the Flathead-Stillwater TMDL Planning Area

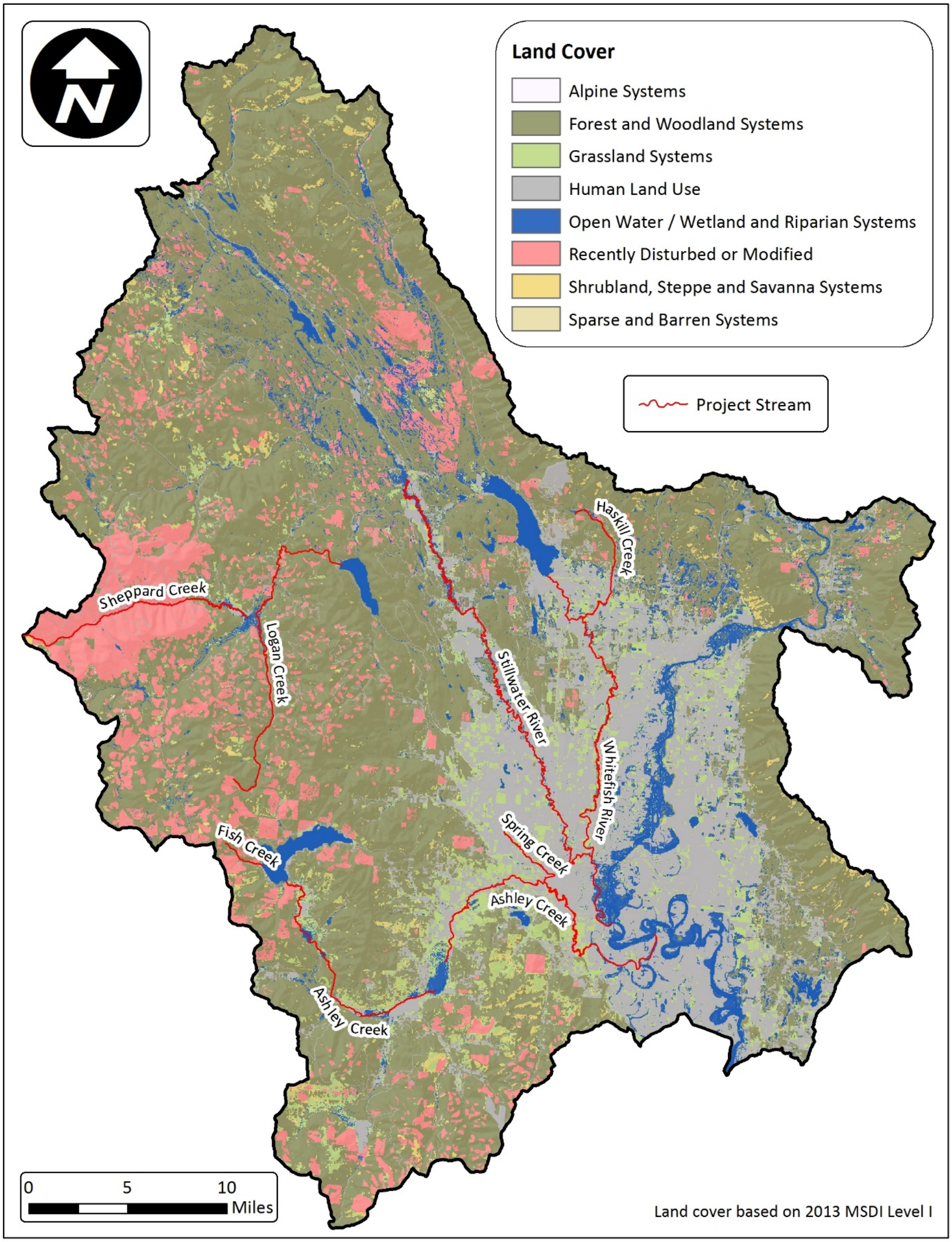


Figure 2-7. Land cover of the Flathead-Stillwater TMDL Planning Area

3.0 MONTANA WATER QUALITY STANDARDS

The federal Clean Water Act provides for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's surface waters so that they support all designated uses. Water quality standards are used to determine impairment, establish water quality targets, and to formulate the Total Maximum Daily Loads (TMDLs) and allocations.

Montana's water quality standards and water quality standards in general include three main parts:
1. Stream classifications and designated uses
2. Numeric and narrative water quality criteria designed to protect designated uses
3. Nondegradation provisions for existing high-quality waters

Montana's water quality standards also incorporate prohibitions against water quality degradation as well as point source permitting and other water quality protection requirements.

Nondegradation provisions are not applicable to the TMDLs developed within this document because of the impaired nature of the streams addressed. Those water quality standards that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards may be found in the Montana Water Quality Act (75-5-301,302 Montana Code Annotated (MCA)), Montana's Surface Water Quality Standards and Procedures (Administrative Rules of Montana (ARM) 17.30.601-670); Circular DEQ-7, Montana Numeric Water Quality Standards (Montana Department of Environmental Quality, 2012a); and Circular DEQ-12A, Montana Base Numeric Nutrient Standards (Montana Department of Environmental Quality, 2014b).

3.1 STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. The streams in the Flathead – Stillwater TMDL Planning Area have multiple classifications, including A-1, B-1, B-2, and C-2 (**Table 3-1**). A-1 classifications are for high quality waters with the principal use as a public water supply. For a B-1, B-2, and C-2 classifications, the 'B' and 'C' denote the specific level of protection applied to designated uses and the '1' and '2' denote the suitability for growth and propagation of salmonid fishes and associated aquatic life. **Table A2-1** in **Appendix A** defines the uses, their levels of protection, and growth and propagation suitability for each of these stream classifications.

Majority of the streams in the planning area are classified B-1, and waters classified as B-1 are to be maintained suitable to support all of the following uses ((Administrative Rules of Montana (ARM) (17.30.623(1), State of Montana, 2014):
- Drinking, culinary, and food processing purposes, after conventional treatment (Drinking Water)
- Bathing, swimming, and recreation (Primary Contact Recreation)
- Growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers (Aquatic Life)
- Agricultural and industrial water supply

B-2 streams must be maintained suitable for these same uses, but only *marginal* propagation of salmonid fishes and associated aquatic life. C-2 streams must be maintained suitable for the same uses as B-2 streams, with the exception of drinking water.

While some of the waterbodies might not actually be used for a designated use (e.g., drinking water supply), their water quality still must be maintained suitable for that designated use. More detailed descriptions of Montana's surface water classifications and designated uses are provided in **Appendix A**. Department of Environmental Quality's (DEQ) water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant group addressed within this document, thus ensuring protection of all designated uses (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011). For streams in Western Montana, the most sensitive use assessed for sediment and temperature is aquatic life, and for nutrients is aquatic life and primary contact recreation. DEQ determined that nine waterbody segments in the Flathead – Stillwater TMDL Planning Area do not meet the nutrient, sediment, and/or temperature water quality standards (**Table 3-1**).

Table 3-1. Impaired Waterbodies and their Use Classes and Impaired Designated Uses in the Flathead – Stillwater TMDL Planning Area

Waterbody & Location Description	Waterbody ID	Use Class	Impairment Cause*	Impaired Use(s)
Ashley Creek, Ashley Lake to Smith Lake	MT76O002_010	B-1	Total Nitrogen	Aquatic Life, Primary Contact Recreation
			Sediment	Aquatic Life
			Temperature	Aquatic Life
Ashley Creek, Smith Lake to Kalispell Airport Road	MT76O002_020	B-2	Total Nitrogen	Aquatic Life, Primary Contact Recreation
			Total Phosphorus	Aquatic Life, Primary Contact Recreation
			Sediment	Aquatic Life
			Temperature	Aquatic Life
Ashley Creek, Kalispell airport road to mouth (Flathead River)	MT76O002_030	C-2	Total Nitrogen	Aquatic Life, Primary Contact Recreation
			Total Phosphorus	Aquatic Life, Primary Contact Recreation
			Sediment	Aquatic Life
			Temperature	Aquatic Life
Haskill Creek, Haskill Basin Pond to mouth (Whitefish River)	MT76P003_070	A-1	Sediment	Aquatic Life
Logan Creek, Headwaters to Tally Lake	MT76P001_030	B-1	Sediment	Aquatic Life
Sheppard Creek, Headwaters to mouth (Griffin Creek)	MT76P001_050	B-1	Sediment	Aquatic Life
Spring Creek, Headwaters to mouth (Ashley Creek)	MT76O002_040	B-1	Total Nitrogen	Aquatic Life, Primary Contact Recreation
			Total Phosphorus	Aquatic Life, Primary Contact Recreation
Stillwater River, Logan Creek to mouth	MT76P001_010	B-2	Sediment	Aquatic Life
Whitefish River, Whitefish Lake to mouth (Stillwater River)	MT76P003_010	B-2	Temperature	Aquatic Life

* Only includes those pollutant impairments addressed by TMDLs in this document

3.2 Numeric and Narrative Water Quality Standards

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria that protect the designated uses. Numeric criteria define the allowable concentrations, frequency, and duration of specific pollutants so as not to impair designated uses.

Numeric standards apply to pollutants that are known to have adverse effects on human health or aquatic life (e.g., metals, nutrients, organic chemicals, and other toxic constituents). Human health standards are set at levels that protect against long-term (lifelong) exposure via drinking water and other pathways such as fish consumption, as well as short-term exposure through direct contact such as swimming. Numeric standards also apply to other designated uses such as protecting irrigation and stock water quality for agriculture.

Narrative standards are developed when there is insufficient information to develop numeric standards and/or the natural variability makes it impractical to develop numeric standards. Narrative standards describe the allowable or desired condition. This condition is often defined as an allowable increase above "naturally occurring." DEQ often uses the naturally occurring condition, called a "reference condition," to help determine whether or not narrative standards are being met (see **Appendix A**).

For the Flathead – Stillwater TMDL Planning Area, a combination of numeric and narrative standards are applicable. The numeric standards apply to nutrients, and narrative standards are applicable for sediment and temperature, as well as nutrients. The specific numeric and narrative standards are summarized in **Appendix A**.

4.0 DEFINING TMDLS AND THEIR COMPONENTS

A total maximum daily load (TMDL) is a tool for implementing water quality standards and is based on the relationship between pollutant sources and water quality conditions. More specifically, a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive from all sources and still meet water quality standards.

Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are discernible, confined and discrete conveyances, such as pipes, ditches, wells, containers, or concentrated animal feeding operations, from which pollutants are being, or may be, discharged. Some sources such as return flows from irrigated agriculture are not included in this definition. All other pollutant loading sources are considered nonpoint sources. Nonpoint sources are diffuse and are typically associated with runoff, streambank erosion, most agricultural activities, atmospheric deposition, and groundwater seepage. Natural background loading is a type of nonpoint source.

As part of TMDL development, the allowable load is divided among all significant contributing point and nonpoint sources. For point sources, the allocated loads are called “wasteload allocations” (WLAs). For nonpoint sources, the allocated loads are called “load allocations” (LAs).

A TMDL is expressed by the equation: $TMDL = \Sigma WLA + \Sigma LA$, where:

ΣWLA is the sum of the wasteload allocation(s) (point sources)
ΣLA is the sum of the load allocation(s) (nonpoint sources)

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation. Alternatively, the MOS can be implicit in the TMDL. A TMDL must also ensure that the waterbody will be able to meet and maintain water quality standards for all applicable seasonal variations (e.g., pollutant loading or use protection).

Development of each TMDL has four major components:

- Determining water quality targets
- Quantifying pollutant sources
- Establishing the total allowable pollutant load
- Allocating the total allowable pollutant load to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs, regardless of pollutant. Each component is described in further detail in the following subsections.

Figure 4-1 illustrates how numerous sources contribute to the existing load and how the TMDL is defined. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

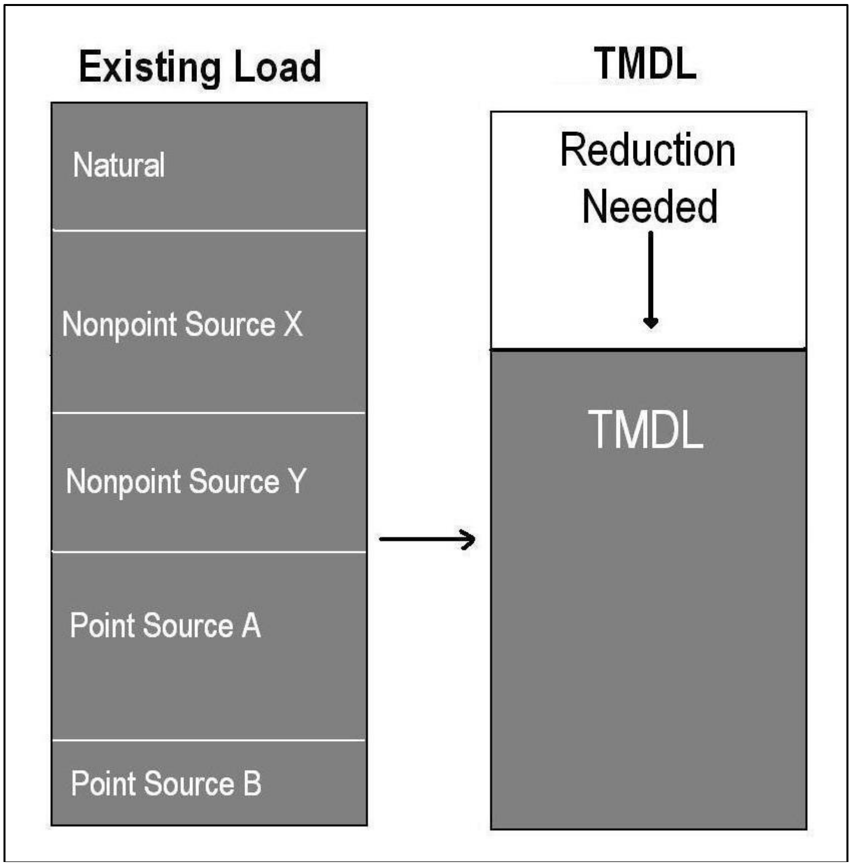


Figure 4-1. Schematic Example of TMDL Development

4.1 Developing Water Quality Targets

TMDL water quality targets are a translation of the applicable numeric or narrative water quality standard(s) for each pollutant. For pollutants with established numeric water quality standards, the numeric value(s) are used as the TMDL targets. For pollutants with narrative water quality standard(s), the targets provide a waterbody-specific interpretation of the narrative standard(s).

Water quality targets are typically developed for multiple parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s). Therefore, the targets provide a benchmark by which to evaluate attainment of water quality standards. Furthermore, comparing existing stream conditions to target values allows for a better understanding of the extent and severity of the problem.

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 the effects of pollutants on water quality can vary throughout the year, assessing pollutant sources must include an evaluation of the seasonal variability of the pollutant loading. The source assessment helps to define the extent of the problem by linking the pollutant load to specific sources in the watershed.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Nonpoint sources are quantified by source categories (e.g., unpaved roads or eroding streambanks) and/or by land uses (e.g., crop production or forestry). These source categories and land uses can be divided further by ownership, such as federal, state, or private. Alternatively, most, or all, pollutant sources in a sub-watershed or source area can be combined for quantification purposes.

Because all potentially significant sources of the water quality problems must be evaluated, source assessments are conducted on a watershed scale. The source quantification approach may produce reasonably accurate estimates or gross allotments, depending on the data available and the techniques used for predicting the loading (40 code of federal regulation (CFR) 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.

4.3 Establishing the Total Allowable Load

Identifying the TMDL requires a determination of the total allowable load over the appropriate time period necessary to comply with the applicable water quality standard(s). Although a "TMDL" is specifically defined as a "daily load," determining a daily loading may not be consistent with the applicable water quality standard(s), or may not be practical from a water quality management perspective. Therefore, the TMDL will ultimately be defined as the total allowable loading during a time period that is appropriate for applying the water quality standard(s) and which is consistent with established approaches to properly characterize, quantify, and manage pollutant sources in a given watershed. For example, sediment TMDLs may be expressed as an allowable annual load.

If a stream is impaired by a pollutant for which numeric water quality criteria exist, the TMDL, or allowable load, is typically calculated as a function of streamflow and the numeric criteria. This same approach can be applied when a numeric target is developed to interpret a narrative standard.

Some narrative standards, such as those for sediment, often have a suite of targets. In many of these situations it is difficult to link the desired target values to highly variable, and often episodic, instream loading conditions. In such cases the TMDL is often expressed as a percent reduction in total loading based on source quantification results and an evaluation of load reduction potential (**Figure 4-1**). The degree by which existing conditions exceed desired target values can also be used to justify a percent reduction value for a TMDL.

Even if the TMDL is preferably expressed using a time period other than daily, an allowable daily loading rate will also be calculated to meet specific requirements of the federal Clean Water Act. Where this occurs, TMDL implementation and the development of allocations will still be based on the preferred time period, as noted above.

4.4 Determining Pollutant Allocations

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources. The allocations are often determined by quantifying feasible and achievable load reductions through application of a variety of best management practices and other reasonable conservation practices.

Under the current regulatory framework (40 CFR 130.2) for developing TMDLs, flexibility is allowed in 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 (e.g., a percent increase in canopy density for temperature TMDLs).

Figure 4-2 illustrates how TMDLs are allocated to different sources using WLAs for point sources and load allocations (LA) for natural and nonpoint sources. Although some flexibility in allocations is possible, the sum of all allocations must meet the TMDL for all segments of the waterbody. **Figure 4-2** shows multiple point and nonpoint source allocations; however, composite allocations may be used in some cases where data is limited. Composite wasteload or load allocations provide stakeholders with flexibility in addressing sources, allowing them to choose where to focus remediation or restoration efforts.

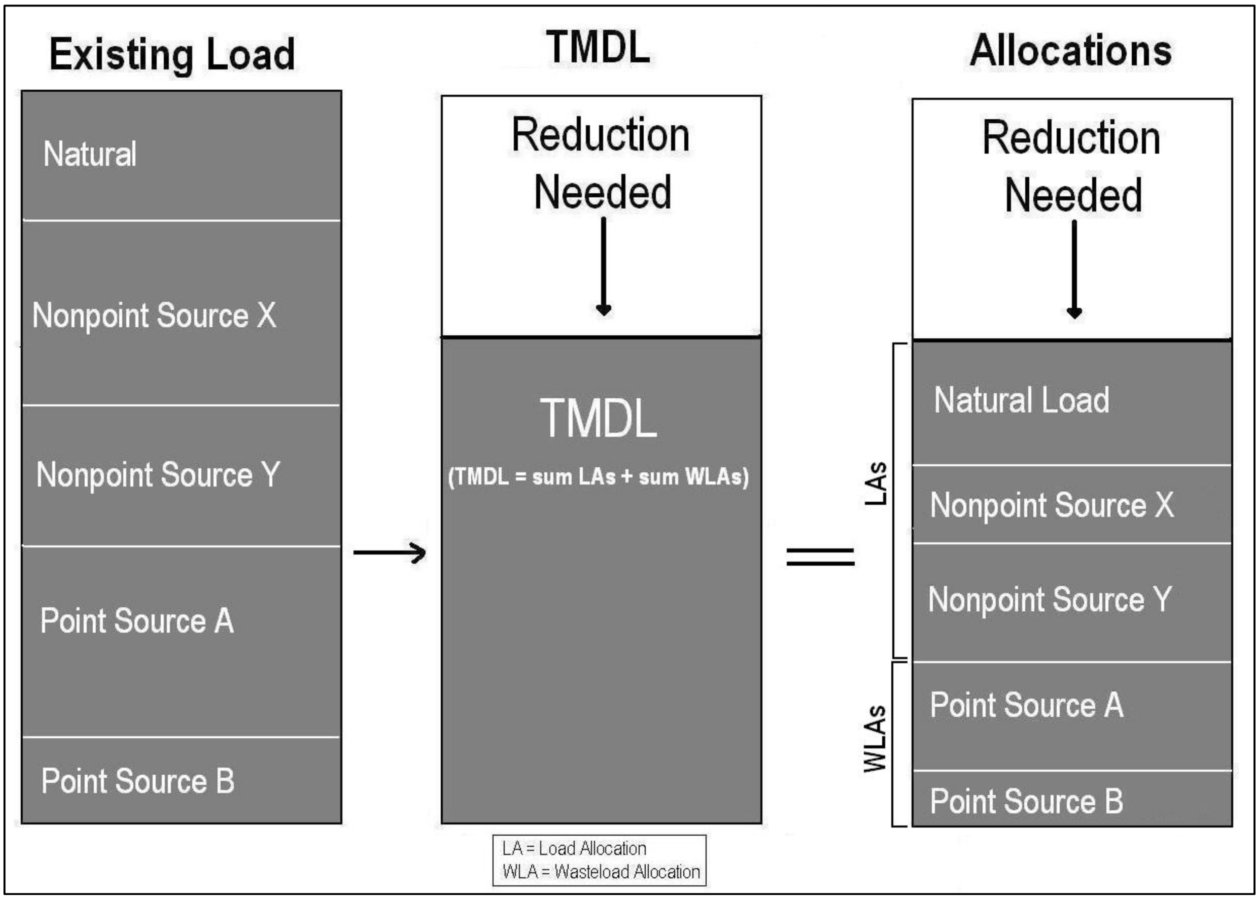


Figure 4-2. Schematic Diagram of a TMDL and its Allocations

TMDLs must also incorporate a margin of safety. The margin of safety accounts for the uncertainty, or any lack of knowledge, about the relationship between the pollutant loads and the quality of the receiving waterbody. The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process, or explicitly by setting aside a portion of the allowable loading (i.e., a TMDL = WLA + LA + MOS) (U.S. Environmental Protection Agency, 1999b). The margin of safety is a required component to help ensure that water quality standards will be met when all allocations are achieved. In Montana, TMDLs typically incorporate implicit margins of safety.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. For TMDLs in this document where there is a combination of nonpoint sources and one or more permitted point sources discharging into an impaired stream reach, the permitted point source WLAs are not dependent on implementation of the LAs. Instead, Department of Environmental Quality (DEQ) sets the WLAs and LAs at levels necessary to achieve water quality standards throughout the watershed. For the temperature TMDLs the LAs are developed independently of the permitted point source WLA such that they would satisfy the naturally occurring target conditions within the stream reach immediately above the point source. In order to ensure that the water quality standard is achieved below the point source discharge, the WLA is based on the point source's discharge not exceeding the allowable increase above naturally occurring conditions.

For the nutrient TMDLs, the LAs are developed independently of the permitted point source WLA such that they would satisfy the TMDL target concentration within the stream reach immediately above the point source. In order to ensure that the water quality standard or target concentration is achieved below the point source discharge, the WLA is based on the point source's discharge concentration set equal to the standard or target concentration for each pollutant unless the loading from an individual point source is negligible based on no measureable impacts to water quality.

4.5 Implementing TMDL Allocations

The Clean Water Act (CWA) and Montana state law (Section 75-5-703 of the Montana Water Quality Act) require wasteload allocations to be incorporated into appropriate discharge permits, thereby providing a regulatory mechanism to achieve load reductions from point sources. Because of limited state and federal regulatory requirements, nonpoint source reductions linked to LAs are implemented primarily through voluntary measures, although there are some important nonpoint source regulatory requirements, such as Montana streamside management zone (SMZ) law and applicable septic system requirements. This document contains several key components to assist stakeholders in implementing nonpoint source controls. **Section 9.0** provides a water quality improvement plan that discusses restoration strategies by pollutant group and source category, and provides recommended best management practices (BMPs) per source category (e.g., grazing, cropland, urban, etc.). **Section 9.6** discusses potential funding sources that stakeholders can use to implement BMPs for nonpoint sources. Other site specific pollutant sources are discussed throughout the document, and can be used to target implementation activities. DEQ's Watershed Protection Section (Nonpoint Source Program) helps to coordinate water quality improvement projects for nonpoint sources of pollution throughout the state and provides resources to stakeholders to assist in nonpoint source BMPs. Montana's Nonpoint Source Management Plan (available at http://www.deq.mt.gov/wqinfo/nonpoint/nonpointsourceprogram.mcpx) further discusses nonpoint source implementation strategies at the state level.

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 10.0**). This includes a monitoring strategy and an implementation review that is required by Montana statute (Section 75-5-703 of the Montana Water Quality Act). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

5.0 Nutrient TMDL Components

This portion of the document focuses on nutrients as a cause of water quality impairment to Ashley Creek. It describes: (1) how excess nutrients impairs beneficial uses, (2) the affected stream segments, (3) the currently available data pertaining to nutrient impairments in the watershed, (4) the sources of nutrients, and (5) the proposed nutrient total maximum daily loads (TMDLs) and their rationales.

5.1 Effects of Excess Nutrients on Beneficial Uses

Nitrogen and phosphorus are natural background chemical elements required for the healthy and stable functioning of aquatic ecosystems. Streams in particular are dynamic systems that depend on a balance of nutrients, and are affected by organic and inorganic nutrient additions, consumption by autotrophic and heterotrophic organisms, cycling of biologically fixed inorganic N and P into higher trophic levels, and cycling of organically fixed nutrients into inorganic forms with biological decomposition. Additions from natural landscape erosion, groundwater discharge, and in-stream uptake and biological decomposition all are components of the balance between organic and inorganic nutrient forms. Human influences may alter nutrient cycling pathways, potentially causing damage to biological stream function and water quality degradation.

Excess nitrogen in the form of dissolved ammonia (ammonia ion; which is typically associated with human sources) can be toxic to aquatic life. Elevated nitrates in drinking water can inhibit normal hemoglobin function in infants. Besides the direct effects of excess nitrogen, elevated inputs of nitrogen and phosphorus from human sources can accelerate aquatic algal growth to nuisance levels. Respiration and decomposition of excessive algal biomass depletes dissolved oxygen, which can kill fish and other forms of aquatic life, and also decreases pH which can affect sensitive membranes on fish and other aquatic species. Nutrient concentrations in surface water can lead to blue-green algae blooms (Priscu, 1987), which can produce toxins lethal to aquatic life, wildlife, livestock, and humans.

Aside from toxicity, nuisance algae can shift the macroinvertebrate community structure, which also may affect fish that feed on macroinvertebrates (U.S. Environmental Protection Agency, 2010). Additionally, changes in water clarity, fish community structure, and aesthetics can harm recreational uses, such as fishing, swimming, and boating (Suplee et al., 2009). Nuisance algae can increase treatment costs of drinking water or pose health risks if ingested in drinking water (World Health Organization, 2003).

5.2 Stream Segments of Concern

In the 2014 Integrated Report, using data collected over the preceding decade, Department of Environmental Quality (DEQ) determined that four waterbody segments in the Ashley Creek watershed (one tributary and three Ashley Creek segments) currently do not meet the nutrient water quality standards (**Figure 5-1** and **Table 5-1**).

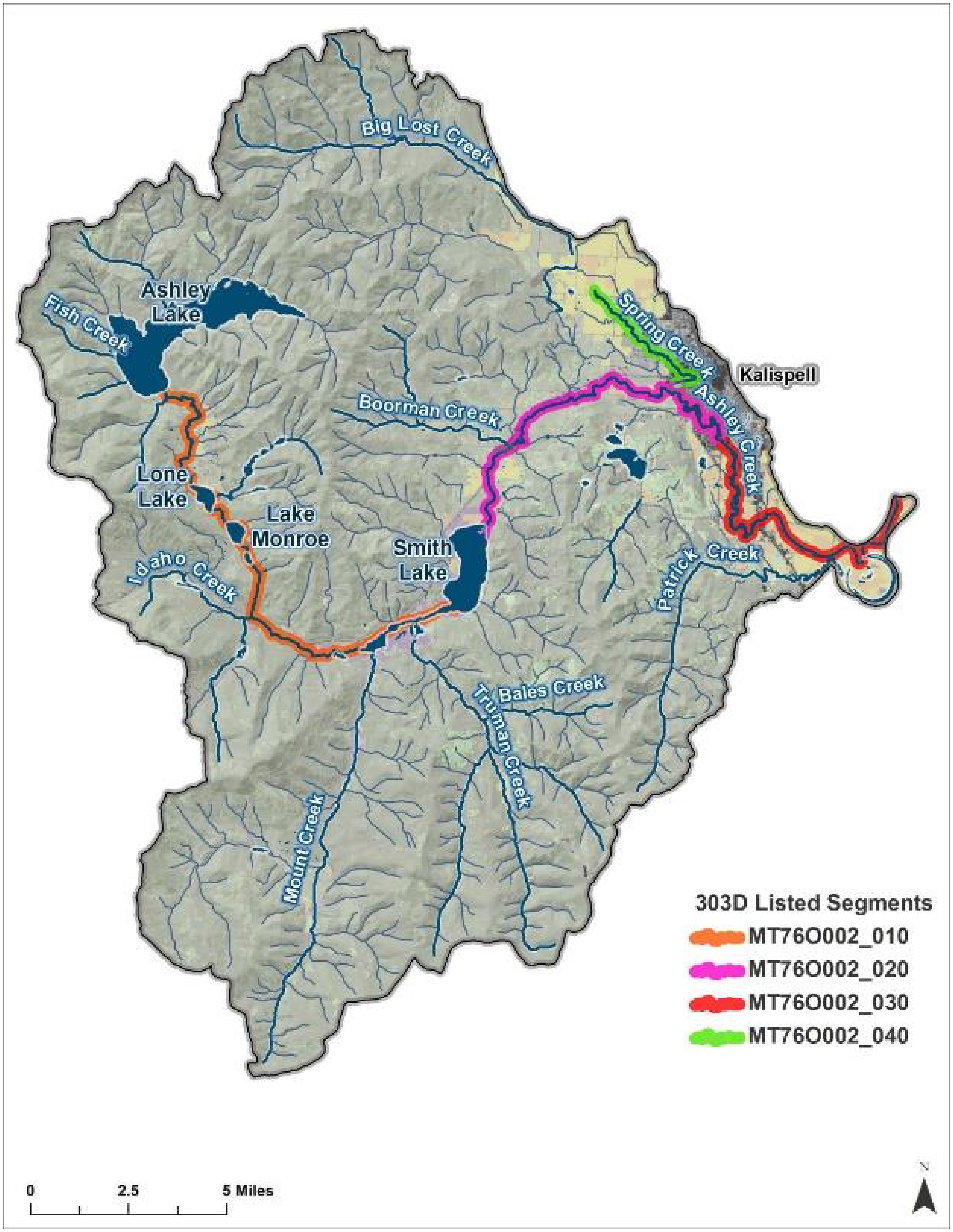


Figure 5-1. Nutrient Impairments in the Ashley Creek Watershed

Table 5-1. Waterbody Segments in the Ashley Creek Watershed with Nutrient Probable Causes on the 2014 303(d) List.

Stream Segment	Waterbody ID	Pollutant
(Upper) Ashley Creek, Ashley Lake to Smith Lake	MT76O002_010	Chlorophyll-*a* Dissolved Oxygen Total Nitrogen
(Middle) Ashley Creek, Smith Lake to bridge crossing on Kalispell Airport Rd	MT76O002_020	Total Phosphorus Total Nitrogen
(Lower) Ashley Creek, bridge crossing on Kalispell airport road to the Flathead River	MT76O002_030	Chlorophyll-*a* Dissolved Oxygen Nitrate/Nitrite Total Nitrogen Total Phosphorus
Spring Creek, headwaters to mouth (Ashley Creek)	MT76O002_040	Dissolved Oxygen Nitrate/Nitrite Total Nitrogen Total Phosphorus

5.3 Information Sources and Assessment Methods

To assess nutrient conditions for TMDL development, DEQ compiled nutrient data and undertook additional monitoring. The following data sources represent the primary information used to characterize water quality.

1) **DEQ TMDL Sampling:** DEQ conducted water quality sampling from 2003 through 2012 to update impairment determinations and assist with the development of nutrient TMDLs. Much of the data was collected during 2003, 2005, 2007-2008, and 2012. All waterbody segments were sampled over a minimum of three years.

Sample locations were generally such that they provided a comprehensive upstream to downstream view of nutrient levels. The location of sample collection also allowed for analysis of potential source impacts (e.g., changes in land use, septic influence). All data used in TMDL development was collected during the summer growing season for algae in the Northern Rockies Level III Ecoregion (July 1 – September 30).

Nutrient chemistry sampling included total nitrogen (TN), total phosphorus (TP), and nitrate/nitrite (NO_3 + NO_2). In some cases total Kjeldahl nitrogen (TKN) was sampled instead of TN. TN was then calculated as the sum of TKN and NO_3 + NO_2. Benthic algae samples were collected from Ashley Creek in 2005 and Spring Creek in 2012. These samples were analyzed for chlorophyll-*a* concentration. Macroinvertebrate samples were collected from Spring Creek in 2005. Ash free dry mass (AFDM) is a measurement that captures both living and dead algal biomass and is particularly helpful for streams where some or all of the algae are dead (because chlorophyll-*a* measures only living algae). AFDM was only measured for Spring Creek. Periphyton was measured in Ashley Creek (upper and lower segments) and Spring Creek.

2) **DEQ Assessment Files:** These files contain information used to make the existing nutrient impairment determinations.

Growing season nutrient data used for impairment assessment purposes and TMDL development are included in **Table B-1** of **Appendix B**. Other nutrient data from the watershed are publicly available through the Environmental Protection Agency's (EPA) STOrage and RETrieval database (STORET) and DEQ's EQuIS water quality databases. Data also is available from the U.S. Geological Survey through their National Water Information System (NWIS).

Additional sources of information used to develop TMDL components include the following:

- Streamflow data
- Geographic Information System (GIS) data layers
- Outside agency and university websites and documentation
- Land-use information

The above information and water quality data are used to compare existing conditions to waterbody restoration goals (targets), to assess nutrient pollutant sources, and to help determine TMDL allocations. Field data sheets were reviewed to rule out irregularities in collection methods or sample quality assurance/quality control (QA/QC). Laboratory methods and QA/QC criteria were also reviewed to ensure these values were accurate. No QA/QC problems were identified.

5.4 Water Quality Targets

TMDL water quality targets are numeric indicator values used to evaluate whether water quality standards have been met. These are discussed further in **Section 4.0**. This section presents nutrient water quality targets and compares them with recently collected nutrient data in the Ashley Creek watershed following DEQ's assessment methodology (Suplee and Sada de Suplee, 2011). To be consistent with DEQ's assessment methodology, and because of improvements in analytical methods, only data from the past 10 years are included in the review of existing data.

5.4.1 Nutrient Water Quality Standards

DEQ has developed numeric nutrient criteria for nitrogen and phosphorus to reflect the intent of the narrative standard requiring that state surface waters must be free from substances attributable to municipal, industrial, or agricultural practices or other discharges that produce nuisance conditions; create concentrations or combinations of material toxic or harmful to aquatic life; or create conditions that produce undesirable aquatic life [Administrative Rules of Montana (ARM) 17.30.637(1)]. The state-approved numeric criteria for TN and TP are in DEQ's Circular DEQ-12A, and are awaiting formal approval by EPA under the federal Clean Water Act. These numeric criteria are the basis for the nutrient TMDL targets consistent with EPA's TMDL development guidance (http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/ strategy/) and federal regulations (40 code of federal regulations (CFR) §131.11(a) & (b)).

5.4.2 Nutrient Target Values

Nutrient water quality targets include nutrient concentrations in surface waters and measures of benthic algae chlorophyll-*a* (a form of undesirable aquatic life at elevated concentrations). The target concentrations for nitrogen and phosphorus are established at levels believed to protect aquatic life and recreation. Since 2002, DEQ has conducted a number of studies in order to develop numeric criteria for nutrients (N and P forms). Nutrient criteria for TN and TP, and threshold concentrations for chlorophyll-*a*, are based on two factors: (1) the results of public perception surveys (Suplee et al., 2009) on what level of algae was perceived as undesirable and (2) the outcome of nutrient stressor-response studies that determine nutrient concentrations that will maintain algal growth below undesirable and harmful levels (Suplee and Watson, 2013; Suplee et al., 2008).

Nutrient targets for TN and TP, based on the numeric criteria in DEQ-12A, and chlorophyll-*a*, and ash-free dry mass (AFDM) target concentrations, based on Suplee and Watson (2013), are presented in **Table 5-2**. The NO_3+NO_2 target is based on research by DEQ Suplee et al. (2008) and Suplee (11/14/2013) and can also be found in **Table 5-2**. DEQ has determined that the values for NO_3+NO_2, TN, and TP provide an appropriate numeric translation of the applicable narrative nutrient water quality standards based on existing water quality data in the Flathead-Stillwater project area. The target values are based on the most sensitive uses; therefore, the nutrient TMDLs are protective of all designated uses.

Macroinvertebrates and periphyton were also included in the nutrient target suite for streams in the Northern Rockies ecoregion as a biometric indicator. For macroinvertebrates, the Hilsenhoff Biotic Index (HBI) score is used. The HBI value increases as the amount of pollution tolerant macroinvertebrates in a sample increases; the macroinvertebrate target is an HBI score equal to or less than 4.0 (Suplee and Sada de Suplee, 2011) (**Table 5-2**). Benthic diatoms, or periphyton, are a type of algae that grow on the stream bottom, and there are certain taxa that tend to increase as nutrient concentrations increase. The diatom target is a periphyton sample with a ≤51% probability of impairment by nutrients (Suplee and Sada de Suplee, 2011) (**Table 5-2**).

Because numeric nutrient chemistry is established to maintain algal levels below target chlorophyll-*a* concentrations and AFDM, target attainment applies and is evaluated during the summer growing season (July 1–September 30 for the Northern Rockies Ecoregion) when algal growth will most likely affect beneficial uses.

Table 5-2. Nutrient Targets for the Flathead-Stillwater TMDL Planning Area.

Parameter	Northern Rockies Level III Ecoregion Target Value
Nitrate[(1)]	≤ 0.100 mg/L
Total Nitrogen[(2)]	≤ 0.275 mg/L
Total Phosphorus[(2)]	≤ 0.025 mg/L
Chlorophyll-*a*[(2)]	≤ 120 mg/m²
Ash Free Dry Mass[(2)]	≤ 35 g /m²
Hilsenhoff's Biotic Index[(3)]	< 4.0
Periphyton[(3)]	≤ 51%

[1] Value is from Suplee (11/14/2013) and Suplee et al., (2008).
[2] Value is from Suplee and Watson (2013).
[3] Value is from Suplee and Sada de Suplee (2011).

5.4.3 Existing Conditions and Comparison to Targets

To evaluate whether attainment of nutrient targets has been met, the existing water quality conditions in each waterbody segment are compared to the water quality targets in **Table 5-2** using the methodology in DEQ guidance document "2011 Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels" (Suplee and Sada de Suplee, 2011). This approach provides DEQ with updated impairment determinations for TMDL development. Because the original impairment listings are based on old data or were listed before developing the numeric criteria, each stream segment will be evaluated for impairment based on nitrate, TN, and TP data collected within the past 10 years.

The assessment methodology uses two statistical tests (Exact Binomial Test and the One-Sample Student's T-test for the Mean) to evaluate water quality data for compliance with established target values. In general, compliance with water quality targets is not attained when nutrient chemistry data shows a target exceedance rate of >20% (Exact Binomial Test), when mean water quality nutrient chemistry exceeds target values (Student T-test), or when a single chlorophyll-*a* exceeds benthic algal target concentrations (125 mg/m^2 or 35 g Ash Free Dry Weight/m^2). Where water chemistry and algae data do not provide a clear determination of impairment, or where other limitations exist, macroinvertebrate and periphyton biometrics are considered in further evaluating compliance with nutrient targets. Lastly, inherent to any impairment determination, is the existence of human sources of pollutant loading. Human-caused sources of nutrients must be present for a stream to be considered impaired. Note: to ensure a higher degree of certainty for removing an impairment determination and making any new impairment determination, the statistical tests are configured differently for an unlisted nutrient than for a listed nutrient. This can result in a different number of allowable exceedances for nutrients within a single stream segment. Such tests help assure that assessment reaches do not vacillate between listed and delisted status by the change in results from a single additional sample. When applying the T-test for assessment and sample values that were below detection limits, one-half the detection limit was used.

Through a continuous improvement process, DEQ will routinely evaluate the above nutrient assessment method and may incorporate updates as more tools and information become available and as the science improves. Any future assessments would apply the updated or revised method.

5.4.3.1 Upper Ashley Creek (MT76O002_010)

Upper Ashley Creek is on the 2014 303(d) List as impaired for TN, chlorophyll-*a,* and dissolved oxygen. This impaired segment of Ashley Creek begins at the outlet of Ashley Lake and flows south and then east 15.64 miles until it discharges to Smith Lake.

Summary nutrient data statistics and assessment method evaluation results for upper Ashley Creek are provided in **Table 5-3** and **Table 5-4**, respectively. Forty nitrate samples were collected from 2003-2005; values ranged from <0.01 to 0.03 mg/L with no samples exceeding the nitrate target of 0.100 mg/L. Forty TKN samples were collected between 2003 and 2005; values ranged from <0.1 to 1.5 mg/L. Thirty-nine TN concentrations were calculated from the nitrate and TKN samples; values ranged from 0.049 to 1.5mg/L with 22 samples exceeding the TN target of 0.275 mg/L. Forty TP samples were collected between 2003 and 2005; values ranged from 0.008 to 0.48 mg/L with five samples exceeding the TP target of 0.025 mg/L.

Three chlorophyll-*a* samples were collected from upper Ashley Creek in 2005. Chlorophyll-*a* values ranged from 34 to 74 mg/m^2 with none exceeding the target of 120 mg/m^2. One periphyton sample was collected in 2008. No macroinvertebrate or AFDM samples were collected in upper Ashley Creek.

Dissolved oxygen (DO) was monitored once at each of four sites along upper Ashley Creek in September 2005. The concentrations ranged from 4.5 to 5.7 mg/L. All four results were below the DO *1-Day Minimum* (i.e., instantaneous according to DEQ (2012a) standard for *Early Life Stages* of fish and other aquatic life, which is 8.0 mg/L for B-1 classified streams (Montana Department of Environmental Quality, 2012a).

Assessment results shown in **Table 5-4** indicate that upper Ashley Creek is impaired for TN based on proposed criteria for the Northern Rockies Level III Ecoregion. As a result, a TMDL will be written for the nutrient probable causes of TN. Per DEQ's assessment methodology for nutrients, if TN and/or TP exceed the targets and the exceedance rate, and chlorophyll-*a* (or periphyton) measurements are less than the targets, then results suggest that algal sampling may have missed peaks of benthic algal biomass. In the case of upper Ashley Creek, the stream will remain listed as impaired for chlorophyll-*a*, and the TN TMDL will address the impairment. The DO impairment is further discussed in **Section 5.4.4**.

Table 5-3. Nutrient Data Summary for Upper Ashley Creek.

Nutrient Parameter	Sample Timeframe	Sample Size	Min[1] (mg/L)	Max (mg/L)	Mean (mg/L)
Nitrate, mg/L	2003-2005	40	< 0.01	0.03	0.006[2]
TN, mg/L	2003-2005	39	0.049	1.5	0.38
TP, mg/L	2003-2005	40	0.008	0.48	0.0165
Chlorophyll-*a*, mg/m^2	2005	3	34	74	50
AFDM, g/m^2	NA	0	NA	NA	NA
Macroinvertebrate HBI	NA	0	NA	NA	NA
Periphyton	2008	1	NA	NA	NA

[1] Values preceded by a less than ("<") symbol are detection limits for that parameter. The actual sample value was below the detection limit.
[2] The value of 0.005 mg/L, which is one-half of the detection limit of 0.01 mg/L, was used to calculate the mean for all samples reported as less than the detection limit.

Table 5-4.Nutrient Assessment Method Evaluation Results for Upper Ashley Creek.

Nutrient Parameter	Sample Size	Target Value (mg/l)	Target Exceed	Binomial Test Result	T-test Result	Chlorophyll-*a* Test Result	AFDM Test Result	Macroinvertebrate Test Result	Periphyton Test Result	TMDL Required?
Nitrate	40	0.100	0	PASS	PASS	PASS	NA	NA	FAIL	NO
TN	39	0.275	22	FAIL	FAIL					YES
TP	40	0.025	5	PASS	PASS					NO

5.4.3.2 Middle Ashley Creek (MT76O002_020)

Middle Ashley Creek is listed for TN and TP on the 2014 303(d) List; the segment was not on the 2012 303(d) List. DEQ's Monitoring and Assessment section recently performed an assessment of this waterbody segment and determined that it is impaired for TN and TP. Middle Ashley Creek begins at the outlet of Smith Lake and flows northeast, east, then southeast for 14.17 miles to Kalispell Airport Road.

Summary nutrient data statistics and assessment method evaluation results for middle Ashley Creek are provided in **Table 5-5** and **Table 5-6**, respectively. Thirty-eight nitrate samples were collected between 2003 and 2005; values ranged from <0.01 to 0.07 mg/L with no samples exceeding the nitrate target of 0.100 mg/L. Thirty-eight TKN samples were collected between 2003 and 2005; values ranged from 0.56 to 1.7 mg/L. Thirty-eight TN concentrations were calculated from the nitrate and TKN samples; values ranged from 0.565 to 1.7 mg/L with all 38 samples exceeding the TN target of 0.275 mg/L. Forty-eight TP samples were collected between 2003 and 2008; values ranged from <0.001 to 0.059 mg/L with 27 samples exceeding the TP target of 0.025 mg/L.

Four chlorophyll-*a* samples were collected from middle Ashley Creek in 2005. Chlorophyll-*a* values ranged from 11 to 57 mg/m² with none exceeding the target of 120 mg/m². There were no macroinvertebrate, AFDM, or periphyton samples collected from middle Ashley Creek.

Assessment results shown in **Table 5-6** indicate that middle Ashley Creek is impaired for TN and TP. As a result TMDLs will be written for these nutrient probable causes.

Table 5-5. Nutrient Data Summary for Middle Ashley Creek.

Nutrient Parameter	Sample Timeframe	Sample Size	Min(1) (mg/L)	Max (mg/L)	Mean (mg/L)
Nitrate, mg/L	2003-2005	38	<0.01	0.07	0.007(2)
TN, mg/L	2003-2005	38	0.565	1.7	0.868
TP, mg/L	2003-2005, 2007, 2008	48	<0.001	0.059	0.029
Chlorophyll-*a*, mg/m²	2005	4	11	57	50
AFDM, g/m²	NA	0	NA	NA	NA
Macroinvertebrate HBI	NA	0	NA	NA	NA
Periphyton	NA	0	NA	NA	NA

[1] Values preceded by a less than ("<") symbol are detection limits for that parameter. The actual sample value was below the detection limit.
[2] The value of 0.005 mg/L, which is one-half of the detection limit of 0.01 mg/L, was used to calculate the mean for all samples reported as less than the detection limit.

Table 5-6. Nutrient Assessment Method Evaluation Results for Middle Ashley Creek.

Nutrient Parameter	Sample Size	Target Value (mg/l)	Target Exceed	Binomial Test Result	T-test Result	Chlorophyll-*a* Test Result	AFDM Test Result	Macroinvertebrate Test Result	Periphyton Test Result	TMDL Required?
Nitrate	38	0.100	0	PASS	PASS	PASS	NA	NA	NA	NO
TN	38	0.275	38	FAIL	FAIL					YES
TP	48	0.025	27	FAIL	FAIL					YES

5.4.3.2 Lower Ashley Creek (MT76O002_030)

Lower Ashley Creek is on the 2014 303(d) List as impaired for nitrate/nitrite, TN, TP, chlorophyll-*a*, and dissolved oxygen. This impaired segment of Ashley Creek begins at the Kalispell Airport Road and generally flows southeast and east 13.17 miles until it discharges to the Flathead River.

Summary nutrient data statistics and assessment method evaluation results for lower Ashley Creek are provided in **Table 5-7** and **Table 5-8**, respectively. Twelve nitrate samples were collected between 2003 and 2005; values ranged from 0.03 to 3.93 mg/L with eleven samples exceeding the target of 0.100 mg/L. Twelve TKN samples were collected between 2003 and 2005; values ranged from 0.78 to 1.8 mg/L. Twelve TN concentrations were calculated from TKN and nitrate plus nitrite samples; values ranged from 0.83 to 5.11 mg/L with all twelve samples exceeding the TN target of 0.275 mg/L. Twenty

TP samples were collected between 2003 and 2008; values ranged from 0.019 to 0.089 mg/L with 18 samples exceeding the TP target of 0.025 mg/L.

One chlorophyll-*a* sample was collected from this segment of Ashley Creek in 2005. Chlorophyll-*a* was 69 mg/m² and did not exceed the target of 120 g/m². One periphyton sample was collected in 2008. No macroinvertebrate or AFDM samples were collected.

DO was monitored four sites along lower Ashley Creek from 2004-2008; the concentrations ranged from 2.64 to 14.7 mg/L. Eight concentrations were below the DO *1-Day Minimum* (i.e., instantaneous according to DEQ (2012a) standard for *Early Life Stages* of fish and other aquatic life, which is 8.0 mg/L for C-2 classified streams (Montana Department of Environmental Quality, 2012a).

Assessment results shown in **Table 5-8** indicate that lower Ashley Creek is impaired for nitrate, TN, and TP. TMDLs will be written for TN and TP. It is assumed that nitrate will be addressed by the TN TMDL. Per DEQ's assessment methodology for nutrients, if TN and/or TP exceed the targets and the exceedance rate, and chlorophyll-*a* (or periphyton) measurements are less than the targets, then results suggest that algal sampling may have missed peaks of benthic algal biomass. In the case of lower Ashley Creek, the stream will remain listed as impaired for chlorophyll-*a*, and both the TN and TP TMDLs will address the impairment. The DO impairment is further discussed in **Section 5.4.4**.

Table 5-7. Nutrient Data Summary for Lower Ashley Creek.

Nutrient Parameter	Sample Timeframe	Sample Size	Min (mg/L)	Max (mg/L)	Mean (mg/L)
Nitrate, mg/L	2003-2005,	12	0.03	3.93	2.06
TN, mg/L	2003-2005, 2008	12	0.83	5.11	3.14
TP, mg/L	2003-2005, 2007, 2008	20	0.019	0.089	0.059
Chlorophyll-*a*, mg/m^2	2005	1	69	69	69
AFDM, g/m^2	NA	0	NA	NA	NA
Macroinvertebrate HBI	NA	0	NA	NA	NA
Periphyton	2008	1	NA	NA	NA

Table 5-8. Nutrient Assessment Method Evaluation Results for Lower Ashley Creek.

Nutrient Parameter	Sample Size	Target Value (mg/l)	Target Exceed	Binomial Test Result	T-test Result	Chlorophyll-*a* Test Result	AFDM Test Result	Macroinvertebrate Test Result	Periphyton Test Result	TMDL Required?
Nitrate	12	0.100	11	FAIL	FAIL					YES
TN	12	0.275	12	FAIL	FAIL	PASS	NA	NA	PASS	YES
TP	20	0.025	18	FAIL	FAIL					YES

5.4.3.3 Spring Creek (MT76O002_040)

Spring Creek is on the 2014 303(d) List as impaired for nitrate/nitrite, TN, TP, and dissolved oxygen. The impaired segment of Spring Creek begins at the headwaters and flows southeast 4.8 miles until it discharges to middle Ashley Creek (the segment from Smith Lake to Kalispell Airport Road).

Summary nutrient data statistics and assessment method evaluation results for Spring Creek are provided in **Table 5-9** and **Table 5-10**, respectively. Fourteen nitrate samples were collected in 2005, 2007, and 2012 (one 2012 sample was excluded from analyses); values ranged from < 0.01 to 0.81 mg/L with nine samples exceeding the nitrate target of 0.100 mg/L. Nine TN samples were collected and evaluated using persulfate digestion in 2007 and 2012 (one 2012 sample was excluded from analyses). Five additional TN concentrations were calculated from TKN and nitrate plus nitrite data from 2005. The combined dataset of TN values ranged from 0.25 to 1.3 mg/L with 12 samples exceeding the TN target of 0.275 mg/L. Fourteen TP samples were collected in 2005, 2007, and 2012; values ranged from <0.003 to 0.079 mg/L with two samples exceeding the TP target of 0.025 mg/L.

Three chlorophyll-*a* and one AFDM samples were collected from Spring Creek in 2005 and 2012. Chlorophyll-*a* values ranged from 10 to 20 mg/m² with none exceeding the target of 125 mg/m². The single AFDM sample did not exceed the target of 35 g/m². There were two macroinvertebrate samples collected from Spring Creek in 2005 and 10 periphyton samples collected between 2003 and 2008.

According to DEQ's assessment record (Montana Department of Environmental Quality, 2014d), nine instantaneous DO results from four sampling sites ranged from 6.2 to 9.18 mg/L. Five of these DO values were lower than the *1-Day Minimum* standard for B-1 classified streams, which is 8.0 mg/L for *Early Life Stages* of fish and other aquatic life. The *1-Day Minimum* DO standards are considered to be instantaneous concentrations that must be achieved at all times (Montana Department of Environmental Quality, 2012a).

Assessment results shown in **Table 5-10** indicate that Spring Creek is impaired for nitrate, TN, and TP. As a result a TMDL will be written for TN and TP to address these nutrient probable causes. The nitrate impairment will be addressed by the TN TMDL. The dissolved oxygen impairment is further discussed in **Section5.4.4**.

Table 5-9. Nutrient Data Summary for Spring Creek.

Nutrient Parameter	Sample Timeframe	Sample Size	Min[1] (mg/L)	Max (mg/L)	Mean (mg/L)
Nitrate, mg/L	2005, 2007, 2012	13[2]	< 0.01	0.81	0.315[3]
TN, mg/L	2005, 2007, 2012	13[2]	0.25	1.3	0.576
TP, mg/L	2005, 2007, 2012	14	< 0.003	0.079	0.015[3]
Chlorophyll-*a*, mg/m2	2012	3	10	20	18
AFDM, g/m2	2012	1	NA	NA	NA
Macroinvertebrate HBI	2005	2	7.49	7.56	--
Periphyton	2003, 2005, 2007, 2008	10	NA	NA	NA

TN = total nitrogen, TP = total phosphorus, NN = nitrate + nitrite

¹ Values preceded by a less than ("<") symbol are detection limits for that parameter. The actual sample value was below the detection limit.

² One sample was excluded from assessment analysis due to lack of spatial independence.

³ The values of 0.005 mg/L for NN and 0.0015 mg/L for Total Phosphorus , which are one-half of the detection limits, were used to calculate the mean for all samples reported as less than the detection limit.

Table 5-10. Nutrient Assessment Method Evaluation Results for Spring Creek.

Nutrient Parameter	Sample Size	Target Value (mg/l)	Target Exceed	Binomial Test Result	T-test Result	Chlorophyll-*a* Test Result	AFDM Test Result	Macroinvertebrate Test Result	Periphyton Test Result	TMDL Required?
Nitrate	13	0.100	9	FAIL	FAIL	PASS	PASS	FAIL	PASS	YES
TN	14	0.275	12	FAIL	FAIL					YES
TP	14	0.025	2	FAIL	PASS					YES

5.4.4 Dissolved Oxygen (DO) Impairments

Most aquatic life requires oxygen for survival, and most are dependent upon DO in the water column. Free-flowing and unpolluted streams typically have dissolved oxygen (DO) concentrations that support fish and other aquatic life. However, when too much or too little DO is present it can be harmful. In addition, large fluctuations in DO levels over relatively short periods of time (e.g., daily) can stress aquatic organisms.

DO is generally considered a response variable in streams and lakes. In other words, there are usually no anthropogenic sources that directly add or remove DO from a stream. Instead, DO usually responds to other anthropogenic and natural variables such as nutrients, algae, macrophytes, stream temperature, habitat alteration, excess sediment, stream dynamics, lake and wetland dynamics, elevation, reaeration rate, and sediment oxygen demand. The DO concentration in any waterbody at any given time is a function of a combination of all of those variables.

In upper Ashley Creek, lower Ashley Creek, and Spring Creek, DO concentrations have been measured that are lower than the Montana DEQ criteria, and the segments are listed as impaired because of “low dissolved oxygen.” However, there are currently limited data for each segment, and the assessment records do not identify the cause of the low DO concentrations. Based on the existing sources in the watershed, DEQ believes that the cause of low DO is potentially related to excess nutrients, algae/macrophyte growth and decomposition, and stream/lake/wetland dynamics. Elevated stream temperatures (discussed in **Section 7)** may also be contributing to the low DO concentrations.

It is difficult to estimate a load of DO to a stream and allocate to the various sources. Rather, DO impairments are usually addressed through the primary causal variables such as nutrients, temperature, or sediment. In the case of upper and lower Ashley Creek, DEQ is addressing the DO impairment through the implementation of nutrient, temperature, and sediment TMDLs. In Spring Creek, DEQ is addressing the DO impairment with the nutrient TMDLs. Additional monitoring and an adaptive management strategy for dissolved oxygen are described in **Sections 9 and 10**.

5.4.5 Nutrient TMDL Development Summary

Table 5-11 summarizes the nutrient impairment determinations for the Ashley Creek watershed described previously, along with the summary of the nutrient pollutants for which TMDLs will be prepared based on DEQ’s updated assessments for these streams. Changes from the 2012 303(d) List are due to a number of reasons. The original listings were based on limited data collection and do not represent the best available information. Significant data collection has taken place since original impairment determinations, and the improved assessment method was used to evaluate available data. The updated impairment determinations are reflected in the 2014 Water Quality Integrated Report (IR). As shown in **Table 5-11,** a total of seven separate nutrient TMDLs will be developed for four stream segments. These seven TMDLs address nine nutrient impairment causes, three dissolved oxygen, and two chlorophyll-*a* (non-pollutant) impairment causes.

Table 5-11. Summary of Nutrient TMDL Development Determinations.

Stream Segment	Waterbody ID	2014 303 (d) Nutrient Impairment(s)	TMDLs Prepared
(Upper) Ashley Creek, Ashley Lake to Smith Lake	MT76O002_010	Chlorophyll-*a*(1), Dissolved Oxygen(2), Total Nitrogen	Total Nitrogen
(Middle) Ashley Creek, Smith Lake to Kalispell Airport Road	MT76O002_020	Total Nitrogen Total Phosphorus	Total Nitrogen, Total Phosphorus
(Lower) Ashley Creek, Kalispell Airport Road to mouth (Flathead River)	MT76O002_030	Dissolved Oxygen(2), Chlorophyll-*a*(1), Nitrate/nitrite(3), Total Nitrogen, Total Phosphorus	Total Nitrogen, Total Phosphorus
Spring Creek, headwaters to mouth (Ashley Creek)	MT76O002_040	Dissolved oxygen(2), Nitrate/nitrite(3), Total Nitrogen, Total Phosphorus	Total Nitrogen, Total Phosphorus

1 Non-pollutant; this impairment cause is addressed via nutrient TMDLs.
2 The upper and lower Ashley Creek and Spring Creek dissolved oxygen impairment causes are addressed via the nutrient TMDLs within this section.
3 The nitrate/nitrite impairment cause is addressed via TN TMDLs.

5.5 Source Assessment and Quantification

This section provides the overall approach used for source assessment, TMDL development, allocations, and reductions. This approach was applied to each of the four stream segments and is discussed further in **Section 5.6**.

5.5.1 Source Assessment Approach

Source characterization links nutrient sources and nutrient loading to streams and their associated water quality response, and supports the formulation of the load allocation portion of the TMDL. As described in **Section 5.4.2**, nitrate, TN, and TP water quality targets are applicable during the summer growing season (i.e., July 1 – September 30). Consequently, source characterizations are focused mainly on sources and mechanisms that influence nutrient contributions during this period. Source characterization and assessment was conducted using a computer watershed model, the Loading Simulation Program C++ (LSPC) described in the Model Report (Tetra Tech, Inc., 2014b). Simulated loading estimates and load allocations are established for the summer growing season time period and are based on the calibrated LSPC model results.

5.5.2 LSPC

The EPA-approved LSPC model (http://www.epa.gov/athens/wwqtsc/html/lspc.html) was selected for the Flathead-Stillwater TMDL Planning Area (TPA) and the Ashley Creek watershed. LSPC is a watershed modeling system that includes streamlined Hydrologic Simulation Program FORTRAN (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land as well as a stream fate and transport model (Tetra Tech, 2012).

5.5.2.1 Model Description

The LSPC modeling system links upstream contributions to downstream segments, allowing users to freely model subareas while maintaining a top-down approach (i.e., from upstream reaches to downstream segments). The model simulates watershed hydrology and pollutant transport, as well as stream hydraulics and in-stream water quality. It is capable of dynamically simulating flow, nutrients, sediments, as well as other conventional pollutants for pervious and impervious lands and waterbodies of varying order on a sub-daily time step.

LSPC's algorithms are identical to a subset of those in the EPA-supported HSPF watershed model. LSPC is distributed by EPA's Office of Research and Development in Athens, Georgia, and is a component of EPA's National Total Maximum Daily Load (TMDL) Toolbox (http://www.epa.gov/athens/wwqtsc/index.html). A brief overview of the underlying HSPF model is provided below; additional detailed discussions of HSPF-simulated processes and model parameters is available in the HSPF User's Manual (Bicknell et al., 2004) and in the Model Report (Tetra Tech, Inc., 2014b)

HSPF is a comprehensive watershed and receiving water quality modeling framework that was originally developed in the mid-1970s. Over the past decade it has been used to develop hundreds of EPA-approved TMDLs, and it is generally considered one of the most advanced hydrologic and watershed loading models available. The hydrologic portion of the model is based on the Stanford Watershed Model (Crawford and Linsley, 1966), which was one of the pioneering watershed models. The HSPF framework is developed modularly, with different components that can be assembled in different ways, depending on the objectives of the individual project. Major modules relevant to the Flathead-Stillwater TPA and the Ashley Creek watershed include the following:

- PERLND/IMPLND for simulating watershed processes on pervious/impervious land areas
- SEDMNT/SOLIDS for simulating production and removal of sediment/solids from pervious/impervious land
- PQUAL/IQUAL for simulating production and removal of pollutants from pervious/impervious land
- RCHRES for simulating flow and hydraulic processes in streams and vertically mixed lakes
- SEDTRN for simulating transport, deposition, and scour of sediment in modeled waterbodies
- RQUAL for simulating transport, transformations, and loss of pollutants in modeled waterbodies

All of these modules include many sub-modules that calculate hydrologic, sediment, and water quality processes in the watershed. Many options are available for both simplified and complex process formulations.

Spatially, the Flathead-Stillwater TPA and Ashley Creek specifically are divided into a series of subbasins representing the drainage areas that contribute to each of the stream reaches, as described subsequently in the model setup (**Section 5.5.2.2**). The subbasins are then further subdivided into segments representing different land uses and then these land use segments are divided into pervious and impervious fractions. Meteorological forcing data are used to simulate impacts of precipitation, air temperature, and evapotranspiration on runoff and groundwater flow from the land use segments. The stream network links the surface runoff and groundwater flow contributions from each of the land segments in the subbasins, and routes them through the waterbodies using storage routing techniques. The stream model includes precipitation and evaporation from the water surfaces, as well as flow contributions from the watershed, tributaries, and upstream stream reaches. Flow withdrawals can also be accommodated. The stream network is constructed to represent all the major tributary streams and different portions of stream reaches where significant changes in water quality occur. For full details, see the Model Report (Tetra Tech, Inc., 2014b).

LSPC was used to estimate nutrient loading from various sources within the watershed. Specific information regarding LSPC and how it was used for the Ashley Creek watershed can be found in the Model Report (Tetra Tech, Inc., 2014b).

5.5.2.2 Model Setup Overview

The Ashley Creek watershed was divided into 33 subbasins within the model, including subbasins for each stream segment requiring a TMDL (**Figure 5-2**). Each subbasin was further divided into areas with unique land use, soil attributes, and land management practices (e.g., timber harvest on forest lands, fertilization on crop lands) called hydrologic response units (HRUs). HRUs are not spatially connected within each subbasin, and all HRUs route directly into the stream reach. The model hydrology was calibrated as part of the larger Flathead Lake watershed LSPC model, which was developed to support other TMDLs in the region. The Flathead LSPC model was calibrated to continuous flow monitoring at eight United States Geological Survey (USGS) gages, which allowed for the specification of hydrology response from each of the land uses in the model. As a result, upland land use hydrology was considered to be well represented in Ashley Creek by virtue of the calibration to other locations in the same region.

Refinements to the hydrology calibration in the Ashley Creek watershed were made based on long-term estimated outflows at Ashley Lake, and short-term flow monitoring data below Smith Lake and within Kalispell. As a result, the model includes some loss to groundwater in areas where Ashley Creek is likely connected to the gravel aquifer and flow is lost from the creek channel. Water quality calibration used observed data from multiple monitoring stations along the length of Ashley Creek using data collected by several different agencies. The model uses hourly inputs and can generate outputs on timescales ranging from hourly to annual. Because the nutrient targets apply from July 1 through September 30, model outputs summarized in source assessments are for that time frame only. Model output spanning October 2002 through September 2012 was used in preparation of the source assessment.

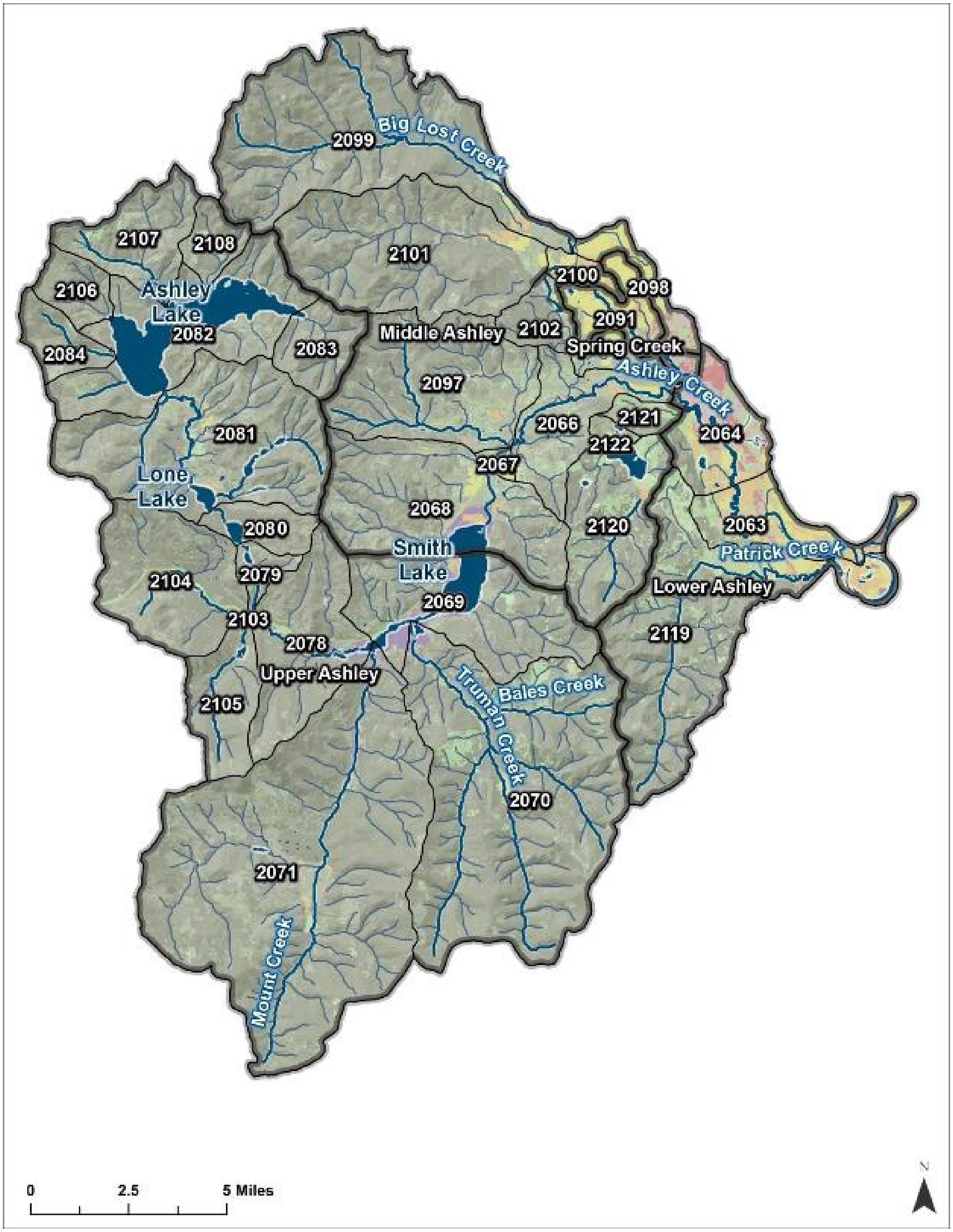


Figure 5-2. LSPC Model Subbasins in the Ashley Creek Watershed.

During model development, the Technical Advisory Group identified an area in the northern part of the Ashley Creek watershed where streams are not connected to Ashley Creek. In other words, the surface streams drain back into the stream beds and dry up without discharging to a downstream location.

Identified creeks include Big Lost Creek and McMannamy Draw, among others. These subbasins are identified in **Figure 5-2** as 2098, 2099, 2100, and 2101. Because these subbasins drain to groundwater and do not provide any surface water to Ashley Creek, they do not deliver any pollutant loads within the model or within the TMDL framework. When land area totals for middle Ashley Creek are presented in this document, these subbasins are included since they are technically part of the watershed. However, any source loading from these subbasins is excluded from the modeling analysis.

During water quality calibration it became clear there was a source of nutrient loading between Ashley Lake and Smith Lake that was not accounted for the in model. The source was identified as being a large wetland complex between the lakes and surrounding Smith Lake. As a result, the model was configured to release a constant load of nutrients from Smith Lake into Ashley Creek. See **Section 5.5.3.8** for more details regarding the wetlands and the addition of nutrient loads to the model.

5.5.3 Source Categories

The following source categories were considered in the LSPC model:

- Agriculture
- Atmospheric Deposition
- Bank Erosion
- Forest Fire
- Golf Courses
- Natural Background
- Point Sources
- Septic Systems
- Timber Harvest
- Unpaved Roads
- Urban Areas

Assessments of loading by source category for each of the impaired reaches are provided in **Section 5.6**. A summary of each of the source categories is provided in the following subsections. Details regarding how these are simulated with the LSPC model are provided in a separate Model Report (Tetra Tech, Inc., 2014b).

5.5.3.1 Agriculture

A detailed analysis of agriculture was completed in the Flathead Valley and is summarized in *The Flathead Valley Agricultural Impacts Report* (Wendt, 2011). The Wendt report provides details regarding:

- Types of crops (e.g., hay, cereal grains, oilseeds, pulse crops, seed potatoes, and summer fallow or other agricultural practices) and where they are located
- Types and numbers of livestock and locations of concentrated animal feeding operations (CAFOs)
- Locations of irrigated lands and types of irrigation
- Types and magnitudes of fertilizers applied to agricultural lands
- Assessment of trends in agriculture in the Flathead Valley

As shown in **Figure 5-3**, the Wendt study area covered most of the agricultural areas in the Ashley Creek watershed, but only approximately 14 percent of the total watershed area. The 2006 National Land Cover Dataset (NLCD; (Multi-Resolution Land Characteristics Consortium, 2006)) was used to characterize agricultural areas outside the Wendt study area. A summary of the agricultural lands is provided in **Table 5-12**.

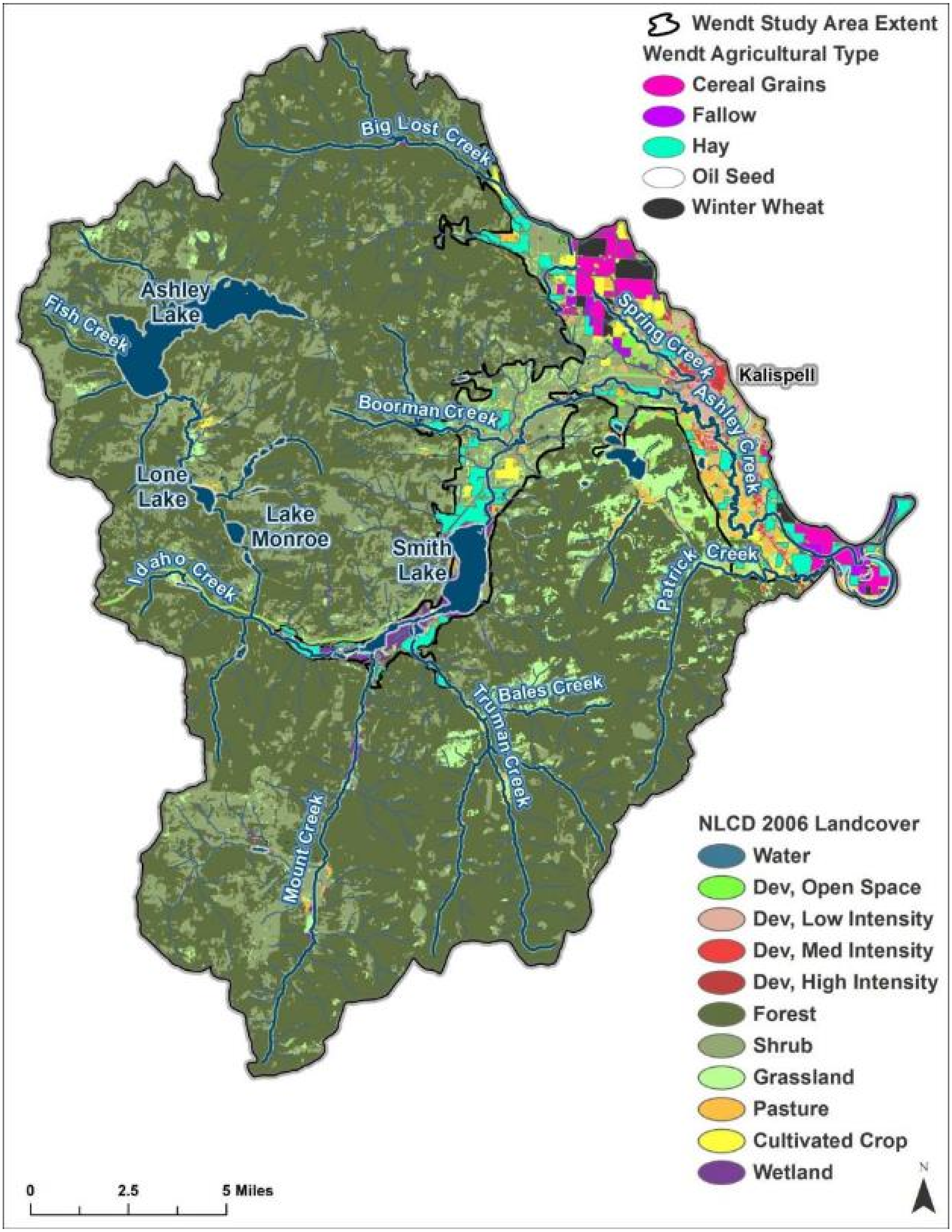


Figure 5-3. Agriculture and Land Cover in the Ashley Creek Watershed

Table 5-12. Agricultural Land Use Summary.

Land use	Upper Ashley Creek	Middle Ashley Creek	Spring Creek	Lower Ashley Creek	Ashley Creek Watershed
Cereal Grains (1)	0	784	606	670	2,060
Cultivated Crops (1),(2),(3)	38	794	389	414	1,635
Fallow (1)	26	109	109	344	588
Hay (1)	519	1,731	116	1,225	3,591
Oil Seed (1)	0	0	0	17	17
Pasture/Hay (2)	464	888	154	1,915	3,421
Winter Wheat (1)	0	386	291	121	798
Total	**1,047**	**4,693**	**1,665**	**4,706**	**12,111**
% of Watershed	1%	7%	61%	22%	6%

Units are acres.
[1] Agricultural land uses are from Wendt (2011).
[2] Agricultural land uses are from Multi-Resolution Land Characteristics Consortium (2006).
[3] Cultivated crops include such crops as peas & lentils, and seed potatoes.

As shown in **Table 5-13**, agricultural lands were placed into three categories (low, medium, and high) in the LSPC model based on fertilizer application rates presented by Wendt (2011). Areas outside the Wendt study area were assigned to the medium category in the absence of site specific data on fertilizer application rates. It was assumed that livestock grazing occurred primarily on lands classified as pasture by Wendt or NLCD (Multi-Resolution Land Characteristics Consortium, 2006). The number of cattle, sheep, and pigs in the Ashley Creek watershed was estimated using the *Montana 2012 Agricultural Statistics* (Montana Department of Agriculture and U.S. Department of Agriculture, National Agricultural Statistics Service, 2012). Nutrient loading rates from livestock manure were obtained online from Natural Resources Conservation Service (NRCS) (1995).

Table 5-13. LSPC Agricultural Fertilizer Categories.

Crop Type	Fertilization Category
Pasture/Hay	Pasture
Fallow	Cropland Low
Hay	
Annual Cropland	Cropland Medium
Oil Seed	
Other	
Cereal Grain	Cropland High
Peas & Lentils	
Seed Potatoes	
Winter Wheat	

5.5.3.2 Atmospheric Deposition

Dry deposition occurs when pollutants are transported via wind and are deposited due to gravitational force. Dry deposition typically occurs in a more constant pattern than wet deposition, where pollutants collide with water in the atmosphere and are transported to the watershed surface during precipitation events. Both dry and wet nitrogen deposition was simulated with the LSPC model using data obtained from the EPA's Clean Air Status and Trends Network (CASTNET) station in Glacier National Park (within the Flathead Lake watershed).

5.5.3.3 Bank Erosion

While the LSPC model does not directly simulate bank erosion, land surface scour (representing erosion in the headwater tributaries) and bed degradation in the modeled stream reaches are two processes in the model that together serve as a proxy for representing bank erosion. Bed degradation in a one-dimensional reach model, such as LSPC, serves as a proxy for generalized stream channel erosion, which includes both the bank and the bed as sediment sources. Careful calibration was performed to compare model response to Total Suspended Solids (TSS) monitoring data throughout the watershed. Parameters related to both settling and scour were adjusted to obtain a good overall fit to monitoring data at low and high flows.

5.5.3.4 Fire

Fire is a natural part of the Ashley Creek ecosystem and many species have evolved to exist with the disturbance. Fire perimeters in the project area from 1919-2008 were obtained from the U.S. Forest Service (Flathead National Forest) and Department of Natural Resources & Conservation (DNRC). In the Ashley Creek watershed, only one fire occurred during the period of record. The burn occurred in the Truman Creek subwatershed in 1990 and covered 160.7 acres (**Figure 5-4**). Burned lands, resulting from forest fires, were modeled dynamically to simulate the changes in water and pollutant yield that occur over time as a result of re-growth of the forest, post-fire. However, the fire in the Truman Creek subwatershed occurred prior to the beginning of the model simulation used to develop the source assessment (October 2002), so forest fire was not considered further.

5.5.3.5 Golf Courses

Of the land uses in the urban landscape, turf is the most intensively managed (King et al., 2007). In many cases, chemical additions on golf courses are similar to, and often greater than, those used in intensive agriculture (Winter and Dillon, 2006). There is only a portion of one golf course in the Ashley Creek watershed (i.e., approximately 16 acres in the lower Ashley Creek subwatershed). The golf course was simulated as a separate land use category using nutrient concentrations based on fertilizer application rates on the Buffalo Hills Golf Course.

5.5.3.6 Natural Background

For purposes of this analysis, loading of nutrients from the following land types was considered to be, and is reported as, natural background: barren, forest, herbaceous, snow/ice, water, and wetland. Additionally, a considerable portion of the contributions reported in **Section 5.6** from bank erosion, atmospheric deposition, and forest fire are also likely natural in origin. The fractions attributable to natural and anthropogenic sources have not been defined at this time, but may be estimated at a later date to support TMDL implementation, or other assessments.

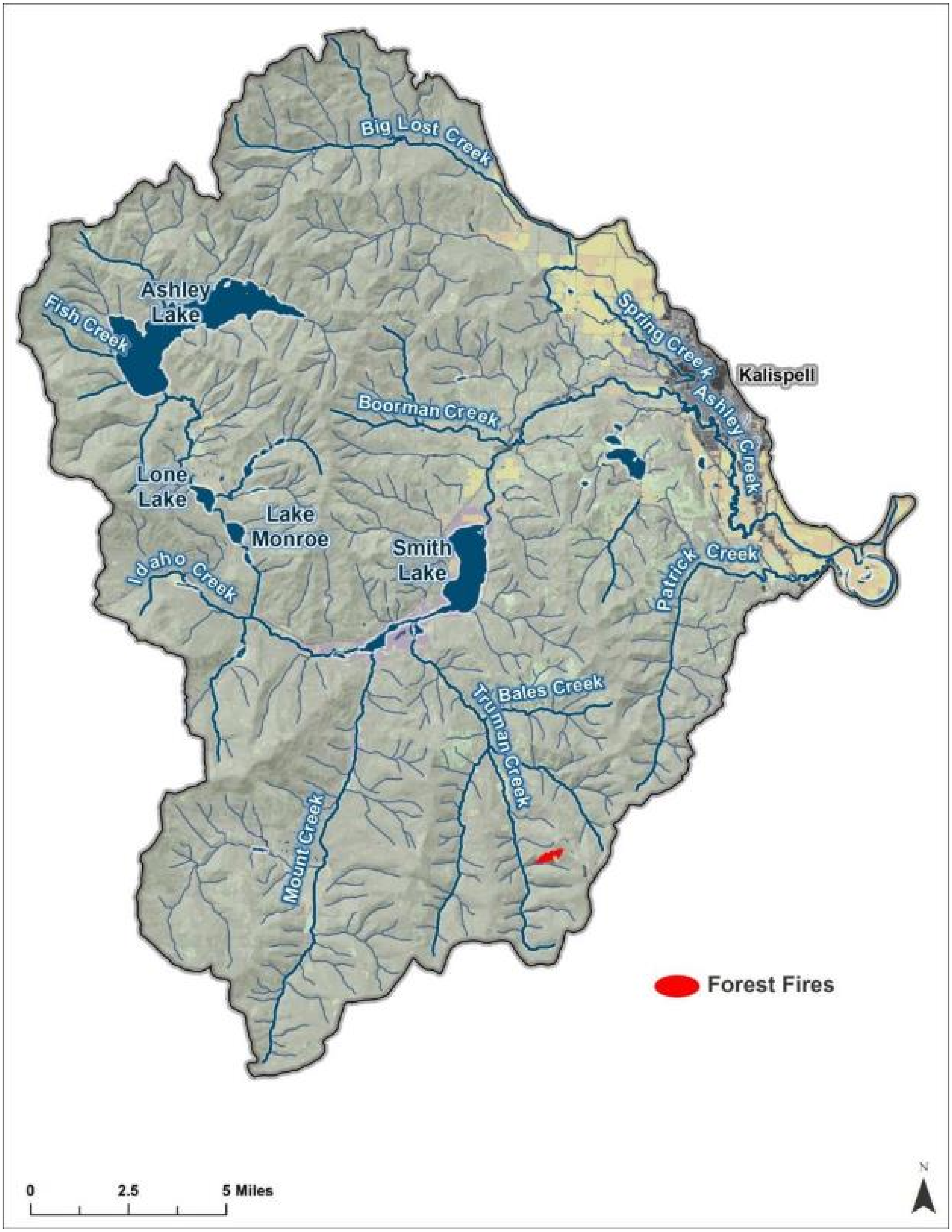


Figure 5-4. Forest Fire in the Ashley Creek Watershed

5.5.3.7 Point Sources

The state of Montana has regulatory authority for all point source discharges to surface waterbodies, including those discharges that are composed of stormwater runoff. The permitted national pollutant discharge elimination system (NPDES) facilities within the Ashley Creek watershed are listed in **Table 5-14** and shown in **Figure 5-5**.

The city of Kalispell's wastewater treatment plant (WWTP) discharge was input into the LSPC model as daily time series of flow and pollutant concentration using data provided by the city of Kalispell. Stormwater discharges were simulated as urban land in LSPC as a function of build-up and wash-off of pollutants from the land surface, adjusted using stormwater monitoring data from Kalispell and Big Fork. Stormwater infrastructure (e.g., conveyances, ponds) was not explicitly modeled. However, it is assumed that the loads from urban lands produced by LSPC generally accounted for existing best management plans (BMPs) given that loading from urban lands was informed using local stormwater monitoring data in watersheds where BMPs were present. The LSPC model was set up to produce output explicitly from the geographic area included within the boundaries of the City of Kalispell Small MS4 (MTR040005), to which the City of Kalispell and Montana Department of Transportation are co-permittees. It is not possible to produce output for the individual industrial and construction facilities, given their small size (maximum of approximately 23 acres).

Table 5-14. Permitted Point Sources in the Ashley Creek Watershed.

NPDES ID	Facility Name	Permit Type	Discharge To	Size (acres)
MT0021938	City of Kalispell WWTP	Individual	lower Ashley Creek	n/a
MTR000251	Wisher's Auto Recycling	General: Storm Water - Industrial Activity	lower Ashley Creek	22.27
MTR000419	Building Materials Holding Corp. - BMC West Truss Plant	General: Storm Water - Industrial Activity	lower Ashley Creek	6.3
MTR000447	UPS - Kalispell	General: Storm Water - Industrial Activity	middle Ashley Creek	4.0
MTR000531	City of Kalispell WWTP	General: Storm Water - Industrial Activity	lower Ashley Creek	17.04
MTR040005	City of Kalispell Small MS4	General: Storm Water - Small MS4 (Municipal Separate Storm Sewer System)	Spring Creek, middle Ashley Creek, lower Ashley Creek	3,928
MTR103908	Montana Department of Transportation - Kalispell Bypass US 93 Bike path Connection	General: Storm Water - Construction Activity	lower Ashley Creek	9
MTR105263	NELCON INC - Town Pump - Kalispell No 5	General: Storm Water - Construction	lower Ashley Creek	22
MTR105434	LHC INC - KBP Three Mile Drive	General: Storm Water - Construction	Spring Creek	15
MTR105578	Willow Creek Subdivision	General: Storm Water - Construction	lower Ashley Creek	23

n/a = not applicable

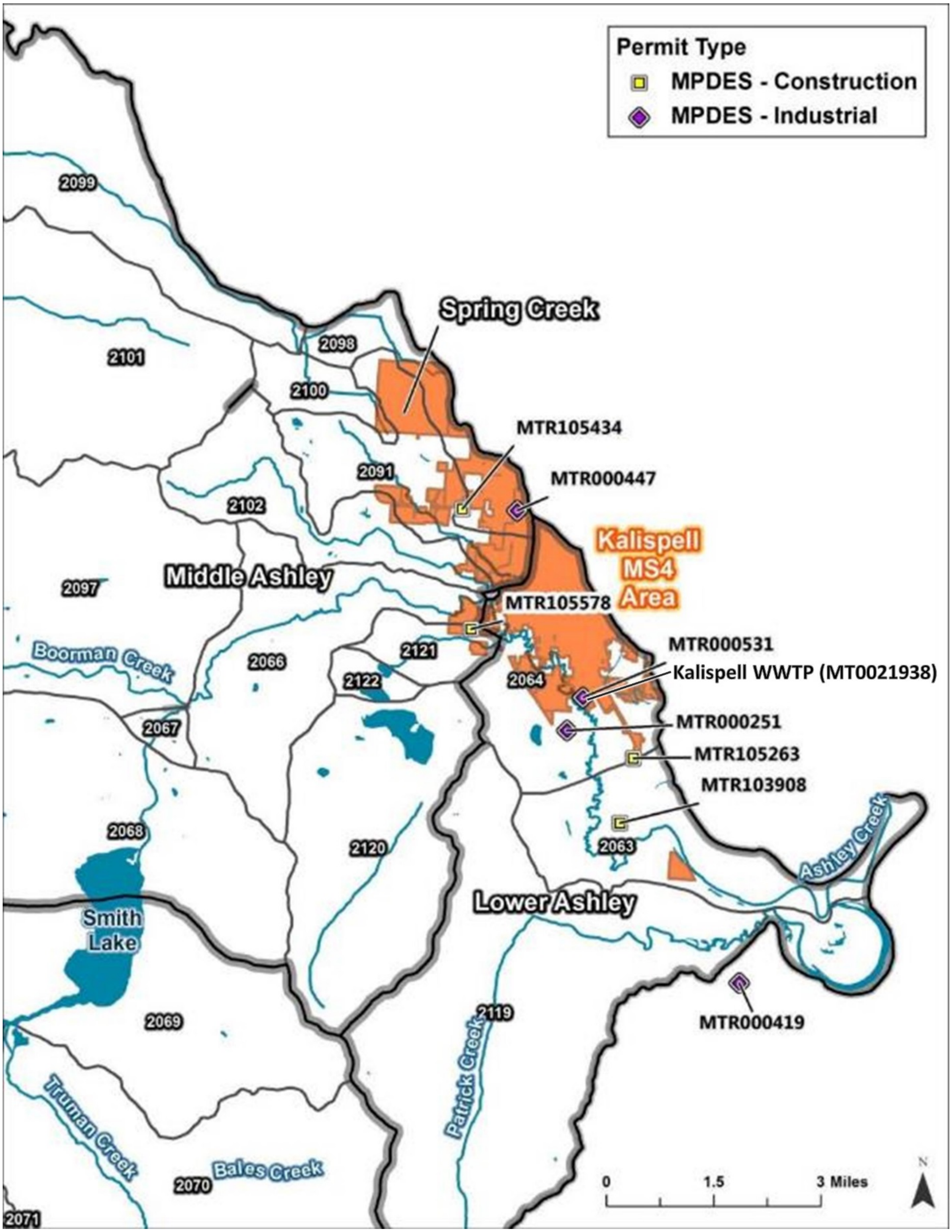


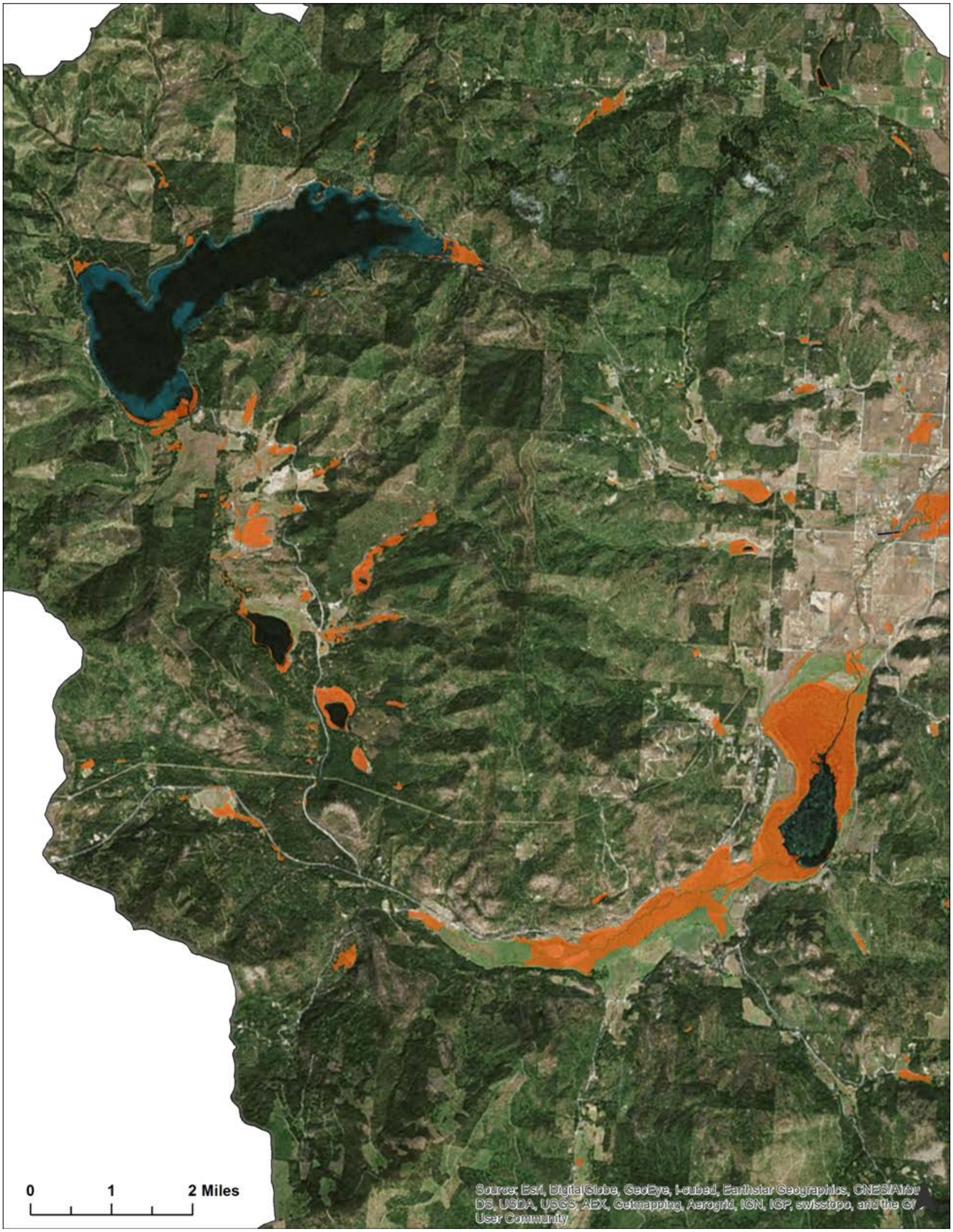
Figure 5-5. Permitted Point Sources in the Ashley Creek Watershed

5.5.3.8 Smith Lake Area

A large complex of wetlands is present in the watershed between Ashley Lake and Smith Lake, and extends to surround Smith Lake (**Figure 5-6**, wetlands shown in orange). Altogether there are about 2,700 acres of wetlands – over four square miles – in this region of the watershed. During water quality calibration it became clear there was a source of nutrient loading between Ashley Lake and Smith Lake that was not accounted for the in model. TN and TP monitoring data collected along the mainstem of Ashley Creek are shown in **Figure 5-7** and **Figure 5-8**, respectively[1]. The plots show an increase in both TN and TP between Sites AC1 and AC5, which are located between the Ashley Lake outlet and Marquardt Ln (downstream of Smith Lake). The increase in nutrients in this area could not be reasonably related to any source in the watershed. Wetlands are known to have a large capacity to absorb nutrients, but they can also release nutrients under some circumstances. Using monitoring data as a guide, the model was configured to release a constant load of nutrients from Smith Lake into Ashley Creek. The load corresponded to an increase in TP of 0.02 mg/L and an increase of TN of 0.5 mg/L.

It is important to note that there is a great deal of uncertainty about the balance of loading between the wetlands and other upstream sources. The load attributed to the wetlands may be overestimated or underestimated. Other sources may be present that are not accounted for by the model and the load assessment. Future monitoring and investigation are needed to develop a better understanding of the system to more accurately characterize nutrient loads. Adaptive management can be used to respond to changes in load attribution as further study provides better information about the relative magnitude of sources (see **Section 9**).

[1] The monitoring data used to generate the plots includes data not used in the assessments in **Section 5.4.3**. The previous assessments used only growing season values for regulatory purposes, while the two box and whiskers plots use all available monitoring data (from sites with greater than 15 data points) regardless of season (see Tetra Tech 2014b). Using all of the data provides a better statistical indication of trend.



Source: National Wetland Inventory.

Figure 5-6. Wetlands along upper Ashley Creek

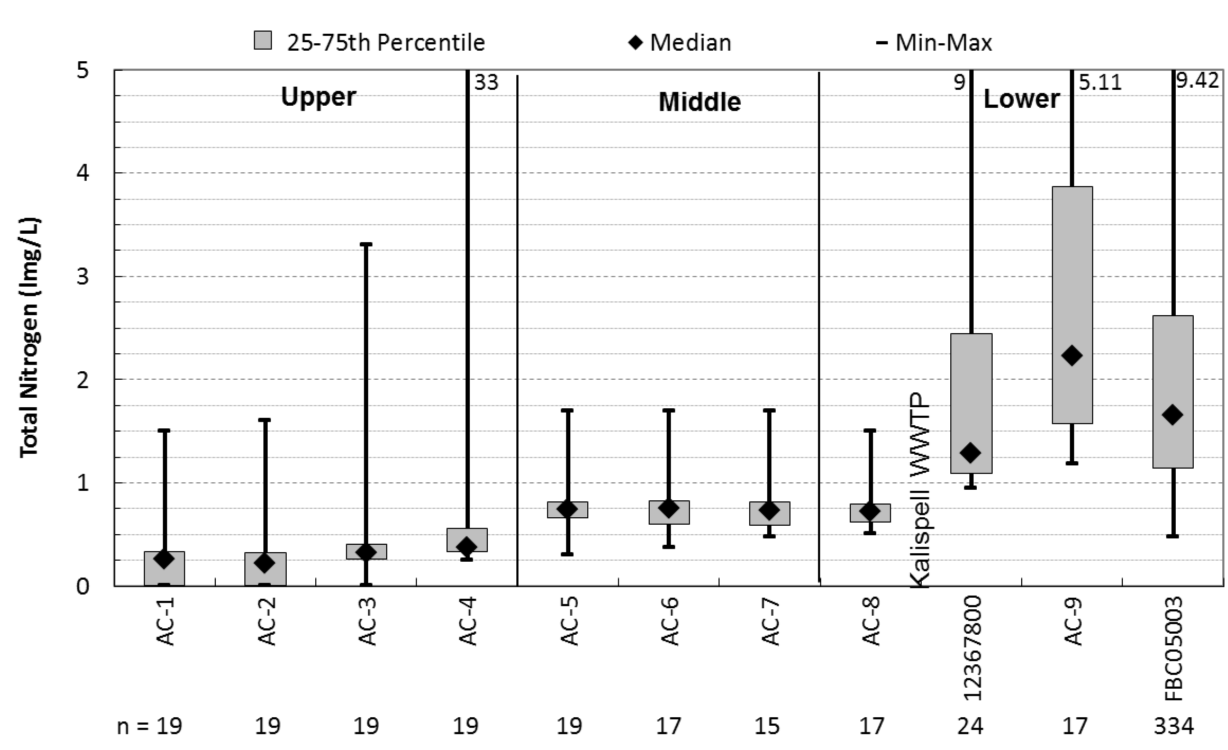


Figure 5-7. Box-and-Whisker Plots for TN along Ashley Creek from Ashley Lake to near the Mouth

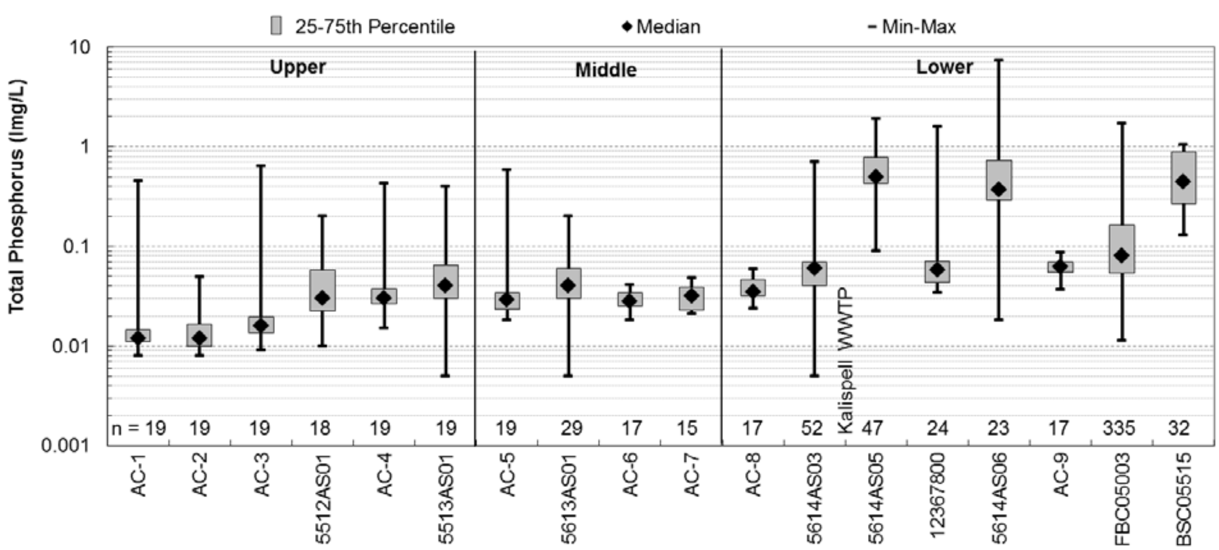


Figure 5-8. Box-and-Whisker Plots for TP along Ashley Creek from Ashley Lake to near the Mouth

5.5.3.9 Septic Systems

Septic systems, even when operating as designed, can contribute nutrients to surface water through subsurface pathways. A simple model, the Method for Estimating Attenuation of Nutrients from Septic Systems (MEANSS), was used to incorporate the previously mentioned variables and provide coarse estimates of the nitrate and TP loads to each waterbody (see the model report (Tetra Tech, Inc., 2014b)).

The number of septic systems in the watershed was estimated based on land uses and cadastral data. It is estimated there are a total of 3,353 septic systems in the Ashley Creek watershed (**Table 5-15**). Approximately 416 of these are located within the internally drained portions of the watershed.

Table 5-15. Septic System Distribution in the Ashley Creek Watershed.

Watershed	No. of septic systems at specified distance (feet) from a stream				Total Number of Septic Systems
	< 100	**100 to 500**	**500 to 5,000**	**5,000 to 20,000**	
Upper	92	182	343	40	657
Middle	67	330	1,213	97	1,707
Spring	7	48	106	0	161
Lower	16	180	618	14	828
Sum	**182**	**740**	**2,280**	**151**	***3,353***

The daily load from each septic system was based on literature values and conservative assumptions used during permitting for subdivisions in Montana (Montana Department of Environmental Quality, 2009). Because a complete system failure is typically addressed very quickly and no site-specific data were available, it was assumed that all septic systems are working properly (i.e., 0% failure rate). Without any reliable data it was assumed that all septic tanks are conventional systems consisting of a septic tank and drain field. Conservative assumptions were used for the load estimates of nitrate and TP to surface waters (i.e. low nutrient removal efficiency).

Key assumptions for this method are as follows:

- All septic systems in a watershed are conventional
- The loading rate before attenuation for nitrate from conventional systems is 30.5 lbs/yr
- The loading rate before attenuation for phosphorus from conventional systems is 6.44 lbs/yr
- Load reductions are dependent on soil type and distance from surface water as described in the Model Report (Tetra Tech, Inc., 2014b).

The typical loading rate to streams was estimated using MEANSS and then added to the LSPC model as daily point sources. These point sources were calculated independently for each subbasin based on the number of septic tanks assigned to the specific subbasin and the delivered load calculated for each system.

Because this modeling exercise assumes a 0% failure rate, for a TMDL to be achieved it is assumed that any failing septic systems would be identified and repaired. This method estimates the load from septic systems as the wastewater enters a stream. It does not account for uptake that occurs once the nutrients enter a stream (Ensign and Doyle, 2006; Valett et al., 2002).

The MEANSS model incorporates many assumptions and as a result there is uncertainty in the loading estimates. It is meant to develop coarse estimates of nutrient loading from septic systems in the Ashley Creek watershed. As part of the implementation of a watershed restoration plan (**Section 9**) more refined models or site-specific water quality studies could be used to reduce uncertainty in estimates of nutrient loading from septic systems.

5.5.3.10 Timber Harvest

As described in Ashley Creek Watershed Characterization (Tetra Tech, Inc., 2014a) there has been considerable timber harvest in the Ashley Creek watershed (**Table 5-16**). Much of the harvest occurred on private lands where no spatial or temporal data are available describing how much harvest, of what type, occurred when. In the absence of data for much of the watershed and for LSPC model set up, it was assumed that areas converted from "forest" to "shrub" or "grassland" between NLCD snapshots (2001 and 2006), and that were not within a burned area, were timber harvest. This approach likely underestimates the total area of forest that has been harvested, but captures those areas thought most likely to have an impact from the perspective of water, sediment, and nutrient yield.

Table 5-16. Area of Timber Harvest in the Ashley Creek Watershed Simulated in LSPC.

Subwatershed	Area (acres)
upper Ashley Creek	2,415
middle Ashley Creek	1,169
lower Ashley Creek	283
Spring Creek	1

5.5.3.11 Unpaved Roads

A database of the road network in the Flathead Lake watershed was developed and is described in a technical memorandum (United States Environmental Protection Agency, 2010). There are 409 miles of unpaved roads in the Ashley Creek watershed (**Figure 5-9** and **Table 5-17**).

Set up of the LSPC model for roads was based on results from Water Erosion Prediction Project (WEPP) modeling for roads from 240 road segments in the Swan River watershed obtained from Atkins (2012) and the Flathead National Forest (Kendall, Craig personal communication 2013[2]). The 240 road segments represented existing roads in the Flathead watershed with the full range of BMP implementation (from no BMPs to full BMP implementation) and are assumed to represent the "average" road in the Ashley Creek watershed. The WEPP results indicated that very little sediment is delivered from the road surface to streams beyond a distance of 100 meters. As a result, only those road segments within 100 meters of streams shown on the high resolution National Hydrography Database (NHD) are included in the LSPC model (**Table 5-17**). Road loading rates in the LSPC model were calibrated using the WEPP results and literature values (Sugden and Woods, 2007).

[2] Personal communication with Craig Kendall, U.S. Forest Service. February 19, 2013

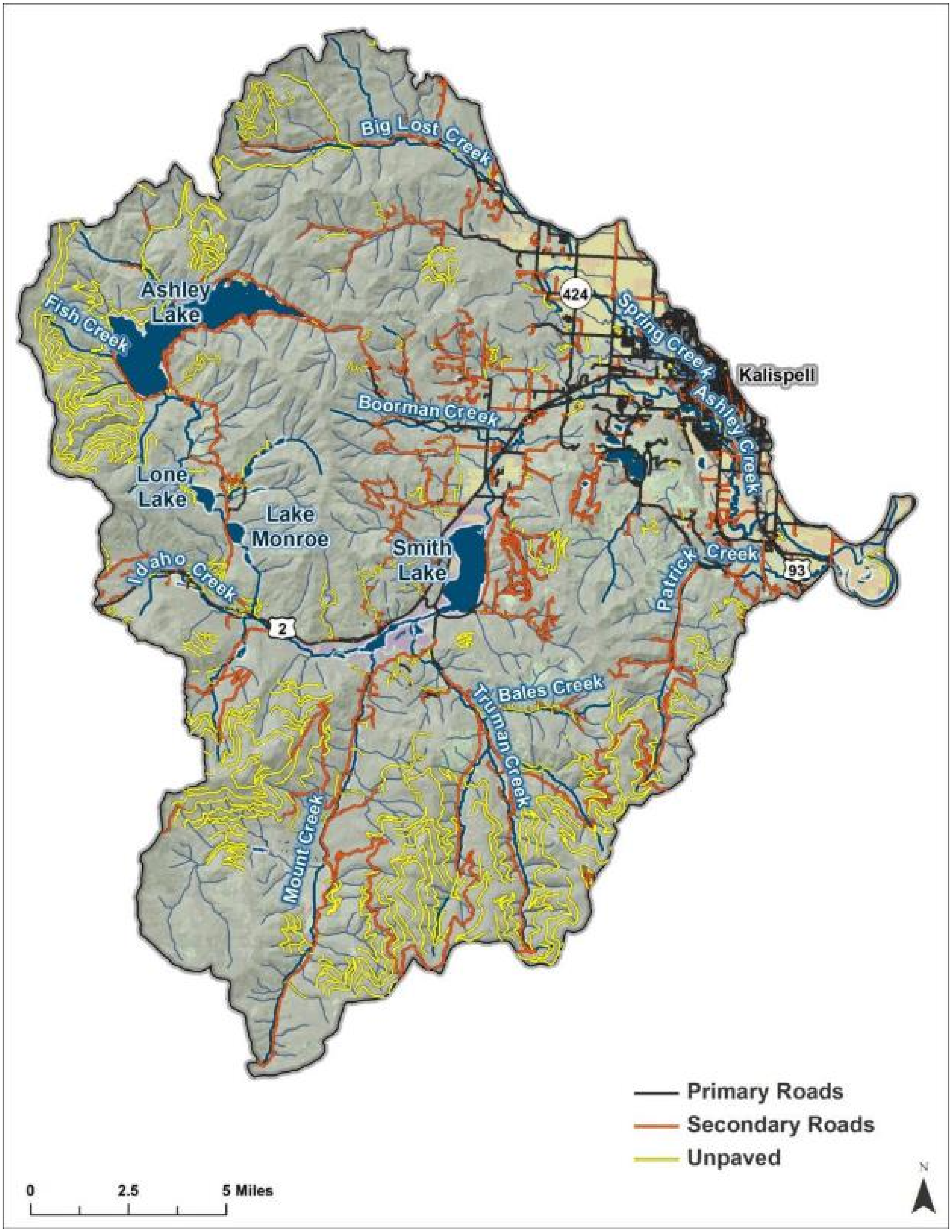


Figure 5-9. Road Network in the Ashley Creek Watershed.

Table 5-17. Road Length in the Ashley Creek Watershed (miles).

Subwatershed	Total	Within 100 Meters of Perennial Streams
lower Ashley Creek	26	5
middle Ashley Creek	55	19
Spring Creek	2	0
upper Ashley Creek	327	68
Total	**409**	**92**

5.5.3.12 Urban Areas

According to the 2006 NLCD (Multi-Resolution Land Characteristics Consortium, 2006), approximately 3% of the Ashley Creek watershed is classified as urban land, with the largest concentration in the lower portion of the watershed within the city limits of Kalispell (**Table 5-18** and **Figure 5-3**). This urban area includes, but is not limited to, the City of Kalispell's MS4 boundary.

Table 5-18. Urban Lands in the Ashley Creek Watershed (acres).

Urban Land Classification	Upper Ashley Creek	Middle Ashley Creek	Spring Creek	Lower Ashley Creek	Ashley Creek Watershed
Developed, High Intensity	0	24	42	139	205
Developed, Low Intensity	228	838	234	1,700	3,000
Developed, Medium Intensity	20	141	121	678	960
Developed, Open Space	296	1,081	268	1,003	2,648
Total	**544**	**2,084**	**665**	**3,521**	**6,814**
Percent of Watershed	0%	3%	24%	16%	3%

5.6 Source Assessments, TMDLs, Allocations, and Reductions for Each Stream

The below sections describe the most significant natural, non-permitted, and permitted sources of nutrients in more detail, establish TMDLs and load allocations, provide nutrient loading estimates for non-point and permitted point source categories to nutrient-impaired stream segments, and estimate reductions necessary to meet water quality targets for the following stream segments:

- upper Ashley Creek (MT76O002_010)
- middle Ashley Creek (MT76O002_020)
- lower Ashley Creek (MT76O002_030)
- Spring Creek (MT76O002_040)

The existing loads are used to estimate load reductions by comparing them to the allowable (TMDL) load and computing a required percent reduction to meet the TMDL. The following addresses each of the impaired segments separately. The example TMDLs and all TMDL calculations in this section are based on the observed data contained in DEQ's assessment record (**Table B-1**, **Appendix B**). The assessment record is based on growing season data (July 1 – September 30) from the last 10 years. An analysis of a more comprehensive data set (year round data from a longer period of record) has been conducted to provide insights into possible source locations and is presented in Tetra Tech (2014a). The LSPC model was used to describe the existing nutrient loads among the potentially significant source categories (e.g., septic systems, agriculture, point sources).

5.6.1 Approach to TMDL Development, Allocations, Wasteload Allocations, and Current Loading

Because the targets are applied during the summer growing season for algae in the Northern Rockies Level III Ecoregion (July 1 – September 30), the nutrient TMDLs and all associated allocations only apply during this same period of July 1 through September 30. The TMDL calculations for TN and TP are based on **Equation 1**:

Equation 1. TMDL= 5.4 * *X* * *Y*

TMDL= Total Maximum Daily Load in lbs/day
X = *water quality target* **(Table 5-2**; *in mg/L)*
Y = streamflow in cubic feet per second
5.4 = conversion factor

Note that the TMDL is not static; as flow increases the allowable (TMDL) load increases as shown by the total phosphorus example in **Figure 5-10**. For upper Ashley Creek the TMDL allocations are composited into a single load allocation to all nonpoint sources, including natural background sources (**Equation 2**). This is done because all sources are nonpoint in the upper watershed. Allocations for middle and lower Ashley and Spring creeks consist of a composite load allocation (LA) for all nonpoint sources, including natural background sources, and the sum of individual wasteload allocations (∑WLA) to the point sources, including permitted stormwater (**Equation 3**). In the absence of an explicit margin of safety (MOS), the TMDLs for TN and TP in each waterbody are equal to the sum of the individual loads as follows:

Equation 2. TMDL = LA (upper watershed)

LA = Composite Load Allocation to all nonpoint sources including natural background sources

Equation 3. TMDL = LA + ∑WLA (middle and lower watershed)

LA = Composite Load Allocation to all nonpoint sources including natural background sources
∑WLA = Sum of *Waste Load Allocations to the permitted point sources*

The allocation approaches for the Kalispell WWTP, Kalispell MS4, and construction and industrial stormwater permits are provided in the following sections.

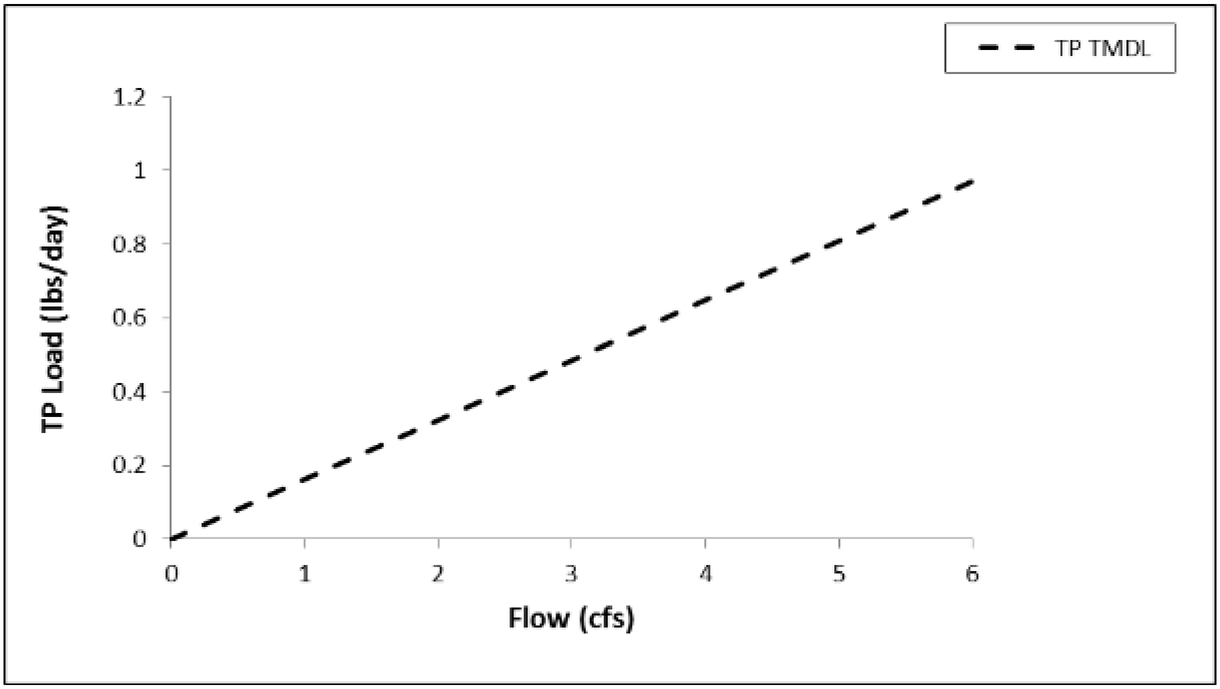


Figure 5-10. Example TMDL for TP from 0 to 6 cfs

5.6.1.1 Approach to the Kalispell WWTP Wasteload Allocation

As required by the state of Montana, ARM 17.30.637(2), "no wastes may be discharged such that the wastes, either alone or in combination with other wastes, will violate, or can reasonably be expected to violate, any of the standards". For a WWTP and other permitted dischargers, this means that a discharge concentration must be less than or equal to an applicable numeric water quality standard if the reach immediately upstream where the discharge occurs is already exceeding the standard. If the reach immediately upstream of the WWTP discharge is determined to be unimpaired for TN and/or TP, the WLA will be modified based on a mass-balance approach if there is sufficient assimilative capacity in the receiving water. In either case, the development of the WLAs is consistent with the reasonable assurance approach defined within **Section 4.4**.

Establishing the Total Allowable Load

The TMDL target values provide a numeric translation of the applicable narrative standard found in ARM 17.30.637(1)(e). The state-approved numeric nutrient criteria provide the basis for the TMDL targets. The reach of Ashley Creek immediately upstream of the Kalispell WWTP discharge is impaired for TP and TN, based on application of DEQ's nutrient assessment methodology (Suplee and Sada de Suplee, 2011). To ensure the Kalispell WWTP discharge does not cause or contribute to a violation of water quality standards, the WLAs for TP and TN are based on a discharge concentration equal to the nutrient target concentration multiplied by the WWTP discharge flow. As the nutrient criteria are seasonal (July 1- Sept 30), the WLA only applies during this time period. The resulting nutrient WLA for TP and TN is based on **Equation 4**:

Equation 4.

$$WLA = 5.4 * X * Y$$

WLA = Wasteload Allocation in lbs/day
X = applicable water quality target for Ashley Creek (0.275 mg/L TN and 0.025 mg/L TP)
Y = WWTP discharge in cubic feet per second

5.4 = conversion factor

Note that the WLA is not static, as flow increases the WLA increases as shown by the total phosphorus example in **Figure 5-11.**

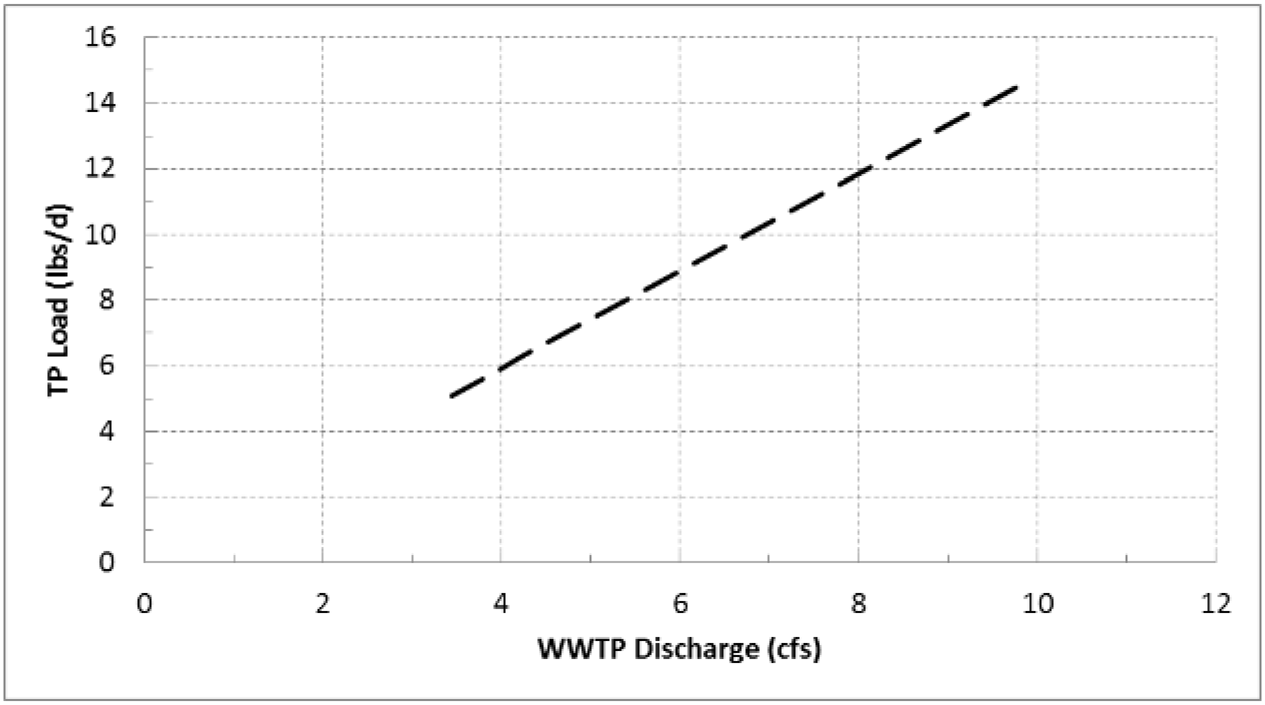


Figure 5-11. WLA for total phosphorus from the Kalispell Wastewater Treatment Plant.
The line representing the WLA is shown over the range of discharges from the WWTP during the summer growing season from water years 2002 through 2012.

For the purpose of setting Montana Pollutant Discharge Elimination System (MPDES) discharge permit conditions, **Equation 4** is always satisfied if the discharge concentration is equal to or less than the target concentration during the applicable time period (in this case, the summer growing season). Therefore, the permit WLA can be satisfied by applying a concentration-based requirement on the discharge as opposed to establishing a load. If a concentration-based approach is not used for MPDES permit integration, then the WLA should be based on the target concentration multiplied by the existing WWTP discharge flow (as opposed to the design flow). Using a concentration-based approach does not result in a load cap and can be used to simplify MPDES permit development.

For **Equation 4**, the target concentration is lower than current limits of technology for treatment of wastewater effluent, which will likely require staged implementation of the WLA as discussed below.

Mixing Zone Allowance

If water quality in Ashley Creek in the reach immediately upstream of the Kalispell WWTP discharge location improves to the point where the water quality targets or adopted numeric nutrient standards are met, then the WLA may be modified as assimilative capacity has been created in the receiving water. This increase would be based on a mass-balance calculation that ensures that water quality standards and/or TMDL targets are met at the end of the mixing zone during July 1 through September 30 under

14Q5 flow conditions. For a given stream, 14Q5 refers to the 14-day low flow with a recurrence interval of 5 years.

A mixing zone would be calculated the same regardless of whether or not numeric nutrient standards are adopted into rule. The 75th percentile of the available upstream water quality data will be used to determine assimilative capacity of TN and TP.

If it is determined that there is assimilative capacity at the WWTP, the WLAs for lower Ashley Creek will need to be adjusted.

Staged Implementation of Nutrient Wasteload Allocations

The TMDL target for TN and TP represents concentrations below the current limits of treatment technology. MPDES permits provide a regulatory mechanism for implementing the TMDL via the variance process, to address affordability issues and concerns about the limits of treatment technology. The variance (75-5-313 Montana Code Annotated (MCA)) allows Montana to implement numeric nutrient criteria in a staged manner thus allowing enough time to address all point and nonpoint sources of nutrient pollution and allow for advancements in treatment technology and associated affordability.

The WLAs for the Kalispell WWTP defined in this document allow staged implementation consistent with the variance process (Montana Department of Environmental Quality, 2014c; 2014a). When the city of Kalispell renews its MPDES permit, it can apply for a variance as part of a staged implementation approach for the WLAs defined in **Sections 5.6.4.3** and **Section 5.6.4.4**. The variance will be implemented as defined within Montana State Law (75-5-313, MCA) and the rule as adopted. If the variance is granted, the city of Kalispell will have 20 years from the time they receive the variance to meet the numeric nutrient standards. The MPDES permit for the Kalispell WWTP is currently in the renewal process. The first stage of the variance process for a WWTP facility like Kalispell's generally requires treatment levels of 10 mg/L for TN and 1 mg/L for TP. The Kalispell WWTP currently satisfies these TN and TP treatment levels.

5.6.1.2 Kalispell MS4 (MTR040005) Loading

Stormwater within the city of Kalispell is regulated under the *General Permit for Storm Water Discharge Associated with Small Municipal Separate Storm Water Sewer System* (MS4) (MTR040000). The city shares the permit with the Montana Department of Transportation. The permit applies within the Kalispell city limits, including a total area of approximately 3,931 acres in the Ashley Creek watershed (**Table 5-19**).

Table 5-19. Spatial Distribution of the Kalispell MS4 in the Ashley Creek Watershed

Subwatershed	Acres
upper Ashley Creek	0
middle Ashley Creek[(1)]	2,012
Spring Creek	952
lower Ashley Creek	1,919
Ashley Creek[(2)] watershed	3,931

[1]Middle Ashley Creek includes the quantity reported for Spring Creek.
[2]This is the cumulative total for the entire Ashley Creek watershed.

The permit does not include effluent limits but does have benchmark goals of 0.41 and 2.00 mg/L for TP and TN, respectively, and requires the development and implementation of a stormwater management program (SWMP) to minimize sediment loading to surface waters. The SWMP must include six minimum control measures: (1) public education and outreach; (2) public involvement/participation; (3) detection and elimination of illicit discharge; (4) control of stormwater runoff from construction sites; (5) management of post-construction stormwater in new development and redevelopment; and (6) pollution prevention/good housekeeping. Additionally, the permit requires monitoring at two sites, one representing a residential area and the other representing a commercial/industrial area.

The estimated average summer growing season (July 1 – September 30) TP and TN loads from the Kalispell MS4 based on the LSPC model are shown in **Table 5-20**. As described in the Model Report (Tetra Tech, Inc., 2014b), the Kalispell MS4 infrastructure (i.e., individual sewers and existing BMPs) was not explicitly modeled in the Flathead Lake watershed. Rather, the model used the MS4 footprint, land use categories, and the measured stormwater data to simulate runoff from the urban area.

Table 5-20. Estimated Summer MS4 TN and TP Loads

Subwatershed	Summer Growing Season (lbs/season)	
	TN	TP
upper Ashley Creek	0	0
middle Ashley Creek[(1)]	417	26
Spring Creek	384	24
lower Ashley Creek watershed[(2)]	1,472	97

[1]Middle Ashley Creek includes the load for Spring Creek.
[2]This is the cumulative load for the entire Ashley Creek watershed.
Note: The TN and TP loads were rounded to the nearest integer.

The Kalispell MS4 does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, daily TN and TP WLAs have not been calculated in this document, and no example WLAs are provided in **Section 5.6.2** for a typical summer flow event where there should be no stormwater discharges to Ashley or Spring creeks. Consistent with EPA guidance (U.S. Environmental Protection Agency, 2002), the Kalispell MS4 (MTR040005) is instead assigned wasteload allocations for TN and TP for the algae growing season. These allocations are based on the modeled existing loads with reductions based on BMP application scenarios. Growing season load reductions for the MS4 were calculated based on typical BMP effectiveness factors as identified in the literature. Load reduction factors (**Table 5-21**) are primarily from two sources – the National Pollutant Removal Performance Database: Version 3 (Center for Watershed Protection, 2007) and the Runoff Reduction Method developed by the Center for Watershed Protection and the Chesapeake Stormwater Network (Hirschman et al., 2008). Average percent reduction values for TN and TP for the suite of BMPs listed in **Tables 5-21** are 30% and 44%, respectively. These values were used to approximate the reduction in loading that additional BMP implementation across all land-use categories within the MS4 could achieve during the growing season, assuming none of these practices are in place currently. Based on these assumptions, growing season WLAs are shown in **Tables 5-22** and **5-23**.

Though the numeric WLAs represent a reasonable estimate of the growing season loading after implementation of stormwater permit requirements, the WLAs are not intended to add concentration or load limits to the permit. Consistent with EPA guidance (U.S. Environmental Protection Agency, 2002), DEQ assumes the WLA will be met by adhering to the permit requirements and reducing either the TN and TP concentrations and/or the discharge volumes, with the percent reduction values of 30% and 44% representing permit implementation goals. As identified in the permit, monitoring data should continue to be evaluated to assess BMP performance and help determine whether and where additional BMP implementation may be necessary. Additional work may be needed in the future to better identify the nutrient sources and BMPs already in place within the system. Also, a stormwater runoff model (such as SWMM) would help to better estimate the load and impact from the MS4.

Table 5-21. TN and TP load Reduction Factors

Structural BMP	Annual Percent Removal	
	Total Nitrogen	Total Phosphorus
Extended Detention Wet Pond[(1)]	30%	50%
Extended Detention Stormwater Wetland[(1)]	25%	50%
Extended Detention Dry Basin[(2)]	24%	20%
Dry Basin (no extended detention) [(2)]	5%	15%
Bioretention[(2)]	64%	55%
Sand Filter[(1)]	30%	60%
Vegetated Filter Strip[(2)]	30%	60%
Average	30%	44%

[1] (Hirschman et al., 2008)
[2] (Center for Watershed Protection, 2007)

Table 5-22. Existing TN Load Estimates and WLAs for the Kalispell MS4 during the Growing Season

Segment	Existing Load (pounds/growing season)	Percent Reduction[(3)]	WLA[(3)] (pounds/growing season)
middle Ashley Creek[(1)]	417	30%	292
Spring Creek	384	30%	269
lower Ashley Creek[(2)]	1,472	30%	1,030

[1]Middle Ashley Creek includes the load for Spring Creek.
[2]Includes the loads from Spring Creek and middle Ashley Creek.
[3]These values are not intended to add concentration or load limits to the MS4 permit; meeting permit BMP and other requirements equates to meeting the TN WLAs

Table 5-23. Existing TP Load Estimates and WLAs for the Kalispell MS4 during the Growing Season

Segment	Existing Load (pounds/growing season)	Percent Reduction[(3)]	WLA[(3)] (pounds/growing season)
middle Ashley Creek[(1)]	26	44%	15
Spring Creek	24	44%	13
lower Ashley Creek[(2)]	97	44%	54

[1]Middle Ashley Creek includes the load for Spring Creek.
[2]Includes the loads from Spring Creek and middle Ashley Creek.
[3]These values are not intended to add concentration or load limits to the MS4 permit; meeting permit BMP and other requirements equates to meeting the TP WLAs

5.6.1.3 Construction Storm Water Permits (MTR100000)

Because construction activities at a site are temporary and relatively short term, the number of construction sites covered by the general permit at any given time varies. Collectively, these areas of severe ground disturbance have the potential to contribute nutrients (TN and TP) if proper BMPs are not implemented and maintained. Each construction stormwater permittee is required to develop a Storm Water Pollution Prevention Plan (SWPPP) that identifies the stormwater BMPs that will be in place during construction. Before a permit is terminated, disturbed areas must have a vegetative density equal to or greater than 70% of the pre-disturbed level (or an equivalent permanent method of erosion prevention). Inspection and maintenance of BMPs is required, and although Montana stormwater regulations provide the authority to require stormwater monitoring, water quality sampling is typically not required.

The permit files were reviewed to determine the amount of disturbed land associated with each permit. The estimated level of disturbance ranged from 9 to 23 acres (see **Table 5-14**). The permits are for a range of construction projects including road/highway, home, business, and stormwater improvements. The SWPPPs contain BMPs such as silt fencing, retention basins, fiber rolls, erosion control blankets, and vegetated buffers.

To estimate nutrient loading from permitted construction sites without BMPs in place DEQ used an approach similar to that in DEQ (2011). For this approach, the average existing annual loading rates for bluffs (i.e., bare, un-vegetated lands) in the LSPC model (1.02 lbs/acre/year TN and 0.098 lbs/acre/year TP) were used to represent construction sites with inadequate BMP implementation. These values were then multiplied by the total disturbed acreage associated with construction storm water permits in each applicable watershed (**Table 5-14**). This approach provides a very conservative estimate of nutrient loads. In reality, each site is required to have BMPs in place and/or native vegetation that prevents runoff and erosion at the rates used to calculate the nutrient loads.

The average BMP reduction values presented in **Table 5-21** were applied to the existing loads (without BMPs) to estimate the reduction in loading associated with following proper BMPs and adhering to permit requirements. The examples shown in **Tables 5-24** and **5-25** are presented to illustrate what kind of load reductions would be achieved by following permit requirements, including SWPPP development and implementation. Because of the low levels of nutrient loading and the existence of BMP requirements, WLAs are not developed for construction stormwater permits.

Table 5-24. TN Loading and Reductions from Permitted Construction Sites

Watershed	Loading Rate (lbs/acre/year)(1)	Disturbed Area(acres)(2)	Load *without* BMPs (lbs/year)(3)	Percent Reduction	Load *with* BMPs (lbs/year)(4)
Spring Creek	1.02	15	15.3	30%	10.7
middle Ashley Creek (5)	1.02	15	15.3	30%	10.7
lower Ashley Creek (6)	1.02	69	70.4	30%	49.3

1 Average loading rate from the LSPC model results (Tetra Tech, Inc., 2014b).
2 Average annual area disturbed by construction activities.
3 Annual load without adequate BMPs (i.e., existing load), which is calculated as the loading rate multiplied by the disturbed area.
4 Load with BMPs implemented
5 Includes the area and load from Spring Creek.
6 Includes the area and loads from Spring Creek and middle Ashley Creek.

Table 5-25. TP Loading and Reductions from Permitted Construction Sites

Watershed	Loading Rate (lbs/acre/year)(1)	Disturbed Area (acres)(2)	Load without BMPs (lbs/year)(3)	Percent Reduction	Load with BMPs (lbs/year)(4)
Spring Creek	0.098	15	1.5	44%	0.84
middle Ashley Creek (5)	0.098	15	1.5	44%	0.84
lower Ashley Creek (6)	0.098	69	6.8	44%	3.8

[1] Average loading rate from the LSPC model results (Tetra Tech, Inc., 2014b).
[2] Average annual area disturbed by construction activities.
[3] Annual load without adequate BMPs (i.e., existing load), which is calculated as the loading rate multiplied by the disturbed area.
[4] Load with BMPs implemented
[5] Includes the area and load from Spring Creek.
[6] Includes the area and loads from Spring Creek and middle Ashley Creek.

5.6.1.4 Industrial Storm Water Permits (MTR000000)

There are currently four facilities that are regulated under the *General Permit for Storm Water Discharges Associated with Industrial Activity* (MTR000000) that could be contributing to segments of concern (see **Table 5-14**). These permits regulate the direct discharge of stormwater draining the facility and its grounds. Under the stipulations of the permits, the facilities maintain an approved SWPPP. The SWPPP sets forth the procedures, methods, and equipment used to prevent the pollution of stormwater discharges. In addition, the SWPPP describes general practices used to reduce pollutants in stormwater discharges. The SWPPPs contain BMPs such as using conveyances that minimize contact between runoff and sediment and other pollutants and retention basins that allow sediment to settle and water to infiltrate into the ground.

The sites range in size from 4.0 to 22.27 acres (**Table 5-14**). Existing loading from the industrial sites were estimated by multiplying the LSPC loading rates for urban impervious lands in Kalispell (6.78 lbs/acre/year TN and 0.437 lbs/acre/year TP) by the acreage of the facilities. This approach provides a very conservative estimate of nutrient loads. In reality, each site is required to have BMPs in place and/or native vegetation that prevents runoff and erosion at the rates used to calculate the nutrient loads. The BMP loads were estimated using the average BMP reduction values presented in **Table 5-21.**

The examples shown in **Tables 5-26** and **5-27** are presented to illustrate what kind of load reductions would be achieved by following permit requirements, including SWPP development and implementation. Because of the low levels of nutrient loading and the existence of BMP requirements, WLAs are not developed for the industrial stormwater permits.

Table 5-26. Existing and Allowable TN Loading from Permitted Industrial Sites

NPDES ID	Facility Name	Ashley Creek Subwatershed	Facility Area (acres)	Loading Rate (lbs/acre/year)(1)	Existing Load (lbs/year)(2)	Percent Reduction	BMP Load (lbs/year)
MTR000251	Wisher's Auto Recycling	Lower	22.27	6.78	150.99	30%	105.7
MTR000419	Building Materials Holding Corp. - BMC West Truss Plant	Lower	6.30	6.78	42.71	30%	29.9
MTR000447	UPS - Kalispell	Middle	4.00	6.78	27.12	30%	19.0
MTR000531	City of Kalispell WWTP	Lower	17.04	6.78	115.53	30%	80.9

[1] Average loading rate from the LSPC model results (Tetra Tech, Inc., 2014b).
[2] The existing load that is calculated as the loading rate multiplied by the facility area.
Facility Area, Average LSPC Model Loading Rate, and Existing Load are rounded to the nearest one-hundredth of the displayed unit.

Table 5-27. Existing and Allowable TP Loading from Permitted Industrial Sites

NPDES ID	Facility Name	Ashley Creek Subwatershed	Facility Area (acres)	Loading Rate (lbs/acre/year)(1)	Existing Load (lbs/year)(2)	Percent Reduction	BMP Load (lbs/year)
MTR000251	Wisher's Auto Recycling	Lower	22.27	0.437	9.73	44%	5.4
MTR000419	Building Materials Holding Corp. - BMC West Truss Plant	Lower	6.30	0.437	2.75	44%	1.5
MTR000447	UPS - Kalispell	Middle	4.00	0.437	1.75	44%	1.0
MTR000531	City of Kalispell WWTP	Lower	17.04	0.437	7.45	44%	4.2

[1] Average loading rate from the LSPC model results (Tetra Tech, Inc., 2014b).
[2] The existing load that is calculated as the loading rate multiplied by the facility area.
Facility Area, Average LSPC Model Loading Rate, and Existing Load are rounded to the nearest one-hundredth of the displayed unit.

5.6.2 Upper Ashley Creek MT76O002_010

5.6.2.1 Assessment of Water Quality Results for Upper Ashley Creek

This reach of Ashley Creek begins at the outlet of Ashley Lake and flows south and east 15.64 miles, through Lone Lake and Lake Monroe, before discharging into Smith Lake. Wetlands are common in this reach. Lake Monroe is surrounded by wetland and the lower four miles of this reach flow through a broad, floodplain wet meadow/emergent marsh complex before discharging into Smith Lake. Land cover in the upper Ashley Creek watershed is largely forest which has been harvested to varying degrees over time. Seasonal cabins and year-round homes with septic systems surround Ashley Lake. Agricultural land uses, primarily hay and grazing, also occur at lower elevations in the valley.

As discussed in **Section 5.4.3.1**, and based on the data set contained in DEQ's assessment record, one-half of TN samples exceeded the target (0.275 mg/L) at three sites (AC-1, AC-2, and AC-3); all TN concentrations were at or exceeded the target at the most downstream site (AC-4). Altogether, 22 of 40 TN samples in upper Ashley Creek exceeded the target. TN concentrations appear to increase from the Ashly Lake outlet to the downstream end of the segment (**Figure 5-7**).

5.6.2.2 Assessment of Loading by Source Categories for Upper Ashley Creek

Based on the LSPC model, the bulk of the total nitrogen loading during the summer growing season is from the Smith Lake area, atmospheric deposition, and natural sources (**Figure 5-12**), making up approximately 71%, 13%, and 8% of the total load, respectively. Other sources comprise only 8% of the total load, with septic systems at 6%. Agriculture, timber harvest, and unpaved roads make up the remaining 2% of the total load. Note that a portion of atmospheric deposition can be linked to an additional form of natural background loading.

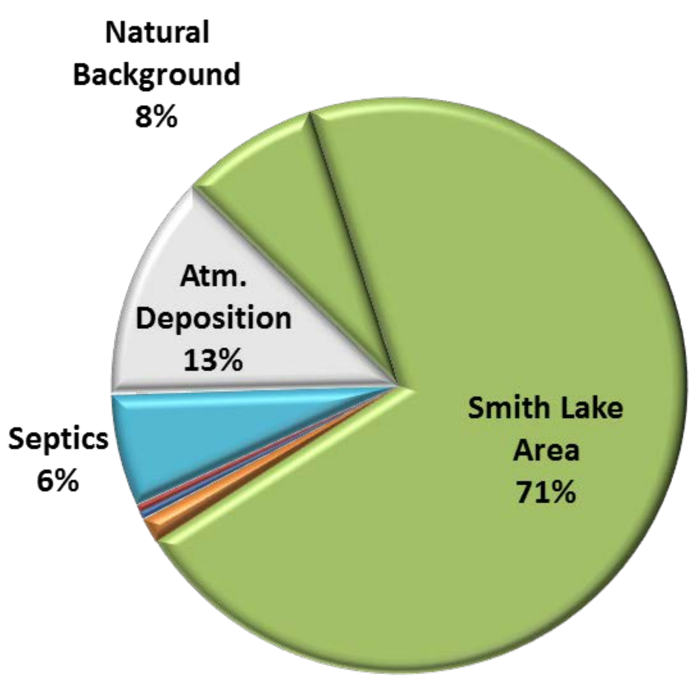
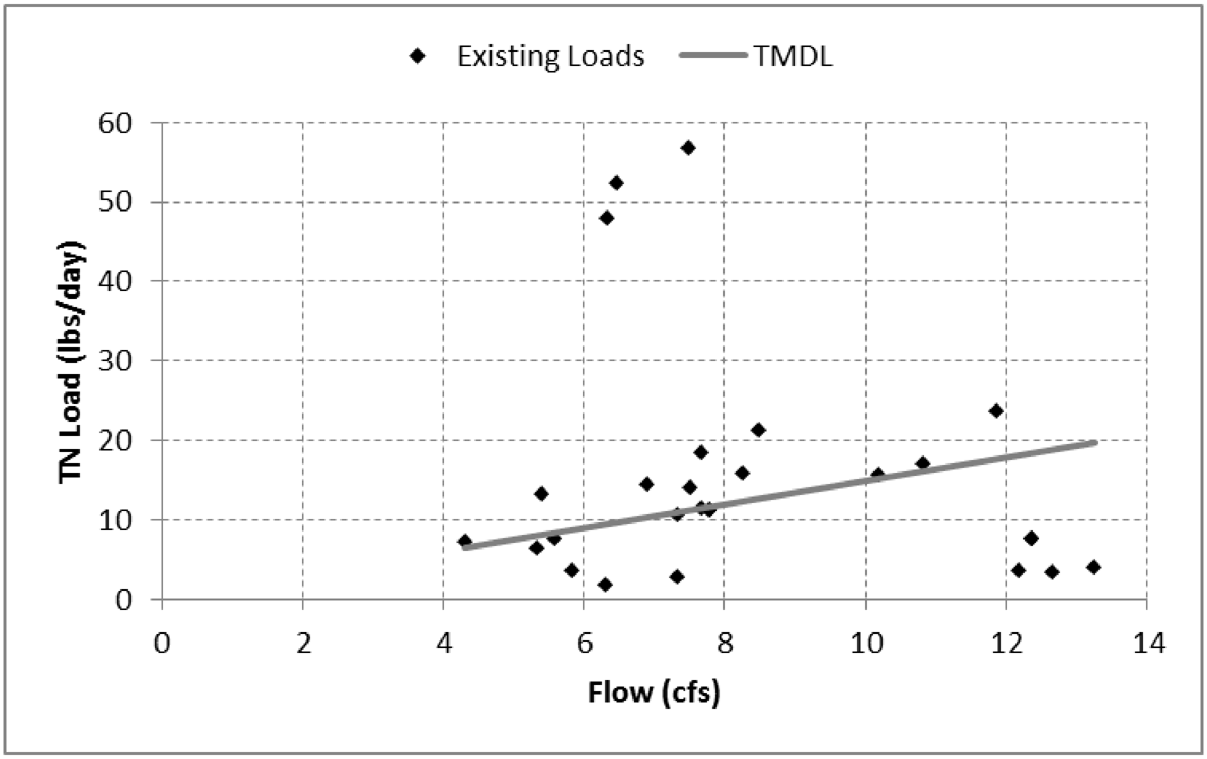


Figure 5-12. Contribution of TN Sources to Upper Ashley Creek during the Summer Growing Season.

5.6.2.3 TN TMDL, Allocations, Current Loading, and Reductions for Upper Ashley Creek

Figure 5-13 shows the TN TMDL for upper Ashley Creek. The TMDL is shown as a line which represents the TN target (0.275 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TN loads need to be reduced by 4 to 82%, with a median reduction of 28%. At times, measured loads are below the TMDL and no reductions are necessary.



All points on or below the gray line are meeting the TMDL.

Figure 5-13. Measured TN loads in Comparison to the TMDL.

Because a proportion of the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TN. Although the source assessment for the upper Ashley Creek subwatershed indicates that septic systems contribute the most controllable human-caused TN loading (see **Figure 5-12**); the origination of loading in the Smith Lake area could also be linked to human-caused TN loading from agriculture or other existing or historical land uses. Load reductions should focus on limiting and controlling TN loading from controllable sources. Meeting load allocations for upper Ashley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. Because no point sources are permitted to discharge in the upper Ashley Creek watershed, the TMDL for upper Ashley Creek is represented by **Equation 2.**

TMDL = LA

The loading in upper Ashley Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. It also accounts for the uncertainty regarding the origination of the TN loading from the Smith Lake Area, giving watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.2.4 Example TMDL

This section of the document provides an example TMDL, existing load, and allocations based on a single flow rate and in-stream concentration. Note that the upper Ashley Creek TMDLs and allocations apply, and will vary, across the range of flows that may be observed during the summer growing season.

The following is an example of the TMDL, existing load, and allocation using an *average* observed flow of 8.35 cfs, using TN data contained in DEQ's assessment record (refer to **Table B-1** in **Appendix B** for a tabular summary of the data used for the TMDL calculations). The example TN TMDL, load allocation, and current loading for a flow of 8.35 cfs are summarized in **Table 5-28**.

__Total Nitrogen__

The TN TMDL target is 0.275 mg/L, and the *average* observed concentration is 0.38 mg/L.

TMDL **= (target)(flow)(5.4)**
= (0.275 mg/L) (8.35 cfs) (5.4)
= 12.40 lbs/day

Existing Load **= (observed)(flow)(5.4)**
= (0.38 mg/L) (8.35 cfs) (5.4)
= 17.13 lbs/day

Table 5-28. Example TN TMDL, Current Loads, and Allowable Loads for Upper Ashley Creek (at an Example Flow of 8.35 cfs)

TN Sources	Existing Load (lbs/day) (1)	Percent Reduction	Allowable Load (lbs/day) (2)
Nonpoint Sources + Natural Background	17.13	28%	LA = 12.40
Total	**17.13**	**28%**	**TMDL = 12.40**

[1] The total load (17.13lb/day) is based on a flow of 8.35 cfs and average measured TN concentration of 0.38 mg/L.
[2] The total allowable load is based on a flow of 8.35 cfs and the TMDL target of 0.275 mg/L.

5.6.2.5 Dissolved Oxygen

As discussed in **Section 5.4.4**, the TN TMDL for upper Ashley Creek provides a surrogate TMDL and allocations to addresses the dissolved oxygen (DO) impairment cause to the upper Ashley Creek waterbody segment. Water quality improvements that address excess TN loading should result in improved (i.e., increased) DO concentrations.

5.6.3 Middle Ashley Creek MT76O002_020

5.6.3.1 Assessment of Water Quality Results for Middle Ashley Creek

Middle Ashley Creek begins at the outlet from Smith Lake and flows northeast, east, then southeast for 14.17 miles to Kalispell Airport Road. The contributing drainage area to middle Ashley Creek includes upper Ashley Creek (discussed above) and Spring Creek (discussed in **Section 5.6.5**). Land cover is predominantly forested, with approximately 7% in agricultural uses and 3% urban use. There are an estimated 1,707 septic systems within the subwatershed (not including septic systems in upper Ashley Creek and Spring Creek). A portion of the City of Kalispell's Small MS4 (MTR040005) is also within the middle Ashley Creek subwatershed. One industrial site (UPS [MTR000447]) and one construction site (LHC, Inc. [MTR105434]) are authorized to discharge within this reach.

As discussed in **Section 5.4.3.1**, and based on the data set contained in DEQ's assessment record (**Table B-1**, **Appendix B**), 38 of 38 TN samples and 27 of 48 TP samples collected in middle Ashley Creek exceeded the targets.

5.6.3.2 Assessment of Loading by Source Categories for Middle Ashley Creek

Figure 5-14 and **Figure 5-15** show the percentage of TN and TP loading from the various sources in middle Ashley Creek, respectively (based on the LSPC model). Similar to upper Ashley Creek, the major source of TN during the summer growing season is the Smith Lake area (58%). This is followed by septic systems, atmospheric deposition, natural background, agriculture, urban areas, and timber harvest.

A similar source composition is shown for TP (**Figure 5-15**) with the Smith Lake area, septic systems, natural background, agriculture, urban areas, unpaved roads, and timber harvest as primary sources. Note that a portion of atmospheric deposition can be linked to an additional form of natural background loading.

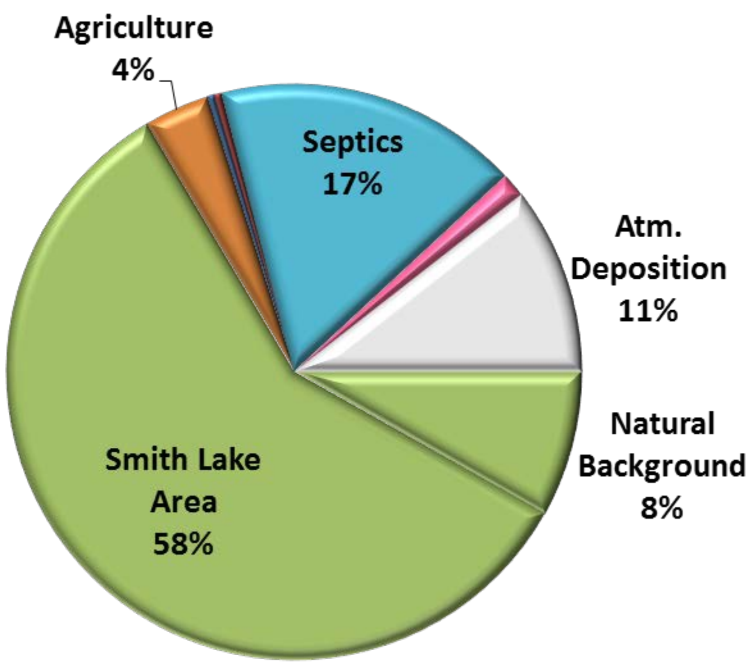


Figure 5-14. Contribution of TN Sources to Middle Ashley Creek during the Summer Growing Season.

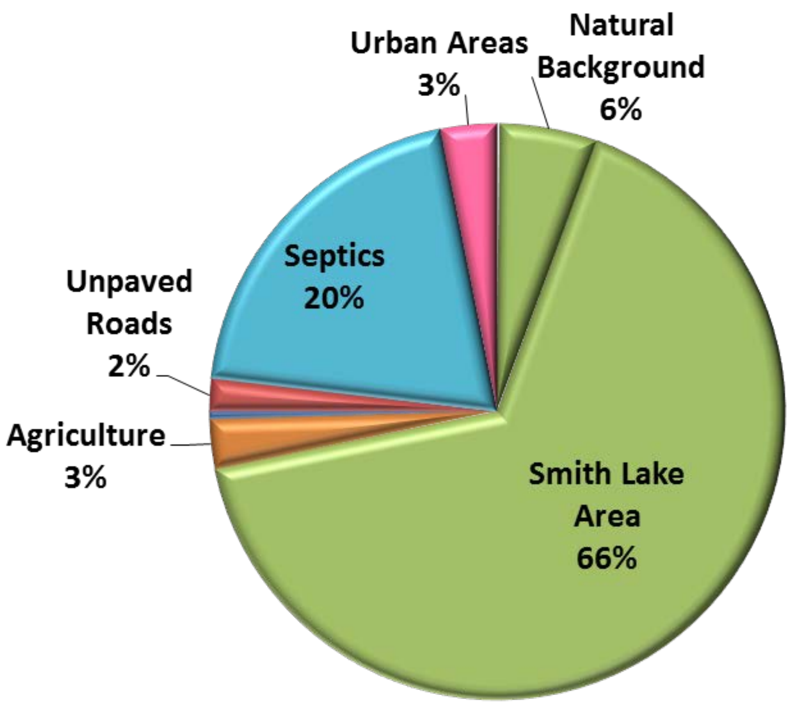
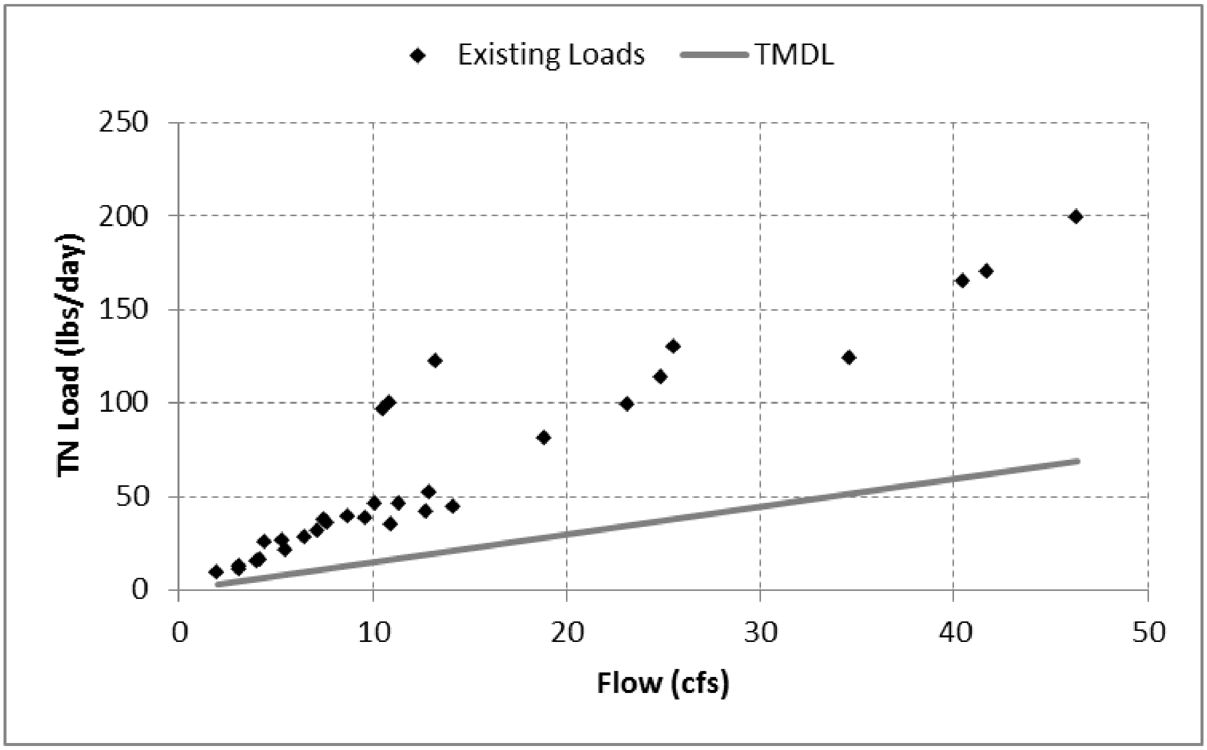


Figure 5-15. Contribution of TP Sources to Middle Ashley Creek during the Summer Growing Season

5.6.3.3 TN TMDL, Allocations, Current Loading, and Reductions for Middle Ashley Creek

Figure 5-16 shows the TN TMDL for middle Ashley Creek. The TMDL is shown as a line which represents the TN target (0.275 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TN loads need to be reduced by 53 to 84%, with a median reduction of 65%.



All points above the gray line are not meeting the TMDL.

Figure 5-16. Measured TN loads in Comparison to the TMDL

Because the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TN. Although the source assessment for the middle Ashley Creek subwatershed indicates that septic systems, agriculture, urban areas, and timber harvest contribute the most controllable human-caused TN loading (see **Figure 5-14**); the origination of loading in the Smith Lake area could also be linked to human-caused TN loading from agriculture or other existing or historical land uses. Load reductions should focus on limiting and controlling TN loading from controllable sources. Meeting load allocations for middle Ashley Creek may be achieved through a variety of water quality planning and implementation actions which are addressed in **Section 9**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TN TMDL includes a WLA for the permitted MS4 stormwater discharge and a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\mathbf{TMDL = WLA_{Kalispell\ MS4} + LA}$$

5.6.3.3.1 Kalispell MS4

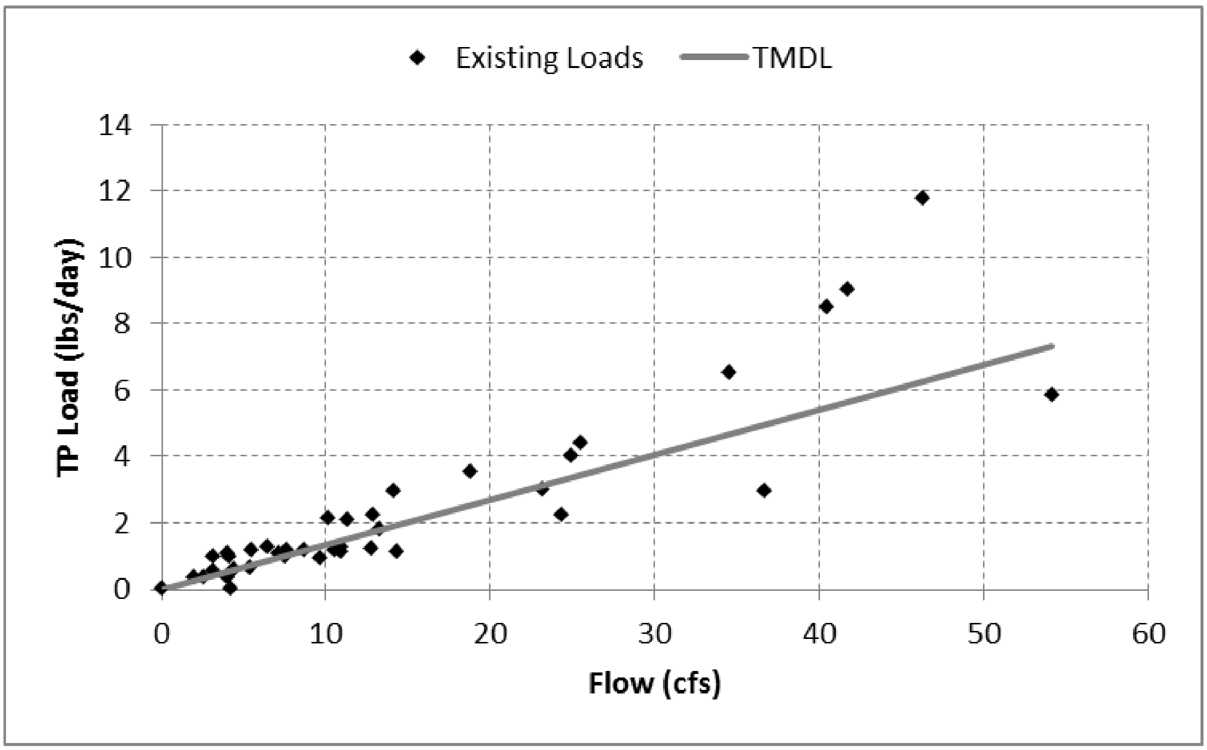
The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TN WLA of 292 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their general stormwater permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.3.3.2 Load Allocations

The remainder of the loading in middle Ashley Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite LA is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. It also accounts for the uncertainty regarding the origination of the TN loading from the Smith Lake Area, giving watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.3.4 TP TMDL, Allocations, Current Loading, and Reductions for Middle Ashley Creek

Figure 5-17 shows the TP TMDL for middle Ashley Creek. The TMDL is shown as a line which represents the TP target (0.025 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TN loads need to be reduced by 4 to 58%, with a median reduction of 36%.



All points on or below the gray line are meeting the TMDL.

Figure 5-17. Measured TP loads in Comparison to the TMDL.

Because a proportion of the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TP. Although the source assessment for the middle Ashley Creek subwatershed indicates that septic systems, agriculture, urban areas, and unpaved roads contribute the most controllable human-caused TP loading (see **Figure 5-15**); the origination of loading in the Smith Lake area could also be linked to human-caused TP loading from agriculture or other existing or historical land uses. Load reductions should focus on limiting and controlling TP loading from controllable sources. Meeting load allocations for middle Ashley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TP TMDL includes a WLA for the permitted MS4 stormwater discharge and a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\mathbf{TMDL = WLA_{Kalispell\ MS4} + LA}$$

5.6.3.4.1 Kalispell MS4

The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TP WLA of 15 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their general stormwater permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.3.4.2 Load Allocations

The remainder of the loading in middle Ashley Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. It also accounts for the uncertainty regarding the origination of the TP loading from the Smith Lake Area, giving watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.3.5 Example TMDL

This section of the document provides an example TMDL, existing load, and allocations based on a single flow rate and in-stream concentration. Note that the middle Ashley Creek TMDLs and allocations apply, and will vary, across the range of flows that may be observed during the summer growing season.

The following is an example of the TMDLs, existing loads, and allocations using an *average* observed flow of 14.91 cfs, using data contained in DEQ's assessment record (refer to **Table B-1** in **Appendix B** for a tabular summary of the data used for the TMDL calculations). The example TMDL, load allocation, and current loading for a flow of 14.91 cfs are summarized in **Table 5-29** for TN and **Table 5-30** for TP**.**

Total Nitrogen

The TN TMDL target is 0.275 mg/L, and the *average* observed concentration is 0.84 mg/L.

TMDL = (target)(flow)(5.4)
= (0.275 mg/L) (14.91 cfs) (5.4)
= 22.14 lbs/day

Existing Load = (observed)(flow)(5.4)
= (0.84 mg/L) (14.91 cfs) (5.4)
= 67.63 lbs/day

Total Phosphorus

The TP TMDL target is 0.025 mg/L, and the *average* observed concentration is 0.03 mg/L.

TMDL = (target)(flow)(5.4)
= (0.025 mg/L) (14.91 cfs) (5.4)
= 2.01 lbs/day

Existing Load = (observed)(flow)(5.4)
= (0.03 mg/L) (14.91 cfs) (5.4)
= 2.42 lbs/day

Table 5-29. Example TN TMDL, Current Loads, and Allowable Loads for Middle Ashley Creek (at an Example Flow of 14.91 cfs)

TN Sources	Existing Load (lbs/day) (1)	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA (2)	NA (2)	NA (2)
Nonpoint Sources + Natural Background	67.63	67%	LA = 22.14
Total	**67.63**	**67%**	**TMDL = 22.14** (3)

[1] The total load (67.63 lb/day) is based on a flow of 14.91 cfs and average measured TN concentration of 0.38 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See **Section 5.6.1** for additional information.
[3] The total allowable load is based on a flow of 14.91 cfs and the TMDL target of 0.275 mg/L.
Note: All values are rounded to the nearest one-hundredth. The summation of values per column may not sum to the values shown in the Total row due to rounding.

Table 5-30. Example TP TMDL, Current Loads, and Allowable Loads for Middle Ashley Creek (at an Example Flow of 14.91 cfs)

TP Sources	Existing Load (lbs/day) (1)	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA (2)	NA (2)	NA (2)
Nonpoint Sources + Natural Background	2.42	17%	LA = 2.01
Total	**2.42**	**17%**	**TMDL = 2.01** (3)

[1] The total load (2.01 lb/day) is based on a flow of 14.91 cfs and average measured TP concentration of 0.03 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See **Section 5.6.1** for additional information.
[3] The total allowable load is based on a flow of 14.91 cfs and the TMDL target of 0.025 mg/L.
Note: All values are rounded to the nearest one-hundredth. The summation of values per column may not sum to the values shown in the Total row due to rounding.

5.6.4 Lower Ashley Creek MT76O002_030

5.6.4.1 Assessment of Water Quality Results for Lower Ashley Creek

This impaired segment of Ashley Creek begins at the Kalispell Airport Road and generally flows southeast and east 13.17 miles until it discharges to the Flathead River. This reach flows through primarily agriculture, residential, and urban areas. The contributing watershed encompasses an area of 324 square miles, including the Upper and middle Ashley Creek subwatersheds (described previously) and Spring Creek (discussed in **Section 5.6.5**). There are an estimated 3,353 septic systems within the watershed contributing to the impaired segment. A portion of the City of Kalispell's Small MS4 (MTR040005) also contributes to lower Ashley Creek. Also, the City of Kalispell's WWTP is authorized to discharge wastewater and four industrial sites and one construction site are authorized to discharge stormwater within the subwatershed contributing to this reach.

As discussed in **Section 5.4.3.3**, and based on the data set contained in DEQ's assessment record, all of the TN samples evaluated as part of DEQ's impairment assessment exceeded the target (0.275 mg/L). All of the TP concentrations exceeded the target (0.025 mg/L), except at site C11AHLYC01 near the mouth where most of the TP concentrations exceed the target. Altogether, 12 of 12 TN concentrations and 18 of 20 TP concentrations exceeded the targets. As shown in **Figure 5-7** and **Figure 5-8** , both TN and TP concentrations increase downstream from the Kalispell WWTP discharge.

5.6.4.2 Assessment of Loading by Source Categories for Lower Ashley Creek

Figure 5-18 and **Figure 5-19** show the percentage of TN and TP loading from the various sources in lower Ashley Creek, respectively (based on the LSPC model). Both pie charts represent cumulative loads including upper Ashley Creek, middle Ashley Creek, and Spring Creek. The LSPC model results indicate that the Smith Lake area is the greatest contributor of nitrogen to lower Ashley Creek (35 percent). Point sources (i.e., the Kalispell WWTP MT0021938) contribute 30% followed by septic systems at 15%. The remaining sources (atmospheric deposition, natural background, agriculture, and urban) each comprise less than 7% of the total estimated load.

The Smith Lake area is also the largest source of phosphorus, at 46% of the total load. This is followed by septic systems (20%) and the Kalispell WWTP (16%). Urban, natural background, agriculture, and unpaved roads contribute the remainder, each at less than 8%. Note that a portion of atmospheric deposition can be linked to an additional form of natural background loading.

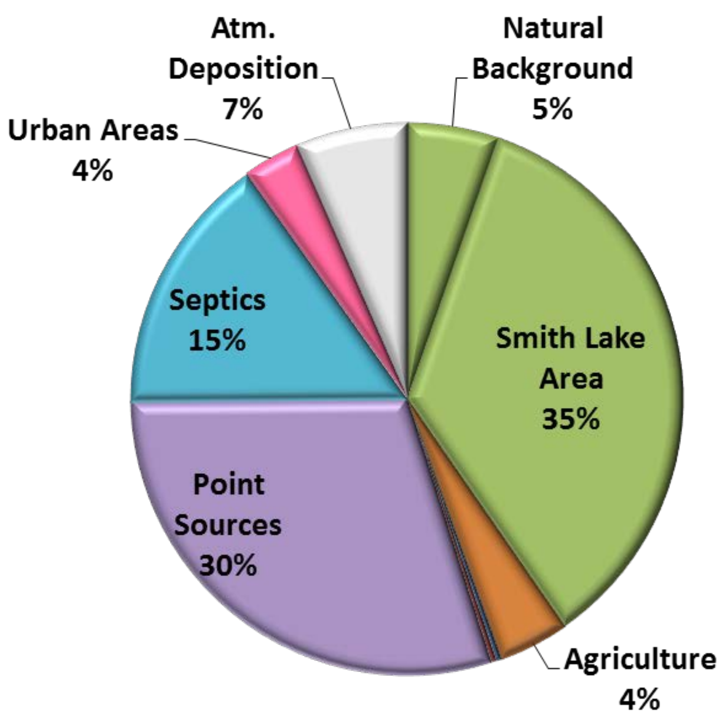


Figure 5-18. Contribution of TN Sources to Lower Ashley Creek during the Summer Growing Season

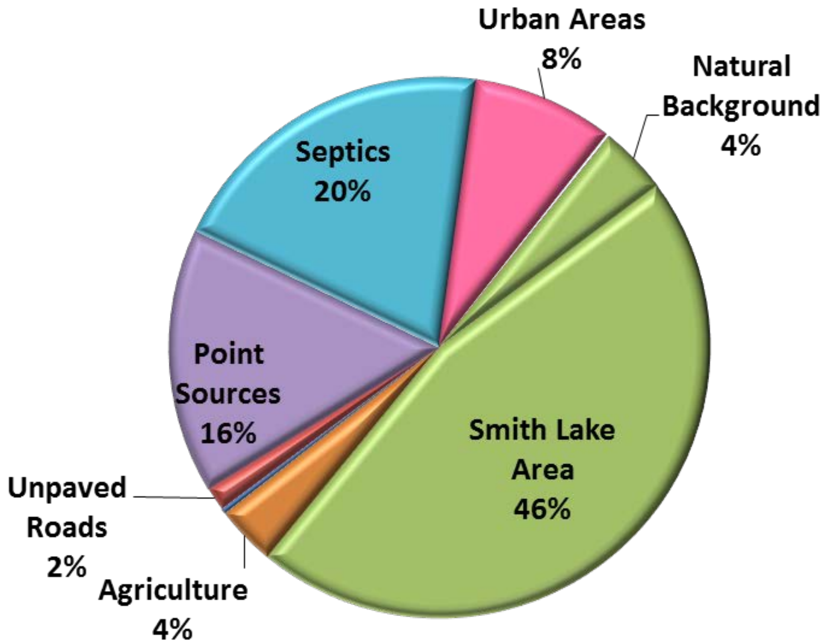
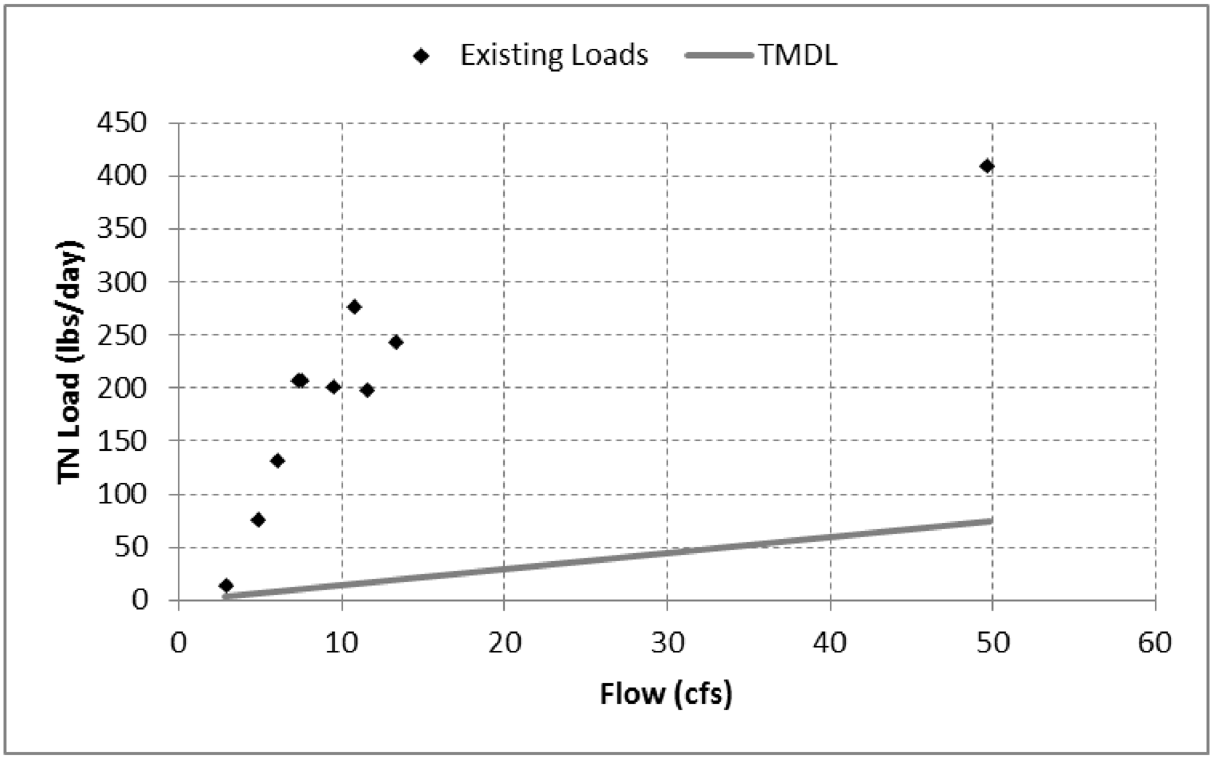


Figure 5-19. Contribution of TP Sources to Lower Ashley Creek during the Summer Growing Season

5.6.4.3 TN TMDL, Allocations, Current Loading, and Reductions for Lower Ashley Creek

Figure 5-20 shows the TN TMDL for lower Ashley Creek. The TMDL is shown as a line which represents the TN target (0.275 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TN loads need to be reduced by 67 to 97%, with a median reduction of 92%.



All points above the gray line are not meeting the TMDL.

Figure 5-20. Measured TN loads in Lower Ashley Creek in Comparison to the TMDL

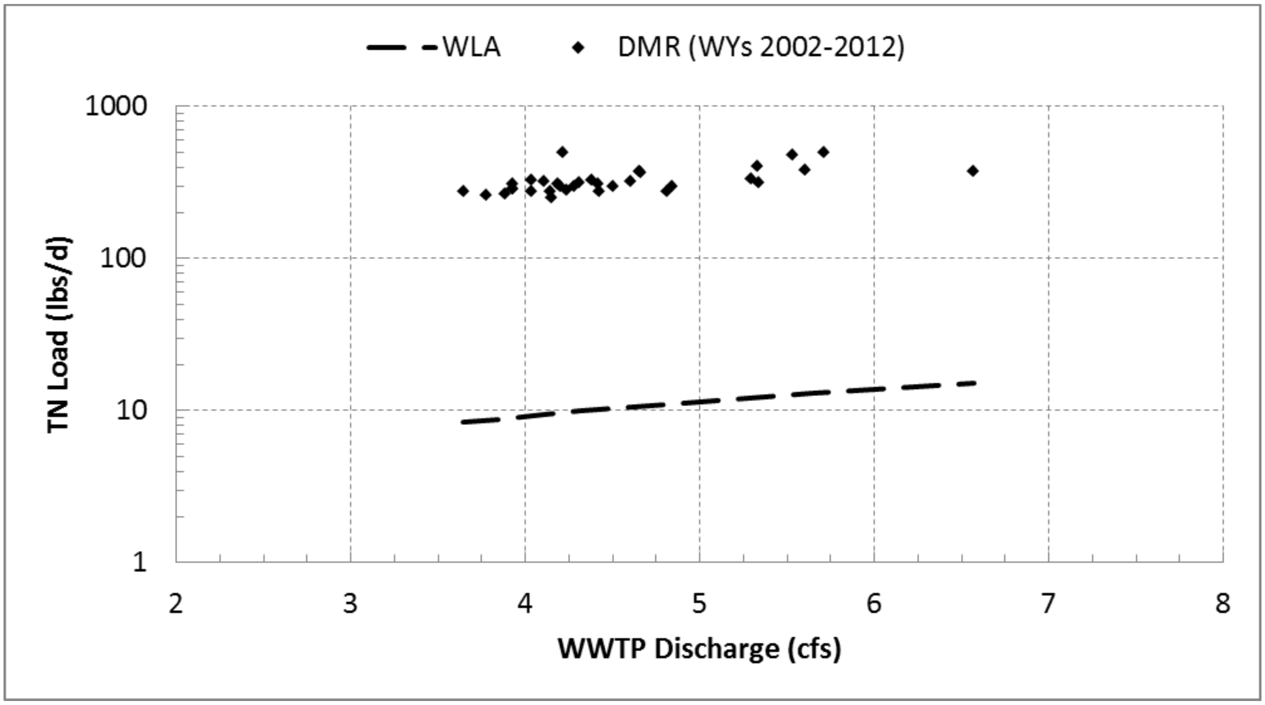
Because the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TN. Although the source assessment for the lower Ashley Creek subwatershed indicates that point sources and septic systems contribute the most controllable human-caused TN loading (see **Figure 5-18**); the origination of loading in the Smith Lake area could also be linked to human-caused TN loading from agriculture or other existing or historical land uses. Load reductions should focus on limiting and controlling TN loading from controllable sources. Meeting load allocations for lower Ashley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TN TMDL includes separate WLAs for the permitted MS4 stormwater discharge and treated wastewater from the Kalispell WWTP and a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\textbf{TMDL} = \textbf{WLA}_{\text{Kalispell WWTP (wastewater)}} + \textbf{WLA}_{\text{Kalispell MS4}} + \textbf{LA}$$

5.6.4.3.1 Kalispell WWTP

The TN WLA for the City of Kalispell’s WWTP is based on meeting the end of pipe criteria of 0.275 mg/L during the summer algae growing season of July 1 through September 30. Meeting this concentration “at the end of pipe” means that no maximum flow or load limits are necessary. **Figure 5-21** shows measured effluent data compared to the flow-variable WLA. Recent TN Discharge Monitoring Report (DMR) data for 30-day average discharge concentrations for June and July 2014 are approximately 6 mg/L. This represents one of the highest levels of TN treatment for a WWTP discharge in Montana. Yet, a 95% reduction is still required to meet the WLA concentration, thus justifying a staged WLA implementation if a variance is granted as discussed in **Section 5.6.1.1.**



The dashed line representing the WLA is shown over the range of discharges from the WWTP during the summer growing season from water years 2002 through 2012.

Figure 5-21. WLA for TN from the Kalispell WWTP

5.6.4.3.2 Kalispell MS4

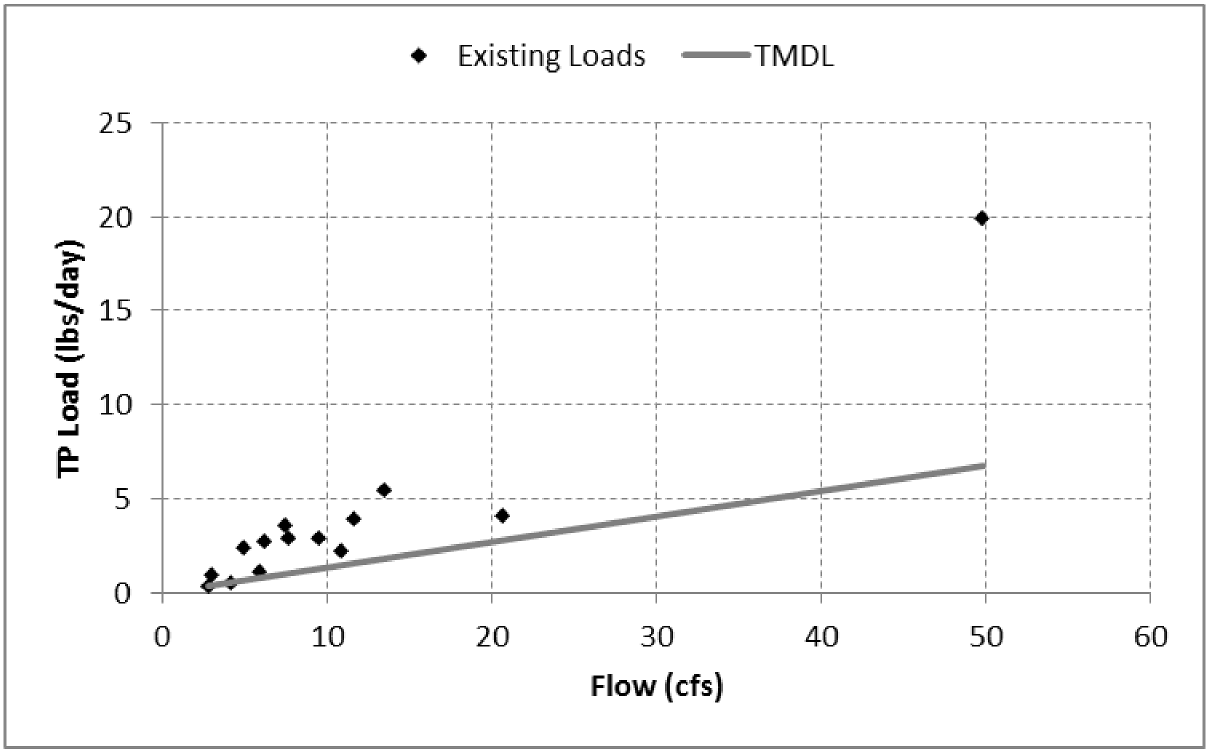
The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TN WLA of 1030 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their most recent permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.4.3.3 Load Allocations

The remainder of the loading in lower Ashley Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. It also accounts for the uncertainty regarding the origination of the TN loading from the Smith Lake Area, giving watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.4.4 TP TMDL, Allocations, Current Loading, and Reductions for Lower Ashley Creek

Figure 5-22 shows the TP TMDL for lower Ashley Creek. The TMDL is shown as a line which represents the TP target (0.025 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TP loads need to be reduced by 26 to 71%, with a median reduction of 63%.



All points on or below the gray line are meeting the TMDL.

Figure 5-22. Measured TP loads in Comparison to the TMDL

Because a proportion of the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TP. Although the source assessment for the lower Ashley Creek watershed indicates that septic systems, point sources, urban areas, and agriculture contribute the most controllable human-caused TP loading (see **Figure 5-19**); the origination of loading in the Smith Lake area could also be linked to human-caused TP loading from agriculture or other existing or historical land uses. Load reductions should focus on limiting and controlling TP loading from controllable sources. Meeting load allocations for lower Ashley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9**.

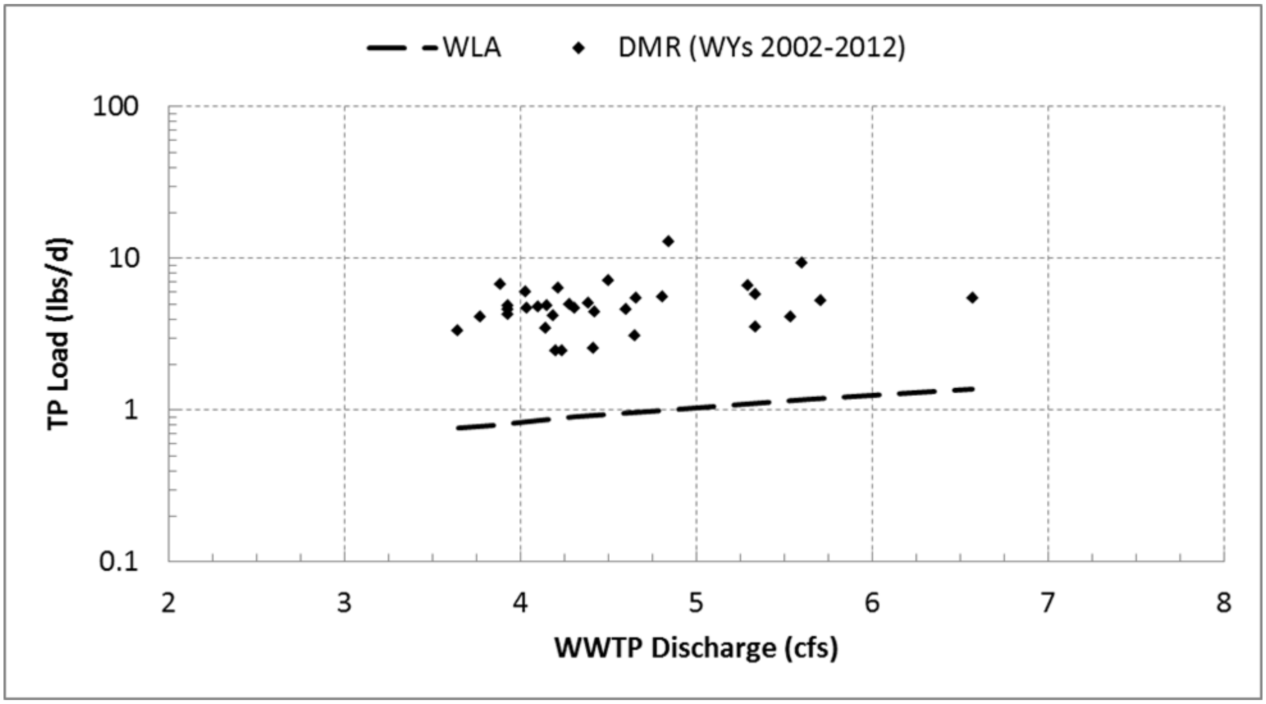
The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TP TMDL includes separate WLAs for the permitted MS4 stormwater discharge and treated wastewater from the Kalispell WWTP and includes a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\mathbf{TMDL = WLA_{Kalispell\ WWTP\ (wastewater)} + WLA_{Kalispell\ MS4} + LA}$$

5.6.4.4.1 Kalispell WWTP

The TP WLA for the City of Kalispell’s WWTP is based on meeting the end of pipe criteria of 0.025 mg/L during the summer algae growing season of July 1 through September 30. Meeting this concentration “at the end of pipe” means that no maximum flow or load limits are necessary. **Figure 5-23** shows measured effluent data compared to the flow-variable WLA. Recent TP Discharge Monitoring Report

(DMR) data for 30-day average discharge concentrations for June and July 2014 are approximately 0.085 mg/L. This represents one of the highest levels of TP treatment for a WWTP discharge in Montana. Yet, a 70% reduction is still required to meet the WLA concentration, thus justifying a staged WLA implementation if a variance is granted as discussed in **Section 5.6.1.1.**



The dashed line representing the WLA is shown over the range of discharges from the WWTP during the summer growing season from water years 2002 through 2012.

Figure 5-23. WLA for TP from the Kalispell WWTP

5.6.4.4.2 Kalispell MS4

The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TP WLA of 54 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their most recent permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.4.4.3 Load Allocations

The remainder of the loading in lower Ashley Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. It also accounts for the uncertainty regarding the origination of the TP loading from the Smith Lake Area, giving watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.4.5 Example TMDL

This section of the document provides an example TMDL, existing load, and allocations based on a single flow rate and in-stream concentration. Note that the lower Ashley Creek TMDLs and allocations apply, and will vary, across the range of flows that may be observed during the summer growing season.

The following is an example of the TMDLs, existing loads, and allocations using an *average* observed flow of 13.6 cfs, using data contained in DEQ's assessment record (refer to **Table B-1** in **Appendix B** for a tabular summary of the data used for the TMDL calculations). The example TMDL, load allocation, and current loading for a flow of 13.6 cfs are summarized in **Table 5-31** for TN and **Table 5-32** for TP.

<u>Total Nitrogen</u>

The TN TMDL target is 0.275 mg/L, and the *average* observed concentration is 3.14 mg/L.

TMDL = (target)(flow)(5.4)
= (0.275 mg/L) (13.6 cfs) (5.4)
= 20.20 lbs/day

Existing Load = (observed)(flow)(5.4)
= (3.14 mg/L) (13.6 cfs) (5.4)
= 230.60 lbs/day

<u>Total Phosphorus</u>

The TP TMDL target is 0.025 mg/L, and the *average* observed concentration is 0.06 mg/L.

TMDL = (target)(flow)(5.4)
= (0.025 mg/L) (13.6 cfs) (5.4)
= 1.84 lbs/day

Existing Load = (observed)(flow)(5.4)
= (0.06 mg/L) (13.6 cfs) (5.4)
= 4.41 lbs/day

Table 5-31. Example TN TMDL, Current Loads, and Allowable Loads for Lower Ashley Creek (at an Example Flow of 13.6 cfs)

TN Sources	Existing Load (lbs/day) (1)	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA (2)	NA (2)	NA (2)
Kalispell WWTP (Wastewater)	68.70 (3)	91% (3)	WLA = 6.22 (3)
Nonpoint Sources + Natural Background	161.90	91%	LA = 13.98
Total	**230.60**	**91%**	**TMDL = 20.20** (4)

[1] The total load (230.60 lb/day) is based on a flow of 13.6 cfs and average measured TN concentration of 3.14 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See **Section 5.6.1** for additional information.
[3] The WLA for Kalispell WWTP (wastewater) is derived from end-of-pipe criteria and an average summer growing season discharge of 4.19 cfs. The existing load and percent reductions are based on modeled loading at a downstream location after uptake within Ashley Creek. The actual WWTP load contributed to Ashley Creek, if measured at the WWTP discharge, would be closer to 136 lbs/day, and the required reduction to meet the WLA would be approximately 95% as discussed in **Section 5.6.4.3.1**.
[4] The total allowable load is based on a flow of 13.6 cfs and the TMDL target of 0.275 mg/L.
Note: All values are rounded to the nearest one-hundredth. The summation of values per column may not sum to the values shown in the Total row due to rounding.

Table 5-32. Example TP TMDL, Current Loads, and Allowable Loads for Lower Ashley Creek (at an Example Flow of 13.6 cfs)

TP Sources	Existing Load (lbs/day) (1)	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA (2)	NA (2)	NA (2)
Kalispell WWTP (Wastewater)	0.70 (3)	19% (3)	WLA = 0.57 (3)
Nonpoint Sources + Natural Background	3.71	66%	LA = 1.27
Total	**4.41**	**58%**	**TMDL = 1.84** (4)

[1] The total load (230.60 lb/day) is based on a flow of 13.6 cfs and average measured TP concentration of 0.06 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See **Section 5.6.1** for additional information.
[3] The WLA for Kalispell WWTP (wastewater) is derived from end-of-pipe criteria and an average summer growing season discharge of 4.19 cfs. The existing load and percent reductions are based on modeled loading at a downstream location after uptake within Ashley Creek. The actual WWTP load contributed to Ashley Creek, if measured at the WWTP discharge, would be closer to 1.9 lbs/day, and the required reduction to meet the WLA would be approximately 70% as discussed in **Section 5.6.4.4.1**.
[4] The total allowable load is based on a flow of 13.6 cfs and the TMDL target of 0.025 mg/L.
Note: All values are rounded to the nearest one-hundredth. The summation of values per column may not sum to the values shown in the Total row due to rounding.

5.6.4.6 Dissolved Oxygen and Nitrate/Nitrite

As discussed in **Section 5.4.4**, the TN and TP TMDLs for lower Ashley Creek provide surrogate TMDLs and allocations to addresses the dissolved oxygen (DO) impairment cause to the lower Ashley Creek waterbody segment. Water quality improvements that address excess TN and TP loading should result in improved (i.e., increased) DO concentrations. Additionally, the TN TMDL for lower Ashley Creek provides a surrogate TMDL and allocations to address the nitrate/nitrite impairment cause to this segment of Ashley Creek. Water quality improvements that address excess TN loading will additionally result in decreased nitrate/nitrite loading and associated decreased nitrate/nitrite concentrations.

5.6.5 Spring Creek MT76O002_040

5.6.5.1 Assessment of Water Quality Results for Spring Creek

Spring Creek flows southeast 4.8 miles through largely agriculture, rural residential, and urban lands until it joins Ashley Creek (the middle segment from Smith Lake to Kalispell Airport Road). The contributing subwatershed is small: only 2,744 acres. There are an estimated 161 septic systems in the subwatershed. A portion of the City of Kalispell's Small MS4 and one construction site discharge stormwater to Spring Creek.

As discussed in **Section 5.4.3.3**, and based on the data set contained in DEQ's assessment record, almost all of the TN concentrations exceeded the target (0.275 mg/L). Most of the TP concentrations did not exceed the target (0.025 mg/L); one sample at each of sites C11SPRGC31 and C11SPRGC30 exceeded the TP target. Altogether, 12 of 13 TN concentrations and 2 of 14 TP concentrations exceeded the targets.

Nine of 13 nitrate results exceeded their target (0.100 mg/L) and nitrate failed the assessment tests. While chlorophyll-*a*, ash free dry weight, and periphyton test results passed, the macroinvertebrates test results failed. The assessment test failures of nitrate and macroinvertebrates are indicative of nutrient causes of impairments; these nutrient causes of impairment will be addressed through TP and TN TMDLs.

5.6.5.2 Assessment of Loading by Source Categories for Spring Creek

The LSPC model results indicate that septic systems contribute roughly half the nitrogen load to Spring Creek during the summer growing season (**Figure 5-24**), with agriculture and urban areas contributing the bulk of the remaining load. The source load distribution for phosphorus is similar (**Figure 5-25**). The model focused only on the land use within the valley contributing to Spring Creek, and did not account for any flows that may originate in hydraulically unconnected watersheds like Big Lost Creek, which may contribute subsurface flows to Spring Creek at various times of the year. This has likely led to underestimating the natural background contribution portion of the loading for TN and TP.

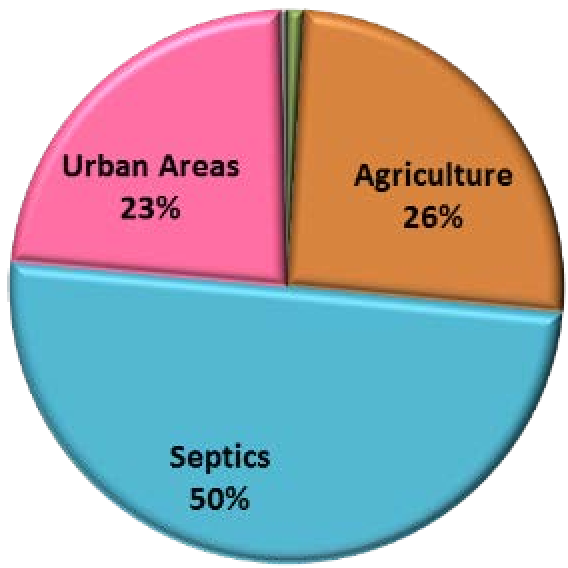


Figure 5-24. Contribution of TN Sources to Spring Creek during the Summer Growing Season

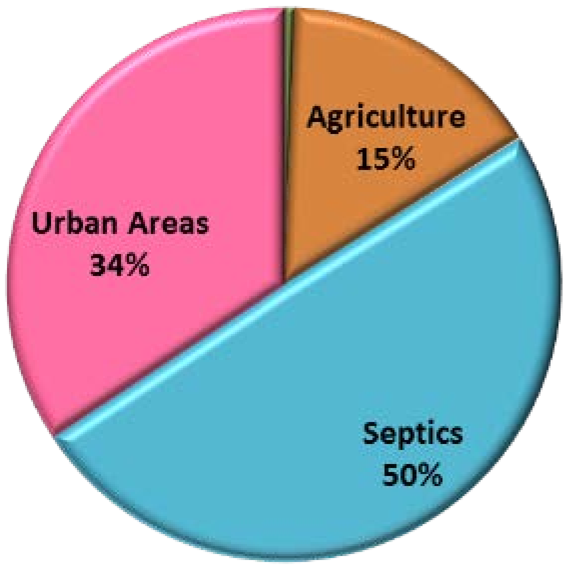
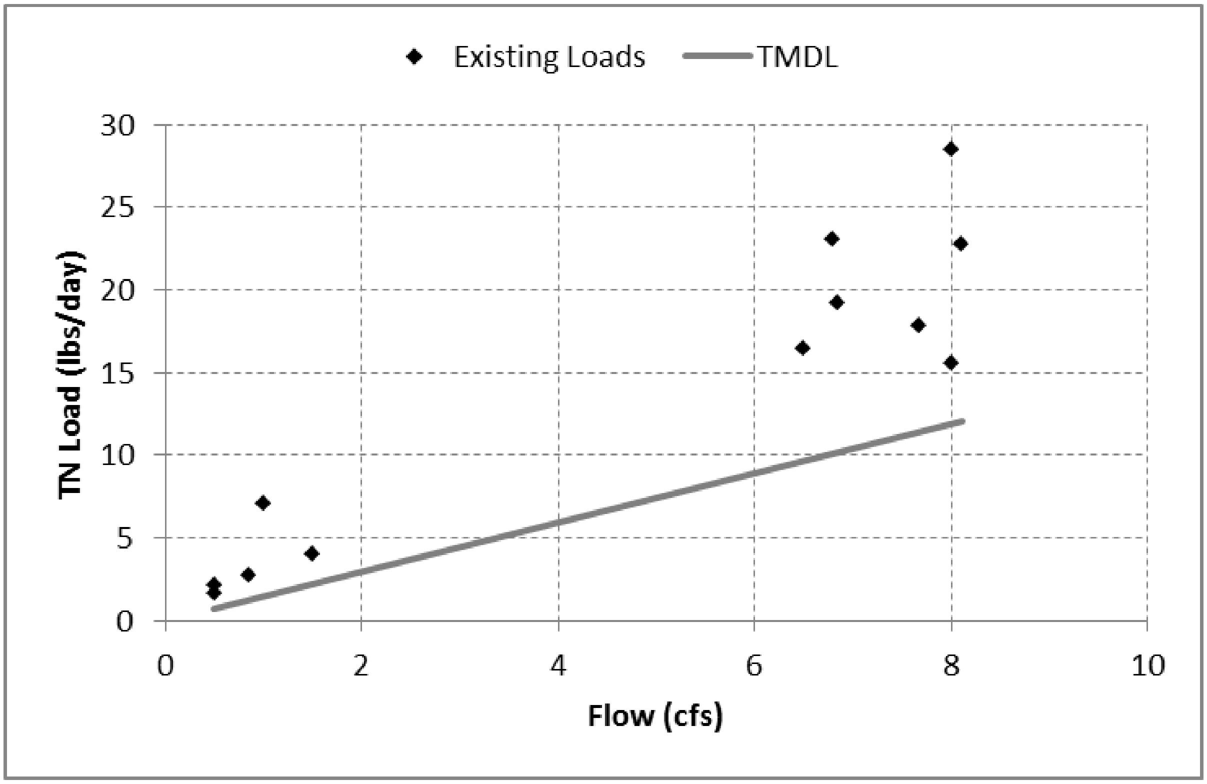


Figure 5-25. Contribution of TP Sources to Spring Creek during the Summer Growing Season

5.6.5.3 TN TMDL, Allocations, Current Loading, and Reductions for Spring Creek

Figure 5-26 shows the TN TMDL for Spring Creek. The TMDL is shown as a line which represents the TN target (0.275 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TN loads need to be reduced by 24 to 79%, with a median reduction of 51%.



All points above the gray line are not meeting the TMDL.

Figure 5-26. Measured TN loads in Comparison to the TMDL.

Because the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TN. The source assessment for the Spring Creek watershed indicates that septic systems, agriculture, and urban contribute the most controllable human-caused TN loading; load reductions should focus on limiting and controlling TN loading from these sources. Meeting load allocations for Spring Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9.0**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TN TMDL includes a WLA for the permitted MS4 stormwater discharge and a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\mathbf{TMDL = WLA_{Kalispell\ MS4} + LA}$$

5.6.5.3.1 Kalispell MS4

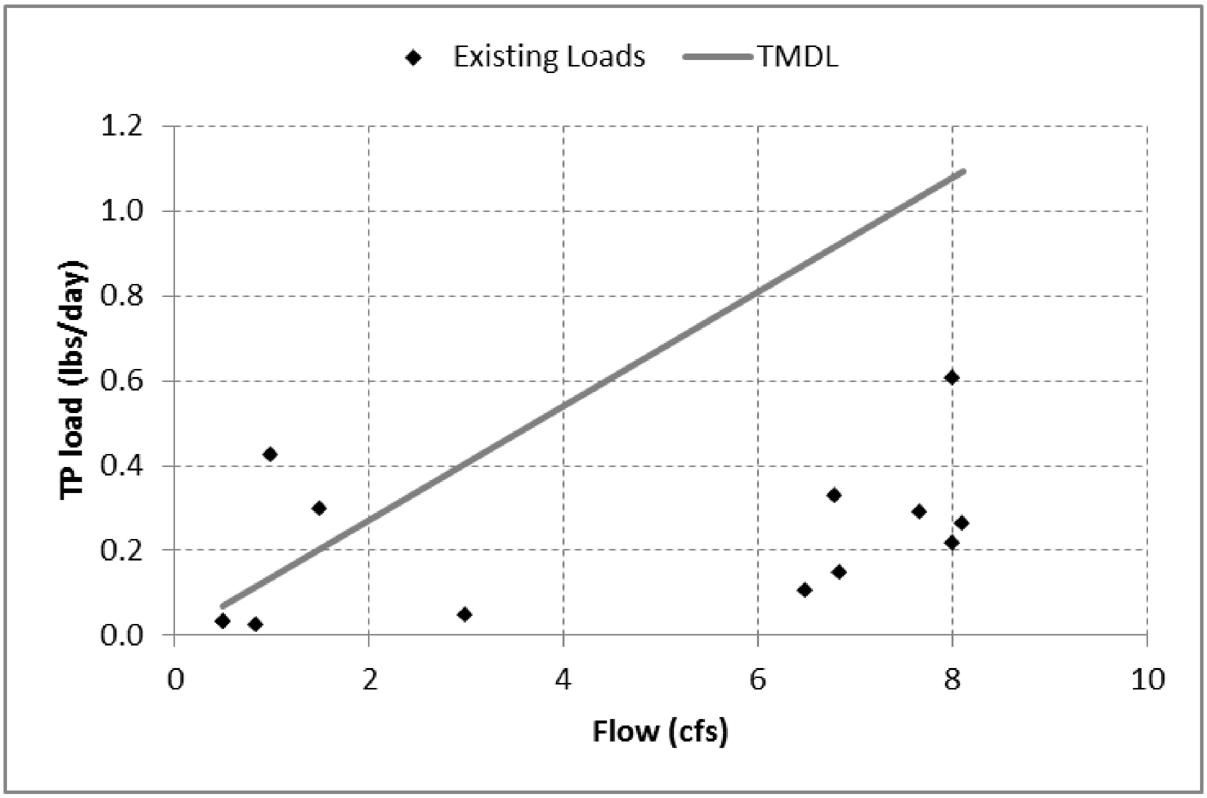
The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TN WLA of 269 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their general stormwater permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.5.3.2 Load Allocations

The remainder of the loading in Spring Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. Also, this method gives watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.5.4 TP TMDL, Allocations, Current Loading, and Reductions for Spring Creek

Figure 5-27 shows the TP TMDL for Spring Creek. The TMDL is shown as a line which represents the TP target (0.025 mg/L) multiplied by flow. Measured loads are also plotted on the graph and demonstrate that nutrient reductions are necessary to meet the TMDL over a wide range of flows. Based on the measured data, TP loads need to be reduced by 32 to 68%, with a median reduction of 50%.



All points on or below the gray line are meeting the TMDL.

Figure 5-27. Measured TP loads in Comparison to the TMDL

Because a proportion of the existing loads are greater than the TMDL, reductions are necessary to meet the water quality target for TP. The source assessment for the Spring Creek watershed indicates that septic systems, agriculture, and urban contribute the most controllable human-caused TP loading; load reductions should focus on limiting and controlling TP loading from these sources. Meeting load allocations for Spring Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9.0**.

The TMDL is also defined as the summation of allocations to point and nonpoint sources. The TP TMDL includes a WLA for the permitted MS4 stormwater discharge and includes a composite LA for nonpoint sources (including natural background) and is expressed via **Equation 3** as:

$$\mathbf{TMDL = WLA_{Kalispell\ MS4} + LA}$$

5.6.5.4.1 Kalispell MS4

The Kalispell MS4 system does not continuously discharge, and it only sporadically discharges during the dry summer growing season. Because of this, a daily WLA has not been calculated. Instead, a growing season TP WLA of 13 lbs is developed for the MS4 system as defined in **Section 5.6.1.2**. This WLA is not intended to add a concentration or load limit to the existing or future stormwater MS4 permits; implementation is instead based solely on the City of Kalispell following the monitoring and BMP requirements as outlined in their general stormwater permit. This requirement also applies to the Montana Department of Transportation as the MS4 co-permittee.

5.6.5.4.2 Load Allocations

The remainder of the loading in Spring Creek is allocated to nonpoint sources and natural background conditions. Rather than prescribing specific LAs to each of the nonpoint sources, a composite load allocation is presented. This is done to account for the fact that loading from the various nonpoint sources changes with location, time, and flow. Also, this method gives watershed stakeholders flexibility in deciding the best method for implementing nonpoint source reductions.

5.6.5.5 Example TMDL

This section of the document provides an example TMDL, existing load, and allocations based on a single flow rate and in-stream concentration. Note that the Spring Creek TMDLs and allocations apply, and will vary, across the range of flows that may be observed during the summer growing season.

The following is an example of the TMDLs, existing loads, and allocations using an *average* observed flow of 4.6 cfs, using data contained in DEQ's assessment record (refer to **Table B-1** in **Appendix B** for a tabular summary of the data used for the TMDL calculations). The example TMDL, load allocation, and current loading for a flow of 4.6 cfs are summarized in **Table 5-33** for TN and **Table 5-34** for TP.

Total Nitrogen

The TN TMDL target is 0.275 mg/L, and the *average* observed concentration is 0.59 mg/L.

TMDL **= (target)(flow)(5.4)**
= (0.275 mg/L) (4.6 cfs) (5.4)
= 6.83 lbs/day

Existing Load **= (observed)(flow)(5.4)**
= (0.59 mg/L) (4.6 cfs) (5.4)
= 14.66 lbs/day

Total Phosphorus

The TP TMDL target is 0.025 mg/L, and the *average* observed concentration is 0.079 mg/L.

TMDL **= (target)(flow)(5.4)**
= (0.025 mg/L) (4.6 cfs) (5.4)
= 0.62 lbs/day

Existing Load **= (observed)(flow)(5.4)**
= (0.079 mg/L) (4.6 cfs) (5.4)
= 1.96 lbs/day

Table 5-33. Example TN TMDL, Current Loads, and Allowable Loads for Spring Creek (at an Example Flow of 4.6 cfs).

TN Sources	Existing Load (lbs/day) [1]	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA [2]	NA [2]	NA [2]
Nonpoint Sources + Natural Background	14.66	53%	LA = 6.83
Total	**14.66**	**53%**	**TMDL = 6.83** [3]

[1] The total load (14.66 lb/day) is based on a flow of 4.6 cfs and average measured TN concentration of 0.59 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See **Section 5.6.1** for additional information.
[3] The total allowable load is based on a flow of 4.6 cfs and the TMDL target of 0.275 mg/L.
Note: All values are rounded to the nearest one-hundredth.

Table 5-34. Example TP TMDL, Current Loads, and Allowable Loads for Spring Creek (at an Example Flow of 4.6 cfs)

TP Sources	Existing Load (lbs/day) [1]	Percent Reduction	Allowable Load (lbs/day)
Kalispell MS4	NA [2]	NA [2]	NA [2]
Nonpoint Sources + Natural Background	1.96	68%	LA = 0.62
Total	**1.96**	**68%**	**TMDL = 0.62** [3]

[1] The total load (1.96 lb/day) is based on a flow of 4.6 cfs and average measured TP concentration of 0.079 mg/L.
[2] This example is for an average growing season day with no storm events and no discharges from the Kalispell MS4 system. See Section 5.6.1 for additional information.
[3] The total allowable load is based on a flow of 4.6 cfs and the TMDL target of 0.025 mg/L.
Note: All values are rounded to the nearest one-hundredth.

5.6.5.6 Dissolved Oxygen and Nitrate/Nitrite

As discussed in **Section 5.4.4**, the TN and TP TMDLs for Spring Creek provide surrogate TMDLs and allocations to addresses the dissolved oxygen (DO) impairment cause to Spring Creek. Water quality improvements that address excess TN and TP loading should result in improved (i.e., increased) DO concentrations. Additionally, the TN TMDL for Spring Creek provides a surrogate TMDL and allocations to address the nitrate/nitrite impairment cause to Spring Creek. Water quality improvements that address excess TN loading will additionally result in decreased nitrate/nitrite loading and associated decreased nitrate/nitrite concentrations.

5.7 Seasonality and Margin of Safety

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 to account for uncertainties between pollutant sources and the quality of the receiving waterbody, 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 Flathead-Stillwater TPA nutrient TMDL development process.

5.7.1 Seasonality

Addressing seasonal variations is an important and required component of TMDL development and throughout this plan seasonality is an integral consideration. Water quality and particularly nutrients concentrations are recognized to have seasonal cycles. Specific examples of how seasonality has been addressed within this document include:

- Water quality targets and subsequent allocations are applicable for the summer growing season for algae (July 1st – Sept 30th), to coincide with seasonal algal growth targets.
- Nutrient data used to determine compliance with targets and to establish allowable loads was collected during the summer growing season to coincide with applicable nutrient targets.

5.7.2 Margin of Safety

A margin of safety is a required component of TMDL development. The margin of safety accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. 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 (U.S. Environmental Protection Agency, 1999a). This plan addresses MOS implicitly in a variety of ways:

- Static nutrient target values (e.g., 0.100 mg/L nitrate, 0.300 mg/L TN, 0.030 mg/L TP) were used to calculate allowable loads (TMDLs). Allowable exceedances of nutrient targets were not incorporated into the calculation of allowable loads, thereby adding a MOS to established allocations.
- Target values were developed to err on the conservative side of protecting beneficial uses.
- By considering seasonality (discussed above) and variability in nutrient loading.
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development.

5.8 Uncertainty

Uncertainties in the accuracy of field data, nutrient targets, source assessment, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. Specific sources of uncertainty are discussed in the following sections. However, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation, as described in **Section 9.0**. The process of adaptive management is predicated on the basis that TMDL targets, allocations, and the analyses supporting them are not static, but are subject to modification and adjustment as new information and relationships are understood. Since uncertainty is inherent in both the water quality-based and model-based modes of assessing nutrient sources and needed reductions, the main sources of uncertainty are summarized below.

5.8.1 Water Quality Conditions (Discrete Samples)

It was assumed that discrete water-quality samples for Ashley Creek and Spring Creek are representative of current conditions. However, much of the data in the middle and upper segments of Ashley Creek were collected more than five years ago, and conditions in the stream may have changed since then. Additionally, some of the major tributaries to Ashley Creek (Mount Creek, Truman Creek) have few recently collected water quality data.

While there are numerous nutrient samples collected in each of the listed segments, chlorophyll-*a* data are limited and are only available from 2005 in Ashley Creek. Since this is a primary response variable that integrates nutrient exposure over time, additional monitoring should be completed to determine the extent of the chlorophyll/algae problems and their interaction with other response variables such as DO and pH. Similarly, DO data also were limited to a few number of grab samples that were mostly collected during the middle of the day. Thus the extent of diurnal variability in primary productivity, and associated excursion frequency is difficult to ascertain. Additional monitoring is recommended to determine the source and magnitude of daily DO changes and its linkage to nutrient loading.

5.8.2 Water Quality Targets

It was assumed that Ashley Creek and Spring Creek are similar to other streams that were used to develop the Northern Rockies ecoregion nutrient targets (uncertainties in the target development are discussed in Suplee and Watson (2013). However, both streams appear to have characteristics that are unique within the region. Ashley Creek has extensive wetland complexes and multiple in-channel lakes. Spring Creek originates from a low-elevation spring and not in the mountainous headwater regions like other Northern Rockies streams. Also, both streams have unusually high TN and TP concentrations for this region, often requiring large load reductions to meet the water quality targets and TMDLs. Additional studies are recommended in both streams to better define the natural background sources and determine if either creek warrants site-specific criteria that differ from the Northern Rockies ecoregion targets used for TMDL development in this document.

As described in Section 4.0 of the “Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers—Update 1,” DEQ recognizes that other reach-specific exceptions to the ecoregional criteria may be identified in the future and can be addressed on a case-by-case basis going forward (Suplee and Watson, 2013). If further investigation reveals that the TMDL targets cannot be achieved because of natural (non-human) loading, then these TMDL targets could be adjusted concurrent with the development of site specific nutrient criteria for either Ashley Creek or Spring Creek.

A future TN or TP target modification would have no impact on nonpoint sources or on the MS4 or other stormwater-permitted facilities. It would only affect the Kalispell WWTP WLA via a potential loading increase allowance consistent with any increases in upstream nutrient criteria, although resolution may not be necessary for about twenty years because of the variance process options allowed within state law (Montana Department of Environmental Quality, 2014c; 2014a) addressing point source nutrient discharge compliance for a facility such as the Kalispell WWTP.

5.8.3 Source Assessment

The assessment of nitrogen and phosphorus loading by source category reported in the previous sections is based largely on the results of an LSPC model, configured and calibrated for the Flathead-Stillwater TPA and the Ashley Creek watershed. Calibrations generally yielded acceptable results, however, there were difficulties in some locations of the watershed, in particular with several of the lakes in the watershed (e.g., Ashley Lake, Smith Lake, etc.), as well as a large wetland complex upstream of Smith Lake which potentially results in enhanced loadings. Calibration results and model uncertainty in the context of parameter and model uncertainty are described in detail in a separate section the Model Report (Tetra Tech, Inc., 2014b).

5.8.4 Wetlands

As stated previously, both measured data and model results suggest that an increase in nutrient loading occurs between Ashley Lake and Smith Lake; the region has been identified to contain a substantial amount of organic soils (>3,000 acres; Dean Sirucek, Flathead County Conservation District, personal communication, September 3, 2014) as well having an active wetland complex. Since DEQ was unable to quantitatively identify the cause of this loading increase, it was assumed that the nutrient loading is attributable to wetland dynamics and nutrient cycling. It is possible, however, that other sources may be present in this portion of the watershed and may be contributing to the nutrient load. Further investigation is needed to determine the exact source of the nutrient loading in upper Ashley Creek.

5.9 Protection of Downstream Uses

The Clean Water Act requires states and tribes to consider and protect downstream uses when setting water quality standards and developing TMDLs. Flathead Lake is located downstream of Ashley Creek, and it is currently listed as impaired because of TN and TP. TMDLs completed for the lake in 2001 required a 15% reduction in both TN and TP to achieve water quality standards. However, no allocations were provided in the TMDL. A phased approach was proposed to give the agencies time to assess watershed sources and develop a water quality model to help quantify loads to the lake. Phase II of the TMDL is still ongoing, which may require additional nutrient load reductions in Ashley Creek and/or Spring Creek to meet annual load limits. If needed, nutrient TMDLs for Ashley Creek and Spring Creek will either be revised in the future to incorporate the findings of the Phase II Flathead Lake nutrient TMDLs or a new layer of allocations may instead be applied to address the annual loading since the existing allocations to the Ashley Creek watershed only apply during the algae growing season. In addition to Ashley Creek and Spring Creek, Flathead Lake Phase II TMDL allocations would also be applied to other tributaries throughout the Flathead Lake watershed. There are several approaches that could be used for setting these allocations. This could include allocations to multiple pollutant sources within a specific tributary, or application of load reductions to specific pollutant sources types across multiple tributaries. Note that tributary allocations can be developed for a downstream lake’s TMDL without writing a TMDL specific to each tributary.

6.0 Sediment TMDL Components

This portion of the document focuses on sediment as a cause of water quality impairment in the Flathead-Stillwater Total Maximum Daily Loads (TMDL) Planning Area (TPA). It describes: (1) how excess sediment impairs beneficial uses, (2) the affected stream segments, (3) the currently available data pertaining to sediment impairments in the watershed, (4) the sources of sediment based on recent studies, and (5) the proposed sediment TMDLs and their rationales.

6.1 Effects of Excess Sediment on Beneficial Uses

Sediment is a naturally occurring component of healthy and stable stream and lake ecosystems. Regular flooding allows sediment deposition to build floodplain soils and point bars, and it prevents excess scour of the stream channel. Riparian and wetland vegetation and natural instream barriers such as large woody debris (LWD), beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent or excessive sediment loading enters the system from increased bank erosion or other sources, it may alter channel form and function and affect fish and other aquatic life by increasing turbidity and causing excess sediment to accumulate in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

More specifically, sediment may block light and cause a decline in primary production, and it may also interfere with fish and macroinvertebrate survival and reproduction. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or fry. Effects from excess sediment are not limited to suspended or fine sediment; an accumulation of larger sediment (e.g., cobbles) can fill pools, reduce the percentage of desirable particle sizes for fish spawning, and cause channel overwidening (which may lead to additional sediment loading and/or increased temperatures). This larger sediment can also reduce or eliminate flow in some stream reaches where sediment aggrades within the channel, causing flow to go subsurface (May and Lee, 2004). Although fish and aquatic life are typically the most sensitive beneficial uses regarding sediment, excess sediment may also affect other uses. For instance, high concentrations of suspended sediment in streams can cause water to appear murky and discolored, negatively impacting recreational use, and can increase filtration costs for water treatment facilities that provide safe drinking water.

6.2 Stream Segments of Concern

A total of five waterbody segments in the Flathead-Stillwater TPA appeared on the 2014 Montana 303(d) List for sediment impairments (**Figure 6-1**): upper Ashley Creek from Ashley Lake to Smith Lake (MT76O002_010), Fish Creek from the headwaters to the mouth at Ashley Lake (MT76O002_050), Logan Creek from the headwaters to Tally Lake (MT76P001_030), Sheppard Creek from the headwaters to the mouth at Griffin Creek (MT76P001_050) and the Stillwater River from Logan Creek to the mouth (MT76P001_010). Middle Ashley Creek from Smith Lake to the Kalispell Airport Road (MT76O002_020), lower Ashley Creek from the Kalispell Airport Road to the mouth at the Flathead River (MT76O002_030), and Haskill Creek from Haskill Basin Pond to the mouth at the Whitefish River (MT76P003_070) did not appear on the 2014 303(d) List for sediment impairments but are evaluated in this document. All of these segments except for middle Ashley Creek are also impaired for various forms of habitat alterations (**Table 1-1**), which are non-pollutant causes commonly 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 non-pollutant impairments.

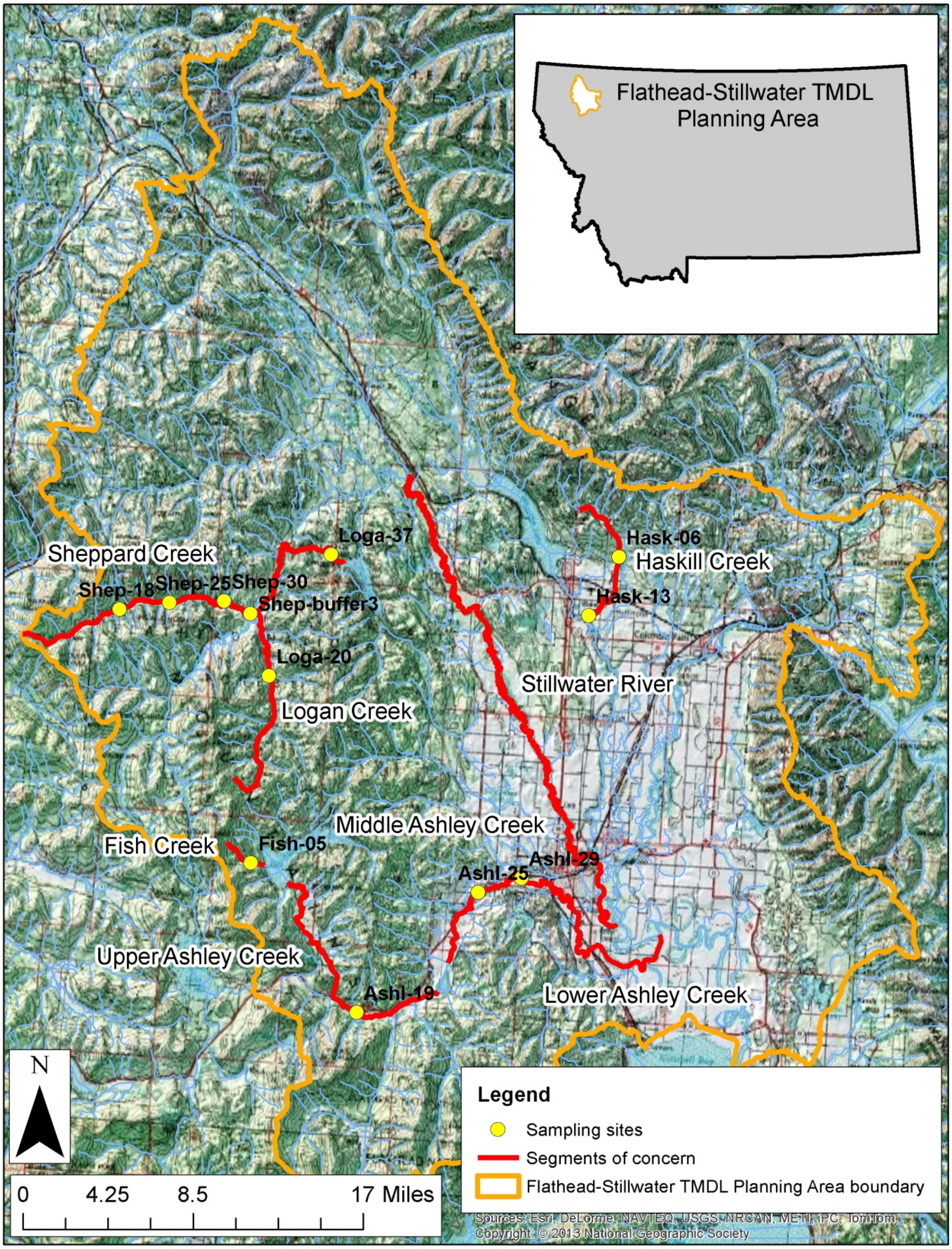


Figure 6-1. Streams segments evaluated in this document and sampling sites on these segments

6.3 Information Sources and Assessment Methods

For TMDL development, information sources and assessment methods fall within two general categories. The first category, discussed within this section, is focused on characterizing overall stream health with focus on sediment and related water quality conditions. The second category, discussed within **Section 6.6**, is focused on quantifying sources of sediment loading within the watershed.

6.3.1 Summary of Information Sources

To characterize sediment conditions for TMDL development purposes, a sediment data compilation was completed and additional monitoring was performed during 2008. The below listed data sources represent the primary information used to characterize water quality and/or develop TMDL targets.

- Department of Environmental Quality (DEQ) Assessment Files
- DEQ 2008 Sediment and Habitat Assessments (**Attachment A**)
- US Forest Service Pacfish/Infish Biological Opinion (PIBO) program data
- Other Data and Reports

6.3.2 DEQ Assessment Files

The DEQ assessment files contain information used to make the existing sediment impairment determinations. The assessment files include a summary of physical, biological, and habitat data collected and/or compiled by DEQ. The files also include information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationales.

6.3.3 DEQ's 2008 Sediment and Habitat Assessments

To aid in TMDL development, field measurements of channel morphology and riparian and instream habitat parameters were collected in September 2008 from 10 reaches within six of the eight segments of concern (**Figure 6-1**; note: Shep-30 and Shep-buffer3 were not sampled and only have descriptive information). An additional 10 reaches within the Flathead-Stillwater TPA were sampled during the same time period; descriptions of these sites and the associated data can be found in **Attachment A**.

Initially, all streams were assessed aerially to characterize reaches by four main attributes not linked to human activity: stream order, valley gradient, valley confinement, and ecoregion. These attributes represent main factors influencing stream morphology, which in turn influence sediment transport and deposition.

The next step in the aerial assessment involved identifying near-stream land uses, since land management practices can influence stream morphology and sediment characteristics. The result was stratifying streams into reaches that allow for comparisons among those reaches of the same natural morphological characteristics, while also indicating stream reaches where land management practices may further influence stream morphology. The stream stratification, along with field reconnaissance, allowed DEQ to select monitoring reaches. Although ownership is not part of the reach type category, most reach type categories contain predominantly either private or public lands.

Monitoring reaches on sediment-listed streams were chosen to represent various reach characteristics, land-use categories, and human-caused influences. There was a preference toward sampling those reaches where human influences would most likely demonstrate impairment conditions, since one step in the TMDL development process is to further characterize sediment impairment conditions. Thus, this is a targeted sampling design that aims to assess a representative subset of reach types, while ensuring that reaches within each 303(d) listed waterbody with potential sediment impairment conditions are incorporated into the overall evaluation. Typically, the effects of excess sediment are most apparent in low-gradient, unconfined streams (Nolan and Marron, 1985; Nolan and Marron, 1988; Coats et al., 1985; Montgomery and Buffington, 1997) larger than 1st order (i.e., having at least one tributary; (Strahler, 1952)); this stream type was the focus of the field effort (**Table 6-1**). Although the TMDL development process necessitates this targeted sampling design, DEQ acknowledges this approach results in less certainty regarding conditions in 1st order streams and higher-gradient reaches, and that conditions within sampled reaches do not necessarily represent conditions throughout the entire stream.

Table 6-1. Stratified Reach Types and Sampling Site Representativeness within the Flathead-Stillwater TMDL Planning Area

Level III Ecoregion	Reach Type	Reach ID	Number Sampled
Canadian Rockies	CR-0-2-U	EFSC-12	1
	CR-2-2-U	STIL-12; WFSC-08	2
	CR-2-4-U	STIL-19; STIL-23	2
Northern Rockies	NR-0-2-U	EFSC-15	1
	NR-0-3-U	**HASK-13**; **LOGA-20**; **SHEP-25**; WFSC-18	4
	NR-0-4-U	**ASHL-19**; **ASHL-25**; **ASHL-29**; LOGA-45; STIL-33	5
	NR-2-2-U	EFSC-16; **SHEP-18**	2
	NR-2-3-U	**HASK-06**	1
	NR-2-4-U	**LOGA-37**	1
	NR-4-1-U	**FISH-05**	1

Note: Bold reach IDs are within the segments of concern and are explicitly discussed in **Section 6.4.2**

The field parameters assessed in 2008 include measures of stream channel morphology, fine sediment, stream habitat, riparian vegetation, and streambank erosion (Montana Department of Environmental Quality, 2012b). Although the sampling areas are frequently referred to as "sites" within this document, to help increase sample sizes and capture variability within assessed streams, stream reaches ranging from 500 to 2,000 feet in length (depending on the channel bankfull width) were assessed. Sampling reaches were broken into five cells of equal length. Generally, a single cross section measurement, pebble count, and riffle grid toss are performed in each cell, and stream habitat, riparian, and bank erosion measures are performed throughout the reach. Field parameters are briefly described in **Section 6.4**, and summaries of all field data and sampling protocols are contained in the 2009 Sediment and Habitat Assessment report (**Attachment A**).

6.3.4 Other Data and Reports

Several other documents that provide historical context to sediment sources, describe the sensitivity of watersheds to disturbance, provide information about current conditions or sources, and describe restoration work that has taken place were also used to help evaluate conditions within the stream segments of concern. These documents include the: *State Forest Land Management Plan* (Montana Department of Natural Resources and Conservation, 2011) and *Revised Phase 1 Total Maximum Daily Load Report for the Stillwater River, Northwest Montana* (River Design Group, Inc., 2003), as well as other Department of Natural Resources & Conservation (DNRC), U.S. Forest Service (USFS), and contractor documents. Physical habitat and fish data collected by the USFS and DNRC was used to augment source assessment for individual streams.

6.4 Water Quality Targets

The concept of water quality targets was presented in **Section 4.1**. This section provides the rationale for each sediment-related target parameter and discusses the basis of the target values.

In developing targets, natural variation within and among streams must be considered. As discussed in more detail in **Section 3.0** and **Appendix A**, DEQ uses the reference condition to gage natural variability and assess the effects of pollutants with narrative standards, such as sediment. The preferred approach to establishing the reference condition is using reference site data, but modeling, professional judgment, and literature values may also be used. DEQ defines "reference" as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, the reference condition reflects a waterbody's greatest potential for water quality given past and current land use. Although sediment water quality targets typically relate most directly to the aquatic life beneficial use, the targets protect all designated beneficial uses because they are based on the reference approach, which strives for the highest achievable condition.

Waterbodies used to determine reference conditions are not necessarily pristine. The reference condition approach is intended to accommodate natural variations from climate, bedrock, soils, hydrology, and other natural physiochemical differences, yet it allows differentiation between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology from human activity.

The basis for each water quality target value varies depending on the availability of reference data and sampling method comparability to the 2008 data. As discussed in **Appendix A**, there are several statistical approaches DEQ uses for target development. They include using percentiles of reference data or of the entire sample dataset, if reference data are limited. For example, if low values are desired (like with fine sediment), and there is a high degree of confidence in the reference data, the 75th percentile of the reference dataset is typically used.

If reference data are not available, and the sample streams are predominantly degraded, the 25th percentile of the entire sample dataset is typically used. However, percentiles may be used differently depending on whether a high or low value is desirable, how representative the data is, data variability, how severe human disturbance is to streams in the watershed, and the size of the dataset.

Additionally, the target value for some parameters may apply to all streams in the Flathead-Stillwater TPA, whereas others may be stratified by bankfull width, reach type characteristics (e.g., ecoregion, gradient, stream order, and/or confinement), or by Rosgen stream type, if those factors are determined to be important drivers for certain target parameters. Although the basis for target values may differ by parameter, the goal is to develop values that incorporate an implicit margin of safety (MOS) and that are achievable. MOS is discussed in additional detail in **Section 6.8.2**.

6.4.1 Targets

The sediment water quality targets for the Flathead-Stillwater TPA area are summarized in **Table 6-2** and described in detail in the sections that follow. These sediment-related targets are based on reference data from the Northern Rockies portion of the PIBO dataset, and sample data from East Fork Swift Creek and West Fork Swift Creek (both determined to be fully supporting by DEQ) during a 2008 DEQ sampling effort. The raw data from the Flathead-Stillwater TMDL Planning Area (TPA) is available by request from DEQ.

Consistent with Environmental Protection Agency (EPA) guidance for sediment TMDLs (U.S. Environmental Protection Agency, 1999b), water quality targets for the Flathead-Stillwater TPA are comprised of a combination of measurements of instream siltation, channel form, biological health, and habitat characteristics that contribute to loading, storage, and transport of sediment, or that demonstrate those effects. Water quality targets most closely linked to sediment accumulation or sediment-related effects to aquatic life habitat are given the most weight (i.e., fine sediment and biological indices). Target parameters and values are based on the current best available information, but they will be assessed during future TMDL reviews for their applicability and may be modified if new information provides a better understanding of reference conditions or if assessment metrics or field protocols are modified. For all water quality targets, future surveys should document stable (if meeting criterion) or improving trends. The exceedance of one or more target values does not necessarily equate to a determination that the information supports impairment; the relative degree to which one or more targets are exceeded are taken into account (as well as the current 303(d) listing status), and the combination of target analysis, qualitative observations, and sound, scientific professional judgment is crucial when assessing stream condition. 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 in **Table 6-2**, or special interpretation of the data relative to the sediment target values. Six of the targets described in **Table 6-2** (percentage of surface fine sediment in riffles < 2mm and < 6mm, percentage of surface fine sediment < 6mm in pool tails, bankfull width/depth ratio, residual pool depth, and pools/mile) are considered primary indicators of sediment impairment and are used by DEQ when making a sediment and/or habitat impairment determination (Kusnierz et al., 2013).

Table 6-2. Sediment Targets for the Flathead-Stillwater TMDL Planning Area

Parameter Type	Target Description	Criterion
Fine Sediment	Percentage of surface fine sediment in riffles via pebble count (reach average)[1]	A, B, & C channel types: 6 mm ≤ 17%; 2 mm ≤ 10% E channel types: 6 mm ≤ 30%; 2 mm ≤ 15%
	Percentage of surface fine sediment < 6mm in pool tails (reach average)[1]	Potential A & B channel types: ≤ 9% Potential C channel type: ≤ 24%
Channel Form and Stability	Riffle stability index	Potential B channel types only: ≤ 85
	Bankfull width/depth ratio (reach average; +/- 2.0 units)[1]	Potential A & E channel types: < 12 Potential B & C channel types: > 12
	Entrenchment ratio (reach average; +/- 0.2 units)	Potential A channel types: < 1.4 Potential B channel types: 1.4 – 2.2 Potential C & E channel types: > 2.2
Instream Habitat	Residual pool depth (reach average)[1]	< 38' bankfull width: ≥ 0.8 feet ≥ 38' bankfull width: ≥ 1.3 feet
	Pools/mile[1]	< 38' bankfull width: ≥ 36 ≥ 38' bankfull width: ≥ 25
Sediment Source	Significant and controllable sediment sources	Identification of significant and controllable anthropogenic sediment sources throughout the watershed and implementation of all appropriate best management practices
Biological Indices	Macroinvertebrate bioassessment metric	O/E ≥ 0.90
	Periphyton Increaser Taxa	Probability of Impairment ≤ 51%

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

6.4.1.1 Fine Sediment

The percent of surface fines <6 mm and <2 mm is a measurement of the fine sediment on the surface of a streambed and is directly linked to the support of the aquatic life beneficial use. Increasing concentrations of surficial fine sediment can negatively affect salmonid growth and survival, clog spawning redds, and smother fish eggs by limiting oxygen availability (Irving and Bjornn, 1984; Weaver and Fraley, 1991; Shepard et al., 1984; Suttle et al., 2004; Fudge et al., 2008). Excess fine sediment can also decrease macroinvertebrate abundance and taxa richness (Mebane, 2001; Zweig and Rabeni, 2001). Because similar concentrations of sediment can cause different degrees of impairment to different species (and even age classes within a species), and because the particle size defined as "fine" is variable (and some assessment methods measure surficial sediment while other measures also include subsurface fine sediment), literature values for harmful fine sediment thresholds are highly variable. Some studies of salmonid and macroinvertebrate survival found an inverse relationship between fine sediment and survival (Suttle et al., 2004) whereas other studies have concluded the most harmful percentage falls within 10% to 40% fine sediment (Bjornn and Reiser, 1991; Mebane, 2001; Relyea et al., 2000). Bryce (2010) evaluated the effect of surficial fine sediment (via reach transect pebble counts) on fish and macroinvertebrates and found that the minimum effect level for sediment <2 mm is 13% for fish and 10% for macroinvertebrates. Literature values are taken into consideration during fine sediment target development; however, because increasing concentrations of fine sediment are known to harm aquatic life, targets are developed using a conservative statistical approach consistent with **Appendix A** and consistent with Montana's water quality standard for sediment as described in **Section 3.2**in order to protect all beneficial uses.

Percent Surface Fine Sediment <6 mm and <2 mm in Riffles via Pebble Count

Surface fine sediment measured in riffles by the modified (Wolman, 1954) pebble count indicates the particle size distribution across the channel width and is an indicator of aquatic habitat condition that can point to excessive sediment loading. Pebble counts in 2008 were performed in three riffles per sampling reach for a minimum of 300 particles.

Riffle pebble count reference data collected for the PIBO dataset (1998 – 2003) were combined with pebble count data from East Fork Swift Creek and West Fork Swift Creek (n = 21) to determine the target for riffle substrate percent fine sediment <6 mm. This target is less than or equal to 17% based on the 75th percentile of the combined PIBO and DEQ datasets. PIBO data are not available for <2 mm but three sites on East Fork Swift Creek and two sites on West Fork Swift Creek were sampled for riffle fines <2 mm in 2008. These values ranged from 3 – 13%. Due to the lack of reference data, the target for <2 mm will be 10% based on the macroinvertebrate minimum effect level found by Bryce et al. (2010). Rosgen E channels tend to have a higher percentage of fine sediment than A, B, and C channels (which compose all of the 2008 DEQ assessment reaches); the PIBO riffle pebble count dataset was composed of B and C stream types. Although there is no robust dataset for E channel types in the Flathead-Stillwater TPA, (Bengeyfield, 2004) sampled 115 E channel reference sites in the Beaverhead Deerlodge National Forest; the target from this database is 30% fine sediment <6 mm with no data for particles <2 mm.

For A, B, and C channel types, 17% <6 mm and 10% <2 mm will be applied as fine sediment targets for riffle pebble counts. The target for riffle pebble count <6 mm is similar to that set in other TMDL documents within the Northern Rockies (e.g., Tobacco/Grave Creek/Prospect Creek/Kootenai-Fisher/Thompson: 15%, Yaak/Flathead Headwaters/St. Regis: 20%). The E channel target for riffle pebble fines <6 mm is 30%. Since the fine sediment <2 mm target for A, B, and C channels is roughly half of the

<6 mm target, this relationship was used to determine that 15% <2 mm will be applied as the riffle fine sediment target for E channels. The pebble count target values for E channels will carry less weight than for the other channel types because they are based on another ecoregion and have a higher level of uncertainty. Target values should be compared to the reach average value from pebble counts.

Percent Surface Fine Sediment <6mm in Pool Tails

Grid toss measurements in pool tails are a measure used to assess the level of fine sediment accumulation in potential fish spawning sites. A 49-point grid toss (Kramer et al., 1993) was used to estimate the percent surface fine sediment < 6mm in pool tails in the Flathead-Stillwater TPA, and three tosses, or 147 points, were performed and the average calculated for the spawning gravel substrate portion of each assessed pool tail. Riffle grid tosses were performed at all pool tails with potential spawning gravel (i.e., not all cobble).

For the pool tail grid toss targets, PIBO and the DEQ East Fork Swift Creek and West Fork Swift Creek pool tail data was used. The 75th percentiles of this combined dataset are 9% for A and B channel types and 24% for the C channels type. There is no target for the E channel type as the reference dataset only contained fine sediment pool tail values from two sites. The fines values from the 2008 DEQ dataset are likely lower than if they had been collected by PIBO as the DEQ method excludes pool tails where the assessor determined sediment was too coarse for spawning. This was done so that pools with substrate too large for fish to move and thus had no spawning potential, would not skew the dataset for a stream that does have pools with suitable spawning habitat. However, to be more comparable to available reference data, DEQ is changing its method to match PIBO protocols for pool tail grid toss. This change should be considered during future collection and evaluation of grid toss data in this project area, as a different target value may be necessary.

Reference data sets used for target setting for other TMDLs in the Northern Rockies ecoregion such as St Regis, Grave Creek, Prospect Creek, and Tobacco resulted in pool tail grid toss targets between 8% and 10%. For A and B channel types the pool tail grid toss target for fine sediment <6mm will be ≤ 9% for C and E channels, the target will be 26% <6 mm. Only two E channels were part of the dataset used to develop the target. As a result this target will carry less weight in E channels.

6.4.1.2 Channel Form and Stability

Parameters related to channel form indicate a stream's ability to store and transport sediment. Stream gradient and valley confinement are two significant controlling factors that determine stream form and function, however, alterations to the landscape and sediment input beyond naturally occurring amounts can affect channel form. Numerous scientific studies have found trends and common relationships between channel dimensions in properly functioning stream systems and those with a sediment imbalance. Two stream channel measurements and an indicator of stream bedload stability are used as targets in the Flathead-Stillwater TPA and are described below.

Width/Depth Ratio and Entrenchment Ratio

The width/depth ratio and the entrenchment ratio provide 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 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 when the stream attempts to regain a balance between sediment load and transport capacity.

Conversely, a decrease in the entrenchment ratio signifies a loss of access to the floodplain. Low entrenchment ratios indicate that stream energy is concentrated in-channel during flood events versus having energy dissipate to 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 (Rosgen, 1996; Knighton, 1998; Rowe et al., 2003).

Width/depth and entrenchment ratios were calculated as the average of five riffle cross-section measurements from each reach. In addition the potential stream type for each site was determined using valley type and parent material. The targets for width/depth ratio and entrenchment are based on those developed by (Rosgen, 1996) for specific stream types (see **Table 6-2**).

Riffle Stability Index

The Riffle Stability Index (RSI); (Kappesser, 2002) describes the mobile portion of substrate in a riffle. RSI has been shown to correlate with pool volume and to differ between reference and managed sites (Cross and Everest, 1995; Kappesser, 2002). In addition, (Cross and Everest, 1995) found bull trout (*Salvelinus confluentus*) redds nearly exclusively in reference streams with RSI less than 65. (Kappesser, 2002) suggests that when RSI values are greater than 85 in Rosgen B channel types they indicates poor watershed condition; therefore, the target for RSI in the Flathead-Stillwater TPA is 85 and is applicable to potential Rosgen B channel types.

6.4.1.3 Instream Habitat Measures

For instream habitat measures (i.e., residual pool depth and pool frequency), there is available reference data from PIBO. Both of the instream habitat measures are important indicators of sediment input and movement as well as fish and aquatic life support. However, they may be given less weight in the target evaluation if they do not seem to be directly related to sediment impacts. The use of instream habitat measures in evaluating or characterizing impairment needs to be considered from the perspective of whether these measures are linked to fine, coarse, or total sediment loading.

Residual Pool Depth

Residual pool depth, defined as the difference between the maximum depth and the tail crest depth, is a discharge-independent measure of pool depth and an indicator of the quality of pool habitat. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes and high flow periods (Bonneau, 1998; Nielson et al., 1994; Baigun, 2003). Similar to channel morphology measurements, residual pool depth integrates the effects of several stressors; pool depth can be decreased as a result of filling with excess sediment (fine or coarse), a reduction in-channel obstructions (such as large woody debris), and changes in-channel form and stability (Bauer and Ralph, 1999). A reduction in pool depth from channel aggradation may not only alter surface flow during the critical low flow periods, but may also reduce fish condition by altering habitat, food availability, and productivity (May and Lee, 2004; Sullivan and Watzin, 2010). Residual pool depth is typically greater in larger systems.

Although the residual pool depth measure is similar between DEQ's method and PIBO's methods, the definition of a pool varies between the two methods. The core definition of a pool for the PIBO protocol is defined as a depression in the streambed bounded by a "head crest" at the upstream end and "tail crest" at the downstream end with a maximum depth that is at least 1.5 times the pool tail depth and spans at least half of the wetted channel width (Archer et al., 2012). The DEQ method uses the PIBO definition of a pool but rather than including only pools that span at least half of the wetted width, pools are classified as large (> 2/3 bankfull channel width), medium (1/3 – 2/3 bankfull channel width), or small (< 1/3 bankfull channel width). When comparing the 2008 DEQ data for the Flathead-Stillwater TPA to the PIBO-based target, data from medium and large pools were combined. In comparison to the PIBO dataset, the 2008 sample dataset could have a smaller residual pool depth and a greater number of pools per mile since the DEQ protocol included smaller pools. However, residual pool depths in the sample dataset are generally not noticeably less than the PIBO depths (**Table 6-3**), indicating the slight protocol differences are not an issue and the reference dataset is appropriate to use for setting residual pool depth targets.

Table 6-3. Residual pool depth and pool count summary data for the 2008 Flathead-Stillwater and PIBO datasets

Dataset	Residual pool depth (feet)					Pools/mile				
	Min	25th	Median	75th	Max	Min	25th	Median	75th	Max
2008 Flathead-Stillwater	0.8	1.1	1.3	1.5	2.2	5	34	42	49	148
2001–2012 PIBO	0.6	0.9	1.2	1.9	4.6	4	28	40	56	261

The residual pool depth target differs based on the bankfull width of the stream site being sampled. The 25th percentile of the PIBO dataset combined with the DEQ East Fork Swift Creek and West Fork Swift Creek data for sites less than 38 feet bankfull width (≥ 0.8 feet) and for sites at least 38 feet bankfull width (≥ 1.3 feet) were chosen as targets for streams in the Flathead-Stillwater TPA. The target values should be assessed based on the reach average residual pool depth value. Because residual pool depths can indicate if excess sediment is limiting pool habitat, this parameter will be particularly valuable for future trend analysis using the data collected in 2008 as a baseline. Future monitoring should document an improving trend (i.e., deeper pools) at sites which fail to meet the target criteria, while a stable trend should be documented at established monitoring sites that are currently meeting the target criteria.

Pool Frequency

Pool frequency is another indicator of sediment loading that relates to changes in channel geometry and is an important component of a stream's ability to support the aquatic life beneficial use for many of the same reasons associated with the residual pool depth discussed above and also because it can be a major driver of fish density (Muhlfeld et al., 2001). Sediment may limit pool habitat by filling in pools with fines. Alternatively, aggradation of larger particles may exceed the stream's capacity to scour pools, thereby reducing the prevalence of this critical habitat feature. Pool frequency generally decreases as stream size (i.e., watershed area) increases.

Similar to the residual pool depth values, protocol differences generally did not result in noticeable differences in the pool frequency (**Table 6-3**), indicating the PIBO reference dataset is suitable for setting targets. As with residual pool depth, the 25th percentile of the combined PIBO and East Fork Swift Creek and West Fork Swift Creek dataset were used to identify targets for stream reaches less than 38 feet bankfull width (≥ 36 pools/mile) and for reaches at least 38 feet bankfull width (≥ 25 pools/mile) for streams in the Flathead-Stillwater TPA. Pools per mile should be calculated based the number of measured pools per reach and then scaled up to give a frequency per mile.

6.4.1.4 Sediment Supply and Sources

Anthropogenic Sediment Sources

The presence of anthropogenic sediment sources does not always result in sediment impairment of a beneficial use. When there are no significant identified anthropogenic 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. There are no specific target values associated with sediment sources, but the overall extent of human sources will be used to supplement any characterization of impairment conditions. This includes evaluation of human induced and natural sediment sources, along with field observations and watershed scale source assessment information obtained using aerial imagery and Geographic Information System (GIS) data layers. Because sediment transport through a system can take years or decades, and because channel form and stability can influence sediment transport and deposition, any evaluation of anthropogenic sediment impacts must consider both historical sediment loading as well as historical impacts to channel form and stability since the historical impacts still have the potential to contribute toward sediment and/or habitat impairment. Source assessment analysis will be provided by 303(d) listed waterbody in **Section 6.6**, with additional information in **Attachments A, B, and C** and **Appendices B** and **C**.

6.4.1.5 Biological Indices

Macroinvertebrates

Siltation exerts a direct influence on benthic macroinvertebrates assemblages by filling in spaces between gravel and by limiting attachment sites. Macroinvertebrate assemblages respond to siltation with a shift towards an increase in biomass of burrowing species as fine sediment increases (Suttle et al., 2004). Macroinvertebrate bioassessment scores are an assessment of the macroinvertebrate assemblage at a site, and DEQ uses one bioassessment method to evaluate stream condition and aquatic life beneficial-use support. Aquatic insect assemblages may be altered as a result of different stressors such as nutrients, metals, flow, and temperature, and the biological index values must be considered along with other parameters that are more closely linked to sediment.

The macroinvertebrate assessment tool used by DEQ is the Observed/Expected model (O/E). The rationale and methodology for the index are presented in (Montana Department of Environmental Quality, 2012d; Feldman and Jessup, 2012). The O/E 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 and is expressed as a ratio of the Observed/Expected taxa (O/E value). The O/E community shift point for all Montana streams is any O/E value < 0.90. Therefore, an O/E score of ≥ 0.90 is established as a sediment target in the Flathead-Stillwater TPA.

An index score greater than the threshold value is desirable, and the result of each sampling event is evaluated separately. Because index scores may be affected by other pollutants or forms of pollution such as habitat disturbance, they will be evaluated in consideration of more direct indicators of excess sediment. Because the macroinvertebrate sample frequency and spatial coverage is typically low for each watershed and because of the extent of research showing the harm of excess sediment to aquatic life, meeting the macroinvertebrate target does not necessarily indicate a waterbody is fully supporting its aquatic life beneficial use. Measures that indicate an imbalance in sediment supply and/or transport capacity will be used in concert with macroinvertebrate data for TMDL development determinations.

The O/E model is very sensitive to the macroinvertebrate collection method and DEQ has determined that it is not appropriate to use the O/E model to evaluate macroinvertebrate health using samples collected by the Hess or Surber methods. Unless noted otherwise, macroinvertebrate samples discussed within this document were collected according to DEQ protocols.

Periphyton

Periphyton are algae that live attached to or in close proximity to the stream bottom. Algae are ubiquitous in Montana surface waters, easy to collect, and represented by large numbers of species. Measures of the structure of algal associations, such as species diversity and dominance, can be useful indicators of water quality impacts and ecological disturbance.

DEQ collected periphyton from reference streams and from streams known to have excess sediment and used statistical analysis to identify taxa that tend to increase in the presence of excess sediment (Teply, 2010a; 2010b). Algal community composition and dynamics differs geographically, and DEQ has developed ecoregion-specific periphyton sediment metrics. The rationale and methodology for the periphyton-based metrics is presented in the DEQ Periphyton Standard Operating Procedure (Montana Department of Environmental Quality, 2011b). The metric is reported as a percent probability of impairment. According to (Montana Department of Environmental Quality, 2011b), a probability of impairment > 51% indicates sediment may be impairing aquatic life but should be used in conjunction with other data when assessing stream condition. Therefore, ≤ 51% probability of impairment will be applied as a target for the Flathead-Stillwater TPA, and it will be interpreted in the context of other indicators of sediment impairment for each stream.

6.4.1.6 Other Measurements

Percent Subsurface Fine Sediment < 6mm in spawning habitat via McNeil Core

The subsurface substrate in gravel-bottomed rivers tends to be finer than that of the surface layer (Parker and Klingeman, 1982). Because salmonid embryo development takes place in subsurface substrate, the percentage of subsurface fine sediment can be an important indicator of harm to aquatic life. Although the creation of redds by salmonids effectively reduces the amount of fines compared to non-redd substrate (MacDonald et al., 2010; McNeil and Ahnell, 1964), over time, the interstices can refill with fine sediment (Zimmerman and Lapointe, 2005). DEQ not does typically collect subsurface sediment data, however, Montana Fish Wildlife and Parks (FWP) has collected McNeil Core (McNeil and Ahnell, 1964) data from bull and cutthroat trout spawning habitat in the Stillwater River and its tributaries (River Design Group, Inc., 2003; Montana Department of Natural Resources and Conservation, 2011). The most downstream site where this data is collected is about 0.25 mile upstream of the Highway 93 crossing in Stryker, MT, well upstream of the listed segment of the Stillwater River. Because this data has been collected at a limited number of locations that are not within sediment-listed segments and it is not typically collected by DEQ, a specific target will not be assigned to subsurface fine sediment in spawning habitat. However, when available, this information may be useful for describing fine sediment levels.

Large Woody Debris

Large woody debris (LWD) is a critical component of stream ecosystems, providing habitat complexity, quality pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989). LWD numbers generally are greater in smaller, low order streams. Because LWD values can vary widely depending on the historical vegetation and land use there is no specific target for LWD; instead data collected by DEQ in 2008 can be used to track changes at sites over time and to inform the planning of restoration work on sediment-listed streams in the Flathead-Stillwater TPA.

Riparian Understory Shrub Cover

Interactions between the stream channel and the riparian vegetation along the streambanks are vital to the support of the aquatic life beneficial use. Riparian vegetation provides organic material used as food by aquatic organisms and supplies LWD that influences sediment storage and channel morphology. Riparian vegetation helps filter sediment from upland runoff, stabilize streambanks, and can provide shading, cover, and habitat for fish. During assessments conducted in 2008, ground cover, understory shrub cover and overstory vegetation were cataloged at 10 to 20 foot intervals along the greenline at the bankfull channel margin along both sides of the stream channel for each monitoring reach (Watershed Consulting, LLC, 2009). The percent of understory shrub cover is of particular interest in valley bottom streams historically dominated by willows and other riparian shrubs. While shrub cover is important for stream health, not all reaches have the potential for dense shrub cover and are instead well armored with rock or have the potential for a dense riparian community of a different composition, such as wetland vegetation or mature conifer forest. While there is specific target for riparian understory shrub, the data collected by DEQ in 2008 (**Attachment A**) can be used like that for LWD to track changes over time and inform restoration planning.

6.4.2 Existing Conditions and Comparison to Targets

This section includes a comparison of existing data with water quality targets, along with a TMDL development determination for each stream segment of concern in the Flathead-Stillwater TPA (**Section 6.2**). The TMDL development determination is whether or not recent data supports the impairment listing and whether a TMDL will or will not be completed, but it is not a formal impairment assessment. All waterbodies reviewed in this section are either listed for sediment impairment on the 2014 303(d) List or are suspected to be impaired by sediment. Although inclusion 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 establishes a benchmark to help evaluate the effectiveness of restoration efforts. Images showing stream and streambank conditions for each of the following stream segments are found in Sections 3 and 4 respectively of **Attachment A**.

6.4.2.1 Upper Ashley Creek (MT76O002_010)

Upper Ashley Creek (MT76O002_010) is listed for sedimentation/siltation on the 2014 303(d) List. In addition, this segment is also listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1988 because of excess sediment associated with crop production, grazing in riparian zones, and loss of riparian habitat. This segment flows 15.64 miles from Ashley Lake to Smith Lake through glacial till, which easily erodes, and areas of agriculture.

Physical Condition and Sediment Sources

The DEQ assessment file states that portions of this segment have been straightened and flow through grazed meadows. In some areas, rip rap is failing and high eroding banks are present. However, in other areas cattle are fenced out of the riparian zone and where there is no riprap, vegetation consists of sedges and grasses. It was noted that fine sediment is high in the upper part of the reach and downstream of Highway 2. Macroinvertebrate samples collected in the early 2000s indicated that fine sediment may be reducing access to stony substrate (Bollman, 2003a). Watershed Consulting, LLC (2002) identified a lack of willows, severe erosion, fine sediment deposition, and channelization within this segment. Erosion was likely exacerbated by high flows in 1997 and 1998; in areas where riparian grazing was restricted, shrub regeneration was occurring (Watershed Consulting, LLC, 2002).

In 2008, DEQ collected sediment and habitat data at one site on upper Ashley Creek (ASHL-19; **Figure 6-1**). This site was located in an area where there are active agricultural and grazing practices (**Attachment A**). The stream at this site had been channelize and was incised; there was active streambank erosion and lateral cutting. Pugging was observed adjacent to the channel. Streambanks were composed of sand and clay and most observed bank erosion was attributed to cropland (hay) and riparian grazing. Vegetation consisted primarily of grasses with very little woody vegetation (hawthorn, red osier dogwood).

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for upper Ashley Creek are summarized in **Table 6-4**. The bioassessment data are located in **Table 6-5**. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-4. Existing sediment-related data for upper Ashley Creek relative to targets

Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6 mm[1]	% <2 mm[1]	Pool % <6mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
ASHL-19	2008	15.5	**B4c**	E4[2]	**33**	14	19	11	**1.5**	--	1.2	37

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

[2] This classification is based on the review of aerial imagery and does not agree with the determination of B4 in **Attachment A**

Table 6-5. Bioassessment data for upper Ashley Creek

Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C11AHLYC06	9/16/2008	EMAP	--	33%

Summary and TMDL Development Determination

For fine sediment, the riffle pebble count < 6 mm exceeded the target value for a potential E stream and the riffle pebble count < 2 mm was 1% below the target. All channel form parameters except entrenchment ratio met the target values. Residual pool depth and pools/mile parameters also met the target values. The single periphyton sample for the segment was well within the target range. These results indicate that while the channel appears stable, there potentially is excess fine sediment moving through the system. Sampling additional sites, especially in forested areas, would be necessary to clearly determine whether upper Ashley Creek is meeting the water quality standard for sediment.

Crop production, grazing in riparian zones, and loss of riparian habitat were originally identified as substantial sediment sources to upper Ashley Creek. Evaluation performed by Wastershed Consulting (2002), and data collected by DEQ in 2008 (**Attachment A**) indicate that these sources continue to contribute fine sediment to the segment and that restoration and implementation of best management practices will reduce sediment input from these sources. Based on current land management practices that are contributing human sources of sediment, the sensitivity of soils in the segment to erosion, the active human-caused erosion observed, and the inconclusive comparison of recent instream data to the targets, upper Ashley Creek will remain listed as impaired for sediment and a TMDL will be written.

6.4.2.2 Middle Ashley Creek (MT76O002_020)

Middle Ashley Creek (MT76O002_020) is not currently listed for sedimentation/siltation on the 2014 303(d) List. Because middle Ashley Creek is directly downstream of a sediment-listed segment (upper Ashley Creek; MT76O002_010) and land use is similar, it is being evaluated for sediment impacts to beneficial uses. This segment flows 14.17 miles from Smith Lake to the Kalispell Airport Road through glacial till and areas of agricultural production.

Physical Condition and Sediment Sources

Watershed Consulting, LLC (2002) identified portions of this segment as having a “dredged, uniform channel;” in addition, livestock was grazed along the stream and in some locations riparian vegetation was noted to be nonexistent. However, Watershed Consulting, LLC (2002) noted that some riparian fencing had been installed at the time of the 2001 field investigation.

In 2008, DEQ collected sediment and habitat data at two sites on middle Ashley Creek (ASHL-25 and ASHL-29; **Figure 6-1**). ASHL-25 was the upstream site in this segment and was located in an urban setting (**Attachment A**) between the Great Northern Historical Trail and Whalebone Drive. There was no cropland, grazing, or development along the site. The stream at this site appeared to have been channelized and some rip rap was present. Streambanks were composed primarily of coarse gravel, cobbles, and boulders with lesser amounts of fine gravel, sand, and clay. There was some natural bank erosion occurring. Vegetation consisted mostly of cottonwoods and shrubs with some reed canary grass. Impacts to the stream channel by beaver were noted.

ASHL-29 was located downstream of ASHL-25 and the Dern Road crossing. There was cropland and grazing along the site, but it appeared that the riparian area had been excluded from grazing (**Attachment A**). Most of the land use impacts at this site appeared historical and included vegetation removal and rip rap and rock barb installation. Streambanks were composed of a mix of coarse gravel, cobbles, boulders, fine gravel, sand and clay. Bank erosion was occurring throughout the site with the majority being attributed to past cropland and riparian grazing practices. Vegetation consisted primarily of reed canary grass but also contained woody shrubs and samplings.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for middle Ashley Creek are summarized in **Table 6-6**. There is currently no DEQ bioassessment data available for this segment. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-6. Existing sediment-related data for middle Ashley Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6 mm[1]	% <2 mm[1]	Pool % <6 mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
ASHL-25	2008	24	C4	C4	**20**	7	14	26	9.4	--	2.2	37
ASHL-29	2008	21.4	B4c	B4c	**29**	**13**	**55**	26	1.6	**100**	2.0	53

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

Summary and TMDL Development Determination
For fine sediment, the riffle pebble count < 6 mm exceeded the target at both sites while the riffle pebble count <2 mm and the pool grid toss results exceeded the target value only at ASHL-29. The channel form parameters met the target values at both sites with the exception of Riffle Stability Index which exceeded the target at ASHL-29 and indicates an unstable streambed. Residual pool depth and pools/mile parameters met the target values at both sites.

Although the two sites used for this assessment did not indicate that existing land use practices are a current source of sediment to middle Ashley Creek, historical practices are still having an effect. Aerial imagery shows that there are substantial portions of middle Ashley Creek that appear to be channelized and lacking riparian cover. In addition, sources of sediment in upper Ashley Creek are likely contributing fine sediment to this segment. This segment appears to generally have a wider riparian buffer than upper Ashley Creek; however, crop production remains a potential fine sediment source. The high percent fines values and Riffle Stability Index measured at ASHL-29 by DEQ in 2008 indicate a fine sediment problem within the segment. Based on the upstream and within segment human-caused sources of sediment and the comparison of recent instream data to the targets, middle Ashley Creek is impaired for sediment and a TMDL will be written.

6.4.2.3 Lower Ashley Creek (MT76O002_030)
Lower Ashley Creek (MT76O002_030) is not currently listed for sedimentation/siltation on the 2014 303(d) List. It is however, listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. Because lower Ashley Creek is downstream of a sediment-listed segment (upper Ashley Creek; MT76O002_010) and middle Ashley Creek and land use is similar, it is being evaluated for sediment impacts to beneficial uses. This segment flows 13.17 miles from Kalispell Airport Road to the mouth (Flathead River) through glacial till and areas of urbanization and agriculture.

Physical Condition and Sediment Sources
The DEQ assessment file states that portions of this stream segment have been straightened and the channel appears overwidened. In some areas the riparian area is well vegetated while in others there is little to no riparian vegetation present due to agricultural activities. The assessment file also references observations from 1987 indicating that the substrate was sand and silt. Macroinvertebrate samples

collected in the early 2000s indicated that fine sediment may be affecting stony substrates (Bollman, 2003a).

Comparison with Water Quality Targets

No physical data was collected by DEQ during the 2008 sampling. As a result, there is no physical data available for comparison to targets. However, there was one periphyton sample collected upstream of the Kalispell Wastewater Treatment Plant (WWTP), at the upstream extent of the segment (**Table 6-7**). This sample indicated a low likelihood of sediment impairment.

Table 6-7. Bioassessment data for Ashley Creek upstream of the Kalispell WWTP

Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C11AHLYC03	9/16/2008	EMAP	--	26%

Summary and TMDL Development Determination

The DEQ assessment record for lower Ashely Creek indicates the possibility of a fine sediment problem. The conditions in upper and middle Ashley Creek and the resulting sediment impairments (**Sections 6.4.2.1** and **6.4.2.2**) provide additional evidence that fine sediment values in lower Ashley Creek have a high probability of being elevated. Finally, this segment is currently listed for alteration in streamside or littoral vegetative covers, which is often linked to a sediment listing due to the increased loading that can result from removal of riparian vegetation. Based on this evidence, a TMDL will be written for lower Ashley Creek.

6.4.2.4 Fish Creek (MT76O002_050)

Fish Creek (MT76O002_050) is listed for sedimentation/siltation and solids (suspended/bedload) on the 2014 303(d) List. It was originally listed in 1992 because of excess sediment associated with silvicultural activities and unknown sources. This segment flows 2.39 miles from the headwaters to Ashley Lake through dense forest.

Physical Condition and Sediment Sources

Pre-1997 field assessment information in the DEQ assessment file states that Fish Creek had excessive bank instability and embeddedness and some channel instability. The assessment file also states that Montana FWP did work to improve channel stability in the 1980’s to address sediment input from roads and timber harvest activities. Bollman (2004) performed a habitat assessment of Fish Creek at a site located 300 feet upstream from the Ashley Lake Road Crossing (C11FISHC10) and found that although overall habitat was in good condition, benthic substrate was embedded and there was moderate sediment deposition. Bollman (2004) also performed a bioassessment at the site and determined that the macroinvertebrate community was: “typical of near-pristine montane stream environs.” The DEQ assessment file was updated for the 2014 Integrated Report (IR) as a result of a nutrient assessment that DEQ performed. Observations in the updated assessment include a stable stream channel, lush riparian area, best management plans (BMPs) in place on roads, and no grazing occurring.

In 2008, DEQ collected sediment and habitat data at one site on Fish Creek (FISH-05; **Figure 6-1**). This site was located in an area where timber harvest has occurred outside of the streamside management zone. The stream at this site had LWD that is forming pools with some surficial silt observed. Banks were composed of mostly sand and clay and all observed bank erosion was attributed to natural sources. Forest canopy was present along the stream within the riparian buffer; outside of this buffer the forest had been harvested and was in a state of regeneration. The riparian buffer contained a diverse community of native shrubs and forbs.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for Fish Creek are summarized in **Table 6-8**. The bioassessment data are located in **Table 6-9**. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-8. Existing sediment-related data for Fish Creek relative to targets

Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6 mm[1]	% <2 mm[1]	Pool % <6 mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
FISH-05	2008	8.54	A4	A4	16	7	3	9	**2.7**	--	0.8	148

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

Table 6-9. Bioassessment data for Fish Creek

Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C11FISHC01	7/9/2012	MAC R 500	**0.88**	--
C11FISHC01	8/13/2012	EMAP	--	37%
C11FISHC01	7/17/2013	EMAP	--	30%
C11FISHC02	7/9/2012	MAC R 500	**0.85**	**--**
C11FISHC03	7/9/2012	MAC R 500	0.95	**--**
C11FISHC10	10/16/2003	KICK – EMAP	**0.60**[1]	**61%**
C11FISHC10	9/8/2006	EMAP	--	**65%**
C11FISHC10	8/13/2012	EMAP	--	**57%**
C11FISHC10	7/17/2013	EMAP	--	41%
FC01	9/13/2005	EMAP	--	19%
FC02	9/13/2005	EMAP	--	32%
FC03	9/13/2005	EMAP	--	41%

[1]This sample was collected using the "Kick" method, not the "MAC R 500" method, which the O/E model was developed for. Therefore, caution should be used when interpreting this data.

Summary and TMDL Development Determination

All physical targets except for entrenchment ratio were met for Fish Creek (**Table 6-8**). However, entrenchment ratio is not a primary indicator of sediment impairment and its failure to meet the target when all of the primary indicators meet their respective targets is not indicative of a sediment problem. Three of the four macroinvertebrate samples for the segment did not meet the target; however two of the samples were close to the target and the sample from 10/16/2003 was collected using a method that the O/E model was not developed for and the information is of limited value. It is also important to note that the O/E model is not sediment specific and therefore not meeting the target does not necessarily indicate excessive sediment. Periphyton samples gave mixed results with two-thirds of the samples meeting the target. Although the biological results give a mixed signal with regards to possible sediment impairment, they are not primary indicators. Because all of the primary indicators meet their respective targets, the biological data provide background information with respect to Fish Creek but do not determine whether or not there is a sediment impairment.

Timber harvest and unknown sources were originally identified as sediment sources to Fish Creek. Information collected by DEQ in 2008 at a representative site indicates that these sources are not contributing fine sediment to the segment in an amount that causes a failure to meet these targets (**Attachment A**). In addition, instream habitat targets are being met and bank erosion data (**Attachment A**) indicate that Fish Creek is in a stable state with the majority of sediment input coming from natural sources. The roads present and timber harvest occurring in the watershed appear to be managed such that any contribution of sediment and/or channel instability is minimal. Based on this evaluation Fish Creek is not impaired by either sedimentation/siltation or solids (suspended/bedload); Fish Creek will be removed from the 303(d) for these impairments and a TMDL will not be written. This change will be reflected on the 2016 Montana 303(d) List.

6.4.2.5 Haskill Creek (MT76P003_070)

Haskill Creek (MT76O003_070) has not been previously assessed by DEQ for any pollutant. The assessment unit spans 8.43 miles from Haskill Basin Pond to the Whitefish River through glacial till. Two tributaries of this segment (Second, and Third creeks) have water supply intakes for the City of Whitefish that are actively maintained (Water Consulting, Inc., 2003). Land use in the watershed consists primarily of forested timber lands with commercial (i.e., Whitefish Mountain Resort) and urban development, residential, and agriculture being smaller components; the upper portion of the watershed tends to be forested whereas the lower portion is dominated by agriculture (River Design Group, Inc., 2007). From the 1960s to the present, timber harvest, ski area development and road building has occurred in the watershed (Water Consulting, Inc., 2003). The hydrology of this watershed is such that spring runoff is influenced by rain-on-snow and rain-on snowmelt events (Water Consulting, Inc., 2003). High magnitude flood events occurred in this watershed in 1967, 1969, 1973, and 1995 as a result of high precipitation and snowpack and human activities in the headwaters (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 1995). The watershed has been modified by channel straightening and vegetation removal (Water Consulting, Inc., 2003). Multiple evaluations have indicated sediment as a pollutant of concern, especially lower in the watershed (Water Consulting, Inc., 2003; River Design Group, 2004; Bollman, 2006).

Physical Condition and Sediment Sources

Water Consulting, Inc. (2003) inventoried fine sediment sources in the summer and fall of 2002. They found that modification of the Haskill Creek stream channel had caused an increase in fine sediment loading and channel instability, and a reduction in aquatic habitat quality and quantity. In addition they determined that medium- to high-risk sources of sediment were present throughout the watershed with those at higher elevations typically being associated with commercial and private development and those at lower elevations being associated with agriculture. Road crossings were not considered to be a significant source of sediment as best management practices were being implemented; however, Water Consulting, Inc. (2003) did identify three moderate to high risk crossings (one on Haskill Basin Road and two on First Creek) and made recommendations for fixing them. During this evaluation, excessive fine sediment (i.e., embeddedness of 50 – 100% and a pebble count with 63% fine sediment < 6.35 mm in First Creek) was observed in pool tails and riffles in headwater areas upstream of the segment of concern. Directly downstream of Haskill Basin Pond, Water Consulting, Inc. (2003) observed excessive sediment deposition and an aggraded channel with reduced sediment transport capacity. Further downstream as Haskill Creek enters and flows across the valley, active streambank erosion was present and the channel was incised and had lost connectivity to the floodplain.

River Design Group (2004) gives a summary of the information found in Water Consulting, Inc. (2003), but also provides additional information regarding pollutant sources. River Design Group (2004) found that more than 95% of the effective contribution area for upland sediment to Haskill Creek came from commercial land use in the First Creek portion of the watershed; the majority of this area was associated with roads and native material parking lots. The three land uses with the greatest effective contribution area to instream channel sediment in this study were agriculture (37%), commercial (36%) and commercial forest (18%). It appears that First Creek typically contributes more fine sediment relative to other tributaries in the Haskill Creek watershed as indicated by Total Suspended Solids (TSS) data collected by the F.H. Stolze Land and Lumber Company from 1998 – 2003 and synoptic sampling by Water Consulting Inc. in 2003 (River Design Group, 2004).

Bollman (2006) evaluated macroinvertebrate samples collected throughout the Haskill Creek watershed. Samples indicated a gradient of water quality with the best being at the upstream sites. The two most downstream sites indicated fine sediment as potential pollutant affecting the macroinvertebrate community.

Substantial mitigation and restoration activities have occurred in the Haskill Creek watershed. Specific to the ski area, a basin is used to capture sediment at the base of Big Ravine; this effort requires removal of deposited sediment and ongoing maintenance (Water Consulting, Inc., 2003). Restoration work occurred on about 1,200 feet of Haskill Creek in 2005 with maintenance occurring in 2007 (River Design Group, 2008b) and post-monitoring data collection in 2008 (River Design Group, 2008a). An evaluation by (Grubb, 2014) indicated that the project appeared to be effective at stabilizing banks and reducing fine sediment loading. As of March, 2014, the US Forest Service has slated $7 million from the Forest Legacy Program to protect more than 3,000 acres in the Haskill Creek watershed from development (Priddy, 3/10/2014).

In 2008, DEQ collected sediment and habitat data at two sites in Haskill Creek (HASK-06 and HASK-13; **Figure 6-1**). HASK-06 was located in an area that experienced past logging including the removal of large cedar trees (**Attachment A**). The channel at this site appeared to be in good condition and in the process of recovery. The streambanks consisted primarily of gravel and most erosion was attributed to natural sources. A healthy riparian vegetation community consisting of fir, birch, alder, cottonwood, and red osier dogwood was present.

HASK-13 had little evidence of current land use impacts but was located downstream of several reaches with active agriculture and the stream channel appeared to be modified by beaver activity (**Attachment A**). There was some indication that floodplain grazing had occurred in the past and the channel was overwidened as a result; silt dominated the streambed. The streambanks consisted primarily of fine gravel and silt/clay; all observed erosion at this site was attributed to natural sources. The vegetative community consisted of a mix of shrubs, but reed canary grass may have been inhibiting shrub regeneration.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for Haskill Creek are summarized in **Table 6-10**. The bioassessment data are located in **Table 6-11**. Two of the bioassessment samples were collected at sites upstream of the segment of concern and help describe biological communities throughout the watershed. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-10. Existing sediment-related data for Haskill Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6mm[1]	% <2mm[1]	Pool % <6mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
HASK-06	2008	23.2	B4	B4	11	6	**16**	17	1.7	**92**	2.1	42
HASK-13	2008	25.7	C5	C5	**94**	**91**	--	12	5.6	--	2.2	37

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

Table 6-11. Bioassessment data for Haskill Creek
Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E[1]	Periphyton
C09HSKLC01	8/20/2012	EMAP	--	**53%**
C09HSKLC02	8/20/2012	EMAP	--	50%
C09HSKLC03	8/20/2012	EMAP	--	37%
C09HSKLC04	8/21/2012	EMAP	--	48%
C09HSKLC05[1]	8/21/2012	EMAP	--	42%
C09HSKLC06[1]	8/21/2012	EMAP	--	42%

[1]Sites are located upstream of the segment of concern

Summary and TMDL Development Determination
For fine sediment, the riffle pebble count for HASK-13 fails the targets for both percent < 6 mm and < 2 mm. The pool grid toss target was exceeded at HASK-06. The channel form parameters met the target values with the exception of riffle stability index at HASK-06 which indicates an unstable streambed. Residual pool depth and pool frequency parameters met the target values at both sites. Although no macroinvertebrate samples were collected in 2012, samples collected by (Bollman, 2006) indicate sediment could be affecting the community at the two lowermost sites. Many of the periphyton samples collected in 2012 are near the target with the most downstream site exceeding the target.

Evaluations by Water Consulting, Inc. (2003) and River Design Group (2004) and data collected by DEQ in 2008 (**Attachment A**) indicate that commercial and agricultural activities and bank erosion are contributing fine sediment to the segment and that restoration and implementation of best management practices will reduce sediment input from these sources. Based on current land management practices that are contributing human sources of sediment, the active human-caused erosion observed, and the comparison of recent instream data to the targets, Haskill Creek is impaired for sediment and a TMDL will be written.

6.4.2.6 Logan Creek (MT76P001_030)
Logan Creek (MT76P001_030) is listed for sedimentation/siltation on the 2014 303(d) List. In addition, this segment is listed for physical substrate habitat alterations, which is a non-pollutant listing

commonly linked to sediment impairment. The stream was originally listed in 1988 because of excess sediment associated with silvicultural activities, streambank modification/stabilization, and forest roads. This segment of Logan Creek flows 21.16 miles from its headwaters to Tally Lake primarily through forested lands and fine soils.

Physical Condition and Sediment Sources

Road building and timber harvest in the upper portion of the Logan Creek watershed began in the 1970s with most timber harvest occurring since 1985 when the Flathead National Forest voluntarily committed to using BMPs (Stevens, 2003). Stevens (2003) noted that there was little evidence of riparian harvest in the upper watershed. The DEQ assessment file notes the observation of sediment clogging riffles and pools in a 2003 DEQ field assessment. In addition, the file contains a review of historical literature related to road building and timber harvest in the Logan Creek watershed and the decreased habitat quality and increased sediment loading that occurred as a result. Specifically, U.S. Department of Agriculture, Forest Service, Flathead National Forest (2001) noted that past activities in the watershed have increased sediment load and decreased channel stability and that upper Logan Creek (above Star Meadow) has fine sediment levels that may be greater than the historical range. In addition, U.S. Department of Agriculture, Forest Service Flathead National Forest (2004a) stated that the road system is the primary anthropogenic source of sediment to Logan Creek and that some of its tributaries are susceptible to accelerated bank erosion due to the soils present. Modeled sediment loading from roads in the watershed indicated that in the headwaters of Logan Creek sediment loading had increased 687% over the unmanaged condition (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 2004a).

In July 2003, macroinvertebrate and periphyton samples were collected from three locations on Logan Creek within the sediment-impaired segment. Bollman (2003b) analyzed the macroinvertebrate samples and determined that they were representative of “undisturbed” conditions and that no “evidence of fine sediment deposition compromising instream habitats” was detected. The periphyton samples from this segment were interpreted by Bahls (2004) who stated that they “indicated minor stress but full support of aquatic life uses at all three sites.” Bahls (2004) also suggested that the results of the upper two sites indicated “minor sedimentation.” During September 2005, a single sample was collected from the sediment-impaired segment of Logan Creek. This sample suggested good water quality and “insignificant” sediment deposition (Bollman, 2006).

Reducing sediment loading to the Logan Creek watershed was a goal of the *Logan Creek Ecosystem Restoration Project* (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 2004a; 2004b). Subsequent to the US Department of Agriculture record of decision for this project (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 2004b) BMPs have been implemented on 155.5 miles of roads in the Logan Creek Drainage in association with timber sales (Guenthner, Mitch, personal communication, 2014[3]); **Appendix C**). In the Griffin Creek watershed (a tributary of Logan Creek), the USFS plans on implementing about 85 miles of road BMP improvements beginning this year (Guenthner, Mitch, personal communication, 2014[4]).

In 2008, DEQ collected sediment and habitat data at two sites in this segment of Logan Creek (LOGA-20 and LOGA-37; **Figure 6-1**). LOGA-20 was located upstream of Star Meadow in a spruce forest with minimal human impacts (**Attachment A**). However, evidence from past logging was observed. The

[3] Personal communication by e-mail between Paul Kusnierz (DEQ) and Mitch Guenther (USFS), 6/27/2014
[4] Personal communication by e-mail between Paul Kusnierz (DEQ) and Mitch Guenther (USFS), 10/6/2014

channel at this site appeared to have diverse habitat but sediment deposits were common and the channel appeared overwidened in areas. Streambanks consisted primarily of sand and clay and all observed erosion was attributed to natural sources. A diverse riparian vegetation community consisting of native species was present.

LOGA-37 was located about 1 mile upstream of Tally Lake; it had little evidence of current land use impacts on the channel but was located within 300 feet of an active road (**Attachment A**). The stream channel was boulder dominated and stable. No bank erosion was observed. The vegetative community was less diverse than that at LOGA-20 but no invasive species were observed.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for Logan Creek are summarized in **Table 6-12**. The bioassessment data are located in **Table 6-13**. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-12. Existing sediment-related data for Logan Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6 mm[1]	% <2 mm[1]	Pool % <6 mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
LOGA-20	2008	20.9	C4	C4	**31**	**20**	15	16	5	--	1.4	79
LOGA-37	2008	56.4	B3	B3	3	2	--	35	1.4	--	1.3	42

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

Table 6-13. Bioassessment data for Logan Creek
Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C09LOGNC01	7/8/2003	EMAP	--	32%
C09LOGNC02	7/8/2003	EMAP	--	24%
C09LOGNC03	7/8/2003	EMAP	--	29%

Summary and TMDL Development Determination

The riffle pebble count exceeded both targets at LOGA-20 and met both at LOGA-37. The grid toss target was met at LOGA-20, and all channel form and instream habitat targets were met targets at both sites. None of the biological samples indicate impairment.

Evaluation by DEQ and U.S. Department of Agriculture, Forest Service, Flathead National Forest (2004a) demonstrated that past management practices have contributed elevated levels of sediment to the stream channel. The physical data and observations made by DEQ in 2008 (**Table 6-12** and **Attachment A**) indicate that the effects of these past activities are still present despite implementation of roads BMPs and changes in timber harvest practices. It is possible that under the current management regime, as time passes, the fine sediment measurements will achieve target values. However, continued restoration and implementation of BMPs in the watershed should be implemented and maintained as needed. Based on historical land management practices that may still be contributing human sources of sediment and the comparison of recent instream data to the targets, Logan Creek is impaired for sediment and a TMDL will be written.

6.4.2.7 Sheppard Creek (MT76P001_050)

Sheppard Creek (MT76P001_050) is a tributary of Logan Creek that is listed for sedimentation/siltation on the 2014 303(d) List. In addition, this segment is listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed for siltation in 1998 because of sediment impacts from agriculture, range land, and silviculture, but the impairment was removed in 2000 due to insufficient data. However, the impairment was re-listed in 2006 because of excess sediment associated with timber harvest, grazing in riparian or shoreline zones, and forest roads. Sheppard Creek flows 15.92 miles from its headwaters to its mouth at Griffin Creek. The upper 2.4 miles of Sheppard Creek contains a genetically pure population of westslope cutthroat trout and has been part of a US Forest service-led cutthroat trout conservation project since 2001 (Gardner, 2014).

Physical Condition and Sediment Sources

The DEQ assessment file states that in 1989, partially filled pools and embedded riffles were observed in the upper reaches of this section and the middle reaches commonly had bank erosion and fine sediment deposits. More recent observations indicate that the upper reaches have limited bank erosion, “somewhat embedded” substrate and a veneer of silt on pool substrates and in the channel margins. The assessment file also describes fine sediment increasing in the downstream direction with the most substantial disturbance to Sheppard Creek being in Star Meadows where habitat and vegetation have been altered by grazing and hay production that occurs up to the channel margins.

Macroinvertebrate samples collected in the 2004 indicated that at the uppermost site the community was indicative of an “unimpaired montane” while at the middle site there was the potential indication of sediment deposition and “water quality degradation and habitat disruption” at the most downstream site (Bollman, 2005). It should be noted that the most downstream site was in Star Meadows, which, in addition to being influenced by grazing and hay production also contains historic and current beaver activity.

As indicated in **Section 6.4.2.6**, reducing sediment loading to the Logan Creek watershed was a goal of the *Logan Creek Ecosystem Restoration Project* (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 2004a; 2004b). Subsequent to the record of decision for this project (U.S. Department of Agriculture, Forest Service, Flathead National Forest, 2004b), BMPs have been implemented on 48.89 miles of roads in the Shepard Creek drainage in association with timber (Guenthner, Mitch, personal communication, 2014[5]; **Appendix C**). Since 2007, 75 miles of ditches and culverts have been cleaned, eight culverts have been upgraded in small tributaries, and upgraded aquatic organism passage culverts have been installed on Dunsire, Upper Sheppard, and Listle creeks (Kendall, Craig, personal communication, 2014[6].

In 2007 the Brush Creek fire burned the upper portion of the Sheppard Creek watershed and the US Forest Service proposed post-fire harvest of marketable wood products (U.S. Department of Agriculture, Forest Service, Flathead National Forest, Tally Lake Ranger District, 2008a). The Record of Decision (U.S.

[5] Personal communication by e-mail between Paul Kusnierz (DEQ) and Mitch Guenther (USFS), 6/27/2014
[6] Personal communication by e-mail between Paul Kusnierz (DEQ) and Craig Kendall (USFS), 9/30/2014

Department of Agriculture, Forest Service, Flathead National Forest, Tally Lake Ranger District, 2008b) for this action indicated that as part the implementation no new roads would be created, monitoring of wildlife, fish, soils, water, and vegetation would take place, and BMPs would be implemented to protect water quality. As part of BMP implementation BMPs will be monitored, evaluated, and maintained (U.S. Department of Agriculture, Forest Service, Flathead National Forest, Tally Lake Ranger District, 2008a).

In 2008, DEQ collected sediment and habitat data at two sites on Sheppard Creek (SHEP-18 and SHEP-25; **Figure 6-1**). In addition, two sites (SHEP-30 and SHEP-BUFFER3; **Figure 6-1**) were visited and observations were recorded. SHEP-18 was located about 3-4 miles below Sylvia Lake in a burned area (**Attachment A**). A forest road paralleled the stream, but it was not an obvious source of sediment. The channel at this site appeared to be well armored with large angular rock; pools were predominantly found in the upper portion of the site. LWD was causing scour. Streambanks consisted primarily of sand and clay and all observed erosion was attributed to natural sources. The riparian community had recently been completely burned. Standing dead trees were present along the stream. Alders were resprouting and riparian forbs and grasses were the most common vegetation.

SHEP-25 was also located in a burned area (**Attachment A**). The stream channel contained boulders and was well-armored with angular rock. Streambanks consisted primarily of sand and clay and all observed erosion was attributed to natural sources. The riparian community had recently been completely burned. However, riparian shrubs were regenerating and native forbs were dominant.

SHEP-30 was located in Star Meadow. The site appeared to be recovering from past grazing; there was little cow manure and no recent hoof-shear observed. The channel at the site was not wadeable (too deep) due to beaver activity. The stream bottom was mostly silt. Streambank erosion was present on outside bends. Riparian vegetation consisted of sedges and willows. At some locations within the site pasture/grass was present.

SHEP-BUFFER3 was also located in Star Meadow. Grazing impacts were observed where cattle had access to the stream; however, most of the stream was too incised for cattle to access. The stream channel was not wadeable in areas due to depth. As with SHEP-30, the stream bottom was mostly fine sediment, but large cobbles were also observed. The deep pools and sedimentation appeared to be the result of past beaver activity. Some high eroding banks were present, and some of these banks were being eroded by cattle use. Riparian vegetation was dominated by reed canary grass with shrubs being infrequent and heavily browsed.

Comparison with Water Quality Targets

The existing physical data in comparison with the targets for Sheppard Creek are summarized in **Table 6-14**. The bioassessment data are located in **Table 6-15**. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-14. Existing sediment-related data for Shepard Creek relative to targets
Values that do not meet the target are in bold.

Reach ID	Assessment Year	Mean Bankfull Width (feet)	Existing Stream Type	Potential Stream Type	Riffle Pebble Count (mean)		Grid Toss (mean)	Channel Form (median)			Instream Habitat	
					% <6 mm[1]	% <2 mm[1]	Pool % <6 mm[1]	W/D Ratio[1]	Entrenchment Ratio	Riffle Stability Index	Residual Pool Depth (feet)[1]	Pools / Mile[1]
SHEP-18	2008	18.8	C4b	C4b	16	6	8	14	2.7	--	1.1	74
SHEP-25	2008	23.7	C3	C3	8	3	10	17	3.4	--	1.4	48

[1] Primary indicator used to determine sediment and habitat impairment (Kusnierz et al., 2013)

Table 6-15. Bioassessment data for Sheppard Creek
Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C09SHEPC01	7/30/2004	KICK – EMAP	1.03[1]	21%
C09SHEPC02	8/1/2004	KICK – EMAP	**0.84**[1]	47%
C09SHEPC02	9/8/2006	EMAP	--	46%
C09SHEPC03	7/31/2004	JAB – EMAP	**0.35**[2]	**88%**
C09SHEPC04	8/14/2012	EMAP	--	**60%**
C09SHEPC05	8/14/2012	EMAP	--	41%
C09SHEPC06	8/14/2012	EMAP	--	**60%**
C09SHEPC07	8/15/2012	EMAP	--	42%
C09SHEPC07	7/17/2013	EMAP	--	20%

[1]This sample was collected using the “Kick” method, not the “MAC R 500” method, which the O/E model was developed for. Therefore, caution should be used when interpreting this data
[2]This sample was collected using the “Jab” method, not the “MAC R 500” method, which the O/E model was developed for. Therefore, caution should be used when interpreting this data

Summary and TMDL Development Determination

All physical data targets were met at SHEP-18 and SHEP-25. Because SHEP-30 and SHEP-BUFFER3 were not wadeable, no physical data was collected from those two sites. Biological samples yielded mixed results with one-third of the periphyton samples and two-thirds of the macroinvertebrate samples not meeting their respective targets.

The physical data and observations made by DEQ in 2008 (**Table 6-14** and **Attachment A**) indicate that Sheppard Creek does not appear to have a fine sediment problem in the upper sections. However, no data was collected at the two sites in Star Meadow and human-caused sources of bank erosion were observed at both assessment sites. Due to the current sediment listing, the lack of information for Sheppard Creek in Star Meadow, and the current land use in the area, Sheppard Creek will remain listed as impaired for sediment and a TMDL will be written.

6.4.2.8 Stillwater River (MT76P001_010)

The Stillwater River (MT76P001_010) is listed for sedimentation/siltation on the 2014 303(d) List. In addition, this segment is listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing commonly linked to sediment impairment. It was originally listed in 1988 because of loss of riparian habitat, site clearance (land development or redevelopment), and upstream sources. This segment of the Stillwater River flows 45.61 miles from Logan Creek to the mouth (Flathead River).

The Stillwater River from Logan Creek to Highway 93 is dominated by a low gradient channel with a pool/riffle ratio of 102 to 1, high banks, and fine sediment substrate (Ganser, 1981). Ganser (1981) performed an analysis of the Stillwater River in which he looked at human impacts to the river via aerial images and by floating the river. In this analysis Ganser (1981), indicated that Logan Creek contributed a large volume of sediment to the Stillwater River, 17% of Stillwater River banks were eroding, and that 55 livestock concentration areas were observed in the Stillwater River floodplain. Downstream of Highway 93 the Stillwater River transitions into a steeper gradient channel with a pool/riffle ratio of 1.4 to 1 and much less fine sediment. In 1979, in this portion of the segment, 8.2% of banks were eroding and 9.9% of the streambank was either rock rip rap or car bodies as rip rap (Ganser, 1981).

DEQ has not collected physical data from this portion of the Stillwater River. However, in September 2012, DEQ observed the Stillwater River by boat to help evaluate the sediment and alteration in stream-side or littoral vegetation covers listings. This float covered about 20 miles from Spring Prairie Road to Lawrence Park (**Figure 6-2**). In the section from Spring Prairie Road to West Reserve Drive, the river was entrenched with a substrate consisting of silt and clay making it a Rosgen F6 channel type, which “are very sensitive to disturbance and adjust rapidly to changes in flow regime and sediment supply from the watershed” (Rosgen, 1996). This area was sparsely populated and little evidence of livestock was observed near the channel. Eroding banks were observed periodically (**Figure 6-3**); these were typically at meander beds with most of this erosion being attributed to natural causes. Steep, densely vegetated banks were generally stable. Riparian vegetation consisted of large coniferous trees and woody shrub species, but also canary reed grass with some native grasses and sedges. Locations where riparian vegetation had been removed at some point in the past were limited, but this accelerated erosion in some instances (**Figure 6-4**). In the section from West Reserve Drive to Lawrence Park, the river was an entrenched Rosgen C channel type (Rosgen, 1996) with well-defined pool/riffle sequencing and point bars with a substrate dominated by cobble. Bank material in this section shifted from all clay to a layer of unconsolidated cobbles and gravel. Vegetation was cleared right up to the river edge in many places along the golf course, and bank instability was more common than in the upstream section. DEQ observed evidence of efforts to stabilize the banks in many locations along the golf course; this included coir fabric bank layering and willow plantings in a number of locations (**Figure 6-5**) and a few locations with riprap (**Figure 6-6**).

Figure 6-2. The Stillwater River near Kalispell, MT

Figure 6-3. Eroding banks on the Stillwater River

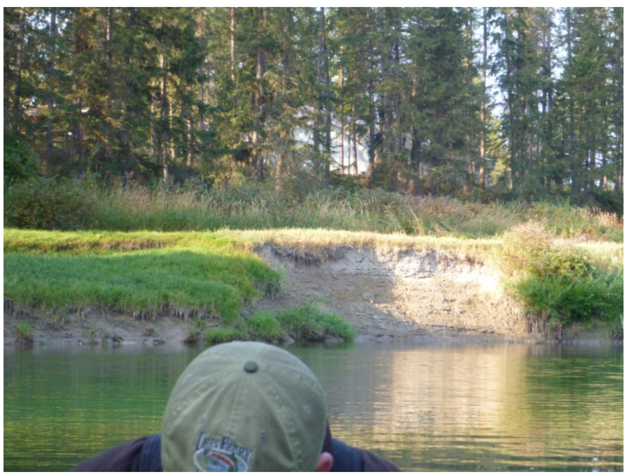


Figure 6-4. Eroding banks exacerbated by vegetation removal on the Stillwater River

Figure 6-5. Coir fabric and willow plantings on the Stillwater River

Figure 6-6. Rip rap on the Stillwater River

The Stillwater River upstream of the impaired segment flows predominantly through lands administered by the Stillwater State Forest and the US Forest Service (**Figure 6-2**). This area historically and currently is managed for timber harvest, and in some areas grazing. Bull trout and westslope cutthroat trout can be found in this part of the Stillwater River and its tributaries. McNeil cores samples, substrate scores, bull trout redd counts, and both bull trout and cutthroat trout population estimates have been recorded for this area since at least the early 1990s (River Design Group, Inc., 2003). Data collected in the upper Stillwater River indicate that substrate scores and McNeil core values remained relatively stable from 2001 to 2010 (Montana Department of Natural Resources and Conservation, 2005; 2011). BMPs are implemented by DNRC in the Stillwater River watershed as part of timber harvest projects. An example of work done recently by DNRC that benefits the Stillwater River is the Stillwater Road Improvement project where a culvert was replaced with a larger diameter pipe at stream grade on Campsite Creek and a drain dip was constructed adjacent to Hellroaring Creek so that water drained away from the stream (Montana Department of Natural Resources and Conservation, 2006b).

Timber harvest is occurring in the upper watershed and BMPs are being implemented to prevent excessive sediment loading. Upstream of the impaired segment of the Stillwater River, there are three lakes (Duck, Upper Stillwater, and Lower Stillwater; **Figure 6-2**) that, based on water quality sampling on May 20, 2014, appear to trap nearly the entire sediment load from the headwaters (**Table 6-16**).

Table 6-16. Synoptic sampling of the Stillwater River upstream and downstream of lakes in the system on 5/20/2014

Sampling Location	Latitude	Longitude	Turbidity (Nephelometric Turbidity Unit)	TSS (mg/L)	Suspended Sediment Concentration (mg/L)
Upstream of Duck Lake	48.62537	-114.68782	3.8	15.5	17.6
Downstream of Duck Lake	48.61039	-114.65850	0.8	2.5	2.0
Upstream of Upper Stillwater Lake	48.60405	-114.65656	1.6	5.5	6.2
Downstream of Upper Stillwater Lake/Upstream of Lower Stillwater Lake	48.56836	-114.63402	0.3	1.5	1.5
Downstream of Lower Stillwater Lake	48.53546	-114.57167	0.1	Not detected	1[(1)]

[(1)]Mean value of sample and duplicate

Logan Creek (**Figure 6-1**) is a major tributary to the listed segment of the Stillwater River and is also impaired by sediment (see **Section 6.4.2.6**). Logan Creek flows into Tally Lake downstream of much of the timber harvest in the watershed. Similar to the lakes on Stillwater River, Tally Lake likely acts as a sediment trap and any excessive sediment from the Logan Creek headwaters likely settles out before it can enter the Stillwater River.

Comparison with Water Quality Targets

DEQ has not collected physical data for this segment of the Stillwater River. Bioassessment data has been collected and are located in **Table 6-17**. All bolded cells are not meeting the target; depending on the target parameter, this may equate to being below or above the target value.

Table 6-17. Bioassessment data for the Stillwater River

Values that do not meet the target threshold (0.90 for O/E and 51% for periphyton) are in bold.

Station ID	Collection Date	Collection Method	O/E	Periphyton
C11STILR01	7/16/2012	MAC R 500	**0.20**	--
C11STILR02	7/16/2012	MAC R 500	**0.44**	--
C11STILR04	7/17/2012	MAC R 500	**0.29**	--
C11STILR05	7/17/2012	MAC R 500	**0.29**	--
C11STILR03	8/28/2012	EMAP	--	37%
C11STILR04	8/28/2012	EMAP	--	44%
C11STILR05	8/28/2012	EMAP	--	32%
C11STILR06	8/27/2012	EMAP	--	36%

This segment of the Stillwater River represents a unique case with regards to sediment assessment and the types of targets typically used by DEQ (**Table 6-2**). Much of the middle portion of the Stillwater River is an incised Rosgen F stream type that has the potential to both transport and store large sediment loads. The targets in **Table 6-2** are only applicable on the Stillwater River in locations where the channel qualifies as a Rosgen A, B, C, or E stream type. While Rosgen A, B, and E stream types are not likely in this segment of the Stillwater River, areas where there is a good potential for Rosgen C stream types include upstream of Twin Bridges Road and downstream of West Reserve Drive.

Summary and TMDL Development Determination

The observations made by DEQ in September 2012 identified bank erosion exacerbated by human impacts. Biological samples yielded mixed results with all of the macroinvertebrate samples failing to meet the target and all of the periphyton samples meeting the target. The presence of lakes on the Stillwater River and Logan Creek are likely limiting sediment loading to the impaired segment. This evidence considered with the observed bank erosion and silt/clay substrate of the stream bottom indicate that much of the sediment loading to this segment is natural and from within the channel itself. However, due to the current listing, the presence of human-caused sources, and the lack of physical data for the segment, this segment of the Stillwater River will remain listed for sediment and a TMDL will be written.

6.5 Source Assessment and Quantification

This section summarizes the assessment approach, current sediment load estimates, and the determination of the allowable load for each source category. DEQ determines the allowable load by estimating the obtainable load reduction once all reasonable land, soil, and water conservation practices have been implemented. The reduction forms the basis of the allocations and TMDLs provided in **Section 6-6**. This section focuses on four potentially significant sediment source categories and associated controllable human loading for each of these sediment source categories:

- streambank erosion
- upland erosion
- unpaved roads
- permitted point sources

EPA's guidance for developing sediment TMDLs states that the basic procedure for assessing sources includes compiling an inventory of all sediment sources to the waterbody. In addition, the guidance suggests using one or more methods to determine the relative magnitude of loading, focusing on the primary and controllable sources (U.S. Environmental Protection Agency, 1999b). Federal 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 code of federal regulation (CFR) 130.2(G)"}.

For each impaired waterbody segment, sediment loads from each source category were estimated using a Loading Simulation Program in C++ (LSPC) model for the Flathead Lake watershed. This model and the assumptions used when estimating sediment loading are described in Tetra Tech (2014b). The results of this model include annual loading of TSS (fine sediment) from different sediment sources and the percent contribution of each to the overall load. This output from the model represents the current conditions within each watershed. Although some sources such as bank erosion contribute a mix of sediment sizes, implementing BMPs that address TSS loading will also reduce larger sediment particles. The following sections describe 1) the percent contribution of sediment from various sources, 2) loading for specific sources, and 3) percent reductions to specific sources necessary to meet the TMDL.

6.5.1 Percent Sediment Contribution from Each Source Type

Figures 6-7 through **6-13** display sediment loading from various sources to the seven segments with TMDLs in this document. The predominant source of sediment is bank erosion; it is always ≥ 49%. The bank erosion category consists of all bank erosion regardless of it is caused by natural processes or human activities; a portion of bank erosion can always be attributed to natural sources. Upland erosion from natural background sources is always ≥ 12% of the load to the segments of concern and is the second largest contributor of sediment to all segments. Agriculture (upland source), unpaved roads, and timber harvest (upland source) are typically the third to fourth largest contributors of sediment, however they tend to contribute substantially less sediment with agriculture always being ≤ 20%, unpaved roads being ≤ 4%, and timber harvest being ≤ 2%. Urban areas contribute 14% of the sediment load in lower Ashley Creek and 7% in middle Ashley Creek, but ≤ 2% in all other segments. Impacts from forest fire contribute 4% of the annual sediment load in Sheppard Creek and ≤ 1% in the other segments.

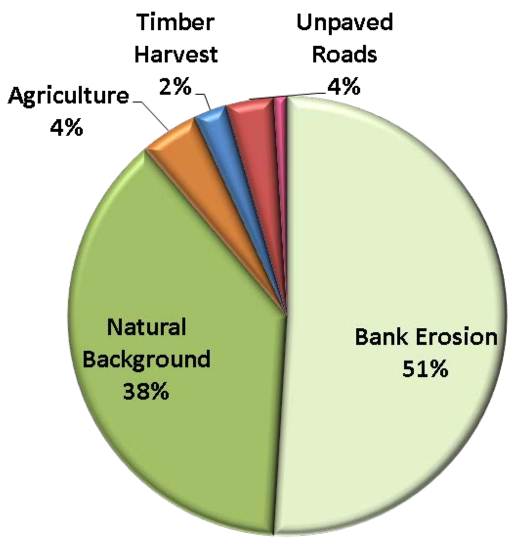


Figure 6-7. Percent contribution of sediment sources to upper Ashley Creek at the downstream end of the segment

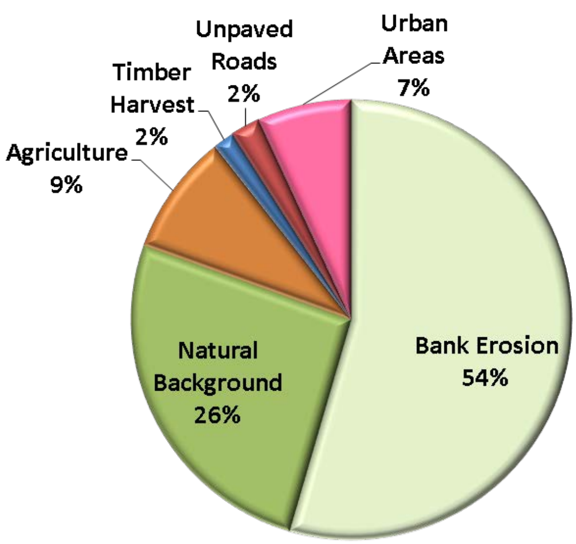


Figure 6-8. Percent contribution of sediment sources to middle Ashley Creek at the downstream end of the segment

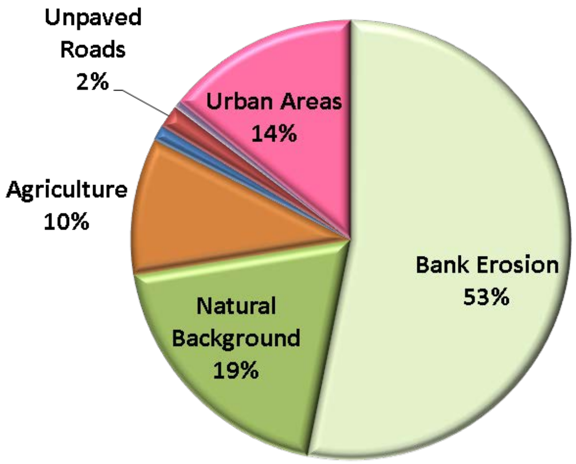


Figure 6-9. Percent contribution of sediment sources to lower Ashley Creek at the mouth (i.e., the entire Ashley Creek watershed)

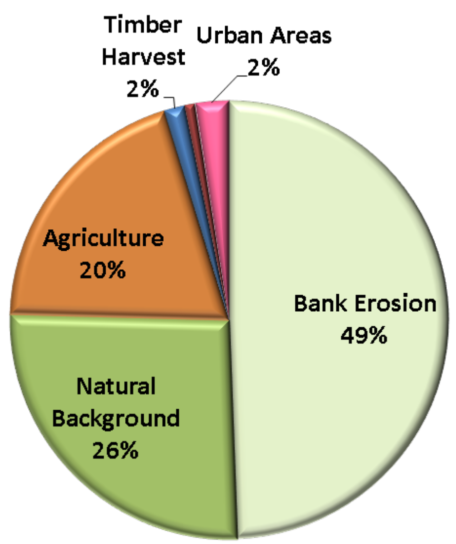


Figure 6-10. Percent contribution of sediment sources to the Haskill Creek watershed

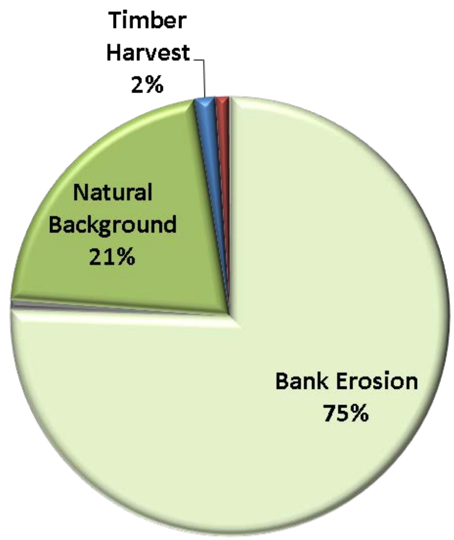


Figure 6-11. Percent contribution of sediment sources to the Logan Creek watershed

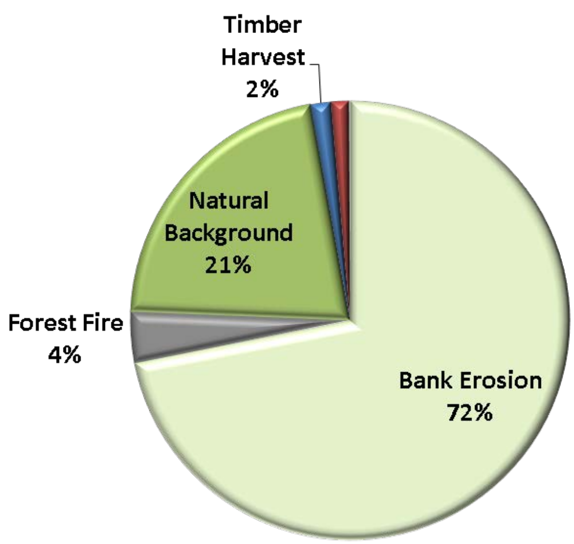


Figure 6-12. Percent contribution of sediment sources to the Sheppard Creek watershed

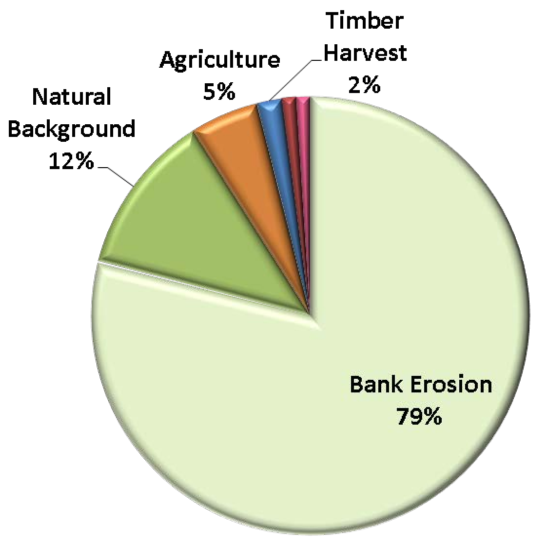


Figure 6-13. Percent contribution of sediment sources to the Stillwater River watershed

6.5.2 Eroding Streambank Sediment Assessment

Streambank erosion is a natural process typically dominated by slowly eroding streambanks. Human disturbances to riparian vegetation and health and/or stream hydrology can accelerate the natural erosion rate. This commonly occurs when streambanks shift from being well vegetated and/or armored (and commonly undercut) to being largely, or entirely, unvegetated with vertical banks. Eroding streambanks were explicitly estimated in the LSPC model for the Flathead Lake watershed. The output from the model represents the current conditions within each watershed. Detailed information regarding how streambank erosion was calculated in the LSPC model and applicable assumptions are in Tetra Tech (2014b). Information from the 2008 Flathead-Stillwater sediment and habitat field work (**Attachment A**) was used to describe controllable sources of bank erosion when observed.

Establishing the Total Allowable Load

To establish the total allowable load when controllable sources of bank erosion are present, a reduction must be applied to the existing load. In this case, the reduction for sediment loading from bank erosion was estimated as the percentage of banks at sites sampled within a segment in 2008 that were eroding due to non- “natural” (i.e., human-caused) sources (see **Attachment A** for erosion assessment details). The reduction was calculated as:

$$\textit{Bank erosion reduction} = (E_{Non\text{-}nat}/E_{Tot})*100$$

Where:

E_{Tot} = *sum of the linear distance of eroding banks at all sites sampled within the segment*
$E_{Non\text{-}nat}$ = *sum of the linear distance of eroding banks at all sites sampled within the segment that are attributed to controllable non-natural sources*

Thus, the reduced load is intended to represent bank erosion caused by natural sources and human sources when best management practices are used.

A key assumption to establishing the allowable load for bank erosion in this manner is that the sampling sites are representative of the segment of concern. In the case of upper Ashley Creek, only one site was sampled. This site was in an area dominated by agricultural land-use. An aerial analysis indicated that 56% of the 15.6 stream miles that comprise upper Ashley Creek adjacent to agricultural land-use with the remainder being forested. Bank erosion at the sampled site was 98% human-caused. To account for the 55% of the stream length that was in forest (and presumably dominated by natural erosion), the percent reduction for bank erosion in upper Ashley Creek was reduced via the following calculation:

98%*0.56 = 55% reduction to human-caused bank erosion to upper Ashley Creek

Sediment loading to the middle Ashley Creek segment consists of sediment from upper Ashley Creek as well as sediment internal to the segment. The percent reduction for this segment was calculated using the data from both upper Ashley Creek and middle Ashley Creek. In this case, the reduction for sites within middle Ashley Creek was 40% based on the human-caused erosion observed. To incorporate the reduction to the sediment load coming from upper Ashley Creek, the middle Ashley Creek reduction was calculated based on the proportion of each segment that ultimately contributed the load to middle Ashley Creek. Upper Ashley Creek is 52% of the linear distance of the two segments combined and middle Ashley Creek is 48%. The overall reduction for sediment loading to middle Ashley Creek was then calculated as:

(55%*0.52) + (40%*0.48) = 48% reduction to human-caused bank erosion loading to middle Ashley Creek

No bank erosion field data was collected for the lower Ashley Creek segment. The reduction to streambank erosion in this segment is 48%, based on the percent reduction for middle Ashley Creek.

Based on the source assessment, streambank erosion loads range from 255.2 tons per year in upper Ashley Creek to 12,240.6 tons per year in the Stillwater River (**Table 6-18**). Significant human-caused sources of streambank erosion include cropland and grazing practices. Depending on the watershed, DEQ estimated that implementing and maintaining riparian BMPs could decrease the human-caused level of streambank erosion by 7% to 55% within specific assessed reaches.

Table 6-18. Existing and reduced sediment loads from eroding streambanks in specific segments of the Flathead-Stillwater TPA

Segment	Estimated Existing Sediment Load (tons/year)	Percent Reduction (i.e., percent human-caused bank erosion)	Allowable Sediment Load with Riparian BMPs (tons/year)
Upper Ashley	255.2	55%	114.8
Middle Ashley	533.7	48%	277.5
Lower Ashley	736.8	48%[1]	388.1
Haskill	372.4	7%	346.3
Logan	2,264.5	0%	2,264.5
Sheppard	393.5	0%	393.5
Stillwater River	12,240.6	0%[2]	12,240.6

[1] No bank erosion field data was collected for this segment. The reduction is based on the percent reduction for middle Ashley Creek
[2] No bank erosion field data was collected for this segment. The reduction is based on field observations made by DEQ personnel in 2012. All controllable sources of bank erosion will need to have BMPs applied to achieve the TMDL and applicable load allocation
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.5.3 Upland Erosion Assessment

Upland sediment is that which originates beyond the stream channel. The erosion rate of sediment from upland sources is influenced by land use and/or vegetative cover. Sediment loading from upland erosion was explicitly estimated in the LSPC model for the Flathead Lake watershed. The output from the model represents the current conditions within each watershed. Detailed information regarding how upland erosion was calculated in the LSPC model and applicable assumptions is in Tetra Tech (2014b). Human-caused upland erosion sources (e.g., agriculture, timber harvest, golf courses) are generally a small proportion of the overall sediment load to the segments of concern (**Figures 6-7** through **6-13)**. However, erosion from these sources can be controlled through the implementation and maintenance of BMPs.

Establishing the Total Allowable Load

The allowable load from upland erosion is based on a 50% reduction to loading from controllable human sources (agriculture and golf courses). This reduction is reasonable based on the sediment trapping efficiency of 53% to 98% documented by Liu (2008) for riparian buffers and the sediment reductions of 76% to 91% reported by Arora (1996) for filter strips. The previously mentioned studies can are summarized in Miller (2012), which provides a review of agricultural BMPs and potential reductions for various pollutants that can be achieved.

The Montana Streamside Management Zone (SMZ) Law (77-5-301 through 307 Montana Code Annotated (MCA)) prohibits specific timber harvest activities within 50 feet of any waterbody. As a result, loading from timber harvest is considered to be implemented with all applicable BMPs in place. Meeting the load allocation for upland erosion assumes that all BMPs are being implemented at timber harvest locations. If any controllable sources of upland erosion result from timber harvest activities, BMPs will be necessary to meet the upland erosion allocation. Meeting the load allocation for upland erosion also assumes that BMPs are in place for any other controllable sources of upland erosion that are not explicitly represented in the LSPC model.

Existing sediment loads from upland erosion range from 146.4 tons/year in the Logan Creek watershed to 3,066.8 tons/year in the Stillwater River watershed (**Table 6-19**). Existing sediment loads from the controllable human sources component of upland erosion range from 0 tons/year in the Sheppard Creek watershed to 149.5 tons/year in the Haskill Creek watershed (**Table 6-19**). A 50% reduction in controllable human sources results in allowable upland loads ranging from 146.4 tons/year in Sheppard Creek to 3,052.2 tons/year in the Stillwater River and overall percent reductions to upland loads from 0.01 to 20%.

Table 6-19. Existing and reduced sediment loads from upland erosion in specific segments of the Flathead-Stillwater TPA

Segment	Existing Delivered Upland Erosion Sediment Load (tons/year)	Existing Delivered Sediment Load from controllable human sources (tons/year)	Percent Reduction to controllable human Sources	Allowable Sediment Load from controllable human Sources (tons/year)	Allowable Sediment Load from Upland Erosion (tons/year)	Overall percent reduction to Upland Erosion
Upper Ashley	227.8	21.5	50%	10.8	217.1	5%
Middle Ashley	383.5	87.1	50%	43.6	340.0	11%
Lower Ashley	496.7	139.5	50%	69.8	427.0	14%
Haskill	375.7	149.5	50%	74.8	301.0	20%
Logan	705.9	0.1	50%	0.05	705.85	0.01%
Sheppard	146.4	0	50%	Not Applicable	146.4	0%
Stillwater River	3,066.8	786.0	50%	393.0	2,673.8	13%

Note: Values were rounded; differences in loads presented in this table may not correspond to the identified percent reduction

6.5.4 Unpaved Road Sediment Assessment

Roads located near stream channels can reduce stream function by degrading riparian vegetation, encroaching on the channel, and adding sediment. The degree of harm is determined by a number of factors including road type, construction specifications, drainage, soil type, topography, and precipitation, as well as the usage and maintenance of BMPs. Culverts and road crossing can be substantial sources of sediment when not installed properly and/or when not appropriately sized. Unpaved roads were identified as a potentially significant sediment source for this project area and were explicitly accounted for in the LSPC model. Failing culverts and road crossings were not explicitly modeled; as a result, meeting the allocations for unpaved road sediment assumes that such issues are addressed as they occur. Detailed information regarding how unpaved road sediment loading was calculated in the LSPC model and applicable assumptions are in Tetra Tech (2014b).

Establishing the Total Allowable Load

The allowable load from unpaved road is based on a 30% reduction to loading and is applied to each segment of concern. This reduction assumes that all BMPs are implemented and maintained. DEQ has performed road loading analyses in watersheds throughout western Montana. Reductions to road sediment range from 8% in Grave Creek (Montana Department of Environmental Quality et al., 2005) to 75% for the worst locations in the Ruby River watershed (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2006). Within the Flathead Lake watershed, a 40% reduction was applied to the Swan Lake watershed (Montana Department of Environmental Quality, 2004) and a 75% reduction in Coal Creek (U.S. Environmental Protection Agency et al., 2004). Northwest of the Flathead-Stillwater TPA, the Tobacco watershed has reductions ranging from 50% to 57% for road sediment loads (Montana Department of Environmental Quality, 2011c). A reduction of 30% to unpaved road sediment represents a value that is within the range used in other TMDLs in western Montana. The 30% reduction is near the low end of those used by DEQ in other western Montana watersheds and was chosen in recognition of the road BMP work being implemented by land managers (e.g., USFS, DNRC; **Section 6.4.2**) in the Flathead-Stillwater TPA. In the case of Logan and Sheppard creeks, the 30% reduction was applied only to unpaved roads in those watersheds where the USFS has not recently implemented BMPs. In the Logan Creek watershed (including roads in the Sheppard Creek and Griffin Creek watersheds), BMPs have been applied to 155.49 of 443.32 road miles (35%), and in the Sheppard Creek watershed best management practices (BMPs) have been applied to 48.89 of 74.52 road miles (66%) (Guenthner, Mitch, personal communication, 2014[7]). The reduction values for unpaved roads can be changed (increased or decreased) if future analyses indicate this is necessary.

Based on the source assessment, the existing sediment load from unpaved roads ranges from 5.6 tons/year in the Haskill Creek watershed to 166.3 tons/year in the Stillwater River watershed (**Table 6-20**). A 30% reduction in sediment load from unpaved roads results in allowable loads ranging from 3.9 to 116.4 tons/year.

Table 6-20. Existing and reduced sediment loads from unpaved roads in specific segments of the Flathead-Stillwater TPA

Segment	Existing Delivered Sediment Load from Unpaved Roads (tons/year)	Percent Reduction to Unpaved Roads	Allowable Sediment Load from Unpaved Roads (tons/year)
Upper Ashley	17.7	30%	12.4
Middle Ashley	21.2	30%	14.8
Lower Ashley	23.2	30%	16.2
Haskill	5.6	30%	3.9
Logan	29.8	22%	23.3
Sheppard	7.1	13%	6.2
Stillwater River	166.3	30%	116.4

Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.5.5 Permitted Point Sources

As of June 10, 2014, the Flathead-Stillwater TPA had 20 Montana Pollutant Discharge Elimination System (MPDES) permitted point sources that could be contributing sediment to sediment-impaired watersheds (**Table B-2** of **Appendix B**). All of the permits fall within the Ashley Creek and Stillwater River watersheds. Nineteen of the permits are general permits; twelve are for construction stormwater, six are for industrial stormwater, and one is for a small Municipal Separate Storm Sewer System (MS4). One permit is an individual permit for the Kalispell Wastewater Treatment Plant (WWTP). To provide the required wasteload allocation (WLA) for permitted point sources, a source assessment was performed for these point sources. The source assessments for the Kalispell WWTP and small MS4 are based on the results of the LSPC model. The source assessments for the construction stormwater and industrial stormwater permits did not use the LSPC model and source assessment methods are described in **Sections 6.5.4.3** and **6.5.4.4** respectively. Because of the conditions set within all of the applicable permits, and the nature of sediment loading associated with these permits, the WLAs are not intended to add load limits to the permits; DEQ assumed that the WLAs will be met by adhering to the permit requirements.

[7] Personal communication by e-mail between Paul Kusnierz (DEQ) and Mitch Guenther (USFS) on 6/27/2014, 10/1/2014, and 10/6/2014

6.5.5.1 Kalispell Wastewater Treatment Plant (MT0021938)

The Kalispell WWTP is a modified Johannesburg treatment system that serves about 19,000 customers (Flathead City-County Health Department, 2009). It has a design capacity of 5.4 million gallons per day (mgd) and a single outfall that discharges to lower Ashley Creek. The facility has average monthly TSS limits of 10 mg/L concentration and 259 lb/day (0.13 tons/day). The permit for this facility has been administratively continued since 2013 and is being evaluated for renewal by DEQ. Additional background information regarding the Kalispell WWTP can be found in **Attachment B**.

Establishing the Total Allowable Load

The average (1/3/1993 – 12/27/2012) effluent TSS concentration from the WWTP was 2.48 mg/L (**Attachment B**), well below the permit limit of 10 mg/L. The LSPC model estimates that the Kalispell WWTP is contributing 6.7 tons TSS per year to lower Ashley Creek. Based on the permit limit of 0.13 tons/day (47.4 tons/year), the WWTP is currently meeting the permit requirements for TSS loading. The WLA for permit MT0021938 (47.4 tons/year) is based on the monthly average load limit and is seven times greater than the existing load.

6.5.5.2 Kalispell Small MS4 (MTR040005)

Stormwater within the city of Kalispell is regulated under the General Permit for Storm Water Discharge Associated with MS4 (MTR040000) and applies within the Kalispell city limits. The city is a co-permittee with the Montana Department of Transportation (MDT), and as such, this section addresses the MDT portion of the MS4 as well. This MS4 has 23 outfalls to the Stillwater River, 24 outfalls to middle Ashley Creek, and five outfalls to lower Ashley Creek (Figures 2 and 3 in **Attachment C**).

The permit does not include effluent limits, but does have a benchmark value of 125 mg/L TSS and requires the development and implementation of a stormwater management program (SWMP) to minimize sediment loading to surface waters. The SWMP must include six minimum control measures: (1) public education and outreach; (2) public involvement/participation; (3) detection and elimination of illicit discharge; (4) control of stormwater runoff from construction sites; (5) management of post-construction stormwater in new development and redevelopment; and (6) pollution prevention/good housekeeping. Additionally, the permit requires monitoring at two sites twice per year following storm events; one must represent a residential area and the other represent a commercial/industrial area (Figure 2 in **Attachment C**).

Using stormwater discharge monitoring data from 2007-2008 for two outfalls in the Kalispell MS4, summary statistics were calculated for the commercial/industrial sample location (average = 100 mg/L TSS; maximum = 167 mg/L TSS) and residential sample location (average = 392 mg/L TSS; maximum = 951 mg/L TSS). Note that stormwater TSS concentrations can vary depending on the size of the outfall's drainage area, the types of activities occurring, the BMPs that are installed, the rainfall volume, and time between storm events.

Establishing the Total Allowable Load

Because of the limited amount of information regarding stormwater BMPs currently in place within the MS4, no BMP scenario was run in the model. Instead, BMP effectiveness values reported from the International Storm Water BMP Database (Geosyntec Consultants, Inc. and Wright Water Engineers, Inc., 2011) will be used as the basis for the WLA. The database includes statistics for loading reduction efficiencies from a compilation of studies for a variety of BMPs. The BMPs include bioretention, bioswales, detention basins, filter strips, manufactured devices, media filters, porous pavement, retention ponds, wetland basins, and wetland channels. The effectiveness range among different studies and practices are fairly tight. Studies were summarized by evaluating the 75th percentile, median, and 25th percentile concentration of influent and effluent. The quartiles for each percentile category ranged from a reduction efficiency of 53% to 76%. Using the median influent and effluent concentration, the average percent reduction among BMPs was 62%.

The LSPC model estimates that the Kalispell MS4 annually contributes 40.4 tons TSS to middle Ashley Creek, 122.4 tons TSS to Lower Ashley, and 43.4 tons to the Stillwater River (**Table 6-21**). The 2007-2008 monitoring data did exceed the TSS benchmark of 125 mg/L TSS. Because some BMPs are already in place within all land-use categories, the average percent reduction of 62% previously described will be used to approximate the reduction in loading that additional BMP implementation across all land-use categories could achieve and to determine the WLA.

Table 6-21. Sediment loading and reductions from the Kalispell small MS4

Segment	Existing Load (tons/year)	Percent Reduction	MS4 WLA (tons/year)
Middle Ashley	40.4	62%	15.4
Lower Ashley	122.4	62%	46.5
Stillwater River	43.4	62%	16.5

Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

As stated previously, the WLAs are not intended to add load limits to the permit. DEQ assumed that the WLAs will be met by adhering to the permit requirements. As identified in the permit, monitoring data should continue to be evaluated to assess BMP performance and help determine whether and where additional BMP implementation may be necessary.

6.5.5.3 Construction Storm Water Permits (MTR100000)

Because construction activities at any given site are temporary and relatively short term, the number of construction sites covered by the general permit at any given time varies. Collectively, these areas of severe ground disturbance have the potential to be significant sediment sources if proper BMPs are not implemented and maintained. Each construction stormwater permittee is required to develop a Storm Water Pollution Prevention Plan (SWPPP) that identifies the stormwater BMPs that will be in place during construction. Before a permit is terminated, disturbed areas must have a vegetative density equal to or greater than 70% of the pre-disturbed level (or an equivalent permanent method of erosion prevention). Inspection and maintenance of BMPs is required, and although Montana stormwater regulations provide the authority to require stormwater monitoring, water quality sampling is typically not required (Heckenberger, Brian, personal communication 2009).

Establishing the Total Allowable Load

The permit files were reviewed to determine the amount of disturbed land associated with each permit. The estimated level of disturbance ranged from 1 to 49 acres (**Table B-2** in **Appendix B**). The permits are for a range of construction projects including road/highway, home, business, and stormwater improvements. The SWPPPs contain BMPs such as silt fencing, retention basins, fiber rolls, erosion control blankets, and vegetated buffers.

To estimate sediment loading from permitted construction sites without BMPs in place an approach similar to that in the "Tobacco Planning Area Sediment TMDLs and Framework Water Quality Improvement Plan" (Montana Department of Environmental Quality, 2011c) was used. For this approach, the average existing annual erosion rate for all cropland land use types in the LSPC model (0.0721 tons/acre/year) was tripled to represent construction sites with some ground cover but inadequate BMP implementation, resulting in an erosion rate of 0.216 tons/acre/year. This value was then multiplied by the total disturbed acreage associated with construction storm water permits in each applicable watershed (**Table 6-22**).

To estimate the reduction in loading associated with following proper BMPs and adhering to permit requirements, a 65% reduction was applied based on studies from EPA and the International Storm Water Best Management Practices Database (Geosyntec Consultants, Inc. and Wright Water Engineers, Inc., 2008; U.S. Environmental Protection Agency, 2009). The reduced loads (**Table 6-22**) will be used to set the WLAs for construction stormwater permits. Because following permit conditions meet the intent of the WLA for construction stormwater, any future permits within any watersheds with sediment TMDLs in the Flathead-Stillwater TPA will meet the TMDL by following all permit conditions, including the SWPPP.

Table 6-22 Sediment loading and reductions from permitted construction sites

Watershed	Average LSPC model loading rate* 3 (tons/acre/year)	Annual Disturbed Acres	Estimated load without adequate BMPs (tons/year)	Percent Reduction	BMP sediment load (tons/year)
Middle Ashley Creek	0.216	38	8.2	65%	2.9
Lower Ashley Creek	0.216	69[(1)]	14.9	65%	5.2
Stillwater River	0.216	114	24.6	65%	8.6

[(1)] Includes area in middle Ashley Creek

Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.5.5.4 Industrial Storm Water Permits (MTR000000)

There are currently six facilities that are regulated under the General Permit for Storm Water Discharges Associated with Industrial Activity (MTR000000) that could be contributing to segments of concern (**Table 6-23**). These permits regulate the direct discharge of stormwater draining the facility and its grounds. Under the stipulations of the permits, the facilities maintain an approved SWPPP. The SWPPP sets forth the procedures, methods, and equipment used to prevent the pollution of stormwater discharges. In addition, the SWPPP describes general practices used to reduce pollutants in stormwater discharges. The SWPPPs contain BMPs such as using conveyances that minimize contact between runoff and sediment and other pollutants and retention basins that allow sediment to settle and water to infiltrate into the ground.

Establishing the Total Allowable Load

At the six facilities with industrial storm water permits, the sites range in size from 6.3 – 310 acres with four being located in the Ashley Creek watershed and two in the Stillwater River watershed (**Table 6-23**). According to the general stormwater permit, the benchmark value for TSS is 100 mg/L; this means that the TSS concentration of runoff from the site should not exceed 100 mg/L if permit conditions are followed. The WLA for each facility was calculated using the area it encompasses, the average annual precipitation rate in Kalispell, MT, the benchmark value of 100 mg/L, and the following equation:

$$Load_{BMP} \text{ (tons/year)} = Area_d * Precip_{aa} * Target_{TSS} * 0.00136$$

Where:

$Area_d$ ***= acres of disturbed land***
$Precip_{aa}$ ***= 1.31 feet (Average annual precipitation in Kalispell, MT; http://www.wrcc.dri.edu/summary/Climsmnidwmt.html)***
$Target_{TSS}$ ***= 100 mg/L***
0.00136 = conversion factor

The WLAs are provided because it is a requirement for permitted point sources but is not intended to add load limits to the permit. DEQ assumed that the WLAs will be met by adhering to each permit's requirements, including the SWPPP.

Table 6-23 Sediment loading from permitted industrial sites

NPDES ID	Facility Name	Watershed	Facility Area (acres)	BMP Load (tons/year)
MTR000447	UPS - KALISPELL	Middle and Lower Ashley Creek	4.0	0.7
MTR000251	WISHER'S AUTO RECYCLING	Lower Ashley Creek	22.27	4.0
MTR000419	BUILDING MATERIALS HOLDING CORP. - BMC WEST TRUSS PLANT	Lower Ashley Creek	6.3	1.1
MTR000531	CITY OF KALISPELL WWTP	Lower Ashley Creek	17.04	3.0
MTR000465	GLACIER GOLD LLC	Stillwater River	38.0	6.8
MTR000476	FLATHEAD COUNTY SOLID WASTE DISTRICT	Stillwater River	310.0	55.2

6.5.6 Source Assessment Summary

Based on field observations, the LSPC model, and associated source assessment work, all assessed source categories represent controllable loads within the Flathead-Stillwater TPA. Each source category has different seasonal loading rates, and the relative percentage of the total load from each source category does not necessarily indicate its importance as a loading source. Instead, because of the coarse nature of the source assessment work, and the unique uncertainties involved with each source assessment category, the intention is to separately evaluate source effects within each assessment category (e.g., bank erosion, upland erosion, roads). Results for each source assessment category provide an adequate tool to focus water quality restoration activities in the Flathead-Stillwater TPA; they indicate the relative contribution of sediment to different subwatersheds for each source category and the percent loading reductions that can be achieved with the implementation of improved management practices.

6.6 TMDL and Allocations

The sediment TMDLs for the Flathead-Stillwater TPA will be based on the percent reduction approach, discussed in **Section 4.0**. This approach will apply to the loading allocated among sources as well as to the TMDL for each waterbody. Each impaired segment's TMDL consists of any upstream allocations and an implicit margin of safety (further discussed in **Section 6.8**).

6.6.1 Application of Percent Reductions

Cover et al. (2008) observed a correlation between sediment supply and instream measurements of fine sediment in riffles and pools. DEQ assumes that a decrease in sediment supply, particularly fine sediment, will correspond to a decrease in the percent fine sediment deposition within the streams of interest and result in attaining sediment-related water quality standards. A percent-reduction approach is preferable because there is no numeric standard for sediment to calculate the allowable load and because of the uncertainty associated with the loads derived from the source assessment (which are used to establish the TMDL), particularly when comparing different load categories such as road crossings to bank erosion. Additionally, the percent-reduction TMDL approach is more applicable for restoration planning and sediment TMDL implementation because it helps focus on implementing water BMPs versus focusing on uncertain loading values. TMDL allocations based on the percent reduction approach dot not preclude new roads, forestry, or other nonpoint source activities as long as those activities incorporate BMPs. However, a significant increase in nonpoint source activities should prompt an evaluation of cumulative impacts even with all BMPs in place.

An annual expression of the TMDLs was determined as the most appropriate timescale because sediment generally has a cumulative effect on aquatic life and other designated uses, and all sources in the watershed are associated with periodic loading. Each sediment TMDL is stated as an overall percent reduction of the average annual sediment load. The reduction is calculated by summing the individual annual source allocations and dividing them by the existing annual total load. EPA encourages TMDLs to be expressed in the most applicable timescale but also requires TMDLs to be presented as daily loads (Grumbles, Benjamin, personal communication 2006). Daily loads are provided in **Appendix D**.

6.6.2 Development of Sediment Allocations by Source Categories

The percent-reduction allocations are based on the implementation and maintenance of BMPs s for each major source type (e.g., streambank erosion, upland erosion, roads, and permitted point sources). These BMPs are discussed in **Section 9.0**. The reductions are reasonable as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. Sediment loading reductions can be achieved through a combination of BMPs and the most appropriate BMPs will vary by site. Sediment loading was evaluated at the watershed scale, and associated sediment reductions are also applied at the watershed scale based on the fact that many sources deliver sediment to tributaries that then deliver the sediment load to the impaired waterbodies.

It is important to recognize that the first critical step toward meeting the sediment allocations involves applying and/or maintaining the land management practices, or BMPs, that will reduce sediment loading. Once these actions have been completed at a given location, the landowner or land manager will have taken action consistent with the intent of the sediment allocations for that location. For many nonpoint source activities, it may take several years to decades to achieve the full load reduction at the location of concern, even though full BMP implementation and maintenance is in effect. For example, it may take several years for riparian areas to fully recover after implementing grazing BMPs or allowing re-growth in areas of past riparian harvest. It is also important to apply proper BMPs and other water quality protection practices for all new or changing land management activities to limit any potential increase to sediment loading.

Progress toward TMDL and individual allocation achievement can be gaged by adhering to point source discharge permits, implementing and maintaining BMPs for nonpoint sources, and improving or attaining the water quality targets defined in **Section 6.4**. Any effort to calculate loads and percent reductions for comparison with TMDLs and allocations in this document should be accomplished via the same methodology and/or models used to develop the loads and percent reductions presented within this document.

The following subsections present additional allocation details for each sediment source category.

6.6.2.1 Streambank Erosion

Streambank stability and erosion rates are closely linked to the health of the riparian zone. Reductions in sediment loading from bank erosion are expected to be achieved by applying and maintaining BMPs within the riparian zone. Sediment loads associated with bank erosion can be identified by separate source categories (e.g., transportation, grazing, natural); however, because of the inherent uncertainty in extrapolating this level of detail to the watershed scale, and also because of uncertainty regarding the effects of past land management activity, all sources of bank erosion were combined to express the TMDL and allocations.

DEQ acknowledges that the annual sediment loads are estimates based on data input to the LSPC model for the Flathead Lake watershed. The assignment of bank erosion loads to the various land uses is not definitive but was done to direct efforts to reduce the loads toward those causes that are likely having the biggest effect on the investigated streams. Ultimately, local land owners and managers are responsible for identifying the causes of bank erosion and for adopting practices to reduce bank erosion wherever practical.

6.6.2.2 Upland Erosion

The allocation to upland sources includes application and maintenance of BMPs to present land-use activities as well as recovery from past land-use influences, such as riparian timber harvest. No reductions were allocated to natural sources, which are a significant portion of all upland land-use categories. The percent reduction for human-caused upland erosion is applied to controllable human sources (agriculture and golf courses) of sediment and will be achieved via riparian improvements.

6.6.2.3 Roads

The allocation to roads can be met by incorporating and documenting that all road crossings with potential sediment delivery to streams have the appropriate BMPs in place and that they are being maintained. Routine maintenance of the BMPs is necessary to ensure that sediment loading remains consistent with the intent of the allocations. The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culverts. At a minimum, culverts should meet the 25-year event; however, for fish-bearing streams and streams with a high level of road and impervious surface development upstream, or for culvert sites with a large amount of fill, meeting the 100-year event is recommended. Although the allocation to roads does not preclude constructing new roads as long as that activity incorporates BMPs, a significant increase in road activity or density should prompt an evaluation of cumulative impacts even with all BMPs in place.

6.6.2.4 Permitted Point Sources

All WLAs are expected to be met by adhering to permit conditions and loads provided within this document are not intended to be incorporated into permit limits or added to permit conditions.

6.6.3 Allocations and TMDL for Each Segment

The following subsections present the existing quantified sediment loads, allocations, and TMDL for each waterbody (**Tables 6-24** through **6-30**).

6.6.3.1 Upper Ashley Creek (MT76O002_010)

Table 6-24. Sediment Source Assessment and Example Allocations and TMDL for upper Ashley Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion	255.2	114.8	55%
Upland Sediment Sources	227.8	217.1	5%[1]
Roads	17.7	12.4	30%
Total Sediment Load	**500.7**	**344.3**	**31%**

[1]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.2 Middle Ashley Creek (MT76O002_020)

Table 6-25. Sediment Source Assessment and Example Allocations and TMDL for middle Ashley Creek

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion		533.7	277.5	48%
Upland Sediment Sources		383.5	340.0	11%[1]
Roads		21.2	16.2	30%
Point Source	Kalispell Small MS4	40.4	15.4	62%
	Construction Stormwater (MTR100000)	2.9	2.9	0%
	MTR000447	0.7	0.7	0%
Total Sediment Load		**982.4**	**652.7**	**34%**

[1]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.3 Lower Ashley Creek (MT76O002_030)

Table 6-26. Sediment Source Assessment and Example Allocations and TMDL for lower Ashley Creek

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion		736.8	383.1	48%[1]
Upland Sediment Sources		496.7	427.0	14%[2]
Roads		23.2	16.2	30%
Point Source	Kalispell WWTP	6.7	47.4	0%
	Kalispell Small MS4	122.4	46.5	62%
	Construction Stormwater (MTR100000)	5.2	5.2	0%
	MTR000447	0.7	0.7	0%
	MTR000251	4.0	4.0	0%
	MTR000419	1.1	1.1	0%
	MTR000531	3.0	3.0	0%
Total Sediment Load		**1,399.8**	**934.2**	**33%**

[1] No bank erosion field data was collected for this segment. The reduction is based on the percent reduction for middle Ashley Creek
[2]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.4 Haskill Creek (MT76P003_070)

Table 6-27. Sediment Source Assessment and Example Allocations and TMDL for Haskill Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion	372.4	346.3	7%
Upland Sediment Sources	375.7	301.0	20%[1]
Roads	5.6	3.9	30%
Total Sediment Load	**753.7**	**651.2**	**14%**

[1]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.5 Logan Creek (MT76P001_030)

Table 6-28. Sediment Source Assessment and Example Allocations and TMDL for Logan Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion	2,264.5	2,264.5	0%[1]
Upland Sediment Sources	705.9	705.85	0.01%[2]
Roads	29.8	23.3	22%
Total Sediment Load	**3,000.2**	**2,993.65**	**0.2%**

[1]No bank erosion field data was collected for the Star Meadow portion of the segment. All controllable sources of bank erosion will need to have BMPs applied to achieve the TMDL and applicable load allocation
[2]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.6 Sheppard Creek (MT76P001_050)

Table 6-29. Sediment Source Assessment, Allocations and TMDL for Sheppard Creek

Sediment Sources	Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion	393.5	393.5	0%[1]
Upland Sediment Sources	146.4	146.4	0%[2]
Roads	7.1	6.2	13%
Total Sediment Load	**547.0**	**546.1**	**0.2%**

[1]No bank erosion field data was collected for the Star Meadow portion of the segment. All controllable sources of bank erosion will need to have BMPs applied to achieve the TMDL and applicable load allocation
[2]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources
Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.6.3.7 Stillwater River (MT76P001_010)

Table 6-30. Sediment Source Assessment and Example Allocations and TMDL for the Stillwater River

Sediment Sources		Current Estimated Load (Tons/Year)	Total Allowable Load (Tons/Year)	Load Allocations (% reduction)
Streambank Erosion		12,240.6	12,240.6	0%[1]
Upland Sediment Sources		3,066.8	2,673.8	13%[2]
Roads		166.3	116.4	30%
Point Source	Kalispell Small MS4	43.4	16.5	62%
	Construction Stormwater (MTR100000)	8.6	8.6	0%
	MTR000465	6.8	6.8	0%
	MTR000476	55.2	55.2	0%
Total Sediment Load		**15,587.7**	**15,117.9**	**3%**

[1] No bank erosion field data was collected for this segment. The reduction is based on observations made by DEQ personnel on a float of the Stillwater River in 2012. All controllable sources of bank erosion will need to have BMPs applied to achieve the TMDL and applicable load allocation

[2]Overall reduction to upland sediment sources; based on a 50% load reduction to controllable human sources

[3]Assuming that no storm event has occurred on a particular day

Note: Values were rounded to the nearest tenth; differences in loads presented in this table may not correspond to the identified percent reduction

6.7 Seasonality and Margin of Safety

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety were applied during development of the Flathead-Stillwater sediment TMDLs.

6.7.1 Seasonality

All TMDL documents must consider the seasonal applicability of water quality standards as well as the seasonal variability of pollutant loads to a stream. Seasonality was addressed in several ways:

- The applicable narrative water quality standards (**Appendix A**) are not seasonally dependent, although low-flow conditions provide the best ability to measure harm-to-use based on the selected target parameters. The low-flow or base-flow condition represents the most practical time period for assessing substrate and habitat conditions, and also represents a time period when high fine sediment in riffles or pool tails will likely influence fish and aquatic life. Therefore, meeting targets during this time frame represents an adequate approach for determining standards attainment.
- The substrate and habitat target parameters within each stream are measured during summer or autumn low-flow conditions consistent with the time of year when reference stream measurements are conducted. This time period also represents an opportunity to assess effects of the annual runoff from snowmelt and early spring rains, which is the typical time frame for sediment loading to occur.
- The DEQ sampling protocol for macroinvertebrates identifies a specific time period for collecting samples based on macroinvertebrate life cycles. This time period coincides with the low-flow or base-flow condition.
- All assessment modeling approaches are standard approaches that specifically incorporate the yearly hydrologic cycle specific to the project area. The resulting loads are expressed as average yearly loading rates to fully assess loading throughout the year.

- Allocations are based on average yearly loading, and the preferred TMDL expression is as an average yearly load reduction, consistent with the assessment methods.

6.7.2 Margin of Safety

Natural systems are inherently complex. Any approach used to quantify or define the relationship between pollutant loading rates and the resulting water quality effects, no matter how rigorous, will include some level of uncertainty or error. To compensate for this uncertainty and ensure water quality standards are attained, a margin of safety (MOS) is required as a component of each TMDL. 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 (U.S. Environmental Protection Agency, 1999a). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to assess a broad range of physical and biological parameters known to illustrate the effects of sediment in streams and rivers. These targets serve as indicators of potential impairment from sediment and also help signal recovery, and eventual standards attainment, after TMDL implementation. Conservative assumptions were used during development of these targets; as discussed for each target parameter in **Section 6.4.1**, an effort was made to select achievable water quality targets, but in all cases, the most protective statistical approach was used. **Appendix A** contains additional details about statistical approaches used by DEQ.
- By developing TMDLs for streams that were close to meeting all target values. This approach addresses some of the uncertainty associated with sampling variability and site representativeness and recognizes that capabilities to reduce sediments exist throughout the watershed.
- Sediment impairment is typically identified based on excess fine sediment but the targets and TMDLs address both coarse and fine sediment delivery.
- By properly incorporating seasonality into target development, source assessments, and TMDL allocations (details provided in **Section 6.7.1**).
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocations, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development (discussed in **Sections 6.8** and **10.0**).
- By using naturally occurring sediment loads as described in Administrative Rules of Montana (ARM) 17.30.602(17) (see **Appendix A**) to establish the TMDLs and allocations based on reasonably achievable load reductions for each source category. Specifically, each major source category must meet percent reductions to satisfy the TMDL because of the relative loading uncertainties between assessment methodologies.
- By developing TMDLs at the watershed scale to address all potentially significant human-related sources beyond just the impaired waterbody segment scale. This approach should also reduce loading and improve water quality conditions within other tributary waterbodies throughout the watershed.

6.8 Uncertainty and Adaptive Management

A degree of uncertainty is inherent in any study of watershed processes. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management is a key component of TMDL implementation. The process of adaptive management is predicated on the premise that TMDLs, allocations, and their supporting analyses are not static but are subject to periodic modification or adjustment as new information and relationships are better understood. Within the Flathead-Stillwater TPA, adaptive management for sediment TMDLs relies on continued monitoring of water quality and stream habitat conditions, continued assessment of effects from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fishes respond to changes in water quality and stream habitat conditions.

As further monitoring and assessment is conducted, uncertainties with present assumptions and consideration may be mitigated via periodic revision or review of the assessment that occurred for this document. As noted in **Section 6.7.2**, adaptive management represents an important component of the implicit MOS. This document provides a framework to satisfy the MOS by including sections focused on TMDL implementation, monitoring, and adaptive management (**Sections 9.0** and **10.0**). Furthermore, state law (ARM 75-5-703) requires monitoring to gauge progress toward meeting water quality standards and satisfying TMDL requirements. These TMDL implementation monitoring reviews represent an important component of adaptive management in Montana.

Perhaps the most significant uncertainties within this document involve the accuracy and representativeness of (a) field data and target development and (b) the accuracy and representativeness of the source assessments and associated load reductions. These uncertainties and approaches used to reduce uncertainty are discussed in following subsections.

6.8.1 Sediment and Habitat Data Collection and Target Development

Some of the uncertainties regarding accuracy and representativeness of the data and information used to characterize existing water quality conditions and develop water quality targets are discussed below.

Data Collection

The stream sampling approach used to characterize water quality is described in **Attachment A**. To control sampling variability and improve accuracy, the sampling was done by trained environmental professionals using a standard DEQ procedure developed to evaluate sediment loading (Montana Department of Environmental Quality, 2011a). This procedure defines specific methods for each parameter, including sampling location and frequency, to ensure proper representation and applicability of results. Before any sampling, a sampling and analysis plan (SAP) was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP and was based on a stratification process described in **Attachment A**. The stratification work ensured that each stream included one or more sample sites representing a location where excess sediment loading or altered stream habitat could affect fish or aquatic life.

Even with the applied quality controls, a level of uncertainty regarding overall accuracy of collected data will exist. There is uncertainty regarding whether the appropriate sites were assessed and whether an adequate number of sites were evaluated for each waterbody. In addition, there is the uncertainty of the representativeness of collecting data from a single sampling season. These uncertainties are difficult to quantify and even more difficult to eliminate given resource limitations and occasional stream access issues.

Target Development

DEQ evaluated several data sets to ensure that the most representative information and statistic were used to develop each target parameter, consistent with the reference approach framework outlined in **Appendix A**. Using reference data is the preferred approach for target setting; however, some uncertainty is introduced because of differing protocols between the available reference data and recent sample data for the project area. These differences were acknowledged within the target development discussion and taken into consideration during target setting. For each target parameter, DEQ stratified the Flathead-Stillwater sample results and target data into similar categories, such as stream width or Rosgen stream type, to ensure that the target exceedance evaluations were based on appropriate comparisons.

The established targets are meant to apply under median conditions of natural background and natural disturbance. DEQ recognizes that under some natural conditions, such as a large fire or flood event, it may be impossible to satisfy one or more of the targets until the stream and/or watershed recovers from the natural event. Under these conditions the goal is to ensure that management activities do not significantly delay achievement of targets as compared to the time for natural recovery to occur.

Also, human activity should not significantly increase the magnitude of water quality effects from natural events. For example, extreme flood events can cause a naturally high level of sediment loading that could be further increased by a large number of road crossing or culvert failures.

Because sediment target values are based on data percentiles, DEQ recognizes that it may be impossible to meet all targets for some streams even under normal levels of disturbance. On the other hand, some target values may underestimate the potential of a given stream, and it may be appropriate to apply more protective targets upon further evaluation during adaptive management. It is important to recognize that the adaptive management approach provides flexibility to refine targets as necessary to ensure resource protection and to adapt to new information concerning target achievability.

6.8.2 Source Assessments and Load Reduction Analyses

Each source of sediment has uncertainties associated with the accuracy and representativeness of the sediment load estimates and percent load reductions. For each source assessment, assumptions were made to evaluate sediment loading and potential reductions at the watershed scale. Because of these uncertainties, conclusions may not represent existing conditions and achievable reductions at all locations in the watershed. Uncertainties are discussed independently for the three major non-point source categories: bank erosion, upland erosion, and unpaved roads.

<u>Bank Erosion</u>

Bank erosion loads were estimated using the LSPC model for the Flathead Lake watershed. Assumptions and uncertainty associated with bank erosion loading can be found in Tetra Tech (2014b). Load reductions were determined using the percentage of eroding banks that were assigned to human sources during 2008 field visits (**Attachment A)**. Before the field sampling, a SAP was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP and was based on a stratification process described in **Attachment A**. Because only one or two sites per segment of concern were evaluated for bank erosion, there is some uncertainty with regards to the accuracy of erosion attributed to human-causes at the watershed scale. For this reason, the loads are intended to provide a relative sense of the loading associated with bank erosion from human and natural sources for each watershed.

There is additional uncertainty regarding the amount of bank erosion linked to human activities and the specific human sources, as well as the ability to reduce the human-related bank erosion levels. This uncertainty is largely associated with identifying sources at the stream segment scale using aerial photos and also because of the heavy influence from past disturbances; it is extremely difficult to identify the level to which historical occurrences still affect streambank erosion, how much is associated with human sources, and what the dominant human sources are. Even if difficult to quantify, the linkages between human activity, such as riparian clearing and bank erosion, are well established, and these linkages clearly exist at different locations throughout the Flathead-Stillwater TPA. Evaluating bank erosion levels, particularly where BMPs have been applied along streams, is an important part of adaptive management that can help define the level of human-caused bank erosion as well as the relative effect that bank erosion has on water quality throughout the Flathead-Stillwater TPA.

Upland Erosion

Professional modelers determined upland erosion loads by using the water quality model LSPC (Tetra Tech, Inc., 2014b). As with any model there is uncertainty in the model input parameters, including land use, land cover, slope, soil types, and assumptions regarding existing levels of BMP application. Thus, there is uncertainty regarding existing erosion prevention BMPs in a given watershed and the ability to reduce erosion with additional BMPs. Even with these uncertainties, the ability to reduce upland sediment erosion and delivery to nearby waterbodies, especially from agricultural sources, is well documented in the literature, and the estimated reductions are consistent with literature values for riparian buffers in agricultural settings.

Unpaved Roads

As described in Tetra Tech (2014b), sediment loading from roads was estimated using the LSPC model. The inputs to this model represent roads with typical BMPs in place and do not account for failing road crossings and culverts. It also does not account for roads that are poorly designed and/or not maintained. As such a 30% reduction was applied to unpaved roads in the watersheds for each of the segments of concern. The reductions to unpaved roads can by adjusted as part of adaptive management as detailed information becomes available. Meeting the allocations for sediment from roads requires that all BMPs are implemented and maintained and all failing road crossings and culverts are repaired and properly functioning.

7.0 Temperature TMDL Components

This portion of the document focuses on temperature as an identified cause of water quality impairment in the Flathead-Stillwater Total Maximum Daily Load (TMDL) Planning Area (TPA). It describes: (1) the mechanisms by which temperature affects beneficial uses of streams; (2) the specific stream segments of concern; (3) information sources used for temperature total maximum daily load (TMDL) development; (4) temperature target development; (5) assessment of sources contributing to excess thermal loading; (6) example temperature total maximum daily loads (TMDLs) and allocations; (7) seasonality and margin of safety; and (8) uncertainty and adaptive management.

7.1 Effects of Temperature on Beneficial Uses

Human influences that reduce stream shade, increase stream channel width, add heated water, or decrease the capacity of the stream to buffer incoming solar radiation all increase stream temperatures. Warmer temperatures can negatively affect aquatic life and fish that depend upon cool water for survival. Increased water temperature reduces dissolved oxygen and causes increased primary production via algal (Robarts and Zohary, 1987) and bacterial (Kaplan and Bott, 1989) growth that can exacerbate nutrient-related problems and lead to further reductions in dissolved oxygen. In addition, higher instream temperatures make fishes more prone to disease (Tops et al., 2006; Roth, 1972; Roberts, 1975). Coldwater fish species are more stressed in warmer water temperatures as these conditions increase metabolism and reduce the amount of available oxygen in the water. In turn, coldwater fish, and other aquatic species, may feed less frequently and use more energy to survive in thermal conditions above their tolerance range, sometimes creating lethal conditions for a percentage of the fish population. Also, elevated temperatures can boost the ability of non-native fish to outcompete native fish if the latter are less able to adapt to warmer water conditions (Bear et al., 2007a). These lower winter temperatures can lead to the formation of anchor and frazil ice, which can harm aquatic life by causing changes in movement patterns (Brown, 1999; Jakober et al., 1998), reducing available habitat, and inducing physiological stress (Brown et al., 1993). Addressing the issues associated with increased summer maximum temperatures will also address these potential winter problems. Assessing thermal effects upon a beneficial use is an important initial consideration when interpreting Montana’s water quality standard (**Appendix A**) and subsequently developing temperature TMDLs.

7.2 Stream Segments of Concern

Three waterbody segments in the Flathead-Stillwater TPA appeared on the 2014 Montana impaired waters list as having temperature limiting a beneficial use: upper Ashley Creek from Ashley Lake to Smith Lake (MT76O002_010), lower Ashley Creek from Kalispell Airport Road to the mouth (MT76O002_030), and the Whitefish River from Whitefish Lake to the mouth (MT76P003_010) (**Figure 7-1**). Although middle Ashley Creek from Smith Lake to the Kalispell Airport Road (MT76O002_020) was not on the 2014 Montana impaired water list as having temperature limiting a beneficial use, it was included as part of this project. The data collected indicate that middle Ashley Creek (Ashley Creek from Smith Lake to Kalispell Airport Road; MT76O002_020) does have temperature limiting a beneficial use and it will appear in the 2016 Integrated Report (IR) as a result. A temperature TMDL will also be written for this segment. The three segments of Ashley Creek have three different use class designations; upper Ashley is B-1, lower Ashley is C-2, and middle Ashley Creek segment is B-2. The Whitefish River is designated B-2. Although there is a slight difference in standard language between B-1, B-2, and C-2 streams, the same temperature standards apply to all three class designations. That language describes a maximum allowable increase above naturally occurring temperature of 0.5 – 1.0°F, depending on the naturally occurring temperature. In addition to the temperature impairment, lower Ashley Creek is listed for alteration in streamside or littoral vegetative covers, which is a non-pollutant listing that can be linked to temperature impairment.

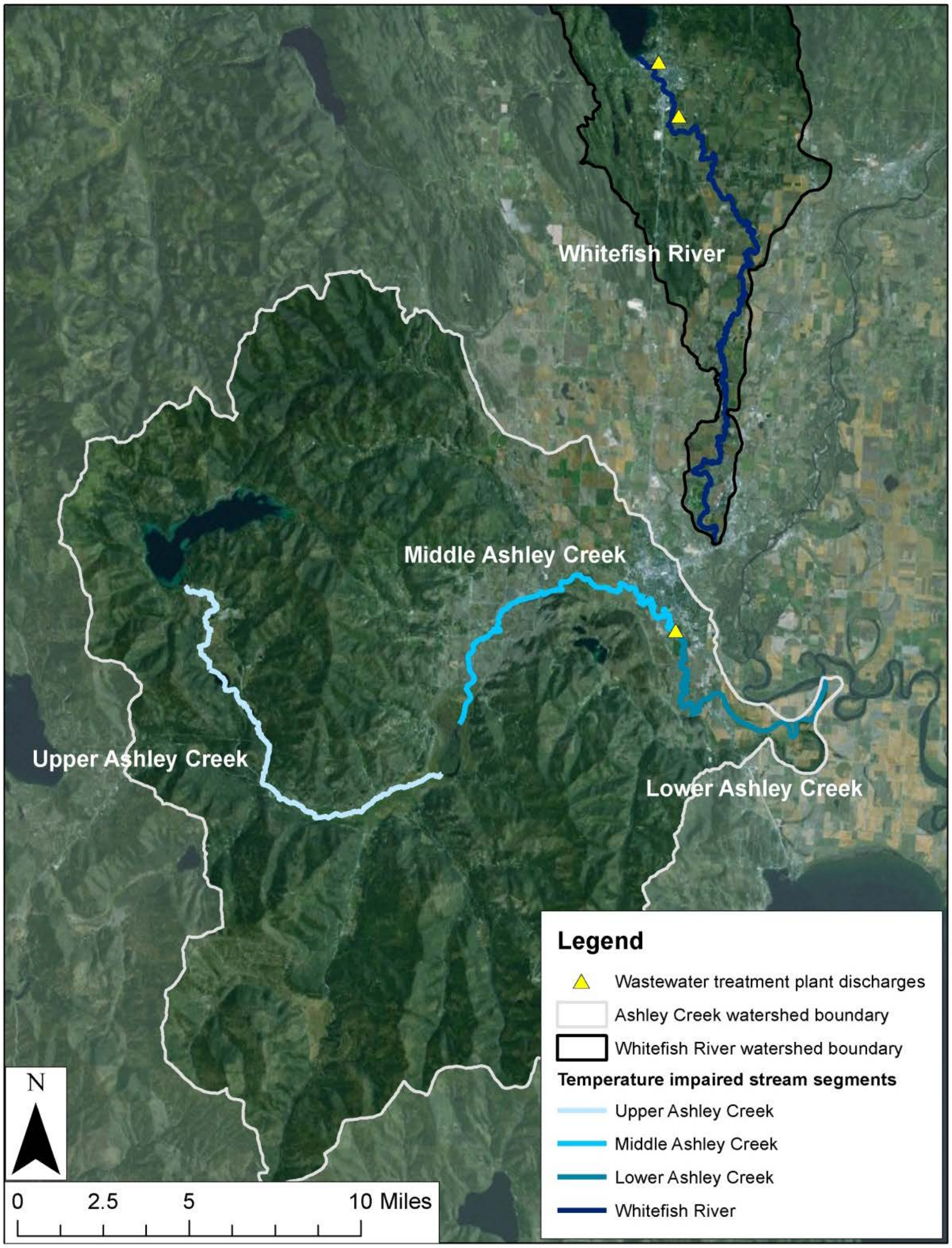


Figure 7-1. Ashley Creek and the Whitefish River watersheds and the four corresponding segments for which TMDLs are presented in this document

Although middle Ashley Creek was not included in the 2014 IR, it has been included here to maintain continuity and a full understanding of the Ashley Creek system. Results from the analysis indicate temperature conditions in middle Ashley Creek are above the standard, therefore temperature TMDLs are included for all three Ashley Creek segments. To help put sampling data into perspective and understand how elevated stream temperatures may affect aquatic life, information on fish presence in Ashley Creek and the Whitefish River and temperature preferences for the most sensitive species are described below.

7.2.1 Fish Presence and Temperatures of Concern

Because different fish species have varying optimal temperature ranges for survival and some are more sensitive than others to elevated stream temperatures, it is important to identify the fish species within each stream segment of concern.

7.2.1.1 Fish Presence in Ashley Creek

According to the Montana Fish, Wildlife, and Parks fisheries resource value ratings (determined by the species present and habitat quality, description at: http://fwp.mt.gov/fwpDoc.html?id=29756), Ashley Creek is considered "Substantial" (rating score 3) from river mile 15.9 to 41.7 (Lone Lake; upper Ashley Creek and middle Ashley Creek segments). Its score is one category lower at "Moderate" (rating score 4) for the reach of Ashley Creek from the mouth to river mile 15.9 (middle Ashley Creek and lower Ashley Creek segments).

Based on a query of the Montana Fisheries Information System (MFISH), brook trout, rainbow trout, and westslope cutthroat/rainbow trout hybrids, and mountain whitefish can all be found in Ashley Creek (**Table B-3** in **Appendix B**). Northern pike and yellow perch are other sport fish that can be found in this watershed. In addition, largescale sucker, longnose sucker, northern pike minnow, peamouth, redside slider, and sculpin are present.

7.2.1.2 Fish Presence in the Whitefish River

According to the Montana Fish, Wildlife, and Parks fisheries resource value ratings, Whitefish River is considered "Substantial" (rating score 3) from river mile 0 to 23.7.

Based on a query of MFISH, brook trout, bull trout, rainbow trout, westslope cutthroat trout, and mountain whitefish can all be found in the Whitefish River (**Table B-4** in **Appendix B**). Northern pike is another sport fish that can be found in this watershed. In addition, largescale sucker, longnose sucker, northern pike minnow, peamouth, redside slider, and slimy sculpin are present.

7.2.1.3 Temperature Levels of Concern

Special temperature considerations are warranted for westslope cutthroat trout, which are listed in Montana as a species of concern and occur within both the Ashley Creek and Whitefish River watersheds. Research by Bear et al. (2007b) found that westslope cutthroat maximum growth occurs around 56.5°F with an optimum growth range (based on 95% confidence intervals) from 50.5 – 62.6°F. Rainbow trout were found to have a similar optimum growth temperature; however, rainbow trout were predicted to grow better over a wider range of temperatures than cutthroat trout, with growth being significantly better at temperatures below 44.2° F and above 69.4°F, possibly allowing for increased competition with cutthroat trout in lower-elevation (warmer) streams.

The ultimate upper incipient lethal temperature (UUILT) is the temperature considered to be survivable by 50% of a population over a specified time period. Bear et al. (2007b) found the 60-day UUILT for westslope cutthroat trout to be 67.3°F and the 7-day UUILT to be 75.4°F. In contrast they observed that rainbow trout had a 60-day UUILT of 75.7°F and a 7-day UUILT of 78.8°F. The lethal, temperature dose for westslope cutthroat that will kill 10% of the population in a 24-hour period is 73.0°F (Liknes and Graham, 1988).

Bull trout require cold water to thrive and survive with maximum growth occurring around 55.8°F and an optimum growth range (based on 95% confidence intervals) from 51.6 – 59.7°F (Selong et al., 2001). Water temperatures important to bull trout for spawning, incubation, and rearing typically range from the upper 30s to low 50s Fahrenheit (U.S. Fish and Wildlife Service, 2002). As water temperatures increase, conditions become more adverse. Selong et al. (2001) found the 60-day UUILT to be 69.6°F and predicted the 7-day UUILT to be 74.3°F. The critical thermal maximum is the arithmetic mean of collected thermal points at which locomotor activity becomes disorganized such that the organism loses its ability to escape lethal conditions (Cowells and Bogert, 1944). According to Selong et al. (2001), the critical thermal maximum for bull trout is in the range of 76.6 – 84.0°F depending on age.

Bull trout are not known to regularly occupy either Ashley Creek or the Whitefish River, but their presence in the Flathead watershed does indicate that the potential exists. However, temperatures recorded in Ashley Creek and the Whitefish River during data collection associated with TMDL development suggest that bull trout presence, especially during summer months would be very unlikely. During the data collection period the 7-day average maximum temperatures at the 19 Ashley Creek sites ranged from 61.4 – 76.8°F and at the 10 Whitefish River sites ranged from 66.9 – 73.3°F (**Attachment EA** of **Appendix E**).

7.3 Information Sources and Data Collection

As part of this TMDL project, Department of Environmental Quality (DEQ) used several information and data sources to analyze and assess the conditions in Ashley Creek and the Whitefish River:

- **DEQ Assessment Files:** These files contain information used to make the existing temperature impairment determinations.

- **Temperature Related Data collection:** Temperature, flow, riparian shade, and channel geometry data were collected from July – September 2008 to update impairment determinations, construct River and Stream Water Quality (QUAL2K) models, and assist with the development of temperature TMDLs.

Sample locations were generally such that they provided a comprehensive upstream to downstream view of stream temperature. The location of sample collection also allowed for analysis of potential source impacts (e.g., shade, irrigation influence, point sources). All data used in TMDL development were collected during July – September, the time of year when fish are likely to be the most stressed by thermal conditions. **Appendix E** contains detailed information regarding data collection and model use.

The data used for the analyses in this document can be obtained from the Montana Department of Environmental Quality's Water Quality Planning Bureau. Other water quality data from the watershed are publicly available through the Environmental Protection Agency's (EPA) STOrage and RETrieval database (STORET) and DEQ's EQuIS water quality databases.

As discussed in **Appendix E** and **Section 7.4.1**, Montana defines temperature impairment as occurring when human sources cause a certain degree of change over the water temperature that occurs as a result of natural sources and human sources that are implementing all reasonable land, soil, and water conservation practices. Because interpreting the standard is more complex than just comparing measured temperatures to the temperature levels of concern discussed in **Section 7.2.1.3**, a QUAL2K water quality model was used to determine if human sources are causing the allowable temperature change to be exceeded. Model details are presented in **Appendix E** but model summaries are provided in **Sections 7.6.1.1 and 7.6.2.1**. To assist with model development and assessment of temperature conditions in Ashley Creek and the Whitefish River, two other categories of data were needed:

- Geographic Information System (GIS) data layers
- Land-use information

7.3.1 DEQ Assessment Files

DEQ maintains assessment files that provide a summary of available water quality and other existing condition information, along with a justification for impairment determinations. This information was compiled from 1999 to 2006 for the four applicable waterbody segments. The following is a short review of the temperature impairment determinations DEQ has made.

7.3.1.1 Ashley Creek

Information about the three segments of Ashley Creek catalogued within the DEQ assessment files describes a variety of sources that indicate potential temperature impairment to aquatic life. A report about macroinvertebrate populations in Ashley Creek by Bollman (2003a) described assemblages between Ashley Lake and Smith Lake that suggest water quality may be affected by nutrients and warm temperatures. These same conclusions were made based on assemblages in the lower segment of Ashley Creek.

7.3.1.2 Whitefish River

Information about the Whitefish River catalogued within the DEQ assessment files references (Montana Department of Fish, Wildlife and Parks, Fisheries Division, 1996) which states, “Poor rearing and spawning success due to dewatering and high water temperatures.” Suggested improvements however were focused on tributary enhancement rather than mainstem improvements. The Montana Bulle Trout Scientific Group (1995) judged the Whitefish River as a low priority stream for restoration due to long-term degraded habitat conditions. The report also stated that the lack of bull trout in the Whitefish drainage is likely due in to the presence of non-native species with road building, logging, and subdivision development also contributing to the population decline.

7.3.2 Ashley Creek and Whitefish River TMDL Field Data Collection

DEQ’s methods for Ashley Creek and Whitefish River temperature TMDL development included a combination of characterizing water temperatures throughout the summer and collecting additional vegetation, channel width, shade, and streamflow data, which were used to model stream temperature. As described in **Attachment ED** of **Appendix E**, the QUAL2K temperature models were calibrated to existing flow, shade, and temperature conditions, with the ability to evaluate temperature impacts from differing riparian health (shade) and streamflow conditions. The following sections describe the data collected in Ashley Creek and the Whitefish River for temperature assessment.

7.3.2.1 Temperature Monitoring

Temperature monitoring was conducted in 2008 on Ashley Creek and the Whitefish River between mid-July and mid-September. The study examined stream temperatures during the period when streamflow tends to be the lowest and water temperatures the warmest and thus, when negative effects to the aquatic life beneficial use are likely most pronounced. Temperature monitoring consisted of placing temperature data loggers at 20 sites in the Ashley Creek watershed (17 on the mainstem and three on tributaries) and at 11 sites in the Whitefish River watershed (nine on the mainstem and two on tributaries). Temperature monitoring sites were selected to bracket stream reaches with similar hydrology, riparian vegetation type, valley type, stream aspect, and channel width. Temperature monitoring locations are shown in **Figures 7-2 and 7-3**; latitude and longitude coordinates for these sites can be found in **Attachment EA** of **Appendix E**. Temperature data can be obtained by contacting DEQ but are summarized within this document and **Appendix E**.

Data loggers were deployed in the Ashley Creek watershed between July 21st and 28th and retrieved between September 10th and 17th. Of the 20 temperature monitoring sites established, temperature data loggers were retrieved from 19 sites (one temperature data logger from the mainstem (ASHL-12) was not recovered). Maximum daily temperatures ranged from 62.2 – 79.8°F with 17 of 19 seasonal maximums being greater than 67°F. These maximum values occurred between July 26th and August 18th, with 15 out of 19 seasonal maximum temperatures occurring on August 17th (**Attachment EA** of **Appendix E**). The QUAL2K model for Ashley Creek indicated that it takes water 15 days to travel from Ashley Lake to the mouth; all scenarios were run for the August 4th-18th timeframe.

Data loggers were deployed in the Whitefish River watershed between July 18th and 21st and retrieved between September 11th and 15th. All of the data loggers were retrieved; however, there were no data for one site (WHTF-03, Haskill Creek) due to technical issues. Maximum daily temperatures ranged from 68.0 – 75.2°F and with 10 of 10 seasonal maximums being greater than 67°F. These maximum values occurred between July 26th and August 18th, with seven out of 10 seasonal maximum temperatures occurring on August 18th (**Attachment EA** of **Appendix E**). The QUAL2K model for the Whitefish River indicated that it takes water two days to travel from Whitefish Lake to the mouth; all scenarios were run for the August 17th-18th timeframe.

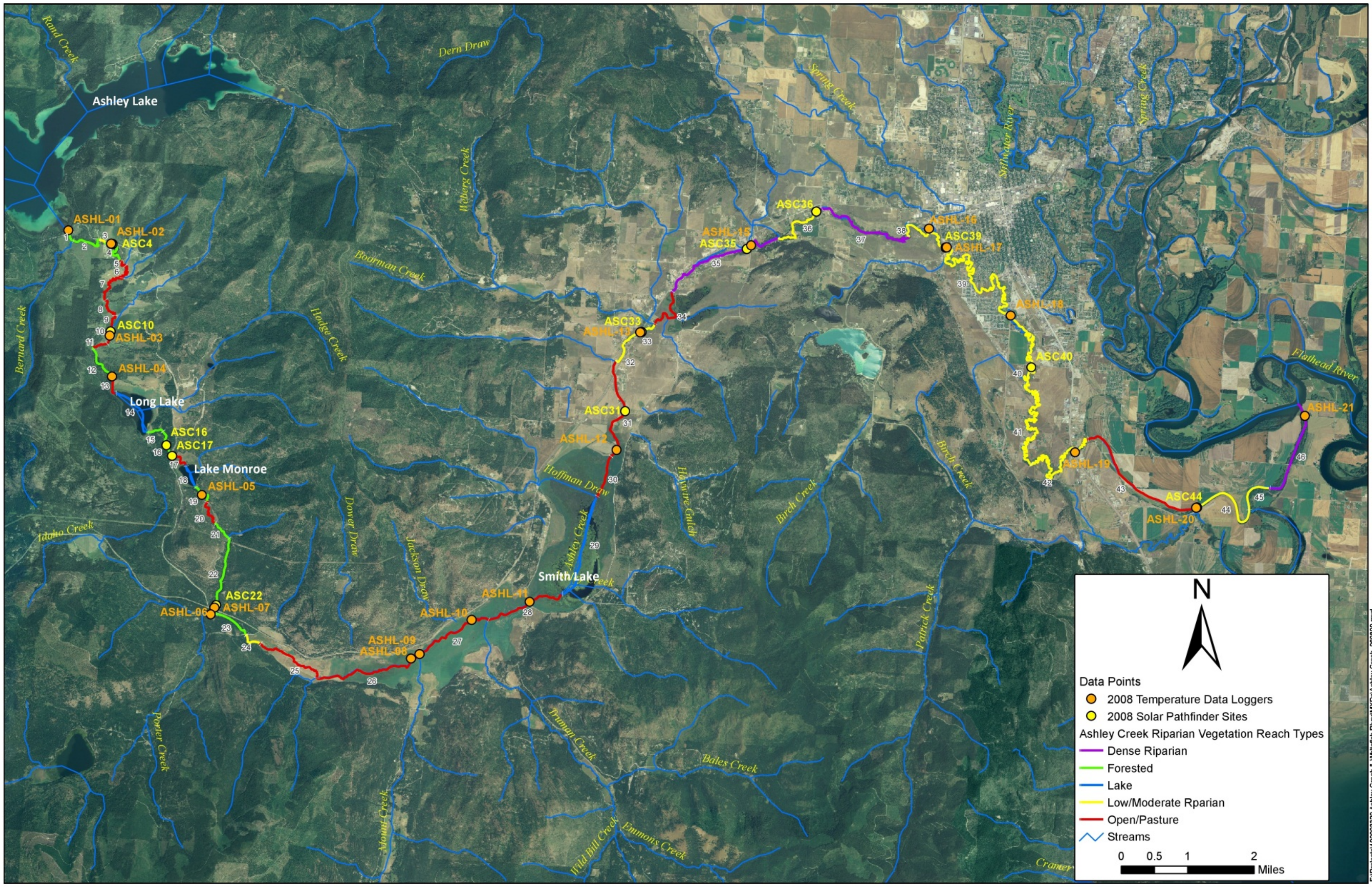


Figure 7-2. Temperature data logger and Solar Pathfinder sampling sites on Ashley Creek

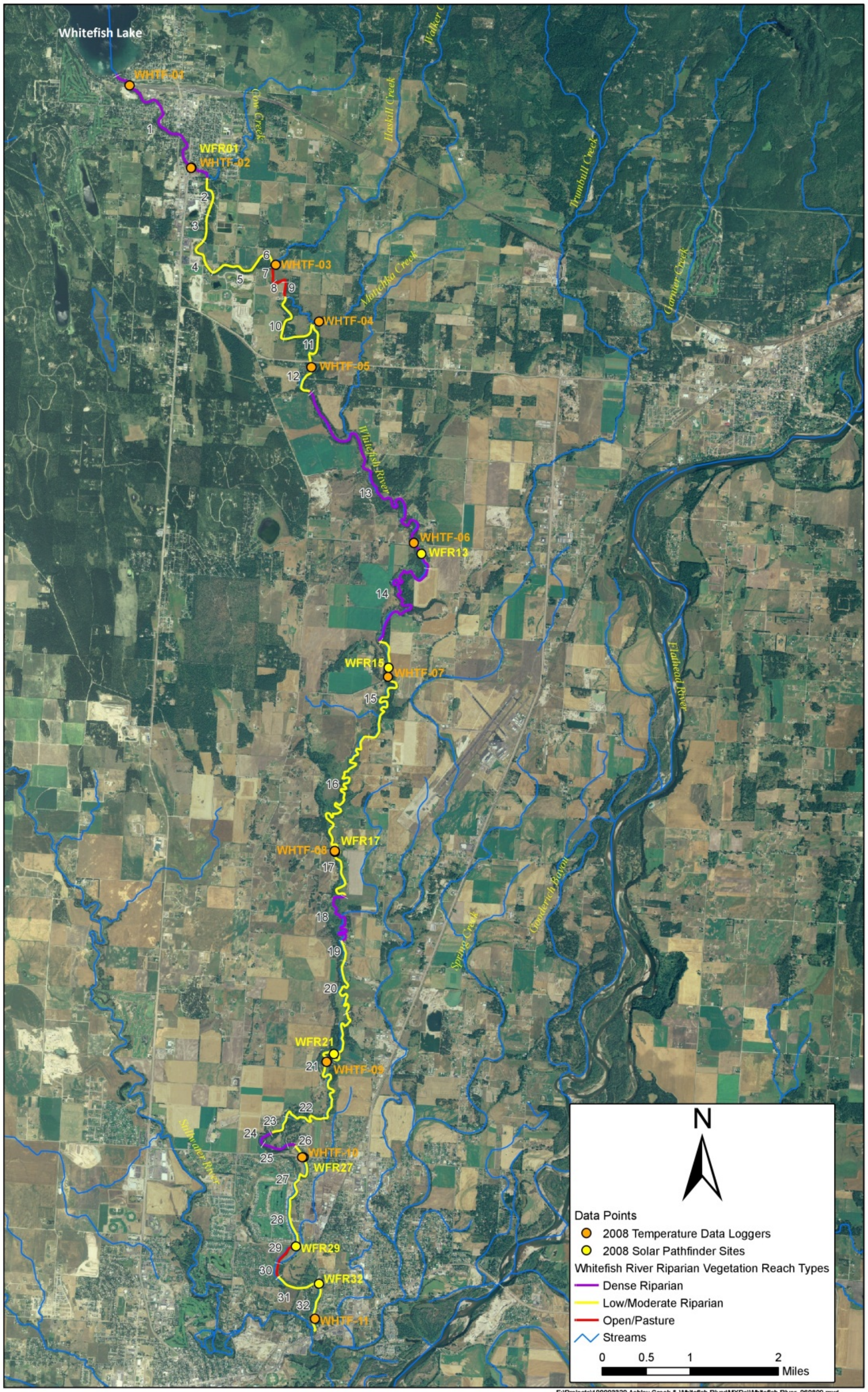


Figure 7-3. Temperature data logger and Solar Pathfinder sampling sites on the Whitefish River

7.3.2.2 Streamflow

Streamflow measurements were collected at 12 temperature monitoring locations in Ashley Creek and two temperature monitoring locations on tributary streams (**Table E2-2** in **Appendix E**) between August 15th and August 25th. Three of the Ashley Creek measurements were not used in the model due to slow velocity, dense aquatic vegetation growth, and poor comparison to United States Geological Survey (USGS) estimates (See **Section E2.2.1.2** in **Appendix E**).

Streamflow measurements were collected at five temperature monitoring locations in the Whitefish River and two temperature monitoring locations on tributary streams (**Table E2-3** in **Appendix E**) between August 11th and August 13th. One of the Whitefish River measurements was not used in the model because it appeared to over-estimate the actual streamflow (See **Section E2.2.1.2** in **Appendix E**).

7.3.2.3 Riparian Shading

Characterization of riparian shade was based on a combination of field data and aerial imagery analysis. A Solar Pathfinder was used to measure effective shade in 2008 at 12 locations on Ashley Creek (**Figure 7-2**) and eight locations on the Whitefish River (**Figure 7-3**). Effective shade is the percent reduction of incoming solar radiation that reaches the stream because of riparian vegetation and topography.

Before collecting field data, Ashley Creek was divided into 46 distinct reaches covering 44.6 miles based on the riparian vegetation type as observed in GIS using National Agricultural Imagery Program (NAIP) color aerial imagery from 2005 and high-resolution color orthophotographs from May 24th, 2004 (**Figure 7-2**). Riparian vegetation reach types included forested, dense riparian, low/moderate riparian and open/pasture. Forested areas were dominated by coniferous vegetation, while dense riparian areas had a mix of deciduous trees and shrubs. Low/moderate riparian areas were comprised primarily of deciduous shrubs and herbaceous vegetation. Each reach was reviewed using aerial imagery of the predominant riparian vegetation and assigned a vegetation type using best professional judgment.

Streamside shading was assessed at 12 sites along Ashley Creek and the average amount of shade within each riparian vegetation reach type was calculated (**Table E2-4** in **Appendix E**). For reaches in which shade measurements were performed, the result was applied directly to the entire reach. For reaches in which no shade measurement was performed, the riparian vegetation reach type average was applied. The complete riparian shading dataset is presented in **Attachment EB** of **Appendix E** and supplemental information for each assessed reach is presented in **Attachment EC** of **Appendix E**. Riparian vegetation reach types as determined through GIS analysis of aerial imagery are presented in **Figure 7-2** and **Attachment EF** of **Appendix E**, along with assumptions applied during the shade model scenario (see **Section E2.2.2.2** of **Appendix E**).

Prior to field data collection, the Whitefish River was divided into 32 distinct reaches covering 24.8 miles based on the riparian vegetation type as observed in GIS using NAIP color aerial imagery from 2005 and high-resolution color orthophotographs from May 24th, 2004 (**Figure 7-3**). Riparian vegetation reach types included dense riparian, low/moderate riparian and open/pasture. Dense riparian areas had a mix of deciduous trees and shrubs, while low/moderate riparian areas were comprised primarily of deciduous shrubs and herbaceous vegetation. Each reach was reviewed using aerial imagery of the predominant riparian vegetation and assigned a vegetation type using best professional judgment.

Streamside shading was assessed at eight sites along the Whitefish River and the average amount of shade within each riparian vegetation reach type was calculated (**Table E2-5** in **Appendix E**). For reaches in which shade measurements were performed, the result was applied directly to the entire reach. For reaches in which no shade measurement was performed, the riparian vegetation reach type average was applied. The complete riparian shading dataset is presented in **Attachment EB** of **Appendix E** and supplemental information for each assessed reach is presented in **Attachment EC** of **Appendix E**. Riparian vegetation reach types as determined through GIS analysis of aerial imagery are presented in **Figure 7-3** and **Attachment EF** of **Appendix E**, along with assumptions applied during the shade model scenario (see **Section E2.2.3.2** of **Appendix E**).

7.3.2.4 Channel Geometry

Although not a direct measure of thermal effect on the stream, channel geometry can influence the rate of thermal loading. Wide, shallow streams transfer heat energy faster than narrow, deep streams. Therefore, channel geometry can be used to identify areas that may be destabilized, and may be more prone to rapid thermal loading, particularly in locations where shading is minimal.

Channel width (wetted and bankfull) was collected at each of the shade sites on Ashley Creek and the Whitefish River. While this data was incorporated into the QUAL2K model, field measurements and observations indicated the respective stream channels had appropriate widths and there was minimal potential to reduce them. Thus, a channel morphology modeling scenario was not applied to either Ashley Creek or the Whitefish River.

7.3.3 Other Information Sources

The following sections describe data used in the analysis of Ashley Creek and the Whitefish River from sources other than the DEQ.

7.3.3.1 USGS Gaging Station

USGS gaging station 12367800 on Ashley Creek was used to evaluate the flows measured at sites ASHL-17, ASHL-19, and ASHL-20. Station 12366080 on the Whitefish River was used to evaluate the flows measured at sites WHTF-07 and WHTF-08. Temperature was not collected throughout each day at these sites and therefore could not be used to validate temperature logger values.

7.3.3.2 Climatic Data

Climatic data inputs for the QUAL2K model were obtained from the Pacific Northwest Cooperative Agricultural Weather Network (AgriMet) site in Creston, Montana (http://www.usbr.gov/pn/agrimet/webaghrread.html) and included air temperature, dew point temperature and wind speed. The dew point temperature was adjusted by increasing the relative humidity by 15% based on local conditions within the stream corridor as measured in a similar assessment in the Big Hole River watershed (Flynn et al., 2008). In addition, cloud cover was assigned based on hourly measurements from the National Climatic Data Center at Kalispell Glacier Park International Airport.

7.4 Water Quality Targets

The following section describes 1) the framework for interpreting Montana’s temperature standard; 2) the selection of indicator parameters used as targets for TMDL development and how target values were developed; and 3) a summary of the temperature target values for Ashley Creek and the Whitefish River.

7.4.1 Framework for Interpreting Montana's Temperature Standard

Montana's water quality standard for temperature is narrative in that it specifies a maximum allowable increase above the naturally occurring temperature to protect fish and aquatic life. For waters classified as B-1 [Administrative Rules of Montana (ARM) 17.30.623(e)], B-2 [ARM 17.30.624(e)], and C-2 [ARM 17.30.627(e)] the maximum allowable increase over the naturally occurring temperature is 1°F when the naturally occurring temperature is less than 66°F. Within the naturally occurring temperature range of 66 – 66.5°F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F the maximum allowable increase is 0.5°F. Under Montana water quality law, naturally occurring temperatures incorporate natural sources and human sources that are applying all reasonable land, soil, and water conservation practices. Naturally occurring temperatures can be estimated for a given set of conditions using QUAL2K or other modeling approaches, but because water temperature changes daily and seasonally, no single temperature value can be identified to represent standards attainment. Therefore, in addition to evaluating if human sources are causing the allowable temperature change to be exceeded, a suite of temperature TMDL targets were developed to translate the narrative temperature standard into measurable parameters that collectively represent attainment of applicable water quality standards at all times. The goal is to set the target values at levels that occur under naturally occurring conditions but are conservatively selected to incorporate an implicit margin of safety that helps account for uncertainty and natural variability.

For Ashley Creek and the Whitefish River, a model (QUAL2K) was used to estimate the extent of human influence on temperature by evaluating the temperature deviation when existing conditions of riparian health and associated shade, channel geometry, and streamflow were compared with naturally occurring conditions for these parameters. If the modeled temperature difference between the existing condition and the naturally occurring condition is greater than allowed by the water quality standard (i.e., 0.5 – 1.0°F, depending on the naturally occurring temperature), this verifies the existing temperature impairments for the Ashley Creek and Whitefish River segments.

7.4.2 Temperature Targets and Target Values

Naturally occurring temperatures can be estimated for a given set of conditions using QUAL2K or other modeling approaches. Because naturally occurring temperatures can significantly vary throughout the summer, as well as from year to year, the quantified temperature targets include those indicator parameters that influence temperature and can be linked to human causes. These indicator or target parameters include riparian health and associated shade, channel geometry, improved streamflow conditions where applicable, and allowable increases from Montana Pollutant Discharge Elimination System (MPDES) -permitted point sources.

Values are developed for each target parameter and are set at levels that result in attainment of Montana's temperature standard under all seasonal and yearly variability. The goal is to set most of the target values at levels that would contribute to naturally occurring temperature conditions, while ensuring that any variability from naturally occurring conditions is less than that allowed by the standard. The target values presented are protective of the use most sensitive to elevated temperatures, aquatic life; as such, the targets are protective of all designated uses for the applicable waterbody segments.

The primary temperature target is the allowable human-caused temperature change (i.e., 0.5 – 1.0°F, depending on the naturally occurring temperature), and the other targets are those parameters that influence temperature and can be linked to human causes. The other targets are for riparian canopy and shade, channel bankfull width, instream discharge, and allowable temperature increase from point source discharges. All targets are described in more detail below.

7.4.2.1 Allowable Human-Caused Temperature Change

The target for allowable human-caused temperature change for Ashley Creek and the Whitefish River links directly to the numeric portion of Montana's temperature standard for B-1 [ARM 17.30.623(e)], B-2 [ARM 17.30.624(e)], and C-2 [ARM 17.30.627(e)] streams. When the naturally occurring temperature is less than 66°F, the maximum allowable increase is 1°F. Within the naturally occurring temperature range of 66 – 66.5°F, the allowable increase cannot exceed 67°F. When the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F. As stated above, naturally occurring temperatures incorporate natural sources, yet also include human sources that are applying all reasonable land, soil, and water conservation practices.

7.4.2.2 Riparian Canopy and Shade

Increased shading from riparian vegetation reduces sunlight hitting the stream and, thus, reduces heat load to the stream. Riparian vegetation also reduces near-stream wind speed and traps air against the water surface, which reduces heat exchange with the atmosphere. In addition, lack of established riparian areas can lead to bank instability, which could result in overwidened streams. Human influences affecting riparian canopy cover in the Ashley Creek and Whitefish River watersheds include present and historical agricultural activities, timber harvest, and some limited areas of recreational activity.

To help minimize the influence of upland activities on stream temperature, a riparian buffer close to 100 feet is commonly recommended (Ledwith, 1996; Knutson and Naef, 1997; Ellis, 2008). However, several studies have shown that most (85-90%) of the maximum shade potential is obtained within the first 50 feet (Brazier and Brown, 1973; Broderson, 1973; Steinblums et al., 1984) or 75 feet of the channel (CH2M, 2000; Castelle and Johnson, 2000; Christensen, 2000). The Natural Resources Conservation Service (NRCS) Conservation Practice Standard recommends a minimum buffer width of 35 feet, and also includes recommendations to use species with a medium or high shade value and to meet the minimum habitat requirements of aquatic species of concern (Natural Resources Conservation Service, 2011a; 2011b). Based on several literature sources finding that most shade is obtained within a buffer width of 50 feet and that 50 feet is the minimum buffer width for the Montana Streamside Management Zone (Montana Department of Natural Resources and Conservation, 2006a), the goal is a buffer width of at least 50 feet. The target does not apply to portions where the riparian zone is already at potential or is dominated by vegetation not likely to attain great heights at maturity (e.g., wetland shrub community).

DEQ uses a reference approach to define naturally occurring conditions for riparian health. DEQ defines "reference" as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, the reference condition reflects a waterbody's greatest potential for water quality given past and current land-use activities. The riparian canopy cover targets for the Ashley Creek and Whitefish River segments of concern are based on measurements made in the field from sites with good to moderate riparian conditions to represent potential reference conditions for the respective streams.

For Ashley Creek, the shade targets for riparian areas range from 7 – 80% effective shade. Specific shade target values are dependent on the reach, the potential vegetation type, and whether or not the reach was deemed to be meeting potential (**Attachment EF** of **Appendix E**).

For the Whitefish River the shade targets for riparian areas range from 47 – 59% effective shade. Specific shade target values are dependent on the reach and whether or not the reach was deemed to be meeting potential (**Attachment EF** of **Appendix E**).

Improvement in riparian health needs significant time before changes are visible. DEQ does not expect these targets to be met in the short-term; however, changes in land management practices and a commitment to those practices would need to be implemented to start meeting goals for temperature in Ashley Creek and the Whitefish River. DEQ recognizes that for a reach, target values may be lower or higher than the actual potential depending on the presence of roads and road crossings and the vegetation that can be established. An adaptive management approach should be used in concert with the effective shade target values to ensure that the true potential effective shade is realized for each reach and the portions thereof.

7.4.2.3 Channel Bankfull Width

A narrower channel with a lower width-to-depth ratio results in a smaller contact area with warm afternoon air and is slower to absorb heat (Poole and Berman, 2001). Also, a narrower channel increases the effectiveness of shading produced by the riparian canopy.

Channel dimensions were not altered in the QUAL2K model scenarios because field measurements and observations suggest there was minimal potential to reduce stream channel width in both Ashley Creek and the Whitefish River. However, a channel geometry target width will apply for all applicable waterbody segments. The width target is no increase in average bankfull width due to human-caused sources from the range of values observed in each segment during 2008 data collection. The target is not intended to be specific to every given point on the stream; the intent rather, is to maintain width values in their current condition throughout each segment. If specific locations have the potential to become narrower, improved vegetation in riparian areas will generally lead to gradual improvements in these width values over time. If deemed appropriate, active restoration techniques could be used to give the stream channel an appropriate width at these locations.

7.4.2.4 Instream Discharge (Streamflow Conditions)

Larger volumes of water take longer to heat up during the day. The volumetric heat capacity of a stream is reduced if water volumes are reduced. In the Ashley Creek watershed, streamflow reductions are largely attributed to irrigation diversions. Therefore, improvements in water diversion infrastructure and water use efficiencies may leave more in the stream, and it is presumed that voluntary actions by water users could increase instream flow volume.

To determine the effects of having instream discharge targets on Ashley Creek, a scenario was run to represent all shade targets being met and an improvement in irrigation and domestic water use efficiency that would result in reducing water withdrawals by 15% (i.e., leaving 15% of the currently withdrawn water in the stream). Reducing the identified irrigation withdrawal volume by 15% is considered to be minimal based on the efficiency estimates of (Howell and Stewart, 2003; Negri et al., 1989; Natural Resources Conservation Service, 1997; Osteen et al., 2012) for different irrigation practices and has been used in other DEQ TMDL documents (e.g., (Montana Department of Environmental Quality, 2008b; 2009; 2013). A second model was run to represent only all shade targets being met.

Table 7-1 shows the results for Ashley Creek from both models as compared to the current condition and the difference between the two scenarios (i.e., the change in temperature as a result of meeting a 15% reduction in irrigation withdrawal) (see **Sections E2.2.2.2** and **E2.2.2.6** in **Attachment E** for detailed model output). Increasing the instream flows in addition to meeting shade targets resulted in no change at four sites, smaller temperature reductions at seven sites (i.e., higher stream temperatures), and greater temperature reductions (i.e., lower stream temperatures) at five sites. The increases in temperature reduction were less than 0.05°F at four of the five sites and never greater than 0.21°F (less than the 0.5°F increase allowed by the standard at naturally occurring temperatures greater than 66.5°F). Because the increased instream flow resulting from 15% less irrigation water being diverted had little benefit to Ashley Creek temperatures, there will not be targets for instream discharge values.

Table 7-1. Temperature reduction from the Baseline Scenario using the Shade and 15% Reduction of Water Withdrawn for Irrigation Scenario and the Shade Scenario

Segment	Site	Baseline Scenario Temperature (°F) – Shade and 15% Reduction of Water Withdrawn for Irrigation Scenario Temperature (°F)	Baseline Scenario Temperature (°F) – Shade Scenario Temperature (°F)	Difference
Upper Ashley Creek	ASHL-01	0.00	0.00	0.00
	ASHL-02	0.58	0.58	0.00
	ASHL-03	10.82	10.81	0.00
	ASHL-04	9.32	9.32	0.01
	ASHL-05	0.91	0.91	0.00
	ASHL-06	0.34	0.68	-0.34
	ASHL-08	1.88	1.95	-0.07
	ASHL-10	1.30	1.37	-0.07
	ASHL-11	1.47	1.53	-0.06
Middle Ashley Creek	ASHL-13	5.12	5.15	-0.03
	ASHL-15	1.99	2.02	-0.03
	ASHL-17	5.34	5.44	-0.10
	ASHL-18	6.26	6.06	0.21
Lower Ashley Creek	ASHL-19	8.42	8.39	0.03
	ASHL-20	9.00	8.99	0.01
	ASHL-21	3.38	3.37	0.01

Per Montana's water quality law, TMDL development cannot be construed to divest, impair, or diminish any water right recognized pursuant to Title 85 (Montana Code Annotated Section 75-5-705), so any voluntary water savings and subsequent in-stream flow augmentation must be done in a way that protects water rights. However, water users in the Ashley Creek watershed are encouraged to work with the United States Department of Agriculture (USDA) Natural Resource Conservation Service, the Montana Department of Natural Resources and Conservation, the local conservation district, and other local land management agencies to review their irrigation systems, practices, and the variables that may affect overall irrigation efficiency (Negri and Brooks, 1990; Natural Resources Conservation Service, 1997). If warranted and practical, users may consider changes that increase in-stream flows, and/or reduce warmwater return flows in Ashley Creek.

No irrigation withdrawals or return flows were identified along the Whitefish River during the 2008 assessment (**Section E2.2.3.4** in **Appendix E**). As a result, the water consumptive use scenario was not explored and there are no targets for instream discharge values for the segment. If irrigation withdrawals are identified during future monitoring, then target development will be assessed using methods similar to those used for Ashley Creek.

7.4.2.5 City of Kalispell Small Municipal Separate Storm Sewer System (MS4)

The City of Kalispell and Montana Department of Transportation are co-permittees to a municipal separate storm sewer system (MS4) permit (MTR040005) that has discharge outfalls to the Ashley Creek watershed (middle Ashley Creek, lower Ashley Creek, and Spring Creek) and the Whitefish River watershed (Whitefish River). The short duration, infrequency, and magnitude of storm events in Montana during the summer makes it likely that any increase in instream temperature due to MS4 discharges will be short-term and the result of the initial flush through the system (Kron et al., 2011). The target for the City of Kalispell MS4 permit will be to follow the minimum control measures provided in the MPDES permit authorization for permit MTR04005, or any subsequent permit renewals. As long as all best management plans (BMPs) are effectively implemented as described in the permit, discharge will be consistent with naturally occurring conditions.

7.4.2.6 Wastewater Treatment Plants

Wastewater treatment plants (WWTPs) may influence a stream's water temperature. The temperature TMDL target is performance based for WWTPs and other point source effluents. This target requirement states that these point sources shall not warm the stream individually or in combination by more than the allowable increase in temperature under Montana's temperature standard that applies to Ashley Creek and the Whitefish River. This translates to no more than a 1.0°F increase when the receiving water is cooler than 66.5°F, no increase above 67°F when the receiving water is 66 – 66.5°F and no more than a 0.5°F increase under conditions where the receiving water is greater than 66.5°F.

7.4.3 Target Values Summary

The allowable human-caused temperature change is the primary target that must be achieved to meet the standard. The primary target for both Ashley Creek and the Whitefish River is as follows:

- When the naturally occurring temperature is less than 66°F, the maximum allowable increase is 1°F.
- Within the naturally occurring temperature range of 66 – 66.5°F, the allowable increase cannot exceed 67°F.
- When the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F.

Alternatively, compliance with the temperature standard can be attained by meeting all temperature-influencing targets for shade, bankfull width, and allowable temperature increase from point sources (**Table 7-2**). In this approach, if all reasonable land, soil, and water conservation practices are installed or practiced, state standards are met.

Table 7-2. Temperature-influencing Targets for Ashley Creek and the Whitefish River

Ashley Creek	
Target Parameter	**Target Value**
Riparian Health - Shade[1]	A buffer with a minimum effective shade of: • 79% at sampling sites with the potential for forested riparian vegetation • 64% at sampling sites with the potential for dense riparian vegetation • 10% at sampling sites with the potential for open/pasture riparian vegetation
Channel Bankfull Width	No increase in average channel bankfull width due to human-caused sources from the range of values observed in each segment during data collection: • Upper Ashley Creek: 16 - 25 feet • Middle Ashley Creek: 24 - 42 feet • Lower Ashley Creek: 26 - 94 feet
City of Kalispell Small MS4	Follow the minimum control measures provided in the MPDES permit authorization for permit MTR04005, or any subsequent permit renewals.
Wastewater Treatment Plants	Individually or in combination no more than a 1.0°F increase when the receiving water is cooler than 66.5°F, no increase above 67°F when the receiving water is 66 – 66.5°F, and no more than a 0.5°F increase under conditions where the receiving water is greater than 66.5°F
Whitefish River	
Target Parameter	**Target Value**
Riparian Health - Shade[1]	A buffer with a minimum of 47% effective shade at a given sample site
Channel Bankfull Width	No increase in average channel bankfull width due to human-caused sources from the range of values observed during data collection: • 63 - 80 feet
City of Kalispell Small MS4	Follow the minimum control measures provided in the MPDES permit authorization for permit MTR04005, or any subsequent permit renewals.
Wastewater Treatment Plants	Individually or in combination no more than a 1.0°F increase when the receiving water is cooler than 66.5°F, no increase above 67°F when the receiving water is 66 – 66.5°F and no more than a 0.5°F increase under conditions where the receiving water is greater than 66.5°F

[1] The shade minimum does not apply to portions where the riparian zone is already at potential or is dominated by vegetation not likely to attain great heights at maturity (e.g., wetland shrub community).

7.5 Approach to Source Assessment, TMDLs, Allocations, and Reductions

This section provides the overall approach used for source assessment, TMDL development, allocations, and reductions. This approach was applied to each of the four stream segments.

7.5.1 Source Assessment Using QUAL2K Models

Source assessment for Ashley Creek and the Whitefish River largely involved QUAL2K temperature modeling. **Appendix E** contains information regarding model setup and the scenarios that were used for source assessment analysis. Four of these scenarios are discussed in detail within this document (Baseline, Shade, Shade with no Kalispell WWTP discharge, and Shade with Kalispell WWTP discharge at the naturally occurring stream temperature).

Water temperature, flow, channel dimension, and riparian shade data were incorporated in a QUAL2K water quality model to characterize existing temperature conditions and to evaluate differing land management scenarios for Ashley Creek and the Whitefish River (see **Appendix E** for details). The QUAL2K model was used to determine the extent that human-caused disturbances within the Ashley Creek and Whitefish River watersheds have increased the water temperature above the naturally occurring level. QUAL2K is a one-dimensional river and stream water quality model that assumes the channel is well-mixed vertically and laterally. The QUAL2K model uses steady state hydraulics that simulates non-uniform steady flow. Within the model, water temperatures are estimated based on climate data, riparian shading, and channel conditions. Each stream is segmented into reaches within the model that are assigned the same channel and shade characteristics. For much of this assessment, the QUAL2K model was used to evaluate maximum summer water temperatures in Ashley Creek and the Whitefish River.

7.5.1.1 QUAL2K Model Assumptions

The following is a summary of the significant assumptions used during the QUAL2K model development:

- Ashley Creek and the Whitefish River can be divided into distinct segments, each considered homogeneous for shade, flow, and channel geometry characteristics. Monitoring site locations were selected to be representative of segments of Ashley Creek and the Whitefish River.
- Stream meander and subsurface flow paths (both of which may affect depth-velocity and temperature) are inherently represented during the estimation of various parameters (e.g., stream slope and channel geometry) for each segment.
- Weather conditions at the AgriMet Creston station and the Kalispell Glacier International Airport are representative of local weather conditions along Ashley Creek and the Whitefish River.
- The effective shade targets are achievable and consistent with the definition of the naturally occurring condition.

Additional assumptions are described in **Attachment ED** of **Appendix E**.

7.5.2 Wastewater Treatment Plant Source Assessment

The Kalispell WWTP (MT0021938) discharges into lower Ashley Creek 13.05 miles from the mouth and has a design flow of 8.36 cfs. The Burlington Northern and Santa Fe (BNSF) Facility (MT0000019) discharges into the Whitefish River 24.05 miles from the mouth and has a design flow of 0.15 cfs. The Whitefish WWTP (MT0020184) discharges into the Whitefish River at 22.25 miles from the mouth and has a design flow of 2.79 cfs. A QUAL2K model and mixing equations are used to evaluate the effect of the Kalispell WWTP on temperature in Ashley Creek. Mixing equations are used to evaluate the effect of the BNSF Facility and the Whitefish WWTP on temperature in the Whitefish River. In all cases where mixing equations are used, DEQ is interpreting the water quality standard for temperature to allow for complete mixing between the discharge water and the receiving waterbody.

7.5.3 Ashley Creek and Whitefish River Temperature TMDLs

TMDLs are a measure of the maximum load of a pollutant a particular waterbody can receive and still maintain water quality standards (**Section 4.0**). A TMDL is the sum of wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources. A TMDL includes a margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. Allocations represent the distribution of allowable load applied to those factors that influence loading to the stream. In the case of temperature, thermal loading is assessed.

Because temperature changes throughout the course of a day, the temperature TMDL is the thermal load, at an instantaneous moment, associated with the stream temperature when in compliance with Montana's water quality standards. As stated earlier, the temperature standard for Ashley Creek and the Whitefish River is defined as follows: the maximum allowable increase over the naturally occurring temperature is 1°F, when the naturally occurring temperature is less than 66°F; within the naturally occurring temperature range of 66 – 66.5°F, the allowable increase cannot exceed 67°F; if the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F. Montana's temperature standard for B-1, B-2, and C-2 classified waters, relative to naturally occurring temperatures, is depicted in **Figure 7-4**.

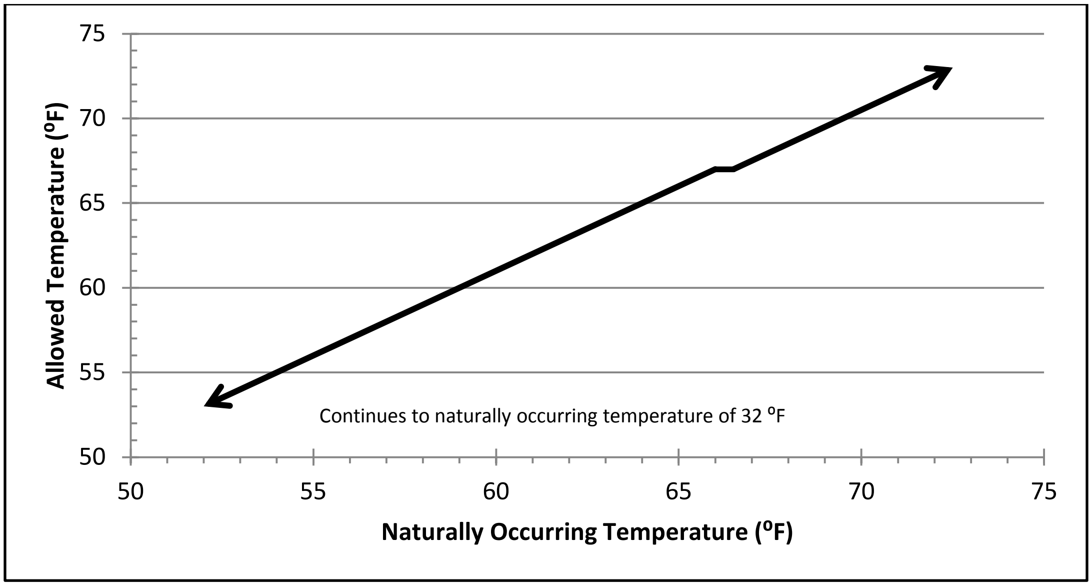


Figure 7-4. Instream Temperatures Allowed by Montana's B-1, B-2, and C-2 Classification Temperature Standards

An instantaneous load is computed by the second and applied at all times. The allowed temperature can be calculated using Montana's B-1, B-2, and C-2 classification standards and using a modeled, measured, or estimated naturally occurring instantaneous temperature. The allowable instantaneous total maximum load (per second) at any location in the waterbody is provided by **Equation 7-1**. This equates to the heat load (kcal/s) increase associated with the warming of the water from 32°F (i.e., water's freezing point) to the temperature that represents compliance with Montana's temperature standard, as determined from **Figure 7-4**.

Equation 7-1:

$$\mathbf{TMDL_{(instantaneous)} = ((T_{NO} + \Delta) - 32)*(5/9) * Q * 28.3}$$

Where:

T_{NO} = naturally occurring water temperature (°F)
Δ = allowable increase above naturally occurring temperature (°F)
Q = streamflow (cfs)
28.3 = conversion factor

The instantaneous load is the most appropriate expression for a temperature TMDL because water temperatures fluctuate throughout the day and an instantaneous load allows for evaluation of human-caused thermal loading when fish are most distressed by elevated water temperatures and when human-caused thermal loading would have the most effect. Although EPA encourages TMDLs to be expressed in the most applicable timescale, it also requires TMDLs to be presented as daily loads (Grumbles, Benjamin, personal communication 2006). Any instantaneous TMDL calculated using **Equation 7-1**, which provides a load per second, can be converted to a daily load (kcal/day) by multiplying by 86,400 (i.e., the number of seconds in a day). Daily loads are provided for all example TMDLs and allocations in **Sections 7.6.1.3** and **7.6.2.3**.

Because calculation of the TMDL on any timescale relies on the identification of the naturally occurring condition, which fluctuates over time and within a stream, it generally requires a water quality model. However, the shade, width, and point source targets that will be met when all reasonable land, soil, and water conservation practices are applied fall under the definition of naturally occurring and are measurable components of meeting the TMDL and water quality standard. Meeting targets for effective shade, width, and point sources and applying all reasonable water conservation measures collectively provide an alternative method for meeting and evaluating the TMDL that more directly translates to implementation than an instantaneous or daily thermal load. Therefore, the targets provided in **Section 7.4.3** will serve as surrogates to the example numeric TMDLs and allocations in **Sections 7.6.1.3** and **7.6.2.3**.

7.5.4 Temperature TMDL Allocations, Wasteload Allocations, Existing Loads, and Reductions

As discussed in **Section 4.0**, the temperature TMDLs for applicable impaired waterbodies consist of the sum of the load allocations and wasteload allocations. For upper Ashley Creek and middle Ashley Creek, the TMDL consists of a single load allocation to all nonpoint sources, including natural background sources and an explicit MOS. For the upper and middle Ashley Creek segments, the load allocation for all nonpoint sources will be based on the naturally occurring temperature (**Equation 7-2**). This results in the entire temperature change allowed by the standard (0.5 – 1.0°F depending on the naturally occurring temperature) to be applied as an explicit MOS. Once the TMDL and load allocations (LA) have been calculated, the MOS (as a load) can be determined using **Equation 7-3**.

Equation 7-2:

$$LA_{(instantaneous)} = (T_{NO} - 32)*(5/9) * Q * 28.3$$

Where:

T_{NO} = *naturally occurring water temperature (°F)*
Q = streamflow (cfs)
28.3 = conversion factor

Equation 7-3:

$$TMDL_{(instantaneous)} = LA_{(instantaneous)} + MOS_{(instantaneous)}$$

Where:

$LA_{(instantaneous)}$ = *Composite Load Allocation to all nonpoint sources including natural background sources*
$MOS_{(instantaneous)}$ = *explicit margin of safety load based on the allowable increase above the naturally occurring temperature*

Allocations for lower Ashley Creek will consist of a composite load allocation for all nonpoint sources including natural background sources (**Equation 7-2**) and a wasteload allocation to the Kalispell WWTP.

In this case, the discharger appears to be causing a temperature change that is greater than allowed by the standard (see **Section 7.6.1.1.5**) and the WLA will be written to meet the standard using **Equation 7-4**. This segment of Ashley Creek will not be given an explicit MOS as the temperature change allowed by the standard will likely be used by the Kalispell WWTP. In the absence of an explicit MOS, an implicit MOS will be applied as described in **Section 7.7** and the TMDL for temperature in this waterbody segment is equal to the sum of the individual loads as follows:

Equation 7-4:

$$TMDL_{(instantaneous)} = LA_{(instantaneous)} + WLA_{(instantaneous)}$$

Where:

$LA_{(instantaneous)}$ = *Composite Load Allocation to all nonpoint sources including natural background sources*

$WLA_{(instantaneous)}$ = *Waste Load Allocation to the applicable point source*

Nonpoint sources in lower Ashley Creek are given a load allocation that is equal to the naturally occurring temperature (**Equation 7-2**). The WLA is given the entire increase above the naturally occurring temperature allowed by the water quality standard (0.5 – 1.0°F depending on the naturally occurring temperature). As such, the WLA for this segment is calculated using **Equation 7-4** as rearranged below:

$$WLA_{(instantaneous)} = TMDL_{(instantaneous)} - LA_{(instantaneous)}$$

In the case of the Whitefish River, the BNSF Whitefish Facility and the Whitefish WWTP do not appear to have a substantial effect on stream temperature (see **Sections 7.6.2.1.3** and **7.6.2.1.4**). The WLAs for these dischargers will be written based on the design flow of the facilities and a maximum temperature per **Equation 7-5**.

Equation 7-5:

$$WLA_{(instantaneous)} = (T_{max} - 32)*(5/9) * Q * 28.3$$

Where:

T_{max} = *maximum temperature of discharge (°F)*

Q = design flow discharge in cubic feet per second

28.3 = conversion factor

Allocations for the Whitefish River will consist of a composite load allocation for all nonpoint sources including natural background sources (**Equation 7-2**), wasteload allocations to the BNSF Facility and the Whitefish WWTP (**Equation 7-5**) and an explicit MOS consisting of the load remaining after the LA and WLAs are assigned (**Equation 7-6**). The WLAs were determined using the design flows, thus addressing future growth for these facilities. A portion of the explicit MOS may be reassigned as an allocation to address new discharges or additional increases in existing discharges if deemed necessary by DEQ. This would likely require a modification to the Whitefish temperature TMDL.

Equation 7-6:

$$TMDL_{(instantaneous)} = LA_{(instantaneous)} + WLA_{BNSF\,(instantaneous)} + WLA_{WHTFWWTP\,(instantaneous)} + MOS_{(instantaneous)}$$

Where:

$LA_{(instantaneous)}$ = Composite Load Allocation to all nonpoint sources including natural background sources
$WLA_{BNSF\,(instantaneous)}$ = Waste Load Allocation to the BNSF Facility
$WLA_{WHTFWWTP\,(instantaneous)}$ = Waste Load Allocation to the Whitefish WWTP
$MOS_{(instantaneous)}$ = explicit margin of safety consisting of the remaining load after the LA and WLAs are calculated

Per Montana state rule (ARM 17.30.637(2)), no wastes may be discharged such that the wastes, either alone or in combination with other wastes, will violate, or can reasonably be expected to violate, any of the standards. With reference to temperature this means that for WWTPs and other permitted dischargers, the discharge concentration must not change the water temperature more than allowed by the water quality standard. **Equations 7-4**, **7-5**, and **7-6**, are used to ensure that the development of the WLAs is consistent with the reasonable assurance approach defined within **Section 4.4**. WLAs will be modified based on a mass-balance approach if the status of assimilative capacity changes in the receiving water.

To provide an example estimate of the total existing loading from all sources combined, the following equation will be used:

Equation 7-7:

$$\textit{Total Existing Load}_{(instantaneous)} = ((T_{meas}) - 32)*(5/9) * Q * 28.3$$

Where:

T_{meas} = measured or modeled existing water temperature (°F)
Q = streamflow (cfs)
28.3 = conversion factor

Reductions for both upper and middle Ashley Creek are calculated using the example LA (**Equation 7-2**) and the example existing load (**Equation 7-7**) using **Equation 7-8**. This was done because an explicit MOS was applied to the TMDLs in each of these segments.

Equation 7-8:

$$\textit{Load Reduction} = ((\textit{Existing Load} – LA) / \textit{Existing Load})*100$$

No explicit MOS was applied to the TMDL for lower Ashley Creek. Therefore, the reduction is calculated using the example TMDL (**Equation 7-1**) and the example existing load (**Equation 7-7**) using **Equation 7-9**:

Equation 7-9:

$$\textit{Load Reduction} = ((\textit{Existing Load} – TMDL) / \textit{Existing Load})*100$$

An explicit MOS was applied to the TMDL for the Whitefish River. The reduction for this segment is calculated using the example LA (**Equation 7-1**), WLAs (**Equation 7-5**) and the example existing load (**Equation 7-7**) using **Equation 7-10**:

Equation 7-10:

$$\textit{Load Reduction} = ((\textit{Existing Load} – (LA + WLA_{BNSF} + WLA_{WHTFWWTP})) / \textit{Existing Load})*100$$

7.6 Source Assessment, Existing Conditions and Comparison to Targets, and Example TMDLs and Allocations for Each Stream

The below sections describe the most significant natural, non-permitted, and permitted sources of temperature in more detail; compare the existing conditions to targets; establish example TMDLs, load allocations, and wasteload allocations; provide existing temperature loading estimates for nonpoint and permitted point sources to temperature-impaired stream segments; and estimate reductions necessary to meet water quality targets for the following waterbody segments:

- Upper Ashley Creek (Ashley Lake to Smith Lake; MT76O002_010)
- Middle Ashley Creek (Smith Lake to Kalispell Airport Road; MT76O002_020)
- Lower Ashley Creek (Kalispell Airport Road to the mouth; MT76O002_030)
- Whitefish River (Whitefish Lake to the mouth; MT76P003_010)

Source assessments are presented for the whole stream, whereas existing conditions and comparison to targets, TMDLs, allocations, and reductions are presented for specific waterbody segments. Existing (baseline scenario) loads are used to estimate load reductions. The existing loads, TMDLs, allocations, and reductions provided in the following sections are examples based on specific instream and effluent temperature and discharge conditions. They are not intended to prescribe what the values should be at all times. The actual values for each vary depending on the naturally occurring water temperature and streamflow which vary by location and time. Use **Equation 7-1** in **Section 7.5.3** to determine the actual TMDL for a given naturally occurring temperature and flow.

7.6.1 Ashley Creek

7.6.1.1 Source Assessment

This section describes the nonpoint and point sources associated with elevated temperatures in Ashley Creek. QUAL2K model scenarios are used to describe the most substantial sources of elevated temperature and conditions under which the water quality standard for temperature are met.

7.6.1.1.1 Baseline Scenario (Existing Conditions)

The baseline scenario represents the existing conditions within Ashley Creek on August 18, 2008, which was determined to be the hottest period for water temperatures during the 2008 summer. To inform the model, this scenario used the measured field data to represent temperature, flow, and shade. When field data were unavailable, reasonable assumptions and extrapolation were used. The model was then run and compared with measured conditions. Hydraulic output in the model accurately reflected measured conditions, indicating that water routing and channel morphology were adequately calibrated. To assure consistency when evaluating the potential to reduce stream temperatures, subsequent model scenarios were compared with the existing-conditions results of the baseline model and not to the field-measured values.

Under the baseline scenario, maximum daily temperatures range from 66.2°F at ASHL-06 to 80.3°F at ASHL-13 (**Figure 7-5**). Temperatures are variable with a slight decrease in the downstream direction. The modeled maximum temperatures exhibit a pattern similar to the maximum measured values with an average error of 4.1% (**Figure 7-5**).

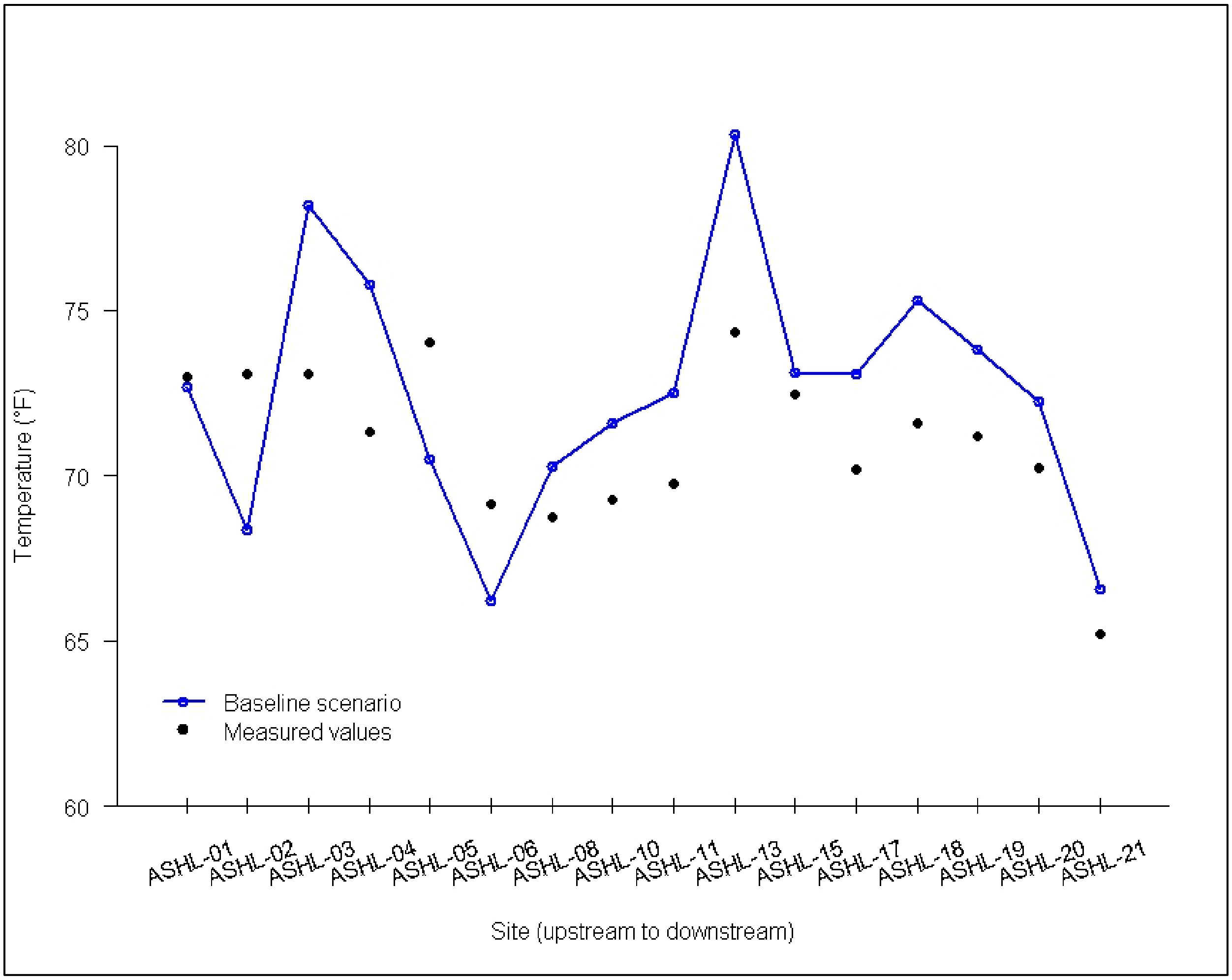


Figure 7-5. Maximum temperatures for measured data and the QUAL2K Baseline Scenario at Ashley Creek sampling sites

7.6.1.1.2 Shade Scenario

The shade scenario altered the model to represent the naturally occurring condition for shade based on field measured shade values and GIS analysis. In this scenario, the upper watershed was set to be forested except in locations that appeared to naturally be meadow environments, which were then set to be open/pasture. The lower reaches of Ashley Creek were set to be dense riparian vegetation as the reference condition. The input from the Kalispell WWTP was not adjusted in this scenario. For the shade scenario, a total of 10 reaches (3.8 miles) were altered to a forested vegetation type and 12 reaches (19.6 miles) were altered to a dense riparian vegetation type (**Table E2-6** in **Appendix E**). Thus, riparian shade density was increased along a total of 23.4 miles of Ashley Creek, which is 52% of the total length (44.7 miles). Percent effective shade for each category was based on the field assessed sites. The results of the shade scenario indicate that an increase in streamside shading along Ashley Creek would decrease stream temperatures from 0 – 10.81°F as compared to the current conditions with a decrease of at least 0.5°F at 15 of 16 sampling sites (**Figure 7-6**).

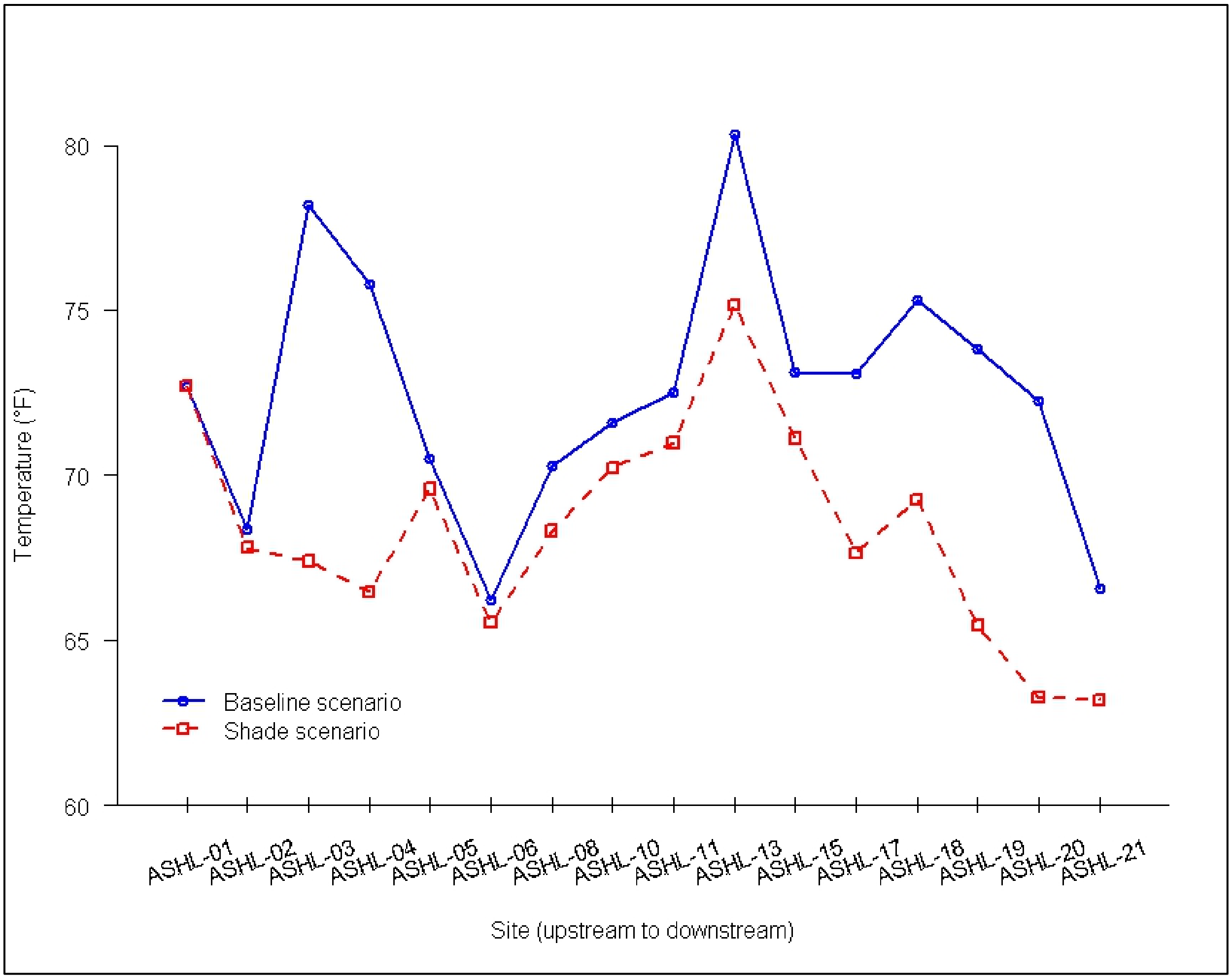


Figure 7-6. Maximum temperatures for QUAL2K Baseline and Shade scenarios at Ashley Creek sampling sites

7.6.1.1.3 Shade with no Kalispell WWTP discharge scenario

This scenario included the same alterations made to the model for the shade scenario but in this case the input of effluent discharge from the Kalispell WWTP was removed. This models the naturally occurring temperature of Ashley Creek from the WWTP location (13.05 miles from the mouth) downstream in the absence of the WWTP discharge (**Section E2.2.2.7** in **Appendix E**). This model resulted in an average naturally occurring temperature near the WWTP location (13.39 miles from the mouth) of 61.95°F (**Table E2-13** in **Appendix E**).

7.6.1.1.4 Shade with the Kalispell WWTP discharging at the naturally occurring stream temperature scenario

This scenario included the same alterations made to the model for the shade scenario but in this case the input of effluent from the Kalispell WWTP was set to the average naturally occurring instream temperature of 61.95°F (**Section 7.6.1.1.3**; **Section E2.2.2.7** in **Appendix E**) at the location of the Kalispell WWTP (13.05 miles from the mouth). To determine the approximate effect of the WWTP when all shade targets are met we can subtract the temperature values produced by this scenario from those produced by the shade scenario at the sites downstream of the WWTP. The WWTP discharging at the naturally occurring temperature decreases temperatures at the sites downstream from the effluent discharge

(**Figure 7-7**). Further evaluation of the effects of the Kalispell WWTP on Ashley Creek is found in **Section 7.6.1.1.5**.

The naturally occurring condition for water temperature results from implementing all reasonable land, soil, and water conservation practices as outlined in ARM 17.30.602. This condition identifies the naturally occurring temperature in waterbodies of interest and establishes the temperature increase that is allowable. In turn, this can be used to identify the impairment status of a waterbody and forms the basis for the allocations and temperature TMDLs in this document. Based on the results of the scenario comparisons, the shade scenario with the Kalispell WWTP discharging at the naturally occurring stream temperature represents the naturally occurring condition and there is the potential for substantial reductions in stream temperatures relative to the baseline (existing) condition.

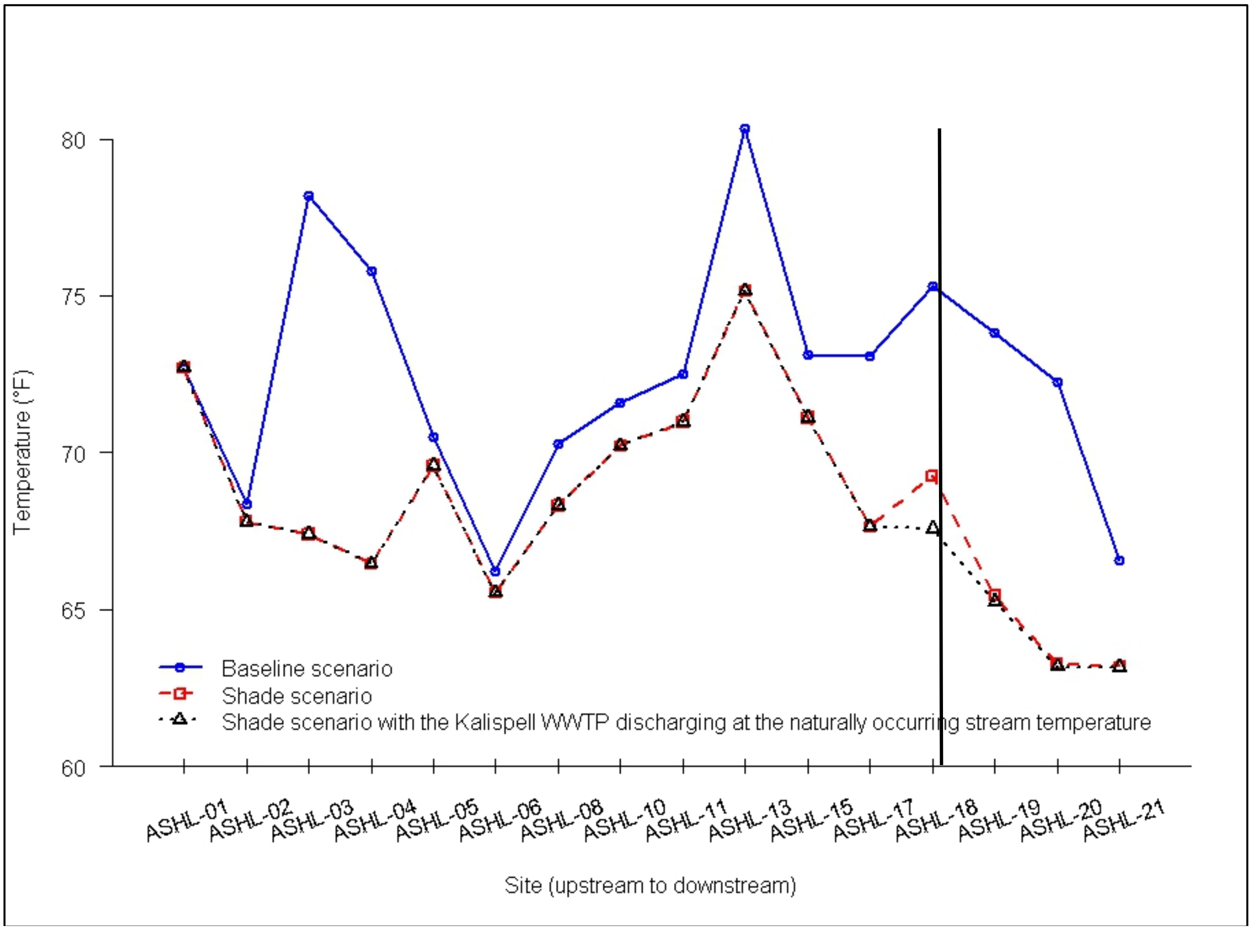


Figure 7-7. Maximum temperatures for QUAL2K Baseline, Shade scenarios, and Shade scenario with the Kalispell WWTP discharging at the average naturally occurring stream temperature at Ashley Creek sampling sites

The WWTP is located just downstream of site ASHL-18 in lower Ashley Creek (black vertical bar). However, the QUAL2K model was set up to incorporate ASHL-18 and the WWTP into the same reach. Therefore, effects from the WWTP are incorporated into the modeled temperature at ASHL-18

7.6.1.1.5 Kalispell WWTP (MT0021938) Point Source Discharge Assessment

The City of Kalispell WWTP discharges directly into Ashley Creek. To evaluate the temperature effects of the WWTP under the current condition, measured data were used. To determine the effects of the WWTP under the shade scenario the QUAL2K model was used.

An instantaneous thermal load (in kilocalories per second) can be calculated for the streamflow and WWTP discharge flows per **Equation 7-11** below. Note that this loading equation is applicable to water at a temperature greater than the freezing point of 32°F. The effects of the WWTP discharge can then be calculated by completely mixing the discharge water with the flow of Ashley Creek under differing conditions.

Equation 7-11:

$$\textbf{Relative Heat Load per unit time (kcal/s)} = ((T_{°F} - 32)*(5/9) * Q * 28.3$$

Where:

Relative Heat Load per unit time (kcal/s) = Heat Energy (kcal)/s
$T_{°F}$ *= Temperature in °F*
Q = Flow in cfs
28.3 = conversion factor

To examine the effects of the Kalispell WWTP on Ashley Creek, we calculated temperature changes for two different examples. The first uses the measured average August 2008 temperature (66.12°F) recorded by the temperature data logger at sampling site ASHL-18 upstream of the WWTP and is considered the measured existing conditions example. The second example uses the modeled average shade scenario temperature of 62.01°F upstream of the WWTP between ASHL-17 and ASHL-18 (15.25 mi from the mouth; **Table E2-13** in **Appendix E**) and is considered the shade scenario example. In this instance the shade scenario temperature is considered a naturally occurring temperature because the location is upstream of the WWTP influence and improving riparian shading is considered to be implementation of all reasonable land, soil, and water conservation practices. Both examples use an average measured August (2003 – 2012) effluent temperature of 68.18°F (**Table B-5** in **Appendix B**) and effluent discharge of 4.1 cfs (**Table B-6** in **Appendix B**) from the Kalispell WWTP and an average measured August (2007 – 2008) streamflow of 11.72 cfs in Ashley Creek downstream of the Kalispell WWTP; **Table B-7** in **Appendix B**). **Equation 7-11** and a basic mixing equation (**Equation 7-12**) were used to calculate the effects of the WWTP on instream temperatures in Ashley Creek.

Equation 7-12:

Heat load of downstream of point source =
Heat load from stream upstream of point source + Heat load from point source effluent

Equation 7-11 rewritten as:

$$T_{°F} = (9/5) * (\text{Relative Heat Load per unit time} / (Q * 28.3)) + 32$$

was used to convert the thermal load of Ashley Creek with the WWTP effluent back to a temperature.

Measured Existing Conditions Example:
For this example, the thermal load of Ashley Creek at ASHL-18 was:

((66.12°F – 32)*(5/9) * 7.62 cfs[(2)] * 28.3 = 4,088 kcal/s

[(2)] 7.62 cfs is the flow at ASHL-18 based on the calculation of 11.72 cfs (**Appendix B**, **Table B-7**) at the gage downstream of the WWTP minus 4.1 cfs, the August 2003 – 2012 average effluent flow from the WWTP (**Appendix B**, **Table B-6**).

The thermal load of the WWTP was:

(68.18°F – 32) * (5/9) * 4.1 cfs * 28.3 = 2,332 kcal/s

The total thermal load of Ashley Creek below the WWTP would therefore be:

4,088 kcal/s + 2,332 kcal/s = 6,420 kcal/s

And the water temperature would be:

(9/5) * (6,421 kcal/s) / (11.72 cfs * 28.3)) + 32 = 66.85°F

In this case, the WWTP causes an increase of 0.72°F (66.84°F – 66.12°F) in the temperature of Ashley Creek, less than the 0.88°F increase allowed by the standard if the naturally occurring temperature of Ashley Creek was 66.13°F.

Modeled Shade Scenario Example:
For this example, the thermal load of Ashley Creek between ASHL-17 and ASHL-18 was:

(62.01°F – 32) * (5/9) * 7.62 cfs * 28.3 = 3,595 kcal/s

The thermal load of the WWTP was:

(68.18°F – 32)*(5/9) * 4.1 cfs * 28.3 = 2,332 kcal/s

The total thermal load of Ashley Creek below the WWTP would therefore be:

3,595 kcal/s + 2,332 kcal/s = 5,927 kcal/s

And the water temperature would be:

(9/5) * (5,927 kcal/s / (11.72 cfs * 28.3)) + 32 = 64.17°F

In this case, the WWTP causes an increase of 2.16°F (64.17°F – 62.01°F) in the temperature of Ashley Creek, which is greater than the 1.0°F increase allowed by the standard at the modeled naturally occurring temperature of 62.01°F.

The results of the two examples indicate that, all other variables remaining the same, as temperature in Ashley Creek upstream of the WWTP decreases, the WWTP has a greater warming effect on downstream temperatures. This means that as BMPs are put into place, shade is increased, and temperatures decrease, the WWTP will have a greater effect on the instream temperature. **Figure 7-8** displays the relationship between modeled Ashley Creek temperature and the effect of the WWTP on temperature immediately downstream of the effluent discharge. It indicates that, with existing WWTP effluent discharge conditions of 4.1 cfs at 68.18°F, the WWTP causes the temperature standard to be exceeded when the stream temperature is below about 66°F and at about 66.5°F. When the stream temperature is greater than about 68°F, the WWTP has a cooling effect on Ashley Creek.

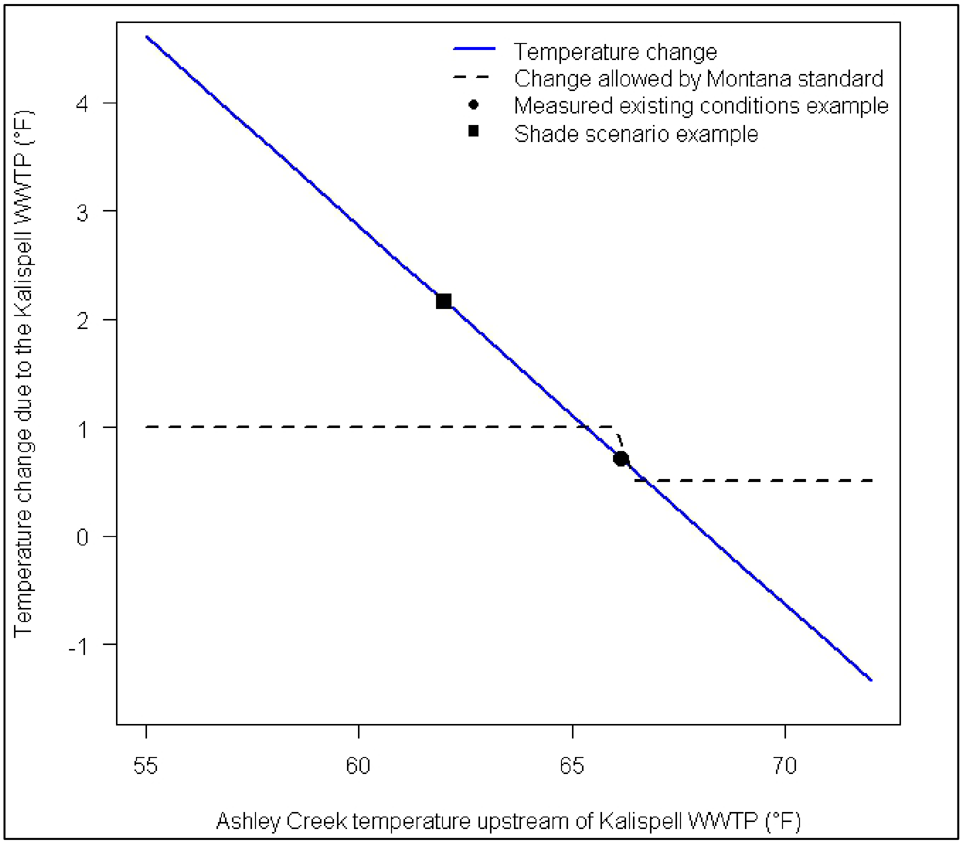


Figure 7-8. Temperature change in Ashley Creek at various stream temperatures caused by the Kalispell WWTP at a stream discharge of 7.62 cfs and a WWTP effluent discharge of 4.1 cfs at 68.18°F

The two examples outlined above (measured existing conditions and modeled shade scenario) and the temperature change due to the Kalispell WWTP plotted in **Figure 7-8** represent temperature change immediately downstream of the WWTP discharge point.

The QUAL2K model also indicates that the WWTP is increasing temperatures above what is described by the standard for a substantial distance downstream of the discharge point. As outlined in **Section 7.6.1.1.4**, the approximate effect of the WWTP when all shade targets are met can be determined by subtracting the temperature values produced by the shade with the Kalispell WWTP discharging at the naturally occurring stream temperature scenario from those produced by the shade scenario at locations downstream of the WWTP. When looking at the differences between these two scenarios, the WWTP (discharging 13.05 miles from the mouth) seems to be causing the standard to be exceeded at least 2.48 mi downstream of the effluent discharge when maximum temperatures are observed and 2.03 mi when minimum temperatures are observed (**Table 7-3**). The WWTP appears to increase temperature throughout the remainder of Ashley Creek, although the difference in temperature is not enough to exceed the standard.

Table 7-3. Comparison of differences in maximum and minimum temperatures on the hottest day of August between the shade scenario and the shade with the Kalispell WWTP (13.05 miles from the mouth) discharging at the average naturally occurring stream temperature (61.95°F) scenario at locations downstream of the effluent discharge

Differences that exceed the standard are in bold text

Distance from mouth (mi)	Modeled maximum temperature (°F)			Modeled minimum temperature (°F)		
	Shade scenario	Shade with WWTP effluent at naturally occurring stream temperature scenario	Difference	Shade scenario	Shade with WWTP effluent at naturally occurring stream temperature scenario	Difference
12.17	69.31	67.93	**1.38**	58.23	56.81	**1.43**
11.60	69.09	67.96	**1.13**	57.76	56.60	**1.16**
11.02	68.81	67.88	**0.92**	57.46	56.52	**0.94**
10.27	68.46	67.78	**0.68**	57.20	56.51	0.69
9.36	68.24	67.74	0.50	57.05	56.54	0.51
8.45	68.10	67.74	0.37	56.93	56.56	0.37
7.60	65.91	65.61	0.29	57.92	57.63	0.29
6.81	65.34	65.11	0.23	58.53	58.30	0.23
6.02	65.44	65.26	0.19	58.70	58.52	0.19
5.27	65.55	65.40	0.15	58.68	58.52	0.15
4.56	65.58	65.45	0.12	58.61	58.49	0.12
3.84	65.56	65.46	0.10	58.57	58.47	0.10
3.27	63.26	63.18	0.08	60.57	60.49	0.08
2.84	63.10	63.03	0.06	60.92	60.86	0.06
2.41	63.13	63.08	0.05	60.91	60.86	0.05
2.09	63.17	63.12	0.04	60.89	60.85	0.04
1.88	63.17	63.13	0.04	60.88	60.84	0.04
1.67	63.17	63.14	0.03	60.88	60.85	0.03
1.30	63.18	63.15	0.03	60.89	60.86	0.03
0.78	63.18	63.16	0.02	60.89	60.87	0.02
0.26	63.19	63.17	0.02	60.90	60.88	0.02
0.00	63.19	63.17	0.02	60.90	60.88	0.02

Table B-5 in **Appendix B** shows monthly average temperature data collected upstream of the Kalispell WWTP, in the effluent of the WWTP, and downstream of the WWTP. These values suggest that there are times when the WWTP is actually cooling Ashley Creek. Because there is evidence that the WWTP is warming Ashley Creek at some times and cooling it at others, it is important that a robust dataset of synoptic temperature samples collected in Ashley Creek directly upstream of the WWTP effluent discharge, from the effluent discharge, and directly downstream of the effluent discharge mixing zone be collected prior to temperature WLAs being incorporated into the MPDES permit for the Kalispell WWTP. These data will help determine if and when the WWTP is warming Ashley Creek such that the water quality standard for temperature is exceeded and when mitigation is warranted. Further discussion of such sampling can be found in **Section 7.6.3**.

7.6.1.2 Ashley Creek Existing Conditions and Comparison to Targets

To evaluate whether attainment of temperature targets has been met, the existing water quality conditions in the Ashley Creek waterbody segments are compared to the conditions when water quality targets are met. This is done using the QUAL2K model and different scenarios that represent the implementation of all reasonable land, soil, and water conservation practices. This approach provides DEQ with updated impairment determinations used for TMDL development.

As part of the temperature analysis, aerial photographs were used to identify study reaches and provide broad classifications of potential riparian vegetation condition in three categories: Forested, dense riparian, and open/pasture. Sites were then analyzed in the field in a selected number of study reaches and average effective shade for those sites was assessed. For modeling purposes, the average of the results for sites in each category was then applied to the corresponding category for those reaches that were not sampled. For all Ashley Creek segments the average effective shade for the reach vegetation classifications are: 10% for open/pasture; 64% for dense riparian; and 79% for forested.

7.6.1.2.1 Upper Ashley Creek (Ashley Lake to Smith Lake)

The QUAL2K model results indicate that maximum naturally occurring summer temperatures ≥ 66.5°F occur at all upper Ashley Creek sites (ASHL-01 to ASHL-11; **Figure 7-7**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 0.5°F (**Figure 7-4**). Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 7.6.1.1.4**) range from 0 to 10.8°F and average 3.0°F (**Figure 7-9**). The allowed increase is being exceeded at all sites in upper Ashley Creek except ASHL-01.

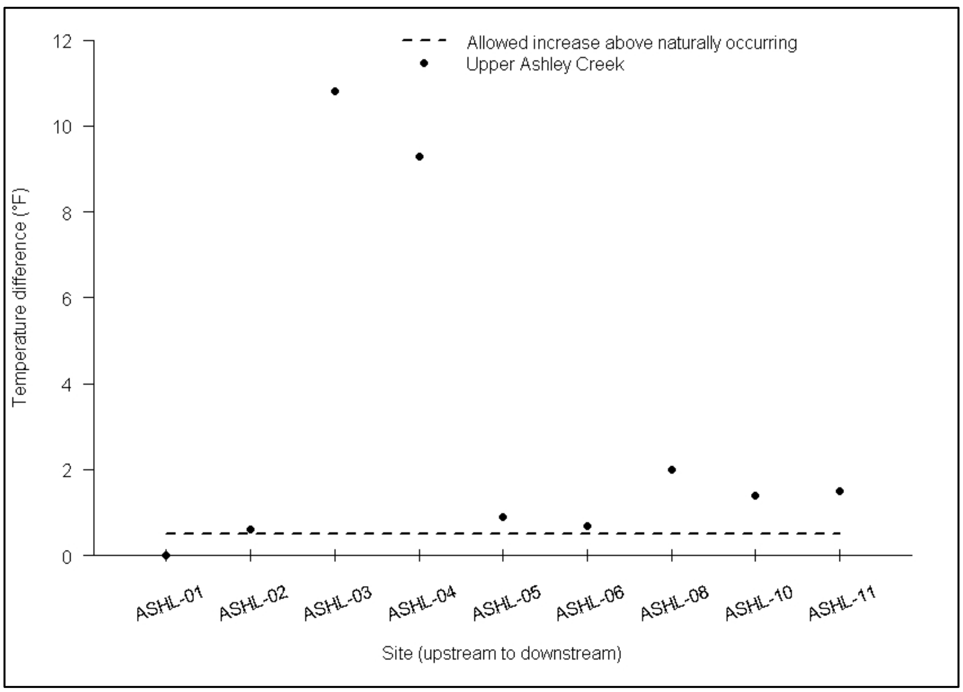


Figure 7-9. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at temperature data logger sites on upper Ashley Creek

Field vegetation classification data for upper Ashley Creek indicate that 57% of the segment is open/pasture, 3% is low/moderate riparian, and 32% is forested with the remainder being lake. The potential riparian vegetation for upper Ashley Creek consists of 56% forested and 36% open pasture. About 24% of the segment is below target for effective shade (**Attachment EF** in **Appendix E**).

As described in **Section 7.4.2.3**, the width target is included because wider streams, especially those with higher width-to-depth ratios absorb more solar energy than narrow, deep channels; therefore, overwidened streams will be more sensitive to thermal loading. Overall, the width of upper Ashley Creek appears to be in a healthy state and as such it meets the target. There may be specific locations that are substantially wider than is ideal. Such areas may be identified and incorporated as potential restoration locations in the Watershed Restoration Plan for Ashley Creek.

Summary and TMDL Development Determination
The human-influenced allowable temperature change target is being exceeded in upper Ashley Creek. Although width values are meeting the targets throughout the segment, riparian vegetation is generally under the shade target, which causes increases in temperature. This information supports the existing temperature impairment listing for upper Ashley Creek; a temperature TMDL has been developed for this segment (see **Section 7.6.1.3.1**).

7.6.1.2.2 Middle Ashley Creek (Smith Lake to Kalispell Airport Road)
The QUAL2K model results indicate that maximum naturally occurring summer temperatures ≥ 66.5°F occur at all middle Ashley Creek sites (ASHL-13 to ASHL-18; **Figure 7-7**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 0.5°F (**Figure 7-4**). Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 7.6.1.1.4**) range from 2.0 to 7.7°F and average 5.1°F (**Figure 7-10**). The allowed increase is being exceeded at all sites in middle Ashley Creek.

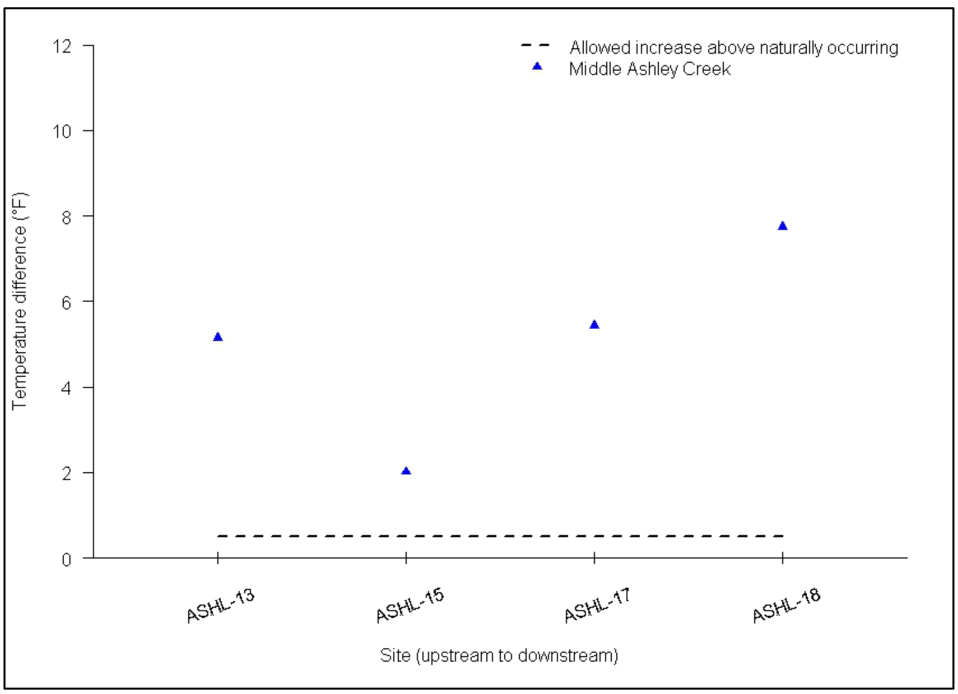


Figure 7-10. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at temperature data logger sites on middle Ashley Creek

Field vegetation classification data for middle Ashley Creek indicate that 22% of the segment is open/pasture, 52% is low/moderate riparian, and 26% is dense riparian. The potential riparian vegetation for middle Ashley Creek consists of 16% open/pasture and 84% dense riparian. About 78% of the segment is below target for effective shade (**Attachment EF** in **Appendix E**).

As described in **Section 7.4.2.3**, the width target is included because wider streams, especially those with higher width-to-depth ratios absorb more solar energy than narrow, deep channels; therefore, overwidened streams will be more sensitive to thermal loading. Overall, the width of middle Ashley Creek appears to be in a healthy state and as such it meets the target. There may be specific locations that are substantially wider than is ideal. Such areas may be identified and incorporated as potential restoration locations in the Watershed Restoration Plan for Ashley Creek.

Summary and TMDL Development Determination

The human-influenced allowable temperature change target is being exceeded in middle Ashley Creek. Although width values are meeting the targets throughout the segment, riparian vegetation is generally under the shade target, which causes increases in temperature. This information supports the addition of a temperature impairment listing for middle Ashley Creek; a temperature TMDL has been developed for this segment (see **Section 7.6.1.3.2**).

7.6.1.2.3 Lower Ashley Creek (Kalispell Airport Road to the mouth)

The QUAL2K model results indicate that the maximum naturally occurring summer temperatures at the three lower Ashley Creek sites are ≤ 66.5°F (ASHL-19 to ASHL-21; **Figure 7-7**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 1.0°F (**Figure 7-4**). Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 7.6.1.1.4**) range from 3.4 to 9.1°F and average 7.0°F (**Figure 7-11**). The allowed increase is being exceeded at all sites in lower Ashley Creek.

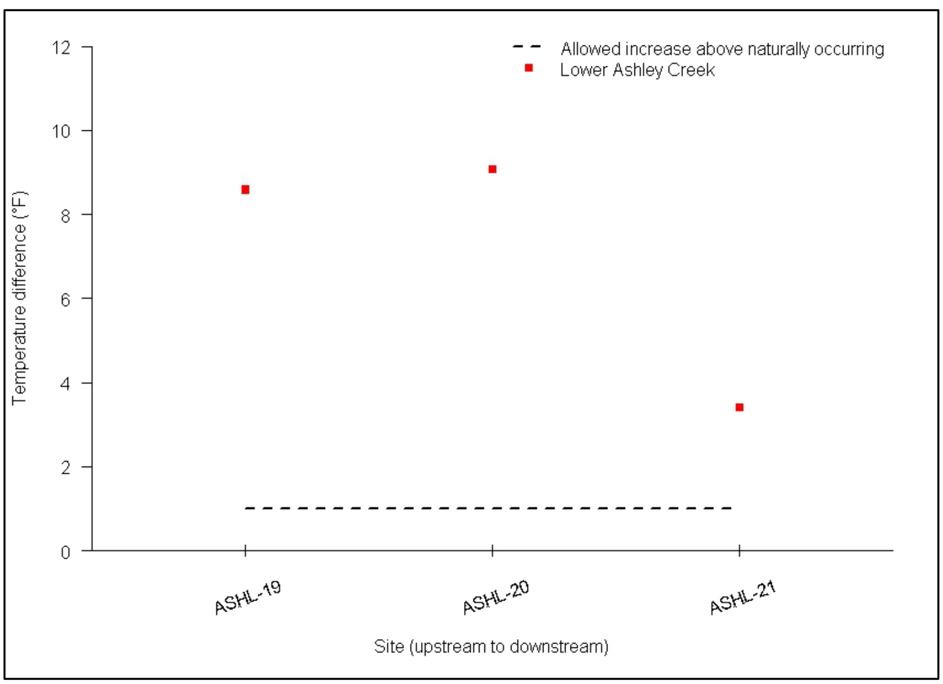


Figure 7-11. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at temperature data logger sites on lower Ashley Creek

Field vegetation classification data for lower Ashley Creek indicate that 17% of the segment is open/pasture, 70% is low/moderate riparian, and 13% is dense riparian. The potential riparian vegetation for lower Ashley Creek consists of 100% dense riparian. About 87% of the segment is below target for effective shade (**Attachment EF** in **Appendix E**).

As described in **Section 7.4.2.3**, the width target is included because wider streams, especially those with higher width-to-depth ratios absorb more solar energy than narrow, deep channels; therefore, overwidened streams will be more sensitive to thermal loading. Overall, the width of lower Ashley Creek appears to be in a healthy state and as such it meets the target. There may be specific locations that are substantially wider than is ideal. Such areas may be identified and incorporated as potential restoration locations in the Watershed Restoration Plan for Ashley Creek.

Point sources of thermal load to Ashley Creek are required to meet temperature discharges that are consistent with the appropriate water quality standards. The City of Kalispell WWTP discharge to lower Ashley Creek is not currently satisfying this target as evaluated in **Section 7.6.1.1.5**.

Summary and TMDL Development Determination

The human-influenced allowable temperature change target is being exceeded in lower Ashley Creek. Although width values are meeting the targets throughout the segment, riparian vegetation is generally under the shade target, which causes increases in temperature. In addition, the Kalispell WWTP is exceeding the target for point source discharges. This information supports the existing temperature impairment listing for lower Ashley Creek; a temperature TMDL has been developed for this segment (see **Section 7.6.1.3.3**).

7.6.1.3 Ashley Creek Example TMDLs and Allocations

7.6.1.3.1 Upper Ashley Creek (Ashley Lake to Smith Lake)

The example numeric temperature TMDL for upper Ashley Creek is based on **Equation 7-1** and the load allocation to nonpoint sources is based on **Equation 7-2**. An explicit MOS of 0.5 to1.0°F will be used in this waterbody segment depending on the naturally occurring temperature. The following example TMDL for upper Ashley Creek uses the flow measured at ASHL-06 on 8/15/08 (5.0 cfs) and the modeled shade scenario (i.e. naturally occurring) maximum temperature of 65.5°F. At this temperature the allowable increase above the naturally occurring temperature is 1.0°F based on the water quality standard for temperature [ARM 17.30.623(e)].

The example TMDL is therefore:

$$\mathbf{TMDL_{(instantaneous)} = ((65.5 + 1) - 32)*(5/9) * 5.0 * 28.3 = 2{,}712\ kcal/s}$$

Converted to a daily load the example TMDL is:

$$\mathbf{TMDL = 2{,}712\ kcal/s * 86{,}400\ s/day = 234{,}316{,}800\ kcal/day}$$

Equation 7-2 is the basis for the example composite load allocation for temperature. To continue with the example at a modeled naturally occurring maximum temperature of 65.5°F, flow of 5.0 cfs, and an explicit MOS of 1.0°F, this allocation is as follows:

$$LA_{(instantaneous)} = \mathbf{(65.5 - 32)*(5/9) * 5.0 * 28.3 = 2{,}633\ kcal/s}$$

Converted to a daily load the example LA is:

LA = 2,633 kcal/s * 86,400 s/day = 227,491,200 kcal/day

Using **Equation 7-3** the resulting explicit MOS at 5.0 cfs is:

$MOS_{(instantaneous)}$ = 2,712 kcal/s - 2,633 kcal/s = 79 kcal/s

Converted to a daily load the MOS is:

MOS = 79 kcal/s * 86,400 s/day = 6,825,600 kcal/day

The instantaneous existing load at ASHL-06 based on **Equation 7-7**, a modeled existing maximum temperature of 66.2°F, and flow of 5.0 cfs is:

$Existing\ Load_{(instantaneous)}$ = (66.2-32)*(5/9) * 5.0 * 28.3 = 2,689 kcal/s

The example temperature TMDL, LA, and MOS are summarized in **Table 7-4**. The targets in **Section 7.4.3** (**Table 7-3**) serve as surrogates to the numeric allocation. Meeting these targets will result in meeting the numeric allocation under all conditions including the example in **Table 7-4**. As demonstrated in **Table 7-5**, the existing temperature loading to upper Ashley Creek is greater than the LA to all nonpoint sources and a reduction is needed; implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for the upper Ashley Creek watershed indicates that a lack of shade contributes the most human-caused temperature loading; load reductions should focus on allowing riparian vegetation to grow and decreasing activities that reduce shade. The 2% reduction to temperature loading that is needed to meet the LA for upper Ashley Creek equates to about 3.8 stream miles having riparian shade increased to the target of 79%. Overall, this means that riparian vegetation needs to be improved on 24% of upper Ashley Creek. Specific reaches that are not meeting the shade target are listed in **Attachment EF** of **Appendix E**. Meeting the LA for upper Ashley Creek may be achieved through a variety of water quality planning and implementation actions, which are addressed in **Section 9.0**.

Table 7-4. Upper Ashley Creek example instantaneous and daily TMDL, LA, and explicit MOS

Category	Instantaneous Load (kcal/s) / Temperature (°F)[1]	Daily Load (kcal/day)[1]
Composite LA	2,633 / 65.5°F	227,491,200
Explicit MOS	79 / 1.0°F	6,825,600
TMDL	2,712 / 66.5°F	234,316,800

[1] *Based on a naturally occurring temperature of 65.5°F, flow of 5.0 cfs, and an explicit MOS of 1.0°F*

Table 7-5. Upper Ashley Creek example reduction based on the modeled instantaneous existing condition and example LA and an explicit MOS

Category	Instantaneous Existing Load (kcal/s) / Temperature (°F)	LA (kcal/s) / Temperature (°F)	Percent Reduction Needed
Nonpoint Sources	2,689 / 66.2 °F	2,633 / 65.5°F	2%

7.6.1.3.2 Middle Ashley Creek (Smith Lake to Kalispell Airport Road)

The example numeric temperature TMDL for middle Ashley Creek is based on **Equation 7-1** and the load allocation to nonpoint sources is based on **Equation 7-2**. An explicit MOS of 0.5 to1.0°F will be used in this waterbody segment depending on the naturally occurring temperature. The following example TMDL for middle Ashley Creek uses the flow measured at ASHL-17 on 8/19/08 (4.6 cfs) and the modeled shade scenario (i.e. naturally occurring) maximum temperature of 67.6°F. At this temperature the allowable increase above the naturally occurring temperature is 0.5°F based on the water quality standard for temperature [ARM 17.30.624(e)].

The example TMDL is therefore:

$$\mathbf{TMDL_{(instantaneous)} = ((67.6 + 0.5) - 32)*(5/9) * 4.6 * 28.3 = 2,611\ kcal/s}$$

Converted to a daily load the example TMDL is:

$$\mathbf{TMDL = 2,611\ kcal/s * 86,400\ s/day = 225,590,400\ kcal/day}$$

Equation 7-2 is the basis for the example composite load allocation for temperature. To continue with the example at a modeled naturally occurring maximum temperature of 67.6°F, flow of 4.6 cfs, and an explicit MOS of 0.5°F, this allocation is as follows:

$$\mathbf{\mathit{LA}_{(instantaneous)} = (67.6 - 32) * (5/9) * 4.6 * 28.3 = 2,575\ kcal/s}$$

Converted to a daily load the example LA is:

$$\mathbf{LA = 2,575\ kcal/s * 86,400\ s/day = 222,480,000\ kcal/day}$$

Using **Equation 7-3** the resulting explicit MOS at 4.6 cfs is:

$$\mathbf{MOS_{(instantaneous)} = 2,611\ kcal/s - 2,575\ kcal/s = 36\ kcal/s}$$

Converted to a daily load the MOS is:

$$\mathbf{MOS = 36\ kcal/s * 86,400\ s/day = 3,110,400\ kcal/day}$$

The instantaneous existing load at ASHL-17 based on **Equation 7-7**, a flow of 4.6 cfs, and a modeled existing maximum temperature of 73.1°F is:

$$\mathbf{Existing\ Load_{(instantaneous)} = (73.1-32) * (5/9) * 4.6 * 28.3 = 2,972\ kcal/s}$$

The example temperature TMDL, LA, and MOS are summarized in **Table 7-6**. The targets in **Section 7.4.3** (**Table 7-2**) serve as surrogates to the numeric allocation. Meeting these targets will result in meeting the numeric allocation under all conditions including the example in **Table 7-6**. As demonstrated in **Table 7-7**, the existing temperature loading to middle Ashley Creek is greater than the LA to all nonpoint sources and a reduction is needed; implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for the middle Ashley Creek watershed indicates that a lack of shade contributes the most human-caused temperature loading; load reductions should focus on allowing riparian vegetation to grow and decreasing activities that reduce shade. The 13% reduction to temperature loading that is needed to meet the LA for middle Ashley Creek equates to about 10 stream miles having riparian shade increased to the target of 64% and 1.6 additional miles having shade increased to the target of 10%. Overall, 78% of middle Ashley Creek needs increased shade in addition to the shade improvements needed on upper Ashley Creek. Specific reaches that are not meeting the shade targets are listed in **Attachment EF** of **Appendix E**. Meeting LA for middle Ashley Creek may be achieved through a variety of water quality planning and implementation actions, which are addressed in **Section 9.0**.

Table 7-6. Middle Ashley Creek example instantaneous and daily TMDL, LA, and explicit MOS

Category	Instantaneous Load (kcal/s) / Temperature (°F)[1]	Daily Load (kcal/day)
Composite LA	2,575 / 67.6°F	222,480,000
Explicit MOS	36 / 0.5°F	3,110,400
TMDL	2,611 / 68.1°F	225,590,400

[1] Based on a naturally occurring temperature of 67.6°F, flow of 4.6 cfs, and an explicit MOS of 0.5°F

Table 7-7. Middle Ashley Creek example reduction based on the modeled instantaneous existing condition and example LA with an explicit MOS

Category	Instantaneous Existing Load (kcal/s) / Temperature (°F)	LA (kcal/s) / Temperature (°F)	Percent Reduction Needed
Nonpoint sources	2,972 / 73.1°F	2,575 / 67.6°F	13%

The WLA for the City of Kalispell Small MS4 was not calculated as part of the example provided in **Tables 7-6** and **7-7**. This was done because storm events during summer occur infrequently and are generally short in duration (Kron et al., 2011). The target for the City of Kalispell Small MS4 in **Section 7.4.3, Table 7-2** serves as a surrogate WLA.

7.6.1.3.3 Lower Ashley Creek (Kalispell Airport Road to the mouth)

The example numeric temperature TMDL for lower Ashley Creek is based on **Equation 7-1** and the load allocation to nonpoint sources is based on **Equation 7-2**. An explicit MOS will not be used in this waterbody segment as it is expected that the Kalispell WWTP will use the entire temperature change above the naturally occurring temperature allowed by the water quality standard. The following example TMDL for lower Ashley Creek uses a flow of 11.72 cfs downstream of the WWTP and the modeled shade scenario (i.e. naturally occurring) average stream temperature of 62.01°F between ASHL-17 and ASHL-18 (15.25 mi from the mouth) used in the shade scenario example source assessment calculation for the Kalispell WWTP (**Section 7.6.1.1.5**). At this temperature the allowable increase above the naturally occurring temperature is 1.0°F based on the water quality standard for temperature [ARM 17.30.627(e)].

The example TMDL is therefore:

$$\textbf{TMDL}_{\text{(instantaneous)}} = ((62.01 + 1.0) - 32)*(5/9) * 11.72 * 28.3 = 5{,}714 \text{ kcal/s}$$

Converted to a daily load the example TMDL is:

$$\textbf{TMDL} = 5{,}714 \text{ kcal/s} * 86{,}400 \text{ s/day} = 493{,}689{,}600 \text{ kcal/day}$$

Equation 7-2 is the basis for the example composite load allocation for temperature. To continue with the example at the modeled naturally occurring average stream temperature of 62.01°F, a flow upstream of the WWTP of 7.62 cfs, and no explicit MOS this allocation is as follows:

$$LA_{\text{(instantaneous)}} = (62.01 - 32)*(5/9) * 7.62 * 28.3 = 3{,}595 \text{ kcal/s}$$

Converted to a daily load the example LA is:

$$LA = 3{,}595 \text{ kcal/s} * 86{,}400 \text{ s/day} = 310{,}608{,}000 \text{ kcal/day}$$

Using **Equation 7-4** the example WLA is:

$$WLA_{(instantaneous)} = 5{,}714 \text{ kcal/s} – 3{,}595 \text{ kcal/s} = 2{,}119 \text{ kcal/s}$$

Converted to a daily load the example WLA is:

$$WLA = 2{,}119 \text{ kcal/s} * 86{,}400 \text{ s/day} = 183{,}081{,}600 \text{ kcal/day}$$

At a discharge of 4.1 cfs from the Kalispell WWTP, the WLA results in a temperature of 64.87°F per **Equation 7-11** and the calculation below:

$$WLA = (9/5) * ((2{,}119 \text{ kcal/s}) / (4.1 \text{ cfs} * 28.3)) + 32 = 64.87°F$$

The instantaneous existing load downstream of the WWTP based on **Equation 7-7**, a flow of 11.72 cfs, and a modeled baseline scenario average temperature of 68.61°F is:

$$\text{Existing Load}_{(instantaneous)} = (68.61 - 32)*(5/9) * 11.72 * 28.3 = 6{,}746 \text{ kcal/s}$$

The example temperature TMDL, LA, and WLA are summarized in **Table 7-8**. The targets in **Section 7.4.3** (**Table 7-2**) serve as surrogates to the numeric allocations. Meeting these targets will result in meeting the numeric allocations under all conditions including the examples in **Table 7-8**. As demonstrated in **Table 7-9**, the existing temperature loading to lower Ashley is greater than the sum of the LA for all nonpoint sources and the WLA for the Kalispell WWTP and a reduction is needed; implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for the lower Ashley Creek watershed indicates that a lack of shade and the Kalispell WWTP contribute the most human-caused temperature loading. Load reductions should focus on allowing riparian vegetation to grow and decreasing activities that reduce shade. The temperature of the effluent from the Kalispell WWTP seems to be causing the delta allowed by the water quality standard for temperature to be exceeded during late July and August when stream temperatures tend to be the greatest and instream flow approaching the lowest. A process to evaluate and address this issue is outlined in **Section 7.6.3**. The 15% reduction to temperature loading that is needed to meet the LA for Lower Ashley Creek equates to about 10.9 stream miles (87% of lower Ashley Creek needs increased shade), having riparian shade increased to the target of 64% in addition to the shade improvements needed on upper Ashley Creek and middle Ashley Creek. Specific reaches that are not meeting the shade target are listed in **Attachment EF** of **Appendix E**. Meeting load allocations for lower Ashley Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9.0**. **Section 7.6.3** discusses the process by which the Kalispell WWTP can achieve the numeric WLA in **Table 7-8** and the surrogate WLA described in **Table 7-2**.

Table 7-8. Lower Ashley Creek example instantaneous and daily TMDL, LA, and WLA

Category	Instantaneous Load (kcal/s) / Temperature (°F)[1]	Daily Load (kcal/day)[1]
Composite LA	3,595 / 62.01°F	310,608,000
Kalispell WWTP WLA	2,119 / 64.87°F	183,081,600
TMDL	5,714 / 63.01°F	493,689,600

[1] Based on a naturally occurring temperature of 62.01°F, flow of 7.62 cfs above the Kalispell WWTP, flow of 4.1 cfs from the Kalispell WWTP , and no explicit MOS

Table 7-9. Lower Ashley Creek example reduction based on the modeled instantaneous existing condition and the example TMDL with no explicit MOS

Category	Instantaneous Existing Load (kcal/s) / Temperature (°F)	TMDL (kcal/s) / Temperature (°F)	Percent Reduction Needed
All Sources	6,746 / 68.61°F	5,714 / 63.01°F	15%

The WLA for the City of Kalispell Small MS4 was not calculated as part of the example provided in **Tables 7-8** and **7-9**. This was done because storm events during summer occur infrequently and are generally short in duration (Kron et al., 2011). The target for the City of Kalispell Small MS4 in **Section 7.4.3, Table 7-2** serves as a surrogate WLA.

7.6.2 Whitefish River

7.6.2.1 Source Assessment

This section describes the nonpoint and point sources associated with elevated temperatures in the Whitefish River. QUAL2K model scenarios are used to describe the most substantial sources of elevated temperature and conditions under which the water quality standard for temperature are met.

7.6.2.1.1 Baseline Scenario (Existing Conditions)

The baseline scenario represents the existing conditions within the Whitefish River on August 17, 2008, which was determined to be the hottest period for water temperatures during the 2008 summer. To inform the model, this scenario used the measured field data to represent temperature, flow, and shade. When field data were unavailable, reasonable assumptions and extrapolation were used. The model was then run and compared with measured conditions. Hydraulic output in the model accurately reflected measured conditions, indicating that water routing and channel morphology were adequately calibrated. To assure consistency when evaluating the potential to reduce stream temperatures, subsequent model scenarios were compared with the existing-conditions results of the baseline model and not to the field-measured values.

Under the baseline scenario, maximum daily temperatures range from 72.0°F at WHFS-08 to 74.8°F at WHFS-02 (**Figure 7-12**). Temperatures are stable with a slight decrease in the downstream direction. The modeled maximum temperatures exhibit a pattern similar to the maximum measured values with an average error of 1.4% (**Figure 7-12**).

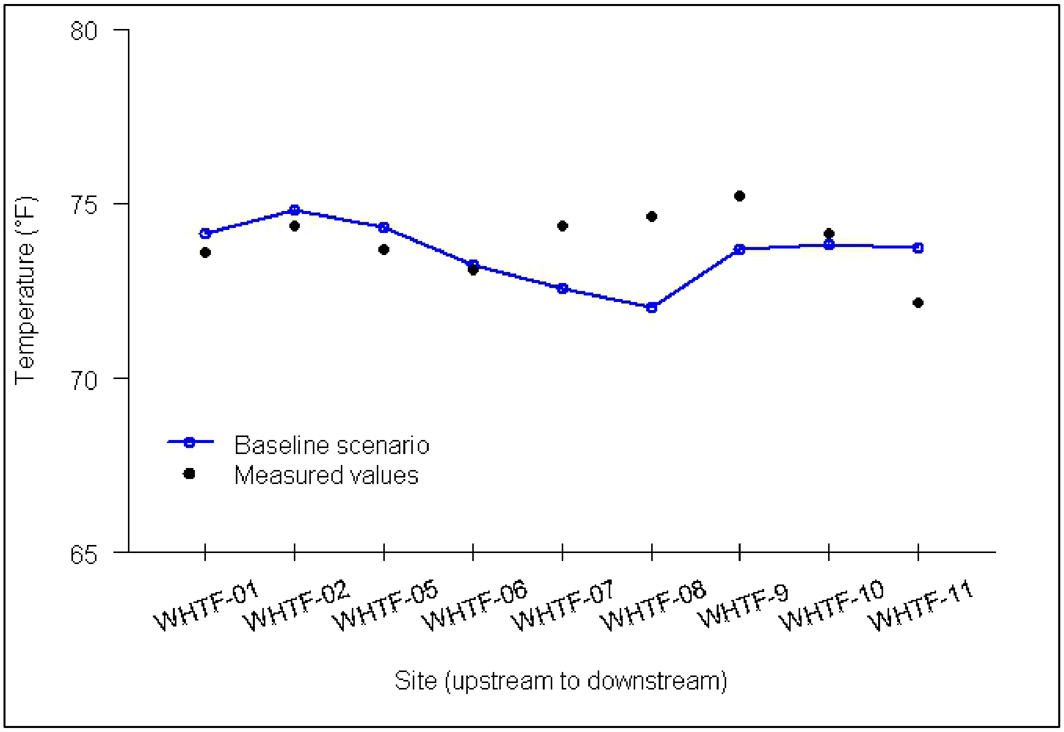


Figure 7-12. Maximum temperatures for measured data and the QUAL2K Baseline Scenario at Whitefish River sampling sites

7.6.2.1.2 Shade Scenario

The shade scenario altered the model to represent the naturally occurring condition based on field measured shade values and GIS analysis. In this scenario, the entire segment was set to be dense riparian vegetation (**Table E2-14** in **Appendix E**). Thus, riparian shade density was increased along a total of 16.2 miles of the Whitefish River, which is 65% of the total length (24.8 miles). Percent effective shade for the dense riparian vegetation category was based on the field assessed sites. The results of the shade scenario indicate that an increase in streamside shading along the Whitefish River would decrease stream temperatures from 0.14 to0.99°F as compared to the baseline scenario with a decrease of at least 0.5°F at 4 of 9 sampling sites (**Figure 7-13**).

The naturally occurring condition represents water temperatures resulting from implementing all reasonable land, soil, and water conservation practices as outlined in ARM 17.30.602. This condition identifies the naturally occurring temperature in waterbodies of interest and establishes the temperature increase that is allowable. In turn, this can be used to identify the impairment status of a waterbody and forms the basis for the allocations and temperature TMDLs in this document. For the Whitefish River, the shade scenario is considered the naturally occurring condition. Based on the results of the comparison between the baseline and shade scenarios, there is the potential for substantial reductions in stream temperatures relative to the baseline (existing) condition.

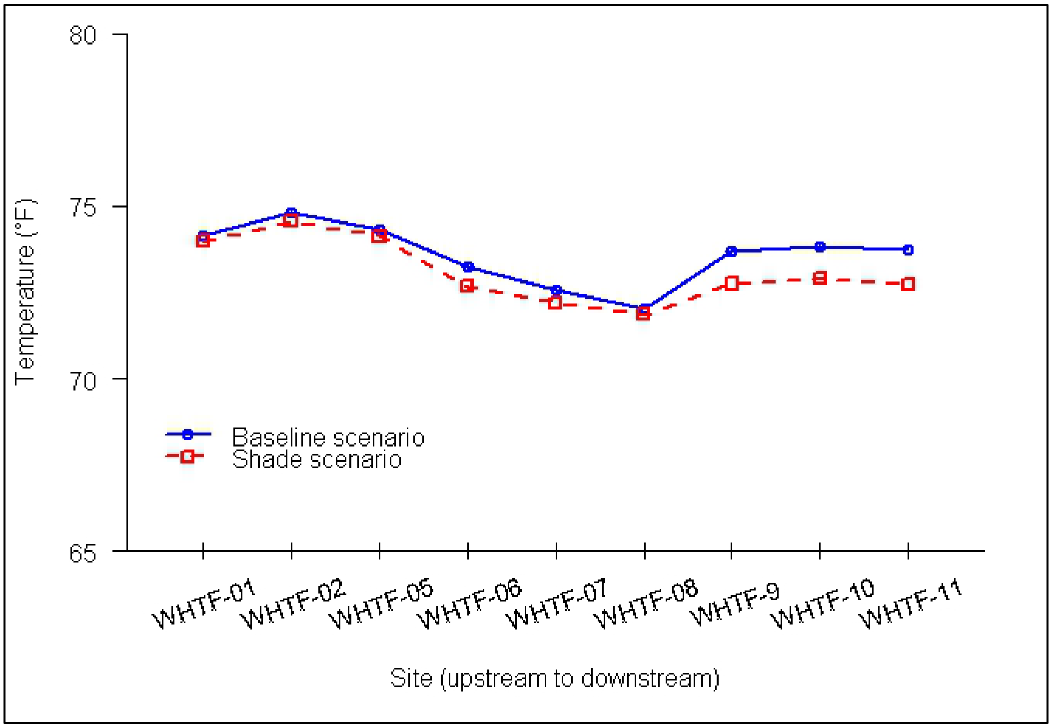


Figure 7-13. Maximum temperatures for QUAL2K Baseline and Shade scenarios at Whitefish River sampling sites

7.6.2.1.3 Burlington Northern Santa Fe Railway Whitefish Facility (MT0000019) Point Source Discharge Assessment

The BNSF Facility discharges directly into the Whitefish River. To evaluate the effects of temperature, an instantaneous thermal load (in kilocalories per second) can be calculated for the streamflow and BNSF facility discharge flows per **Equation 7-11**. Note that this loading equation is applicable to water at a temperature greater than the freezing point of 32°F. The effects of the BNSF facility discharge can then be calculated by completely mixing the discharge water with the flow of the Whitefish River under differing conditions.

To examine the effects of the BNSF Facility on the Whitefish River, we calculated temperature changes for two different examples. The first uses the average August 2008 temperature (66.94°F) measured by the temperature data logger at sampling site WHTF-01 upstream of the BNSF Facility and is considered the measured existing condition example. The second example uses the modeled average shade scenario temperature (70.38°F) at WHTF-01 and is called the modeled shade scenario example. The temperature value from the shade scenario example is greater than the measured existing conditions example temperature value because the model was constructed to examine source effects on the day of the month with the warmest stream temperatures. Both examples use the measured maximum August (2003 – 2012) effluent temperature of 76.80°F (**Table B-8** in **Appendix B**) and effluent design discharge of 0.15 cfs from the BNSF Facility and the measured average August (2008 – 2012) streamflow of 142.22 cfs in the Whitefish River at WHTF-01 (**Table B-9** in **Appendix B**). **Equation 7-11** and a basic mixing equation (**Equation 7-12**) were used to calculate the effects of the BNSF Facility on instream temperatures in the Whitefish River. **Equation 7-11** rewritten as:

$$T_{°F} = (9/5) * (\text{Relative Heat Load per unit time} / (Q * 28.3)) + 32$$

was used to convert the thermal load of Whitefish River with the BNSF Facility effluent back to a temperature.

Measured Existing Conditions Example:
For this example, the thermal load of the Whitefish River at WHTF-01 is:

$$(66.94 - 32) * (5/9) * 142.22 \text{ cfs} * 28.3 = 78{,}125 \text{ kcal/s}$$

The thermal load of the BNSF Facility is:

$$(76.8 - 32) * (5/9) * 0.15 \text{ cfs} * 28.3 = 106 \text{ kcal/s}$$

The total thermal load of the Whitefish River below the BNSF Facility would therefore be:

$$78{,}125 \text{ kcal/s} + 106 \text{ kcal/s} = 78{,}231 \text{ kcal/s}$$

And the water temperature would be:

$$(9/5) * ((78{,}231 \text{ kcal/s}) / (142.37 \text{ cfs} * 28.3)) + 32 = 66.95°\text{F}$$

In this case, the BNSF Facility causes an increase of 0.01°F (66.95°F – 66.94°F) in the temperature of the Whitefish River, which is much less than the 0.5°F increase allowed by the standard at the modeled naturally occurring temperature of 66.94°F.

Modeled Shade Scenario Example:
For this example, the thermal load of the Whitefish River at WHTF-01 is:

$$(70.38°\text{F} - 32) * (5/9) * 142.22 \text{ cfs} * 28.3 = 85{,}807 \text{ kcal/s}$$

The thermal load of the BNSF Facility is:

$$(76.80°\text{F} - 32)*(5/9) * 0.15 \text{ cfs} * 28.3 = 106 \text{ kcal/s}$$

The total thermal load of the Whitefish River below the BNSF Facility would therefore be:

$$85{,}807 \text{ kcal/s} + 106 \text{ kcal/s} = 85{,}913 \text{ kcal/s}$$

And the water temperature would be:

$$(9/5) * ((85{,}913 \text{ kcal/s}) / (142.34 \text{ cfs} * 28.3)) + 32 = 70.38°\text{F}$$

For this example, the BNSF Facility causes an unsubstantial increase (70.38°F – 70.38°F) in the naturally occurring average temperature of the Whitefish River.

Because the BNSF Facility discharges a small amount of effluent relative to the discharge of the Whitefish River, it has a negligible effect on instream temperatures below the effluent discharge. Maintaining operation of this BNSF facility at current levels would appear to cause no significant increase in Whitefish River temperatures.

7.6.2.1.4 Whitefish WWTP (MT0020184) Point Source Discharge Assessment

The City of Whitefish WWTP also discharges directly into the Whitefish River. To evaluate the effects of temperature, an instantaneous thermal load (in kilocalories per second) can be calculated for the streamflow and WWTP discharge flows per **Equation 7-11**. Note that this loading equation is applicable to water at a temperature greater than the freezing point of 32°F. The effects of the WWTP discharge can then be calculated by completely mixing the discharge water with the flow of the Whitefish River under differing conditions.

To examine the effects of the Whitefish WWTP on the Whitefish River, we calculated temperature changes for two different examples. The first uses the average August 2008 temperature (67.40°F) measured by the temperature data logger at sampling site WHTF-02 upstream of the WWTP and is considered the measured existing conditions example. The second example uses the average modeled shade scenario temperature (70.34°F) at WHTF-02 and is called the modeled shade scenario example. The temperature value from the shade scenario is greater than the current condition temperature value because the model was constructed to examine source effects on the day of the month with the warmest stream temperatures. Both examples use the measured maximum August (2003 – 2012) effluent temperature of 74.8°F (**Table B-10** in **Appendix B**) and effluent design discharge of 2.79 cfs from the WWTP and the measured average August (2008 – 2012) streamflow of 142.37 cfs (the flow downstream of the BNSF Facility; described in **Section 7.6.2.1.3**) in the Whitefish River at WHTF-02. **Equation 7-11** and a basic mixing equation (**Equation 7-12**) were used to calculate the effects of the WWTP on instream temperatures in Ashley Creek.

Measured Existing Conditions Example:

For this example, the thermal load of the Whitefish River at WHTF-02 was:

$$(67.40°F – 32) * (5/9) * 142.37 \text{ cfs} * 28.3 = 79{,}238 \text{ kcal/s}$$

The thermal load of the WWTP was:

$$(74.8°F – 32) * (5/9) * 2.79 \text{ cfs} * 28.3 = 1{,}877 \text{ kcal/s}$$

The total thermal load of the Whitefish River below the WWTP would therefore be:

$$79{,}238 \text{ kcal/s} + 1877 \text{ kcal/s} = 81{,}115 \text{ kcal/s}$$

And the water temperature would be:

$$(9/5) * ((81{,}115 \text{ kcal/s}) / (145.16\text{cfs} * 28.3)) + 32 = 67.54°F$$

In this case, the WWTP causes an increase of 0.14°F (67.54°F - 67.40°F) in the temperature of the Whitefish River, less than the 0.5°F increase allowed by the standard at the modeled naturally occurring temperature of 67.40°F.

Modeled Shade Scenario Example:

For this example, the thermal load of the Whitefish River at WHTF-02 was:

$$(70.34°F – 32) * (5/9) * 142.37 \text{ cfs} * 28.3 = 85{,}819 \text{ kcal/s}$$

The thermal load of the WWTP was:

$$(74.8°F – 32)*(5/9) * 2.79 \text{ cfs} * 28.3 = 1877 \text{ kcal/s}$$

The total thermal load of the Whitefish River below the WWTP would therefore be:

$$85{,}819 \text{ kcal/s} + 1877 \text{ kcal/s} = 87{,}696 \text{ kcal/s}$$

And the water temperature would be:

$$(9/5) * ((87{,}698 \text{ kcal/s}) / (145.16 \text{ cfs} * 28.3)) + 32 = 70.40°F$$

In this case, the WWTP causes an increase of 0.06°F (70.40°F – 70.34°F) in the temperature of the Whitefish River. This value is well below the 0.5°F increase allowed by the standard at the naturally occurring average temperature of 70.34°F.

Because the Whitefish WWTP discharges a small amount of effluent relative to the discharge of the Whitefish River, it has a negligible effect on instream temperatures below the effluent discharge. Maintaining operation of this facility at current levels would appear to cause no significant increase in Whitefish River temperatures.

7.6.2.2 Whitefish River Existing Conditions and Comparison to Targets

To evaluate whether attainment of temperature targets has been met, the existing water quality conditions in the Whitefish River waterbody segment are compared to the conditions when water quality targets are met. This is done using the QUAL2K model and different scenarios that represent the implementation of all reasonable land, soil, and water conservation practices. This approach provides DEQ with updated impairment determinations used for TMDL development.

The QUAL2K model results indicate that maximum naturally occurring summer temperatures ≥ 66.5°F occur at all Whitefish River sites (**Figure 7-13**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 0.5°F (**Figure 7-4**). Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 7.6.2.1.2**) range from 0.1 to1.0°F and average 0.5°F (**Figure 7-14**). The allowed increase is being exceeded at four of the nine sites on the Whitefish River.

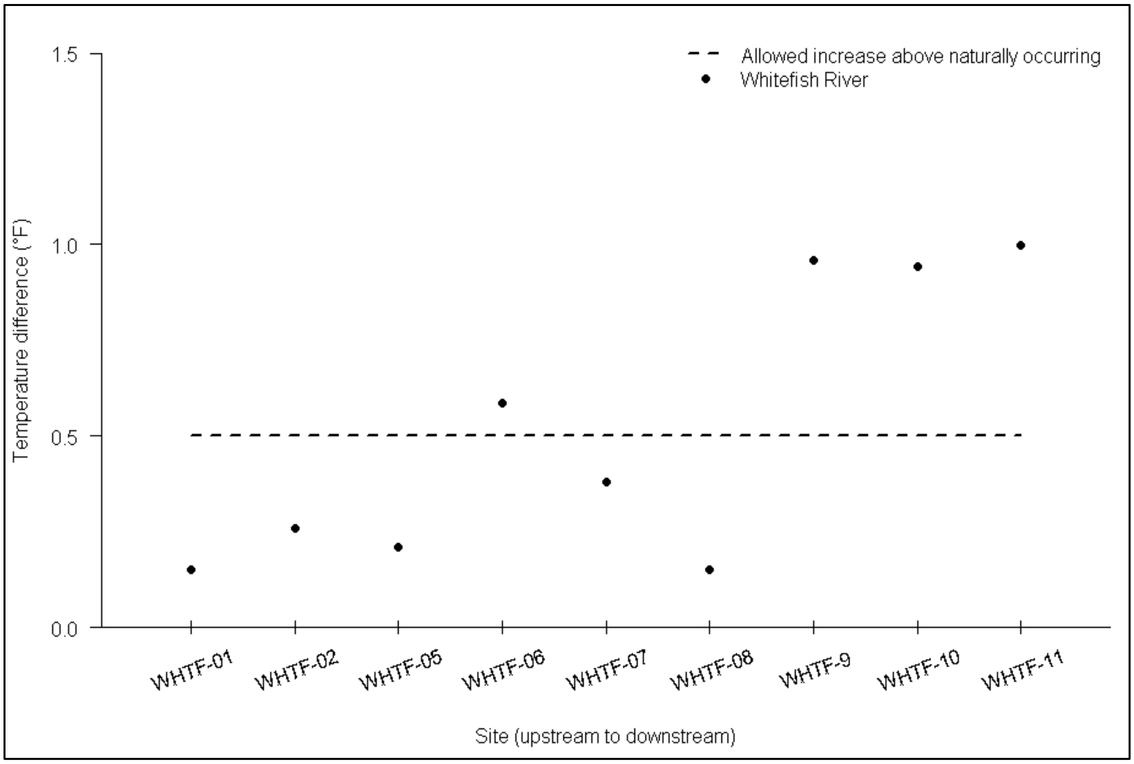


Figure 7-14. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at temperature data logger sites on the Whitefish River

Similar to Ashley Creek, aerial photographs were used to identify study reaches along the Whitefish River. From these, one broad classification of potential riparian vegetation condition was determined: dense riparian. Sites were then analyzed in the field in a selected number of study reaches and average effective shade for those sites was assessed. For modeling purposes, the average of the results for sites in the dense riparian category was then applied to those reaches that were not sampled. Average effective shade for the dense riparian vegetation classification is 47%. Field vegetation classification data for the Whitefish River indicate that 4% of the stream is open/pasture, 61% is low/moderate riparian, and 35% is dense riparian. The potential riparian vegetation for the Whitefish River consists of 100% dense riparian. About 66% of the stream (i.e., waterbody segment) is below target for effective shade (**Attachment EF** in **Appendix E**).

As described in **Section 7.4.2.3**, the width target is included because wider streams, especially those with higher width-to-depth ratios absorb thermal energy from the sun more efficiently than narrow, deep channels and therefore overwidened streams will be more sensitive to thermal loading. Overall, the width of the Whitefish River appears to be in a healthy state and as such it meets the target in all segments. There may be specific locations on the Whitefish River that are substantially wider than is ideal. Such areas may be identified and incorporated as potential restoration locations in the Watershed Restoration Plan for the Whitefish River.

Point sources of thermal load to the Whitefish River are required to meet temperature discharges that are consistent with the appropriate water quality standards. The Burlington Northern Santa Fe Railway Whitefish Facility (BNSF Facility; MT0000019) and Whitefish WWTP (MT0020184) discharges are currently satisfying this target as evaluated in **Sections 7.6.2.1.3** and **7.6.2.1.4**.

Summary and TMDL Development Determination

The human-influenced allowable temperature change target is being exceeded in the Whitefish River. Although width values are meeting the targets, the riparian vegetation is generally not meeting the shade target, which causes increases in temperature. This information supports the existing impairment listing for the Whitefish River. A temperature TMDL will be developed for this segment.

7.6.2.3 Whitefish River Example TMDL and Allocations

The example numeric temperature TMDL for the Whitefish River is based on **Equation 7-1** the load allocation to nonpoint sources is based on **Equation 7-2**. An explicit MOS will be based on the remaining temperature change allowed by the standard after the LA to nonpoint sources is calculated to meet the naturally occurring temperature and the WLAs are calculated based on the design flow of the facilities and the maximum August temperature of effluent discharge (2003 – 2012). The following example TMDL for the Whitefish River uses the flow measured at WHTF-11 on 8/13/08 (139 cfs) and the modeled shade scenario (i.e. naturally occurring) average temperature of 69.08°F. At this temperature the allowable increase above the naturally occurring temperature is 0.5°F based on the water quality standard for temperature [ARM 17.30.624(e)].

The example TMDL is therefore:

$$\mathbf{TMDL_{(instantaneous)} = ((69.08 + 0.5) - 32)*(5/9) * 139 * 28.3 = 82{,}127\ kcal/s}$$

Converted to a daily load the example TMDL is:

$$\mathbf{TMDL = 82{,}127\ kcal/s * 86{,}400\ s/day = 7{,}095{,}772{,}800\ kcal/day}$$

Equation 7-2 is the basis for the example composite load allocation for temperature. To continue with the example at a naturally occurring temperature of 69.08°F, flow of 136.06 cfs subtracting out the discharges from the BNSF Facility and the Whitefish WWTP, and an explicit MOS this allocation is as follows:

$$\mathbf{\mathit{LA}_{(instantaneous)} = (69.08- 32)*(5/9) * 136.06 * 28.3 = 79{,}320\ kcal/s}$$

Converted to a daily load the example LA is:

$$\mathbf{LA = 79{,}320\ kcal/s * 86{,}400\ s/day = 6{,}853{,}248{,}000\ kcal/day}$$

Equation 7-5 is the basis for the example WLAs for the BNSF Whitefish Facility and the Whitefish WWTP. For the BNSF Facility the design flow (0.15 cfs) and maximum August temperature (76.80°F) from the **Section 7.6.2.1.3** examples will be used. The WLA for the BNSF Facility is:

$$\mathbf{WLA_{BNSF\ (instantaneous)} = (76.80 - 32)*(5/9) * 0.15 * 28.3 = 106\ kcal/s}$$

Converted to a daily load the WLA is:

$$\mathbf{WLA_{BNSF} = 106\ kcal/s * 86{,}400\ s/day = 9{,}158{,}400\ kcal/day}$$

Using Equation 7-5, the design flow (2.79 cfs), and the maximum August temperature (73.4°F) from the **Section 7.6.2.1.4** examples, the WLA for the Whitefish WWTP is:

$$\mathbf{WLA_{WHTFWWTP\ (instantaneous)} = (74.8 - 32)*(5/9) * 2.79 * 28.3 = 1{,}877\ kcal/s}$$

Converted to a daily load the WLA is:

$$\mathbf{WLA_{WHTFWWTP} = 1{,}877\ kcal/s * 86{,}400\ s/day = 162{,}172{,}800\ kcal/day}$$

Using **Equation 7-6** the resulting explicit MOS at 139 cfs is:

$$\mathbf{MOS_{\ (instantaneous)} = 82{,}127\ kcal/s – 79{,}320\ kcal/s – 106\ kcal/s – 1{,}877\ kcal/s = 824\ kcal/s}$$

Converted to a daily load the MOS is:

$$\mathbf{MOS = 824\ kcal/s * 86{,}400\ s/day =71{,}193{,}600\ kcal/day}$$

The instantaneous existing load at WHFT-11 based on **Equation 7-7**, a flow of 139 cfs, and a modeled existing average temperature of 69.7°F is:

$$\mathbf{Existing\ Load_{\ (instantaneous)} = (69.7\text{-}32)*(5/9) * 139 * 28.3 = 82{,}389\ kcal/s}$$

The example temperature TMDL, LA, WLAs, and MOS are summarized in **Table 7-10**. The targets in **Section 7.4.3** (**Table 7-2**) serve as surrogates to the numeric allocations. Meeting these targets will result in meeting the numeric allocations under all conditions including the examples in **Table 7-10**. As demonstrated in **Table 7-11**, the existing temperature loading to the Whitefish River is greater than the sum of the LA for all nonpoint sources and WLAs for the BNSF Whitefish Facility and the Whitefish WWTP and a reduction is needed; implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for the Whitefish River watershed indicates that a lack of shade contributes the most human-caused temperature loading; load reductions should focus on allowing riparian vegetation to grow and reducing activities that reduce shade. The 1% reduction to temperature loading that is needed to meet the LA for the Whitefish River equates to about 16.5 stream miles having riparian shade increased to the target of 47%. Overall, this means that riparian vegetation needs to be improved on 66% of the Whitefish River. Specific reaches that are not meeting the shade target are listed in **Attachment EF** of **Appendix E**. Meeting load allocations for the Whitefish River may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 9.0**.

Table 7-10. Whitefish River example instantaneous and daily TMDL, LAs, WLAs, and explicit MOS

Category	Instantaneous Load (kcal/s) / Temperature (°F)[1]	Daily Load (kcal/day)[1]
Composite LA	79,320 / 69.08°F	6,853,248,000
BNSF Facility WLA	106 / 76.8°F	9,158,400
Whitefish WWTP WLA	1,877 / 74.8°F	162,172,800
Explicit MOS	824 / 0.38°F	71, 193,600
TMDL	82,127 / 69.58°F	7,095,772,800

[1] *Based on a naturally occurring temperature of 69.08°F, flow of 139 cfs at WHTF-11, and an explicit MOS*

Table 7-11. Whitefish River example reduction based on the modeled instantaneous existing condition and the example LA, WLAs, and explicit MOS

Category	Instantaneous Existing Load (kcal/s) / Temperature (°F)	LA + WLA_{BNSF} + $WLA_{WHTFWWTP}$ (kcal/s) / Temperature (°F)	Percent Reduction Needed
All Sources	82,389 / 69.7°F	81,303 / 69.2°F	1%

The WLA for the City of Kalispell Small MS4 was not calculated as part of the example provided in **Tables 7-10** and **7-11**. This was done because storm events during summer occur infrequently and are generally short in duration (Kron et al., 2011). The target for the City of Kalispell Small MS4 in **Section 7.4.3** (**Table 7-2**) serves as a surrogate WLA.

7.6.3 Achieving Temperature Allocations

Over time, riparian vegetation has been removed and riparian buffer width reduced along both Ashley Creek and the Whitefish River (**Figures 7-15** and **7-16**). In some locations though, riparian vegetation has been allowed to establish and grow, resulting in temperature-reducing shade (**Figure 7-17**). The historical photographs in **Figures 7-15** and **7-16** provide images of what riparian buffers could look like on Ashley Creek and the Whitefish River with the implementation of riparian BMPs.

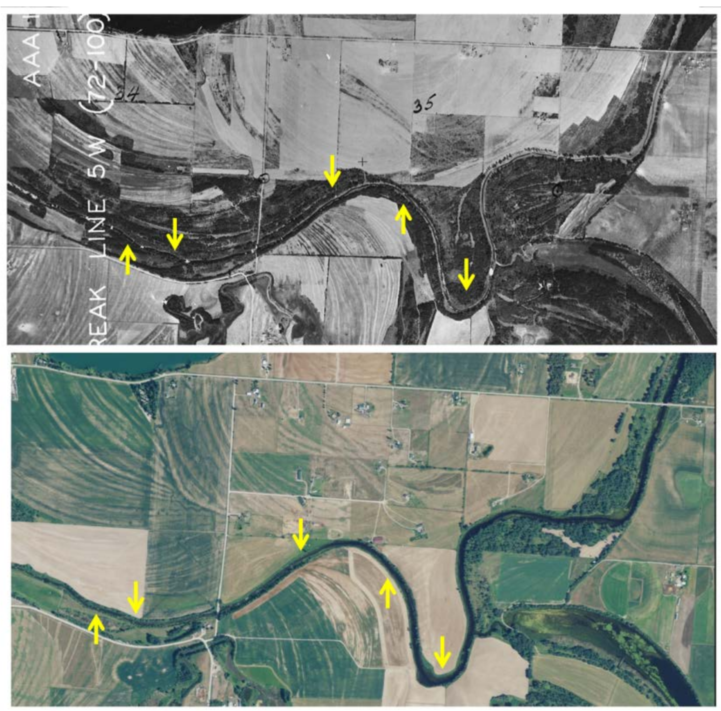


Figure 7-15. Aerial photographs of lower Ashley Creek near the mouth in 1937 (top image) and 2009 (bottom image)

Yellow arrows indicate areas where riparian vegetation has been removed and currently provides less shade than in the past

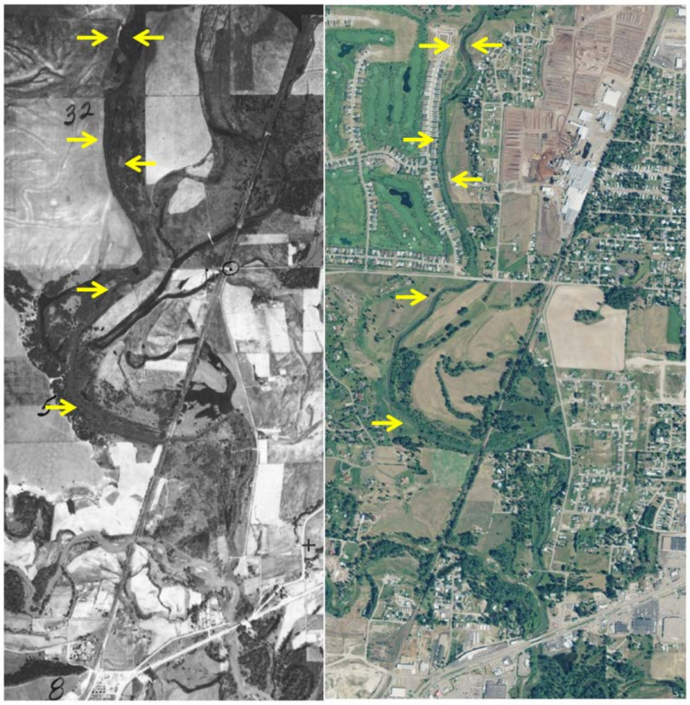


Figure 7-16. Aerial photographs of the Whitefish River near the mouth in 1938 (left image) and 2009 (right image)

Yellow arrows indicate areas where riparian vegetation has been removed and currently provides less shade than in the past

Figure 7-17. Aerial photographs of a portion of middle Ashley Creek in 1937 (top image) and 2009 (bottom image)
Yellow arrows indicate areas where riparian vegetation has grown and currently provides more shade than in the past

Riparian vegetation needs significant time before health improvements and increased shading can be seen. DEQ does not expect these targets to be met in the short-term; however, changes in land management practices and a commitment to BMPs would need to be implemented to start meeting goals for temperature in Ashley Creek and the Whitefish River. In addition, the targets and allocations presented represent the desired conditions that would be expected in most areas along a stream, but DEQ acknowledges that all sites may not be able to achieve them. For instance, some riparian areas may not be physically capable of achieving the desired effective shade target due to naturally occurring conditions. The targets and allocations are not intended to be specific to every given point on the stream; the intent, rather, is to achieve the TMDLs as a typical condition throughout the Ashley Creek and Whitefish River segments. Note that some areas may also be able to achieve conditions greater than the targets, and the management should strive for the best possible condition given all reasonable land, soil, and water conservation practices in all circumstances.

Achieving the Wasteload Allocation for the Kalispell WWTP
The WLA for the Kalispell WWTP may be difficult to achieve based on the limits of technology and/or cost to implement effluent cooling technology. The WLA in **Table 7-8** is an example for a specific set of conditions and is not intended to be a number in the Kalispell WWTP permit. The following approach will begin during the first permit cycle after the TMDL is approved by EPA and will end within 20 years

when all steps have been addressed. The actions outlined below will be written into the permit for the Kalispell WWTP. Meeting these permit requirements will meet the intent of the WLA.

First permit cycle (5 years):
STEP 1 – The City of Kalispell will collect additional data (3-5 years) to address the impacts of the Kalispell WWTP on Ashley Creek

- Place a temperature logger and a trutrack upstream of the WWTP and downstream of the WWTP below the mixing zone (defined by DEQ in consultation with the City of Kalispell), from July 1 – September 30 each year.
- Collect a flow measurement at the trutrack locations on the same day every other week using protocols approved by DEQ.
- Collect real-time (continuous) discharge and temperature data from the WWTP effluent before it enters Ashley Creek at a location approved by DEQ.

Second permit cycle (5 years):
STEP 2 (First 2 years of the permit cycle) – DEQ will analyze data

- Determine when the WWTP is causing the water quality standard for temperature to be exceeded and the magnitude and duration of any exceedances.
- Determine the effluent temperature (target) at which exceedances are eliminated or reduced to an acceptable level.

STEP 3 (Final 3 years of the permit cycle) – If warranted (per the results of STEP 2), the City of Kalispell will study the feasibility of achieving the target

- Identify and analyze the techniques available for achieving the temperature target in WWTP effluent.
- Cost/benefit analysis of each technique.
- Identify and analyze alternatives for reducing temperature in Ashley Creek (e.g., increasing instream flow upstream of the WWTP).

Third permit cycle (5 years):
STEP 4 – If warranted (per the results of STEP 3), the City of Kalispell will determine and outline an implementation plan deemed sensible by DEQ and put it in document format

- Using the information in STEPs 1 – 4 determine what sensible actions will be pursued by the Kalispell WWTP.
- Document 1) the actions that will be taken by the WWTP to improve water temperature in Ashley Creek downstream of the discharge to the extent it is affected by the discharge, 2) a timeline for implementation, and 3) monitoring that will occur.

Fourth permit cycle (5 years):
STEP 5 – If warranted (per the results of STEP 4), the City of Kalispell will implement the plan

- Follow through with the plan as documented in STEP 4.
- Achieve the final effluent limits.

DEQ will collaborate with the City of Kalispell to provide guidance on sampling, data analysis, determining an effective implementation plan, and if applicable, implementation of land, soil, and water conservation practices. This process is expected to occur over multiple years and multiple permit cycles.

7.7 Seasonality and Margin of Safety

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety (MOS) were applied during development of the Ashley Creek and Whitefish River temperature TMDLs.

Seasonality addresses the need to ensure year-round beneficial-use support. Seasonality is addressed for temperature in this TMDL document as follows:

- Temperature monitoring occurred during the summer and modeling simulated August, which is the warmest time of the year and when instream temperatures are most stressful to aquatic life.
- Effective shade for both Ashley Creek and the Whitefish River was based on the August solar path, which is typically the hottest month of the year.
- Although the maximum daily temperature was used for the source assessment and impairment characterization because it is mostly likely to stress aquatic life, sources affecting maximum stream temperatures can also alter daily minimum temperatures; restoration approaches will help to stabilize stream temperatures year round.
- Temperature exceedances occur mostly during the summer, but targets, TMDLs, and load allocations apply year round.

The MOS is included to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. The MOS is addressed in several ways for temperature as part of this document:

- Although there is an allowable increase from human sources beyond those applying all reasonable land, soil, and water conservation practices, the targets (and thus the allocations) for nonpoint sources are expressed (via an explicit MOS) so that all reasonable land, soil, and water conservation practices must be applied.
- Despite the limited amount of irrigation in the watershed and modest improvement in stream temperature that could be obtained by implementing conservation measures to leave additional water instream, the targets section (**7.4.2**) addresses consumptive use as a potential human source and recommends the use of all reasonable water conservation measures.
- Compliance with targets and refinement of load allocations are all based on an adaptive management approach (**Section 7.8**) that relies on future monitoring and assessment for updating planning and implementation efforts to ensure that temperatures are suitable to support all applicable beneficial uses.

7.8 Uncertainty and Adaptive Management

Uncertainties in the accuracy of field data, source assessments, water quality models, loading calculations and other considerations are inherent when evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation, and reduction of uncertainty through adaptive management approaches are key components of ongoing TMDL implementation activities. Uncertainties, assumptions, and considerations are applied throughout this document and point to the need for refining analyses when needed.

The process of adaptive management is predicated on the premise that TMDLs, allocations, and their supporting analyses are not static, but are processes that are subject to periodic modification and adjustment as new information and relationships are better understood. As further monitoring and assessment is conducted, uncertainties with present assumptions and consideration may be mitigated via periodic revision or review of the assessment that occurred for this document. As part of the adaptive management approach, changes in land and water management that affect temperature should be monitored. As implementation of restoration projects that reduce thermal input or new sources that increase thermal loading arise, monitoring should occur. Known changes in management should be the basis for building future monitoring plans to determine if the thermal conditions meet state standards.

Uncertainty was minimized during data collection because field data were collected following a sampling and analysis plan (Montana Department of Environmental Quality, 2008a) and adhering to DEQ sampling protocols (Montana Department of Environmental Quality, 2005b; 2005a). However, there was more uncertainty associated with the model than with the field data because assumptions had to be made to help simulate existing and naturally occurring conditions. Modeling assumptions are briefly described in **Section 7.5.1.1** but are further detailed within the model report in **Attachment ED** of **Appendix E**.

The TMDLs and allocations established in this section are meant to apply to recent conditions of natural background and natural disturbance (e.g., flood, wildfire, diseased vegetation). Under some periodic but extreme natural conditions, it may not be possible to satisfy all targets, loads, and allocations because of natural short-term affects to temperature. The goal is to ensure that management activities are undertaken to achieve loading approximate to the TMDLs within a reasonable time frame and to prevent significant long-term excess loading during recovery from significant natural events.

Any factors that increase water temperatures, including global climate change, could impact thermally sensitive fish species in Montana. The assessments and technical analysis for the temperature TMDLs considered a worst case scenario reflective of current weather conditions, which inherently accounts for any global climate change to date. Allocations to future changes in global climate are outside the scope of this project but could be considered during the adaptive management process if necessary.

Uncertainties in environmental assessments should not paralyze, but should point to the need for flexibility in our understanding of complex systems and to adjust our current thinking and future analysis. Implementation and monitoring recommendations presented in **Sections 9.0** and **10.0** provide a basic framework for reducing uncertainty and further understanding these issues.

8.0 Non-Pollutant Impairments, Previously Completed TMDLs, and Future TMDL Development

This section discusses non-pollutant impairments in the Flathead and Flathead – Stillwater Total Maximum Daily Load (TMDL) Planning Areas, previously completed TMDLs in the full Flathead Lake watershed, and impairments that will be addressed in future TMDL projects. This section is included for informational purposes to help with development of overall watershed management goals and objectives and prioritization of restoration projects in the broader Flathead Lake watershed.

8.1 Non-Pollutant Impairments

A waterbody may be on Montana's list of impaired waters, but does not require a TMDL if it is not impaired for a pollutant, such as sediment, temperature, a nutrient, or metal. Non-pollutant causes of impairment such as "alteration in streamside or littoral vegetative covers" do not require a TMDL. Non-pollutant causes of impairment are often associated with a pollutant cause of impairment; however in some cases, non-pollutant impairments are causing a deleterious effect on beneficial uses without a clearly defined quantitative measurement or direct linkage to a pollutant.

Department of Environmental Quality (DEQ) recognizes that non-pollutant impairments can limit a waterbody's ability to fully support all beneficial uses and these impairment causes are important to consider when improving water quality conditions in both individual streams, and the project area as a whole. **Table 8-1** shows the non-pollutant impairments for waterbodies in the both the Flathead – Stillwater TMDL Planning Area and the Flathead TMDL Planning Area on Montana's 2014 list of impaired waters. They are summarized in this section to increase awareness of the non-pollutant impairment definitions and typical sources, and should be considered during planning of watershed-scale restoration efforts. Non-pollutant impairments for the Flathead Headwaters, Big Creek, and Swan TMDL planning areas are not included in this section, as those impairments are associated with completed TMDL projects (**Section 8.4**), with the exception of a "other flow regime alterations" impairment for the South Fork of the Flathead River.

It is important to note that water quality issues are not limited to waterbodies with identified pollutant and non-pollutant impairments. In some cases, streams have not yet been reviewed through DEQ's water quality assessment process and do not appear on Montana's list of impaired waters even though they may not be fully supporting all of their beneficial uses.

Table 8-1. Waterbody Segments in the Flathead and Flathead – Stillwater TMDL Planning Areas with Non-Pollutant Impairments in the 2014 Water Quality Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	Addressed by a TMDL(s) in this Document[1]
Ashley Creek, Ashley Lake to Smith Lake	MT76O002_010	Alteration in stream-side or littoral vegetative covers	Yes
		Chlorophyll-*a*	Yes
Ashley Creek, Smith Lake to Kalispell Airport Road	MT76O002_020	Low flow alterations	No

Table 8-1. Waterbody Segments in the Flathead and Flathead – Stillwater TMDL Planning Areas with Non-Pollutant Impairments in the 2014 Water Quality Integrated Report

Waterbody and Location Description	Waterbody ID	Impairment Cause	Addressed by a TMDL(s) in this Document[1]
Ashley Creek, Kalispell airport road to mouth (Flathead River)	MT76O002_030	Alteration in stream-side or littoral vegetative covers	Yes
		Chlorophyll-*a*	Yes
Lake Mary Ronan	MT76O004_020	Chlorophyll-*a*	No
Logan Creek, Headwaters to Tally Lake	MT76P001_030	Other flow regime alterations	Yes
		Physical substrate habitat alterations	Yes
Sheppard Creek, Headwaters to mouth (Griffin Creek)	MT76P001_050	Alteration in stream-side or littoral vegetative covers	Yes
Sinclair Creek, Headwaters to mouth (Sheppard Creek)	MT76P001-040	Low flow alterations	No
Spring Creek, Headwaters to mouth (Ashley Creek)	MT76O002_040	Alteration in stream-side or littoral vegetative covers	No
		Other flow regime alterations	No
		Physical substrate habitat alterations	No
Stillwater River, Logan Creek to mouth	MT76P001_010	Alteration in stream-side or littoral vegetative covers	Yes

[1] Habitat alteration impairments and flow regime alteration impairments are addressed by sediment and temperature TMDLs; chlorophyll-*a* impairments are addressed by nutrient TMDLs (**Table 1-1**)

8.2 Non-Pollutant Impairment Cause Descriptions

Non-pollutants are often used as a probable cause of impairment when available data at the time of a water quality assessment do not provide a direct, quantifiable linkage to a specific pollutant. In some cases, the pollutant and non-pollutant categories are linked and appear together in the list of impairment causes for a waterbody; however a non-pollutant impairment cause may appear independently of a pollutant cause. The following discussion provides some rationale for the application of the identified non-pollutant causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation and potential restoration.

Alteration in Streamside or Littoral Vegetation Covers

"Alteration in streamside or littoral vegetation covers" refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the streamside vegetation, destabilized banks from loss of vegetative root mass could lead to overwidened stream channel conditions, elevated sediment and/or nutrient loads, and the resultant lack of canopy cover can lead to increased water temperatures.

Physical Substrate Habitat Alterations

"Physical substrate habitat alterations" generally describe cases where the stream channel has been physically altered or manipulated, such as straightening of the channel or human-influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or placer mine operations.

Chlorophyll-*a*
A chlorophyll-*a* impairment occurs when excess levels of chlorophyll-*a* or algae in the stream impairs aquatic life and/or primary contact recreation (Suplee et al., 2009). These high levels of chlorophyll-*a* or algae are caused by excess concentrations of nutrients in the stream, which increases algal biomass (Suplee and Sada de Suplee, 2011). Chlorophyll-*a* impairments are typically addressed by nutrient TMDLs.

Other Flow Regime Alterations
Flow alteration refers to a change in the flow characteristics of a waterbody relative to natural conditions. An impairment listing caused by other flow regime alterations could be associated with changes in runoff and streamflow due to activities such as urban development, road construction, or timber harvest. Changes in runoff are commonly linked to elevated peak flows, which can also cause excess sedimentation by increasing streambank erosion and channel scour. Road crossings, particularly where culverts are undersized or inadequately maintained, can also alter flows by causing water to back-up upstream of the culvert.

Low Flow Alterations
Streams are typically listed as impaired for low flow alterations when irrigation withdrawal management leads to base flows that are too low to support the beneficial uses designated for that system. This could result in dry channels or extreme low flow conditions unsupportive of fish and aquatic life. Low flow conditions absorb thermal radiation more readily and increase stream temperatures, which in turn creates dissolved oxygen conditions too low to support some species of fish.

It should be noted that while Montana law requires monitoring and assessment to identify threatened or impaired waterbodies (Montana Code Annotated (MCA) 75-5-702) and to subsequently develop TMDLs for these waterbodies (MCA 75-5-703), the law also states that these requirements may not be construed to divest, impair, or diminish any legally-recognized water right (MCA 75-5-705). The identification of low flow alterations as a probable cause of impairment should not be construed to divest, impair, or diminish a water right. Instead, it should be considered an opportunity to characterize the impacts of flow alterations, and pursue solutions that can result in improved streamflows during critical periods, while at the same time ensuring no harm to water rights. These same considerations apply to flow related targets and allocations applied to temperature TMDLs in this document. It is up to local users, agencies, and entities to voluntarily improve instream flows through water and land management, which may include irrigation efficiency improvements and/or instream water leases, that result in reduced amounts of water diverted from streams.

8.3 Monitoring and Best Management Plans (BMPs) for Non-Pollutant Affected Streams

Table 8-1 above indicates whether the non-pollutant impairment causes are addressed by a nutrient, sediment, and/or temperature TMDL in this document. Habitat alteration impairments (i.e., alteration in streamside or littoral vegetative covers and physical substrate habitat alterations) and flow regime alteration impairments can be linked to sediment and/or temperature TMDL development for Ashley, Logan, and Sheppard creeks, and the Stillwater River. It is likely that meeting the sediment and temperature TMDL targets (**Sections 6.4** and **7.4**) will also equate to addressing the habitat and other flow regime alteration impairment conditions in each of these streams. For streams with habitat alteration or other flow regime alteration impairments that do not have a sediment or temperature TMDL, meeting the sediment targets applied to streams of similar size will likely equate to addressing the habitat impairment condition for each stream.

The chlorophyll-*a* impairments for Ashley Creek are addressed by the total nitrogen and total phosphorus TMDLs contained in **Section 5.0** of this document. The chlorophyll-*a* impairment for Lake Mary Ronan will be addressed through future water quality restoration planning that could include additional monitoring and/or possible TMDL development if nutrient impairments are identified.

Streams with non-pollutant impairments should be considered when developing watershed management goals and plans and when prioritizing restoration projects. Additional sediment, nutrient, and/or temperature information should be collected where data is insufficient for pollutant impairment determinations and the linkage between probable cause, non-pollutant listing, and effects to the beneficial uses is not well defined. The monitoring and restoration strategies that follow in **Sections 9.0** and **10.0** are presented to address both pollutant and non-pollutant issues for streams in the Flathead – Stillwater TMDL Planning Area with TMDLs in this document, and they are equally applicable to streams listed for the above non-pollutant impairment causes. The strategies also apply to the entire Flathead Lake and Flathead River watersheds.

8.4 Previously Completed TMDLs

Table 8-2 below lists the waterbody segments in the Flathead Lake watershed that have completed TMDLs. A TMDL Implementation Evaluation has since been completed for Big Creek (Montana Department of Environmental Quality, unpublished 2010), determining that a reassessment of beneficial uses was needed. As a result of an updated water quality assessment, the “sedimentation/siltation” impairment cause was removed from the 303(d) List in 2012. However, Big Creek remains on the impaired waters list as not fully supporting aquatic life, with a probable cause of habitat alteration.

Phase I of nutrient TMDLs for Flathead Lake was completed in 2001, which provided a total nitrogen and total phosphorus load reduction goal and a prioritized nutrient management plan for Flathead Lake and the broader Flathead Basin. A phase II of the nutrient TMDL project for Flathead Lake will involve further refinement of the TMDL allocations provided in the 2001 document (Montana Department of Environmental Quality, 2001).

Table 8-2. TMDLs Previously Completed in the Flathead Lake Watershed

TMDL Planning Area	Waterbody & Location Description	Waterbody ID	Completed TMDL(s)	TMDL Document[1]
Big Creek	**Big Creek,** Headwaters to mouth (North Fork of the Flathead River)	MT76Q002_050	Sediment[2]	2003 “Watershed Restoration Plan for Big Creek, North Fork of the Flathead River”
Flathead Headwaters	**Coal Creek,** South Fork to mouth (North Fork Flathead)	MT76Q002_080	Sediment	2004 “Water Quality Assessment and TMDLs for the Flathead River Headwaters Planning Area, Montana”

Table 8-2. TMDLs Previously Completed in the Flathead Lake Watershed

TMDL Planning Area	Waterbody & Location Description	Waterbody ID	Completed TMDL(s)	TMDL Document[1]
Flathead Lake	**Flathead Lake**	MT76O003_010	Total Nitrogen, Total Phosphorus	2001 "Nutrient Management Plan & Total Maximum Daily Load for Flathead Lake, Montana"
Swan	**Goat Creek,** Headwaters to Squeezer Creek	MT76K003_031	Total Suspended Solids	2004 "Water Quality Protection Plan and TMDLs for the Swan Lake Watershed"
	Jim Creek, Headwaters to mouth (Swan River)	MT76K003_010	Sediment	
	Swan Lake	MT76K002_010	Total Nitrogen, Total Phosphorus, Sediment	

[1] These documents can be found on DEQ's website at: http://deq.mt.gov/wqinfo/TMDL/finalReports.mcpx
[2] The sedimentation/siltation cause of impairment for Big Creek was removed from the 303(d) List in 2012; however, Big Creek remains on the impaired waters list as not fully supporting aquatic life, with a probable cause of habitat alteration.

8.5 Future TMDL Development

There are metals, oil and grease, and polychlorinated biphenyl (PCB) impairments identified on the "2014 Water Quality Integrated Report" for streams and lakes in the Flathead Lake and Flathead – Stillwater TMDL planning areas (**Table 8-3**). These impairments were not part of this TMDL development project. DEQ currently has a separate, ongoing monitoring project to further evaluate most of the impairment causes in **Table 8-3**. These evaluations will help define future TMDL development requirements.

Table 8-3. Waterbodies in the Flathead and Flathead – Stillwater TMDL Planning Areas with Pollutant Impairments on the 2014 303(d) List Not Addressed in this Document

TMDL Planning Area	Waterbody & Location Description	Waterbody ID	Impairment Cause
Flathead - Stillwater	**Spring Creek**, Headwaters to mouth (Ashley Creek)	MT76O002_040	Arsenic
	Whitefish Lake	MT76P004_010	Mercury
			Polychlorinated biphenyls
	Whitefish River, Whitefish Lake to mouth (Stillwater River)	MT76P003_010	Oil and Grease
			PCB in Water Column
Flathead	**Flathead Lake**	MT76O003_010	Mercury
			Polychlorinated biphenyls

Additionally, total nitrogen and total phosphorus TMDLs were written for Flathead Lake in 2001 (**Table 8-2**) (Montana Department of Environmental Quality, 2001). A Phase II component of these TMDLs includes further refinement of the allocations provided within the 2001 document. This Phase II activity is part of a separate and ongoing TMDL project.

9.0 WATER QUALITY IMPROVEMENT PLAN

While certain land uses and human activities are identified as sources and causes of water quality impairment during total maximum daily load (TMDL) development, the management of these activities is of more concern than the activities themselves. This document does not advocate for the removal of land and water uses to achieve water quality restoration objectives, but instead for making changes to current and future land management practices that will help improve and maintain water quality.

9.1 PURPOSE OF IMPROVEMENT STRATEGY

This section describes an overall strategy and specific on-the-ground measures designed to restore water quality beneficial uses and attain water quality standards in the Flathead-Stillwater TMDL Planning Area streams. The strategy includes general measures for reducing loading from identified nonpoint sources of pollutants.

This section should assist stakeholders in developing a watershed restoration plan (WRP) that will provide more detailed information about restoration goals within the Flathead-Stillwater TMDL Planning Area, and also in the broader Flathead Lake and Flathead River watersheds. The WRP may also encompass broader goals than the water quality improvement strategy outlined in this document. The intent of the WRP is to serve as a locally organized “road map” for watershed activities, prioritizing types of projects, sequences of projects, and funding sources towards achieving local watershed goals. Within the WRP, local stakeholders identify and prioritize streams, tasks, resources, and schedules for applying best management practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, this strategy could be adapted and revised by stakeholders based on new information and ongoing improvements.

9.2 WATER QUALITY RESTORATION OBJECTIVE

The water quality restoration objective for the Flathead-Stillwater TMDL Planning Area is to reduce pollutant loads as identified throughout this document in order to meet the water quality standards and TMDL targets for full recovery of beneficial uses for all impaired streams. Meeting the TMDLs provided in this document will achieve this objective for all identified pollutant-impaired streams. Based on the assessment provided in this document, the TMDLs can be achieved through proper implementation of BMPs, and using the appropriate technology for treating wastewater. However; this section focuses on BMPs for nonpoint sources.

A WRP can provide a framework strategy for water quality restoration and monitoring in the Flathead - Stillwater TMDL Planning Area, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document, as well as other water quality issues of interest to local communities and stakeholders. WRPs identify considerations that should be addressed during TMDL implementation and should assist stakeholders in developing a more detailed adaptive plan in the future. A locally developed WRP will likely provide more detailed information about restoration goals and spatial considerations but may also encompass more broad goals than this framework includes. A 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. The WRP is intended to be a living document that can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities.

The Environmental Protection Agency (EPA) requires nine minimum elements for a WRP, summarized here:

1. Identification of the causes and sources of pollutants
2. Estimated load reductions expected based on implemented management measures
3. Description of needed nonpoint source management measures
4. Estimate of the amounts of technical and financial assistance needed
5. An information/education component
6. Schedule for implementing the nonpoint source management measures
7. Description of interim, measurable milestones
8. Set of criteria that can be used to determine whether loading reductions are being achieved over time
9. A monitoring component to evaluate effectiveness of the implementation efforts over time

This document provides, or can serve as an outline, for many of the required elements. Water quality goals for nutrients, sediment, and temperature pollutants are detailed in **Sections 5.0, 6.0,** and **7.0**, respectively. These goals include water quality targets as measures for long-term effectiveness monitoring. These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses of waterbodies in the Flathead-Stillwater TMDL Planning Area. It is presumed that meeting all water quality targets will achieve the water quality goals for each impaired waterbody. **Section 10.0** identifies a general monitoring strategy and recommendations to track post-implementation water quality conditions and measure restoration successes.

9.3 Role of DEQ, Other Agencies, and Stakeholders

The Montana Department of Environmental Quality (DEQ) does not implement TMDL pollutant-reduction projects for nonpoint source activities, but may provide technical and financial assistance for stakeholders interested in improving their water quality. Successful implementation of TMDL pollutant-reduction projects requires collaboration among private landowners, land management agencies, and other stakeholders. DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help support water quality improvement and pollution prevention projects, and help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers work collaboratively with local and state agencies to achieve water quality restoration goals and to meet TMDL targets and load reductions. Specific stakeholders and agencies that will likely be vital to restoration efforts for streams discussed in this document include:

- Flathead Conservation District
- U.S. Environmental Protection Agency (EPA)
- U.S. Forest Service (USFS)
- Natural Resources and Conservation Service (NRCS)
- U.S. Fish & Wildlife Service (USFWS)
- U.S. Army Corp of Engineers
- Bureau of Reclamation
- Montana Department of Natural Resources and Conservation (DNRC)
- Montana Fish, Wildlife and Parks (FWP)

- Montana Department of Environmental Quality (DEQ)
- Montana Department of Transportation
- Montana Bureau of Mines and Geology
- Flathead Basin Commission
- Confederated Salish and Kootenai Tribes
- Flathead Lake Biological Station
- Flathead Lakers
- Haskill Basin Watershed Council
- Whitefish Lake Institute
- Plum Creek Timber Company
- Montana Trout Unlimited
- Local City and County Representatives
- Flathead Regional Wastewater Management Group

Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include:

- Montana Water Center (at Montana State University)
- University of Montana Watershed Health Clinic
- Montana Aquatic Resources Services
- Montana State University Extension Water Quality Program

9.4 Restoration Approaches by Pollutant

TMDLs were completed for four waterbody segments for nutrients, seven waterbody segments for sediment, and four waterbody segments for temperature. Other streams in the planning area may be in need of restoration or pollutant reduction, but insufficient information about them precludes TMDL development at this time. The following sub-sections describe some generalized recommendations for implementing projects to achieve the TMDLs. Details specific to each stream, and therefore which of the following strategies may be most appropriate, are found within **Sections 5.0, 6.0,** and **7.0**.

In general, restoration activities can be separated into two categories: active and passive. Passive restoration allows natural succession to occur within an ecosystem by removing a source of disturbance. Fencing off riparian areas from cattle grazing is a good example of passive restoration. Active restoration, on the other hand involves accelerating natural processes or changing the trajectory of succession. For example, historic placer mining often resulted in the straightening of stream channels and piling of processed rock on the streambank. These impacts would take so long to recover passively that active restoration methods involving removal of waste rock and rerouting of the stream channel would likely be necessary to improve stream and water quality conditions. In general, passive restoration is preferable for nutrient, sediment, and temperature problems due to nonpoint sources because it is generally more cost effective, less labor intensive, and will not result in short term increase of pollutant loads as active restoration activities may. However, in some cases active restoration is the only feasible mechanism for achieving desired goals; these activities must be assessed on a case by case basis (Nature Education, 2013).

9.4.1 Nutrient Restoration Approach

The goal of the nutrient restoration strategy is to reduce nutrient input to Ashley Creek and other stream channels from nonpoint sources by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, and limiting the transport of nutrients from rangeland and cropland.

Cropland filter strip extension, vegetative restoration, and long-term filter area maintenance are vital BMPs for agricultural areas. Grazing systems with the explicit goal of increased vegetative post-grazing ground cover are needed to address the same nutrient loading from rangelands. Grazing prescriptions that enhance the filtering capacity of riparian filter areas offer a second tier of controls on the sediment content of upland runoff. Grazing and pasture management adjustments should consider:

- The timing, frequency, and duration of near-stream grazing
- The spacing and exposure duration of on-stream watering locations
- Provision of off-stream watering areas to minimize near-stream damage and allow impoundment operations that minimize salt accumulations
- Active reseeding and rest rotation of locally damaged vegetation stands
- Improved management of irrigation systems
- Incorporation of streamside vegetation buffer to irrigated croplands and animal feeding areas

In general, these are sustainable grazing and cropping practices that can reduce nutrient inputs while meeting production goals. The appropriate combination of BMPs will differ according to landowner preferences and equipment but are recommended as components of a comprehensive plan for farm and ranch operators. Sound planning combined with effective conservation BMPs should be sought whenever possible. Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in Montana. The local United States Department of Agriculture (USDA) Service Center and county conservation district offices are geared to offer both planning and implementation assistance.

Seasonal livestock confinement areas have a historic precedent for placement near or adjacent to flowing streams. Stream channels were the only available livestock water sources prior to the extension of rural electricity. Although limited in size, their repeated use generates high nutrient concentrations in close proximity to surface waters. Episodic runoff with high nutrient concentrations generates large loads that can settle in pools of intermittent streams and remain bio-available through the growing season. Diversion and routing of confinement runoff to harvestable nutrient uptake areas outside of active water courses are effective controls.

In addition to the agricultural-related BMPs, a reduction of sediment delivery from roads and eroding streambanks is another component of the nutrient reduction restoration plan, particularly where excess phosphorus is a problem. Additional sediment-related BMPs are presented in **Section 9.5**.

9.4.2 Sediment Restoration Approach

The goal of the sediment restoration strategy is to limit the availability, transport, and delivery of excess sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. Monitoring data used to develop targets and determine impairments are described in **Section 6.0** and in **Attachment A**. Sediment restoration activities on impaired stream segments will help reduce the amount of fine sediment, reduce width/depth ratio, increase residual pool depth, increase pool frequency, increase riparian understory shrub cover, reduce impacts of human-caused sediment sources, and restore appropriate macroinvertebrate assemblages. These are indicators of successful restoration activities targeted toward sediment reduction and need to be considered together and within the context of stream potential in comparison to appropriate reference sites. For example, pool frequency tends to decline as stream size increases; therefore, indicators for these parameters will vary. General targets for these indicators are summarized in **Table 6-2**.

Streamside riparian and wetland vegetation restoration and long term management are crucial to achieving the sediment TMDLs. Native streamside riparian and wetland vegetation provides root mass, which hold streambanks together. Suitable root mass density ultimately slows bank erosion. Riparian and wetland vegetation filters pollutants from upland runoff. Therefore, improving riparian and wetland vegetation will decrease bank erosion by improving streambank stability and will also reduce pollutant delivery from upland sources. Suspended sediment is also deposited more effectively in healthy riparian zones and wetland areas during flooding because water velocities slow in these areas enough for excess sediment to settle out. Restoration recommendations involve the promotion of riparian and wetland recovery through improved grazing and land management (including the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of off-site watering areas), application of timber harvest best management practices, floodplain and streambank stabilization, revegetation efforts, and instream channel and habitat restoration where necessary. Appropriate BMPs will differ by location and are recommended to be included and prioritized as part of a comprehensive watershed scale plan (e.g., WRP).

In areas where stormwater is accelerating sediment loading to streams, the sediment restoration strategy will be achieved by BMPs that promote infiltration of runoff and lessen its volume and the timing of delivery to surface water. Smart growth and low impact development are two closely related planning strategies that help reduce stormwater volume, slow its transport to surface waterbodies, and improve groundwater recharge.

Although unpaved roads may be a small source of sediment at the watershed scale, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams primarily include measures that divert water to ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. In addition, routine maintenance of unpaved roads (particularly near stream crossings) and proper sizing and maintenance of culverts, regardless of road use status, are crucial components to limiting sediment production from roads.

9.4.3 Temperature Restoration Approach

The goal of the temperature restoration approach is to reduce water temperatures where possible to be consistent with naturally occurring conditions. The most significant mechanism for reducing water temperature in both Ashley Creek and the Whitefish River is increasing riparian shade. On Ashley Creek, the Kalispell wastewater treatment plant (WWTP) also appears to be increasing temperatures and is addressed in **Section 6.6.3**. Other factors that will help are: maintaining conditions where Ashley Creek and the Whitefish River are currently meeting the targets and using water conservation measures to maximize water left in the stream.

Increases in shade can be accomplished through the restoration and protection of shade-providing vegetation within the riparian corridor. This type of vegetation can also have the added benefit of improving streambank stabilization to reduce bank erosion, slowing lateral river migration, and providing a buffer to prevent pollutants from upland sources from entering the stream. In some cases, this can be achieved by limiting the frequency and duration of livestock access to the riparian corridor, or through other grazing related BMPs such as installing water gaps or off-site watering. Other areas may require planting, active bank restoration, and protection from browse to establish vegetation.

Both Ashley Creek and the Whitefish River appear to have appropriate bankfull width. However, there may be discreet locations where channel morphology could be improved. Recovery of stream channel morphology in most cases will occur slowly over time and follow the improvement of riparian condition, stabilization of streambanks, and reduction in overall sediment load. Stream size, project scale, and cost of restoration in most cases are limiting factors to applying this type of remedy.

Although there is no specific target for instream summer flow in either Ashley Creek or the Whitefish River, if increases in instream summer flows are possible, they can be achieved through a thorough investigation of water use practices and water conveyance infrastructure, and a willingness and ability of local water users to keep more water in the stream. This TMDL document cannot, nor is it intended to, prescribe limitations on individual water rights owners and users. Local water users should work collectively and with local, state, and federal resource management professionals to review water use options and available assistance programs.

The above approaches give only the broadest description of activities to help reduce water temperatures. The temperature assessments described in **Section 7.0** looked at possible scenarios based on limited information at the watershed scale. Those scenarios showed that improvements in stream temperatures can primarily be made by improvements to riparian shade. It is strongly encouraged that resource managers and land owners continue to work to identify all potential areas of improvement and develop projects and practices to reduce stream temperatures in Ashley Creek and the Whitefish River.

9.4.4 Non-Pollutant Restoration Approach

Although TMDL development is not required for non-pollutant causes of impairment, they are frequently linked to pollutants, and addressing non-pollutant causes is an important component of TMDL implementation. Non-pollutant impairment causes within the Flathead-Stillwater TMDL Planning Area (TPA) include alteration in streamside or littoral vegetative covers, physical substrate habitat alterations, other flow regime alterations, and low flow alterations, and are described in **Section 8.0**. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Although flow alterations have the most direct link with temperature, adequate flow is also critical for downstream sediment transport and improving the assimilative capacity of streams for sediment and nutrient inputs. Therefore, if restoration goals within the Flathead-Stillwater TMDL Planning Area are not also addressing non-pollutant impairments, additional non-pollutant related BMP implementation should be considered.

9.5 Restoration Approaches by Source

General management recommendations are outlined below for the major sources of human caused pollutant loads in the Flathead-Stillwater TMDL Planning Area: agricultural sources, riparian and wetland vegetation removal, beaver populations, roads, forestry and timber harvest, stormwater from construction sites, residential development, and roads. The effect of different sources can change seasonally and be dependent on the magnitude of storm/high flow events. Therefore, restoration activities should focus on all major sources for each pollutant category; yet, restoration should begin with addressing significant sources where large load reductions can be obtained within each source category.

Applying and maintaining BMPs is the core of the nonpoint source pollutant reduction strategy, but BMPs are only part of a watershed restoration strategy. It is important that future load increases are avoided by ensuring that new activities within the watershed incorporate all appropriate BMPs and that implementation and maintenance of those BMPs currently in place or in practice is continued. For each major source, BMPs will be most effective as part of a comprehensive management strategy that focuses on critical areas within the watershed, which are those areas contributing the largest pollutant loads or are especially susceptible to disturbance. The source assessment results provided within the appendices and attachments and summarized in **Sections 5.5, 6.5, and 7.5** provide information that should be used to help determine priorities for each major source type in the watershed and for each of the general management recommendations discussed. The WRP developed by local watershed groups and partners should contain more detailed information on restoration goals and specific management recommendations that may be required to address key pollutant sources. BMPs are usually identified as a first effort and further monitoring and evaluation of activities and outcomes, as part of an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality standards. Monitoring is an important part of the restoration process, and monitoring recommendations are outlined in **Section 10.0**.

In recognition that noxious weeds are a problem throughout Montana and may be associated with any of the following source categories, noxious weed control should be actively pursued whenever BMPs are being implemented.

9.5.1 Agriculture Sources

Reduction of pollutants from upland agricultural sources can be accomplished by limiting the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil and runoff before it enters a waterbody. The main BMP recommendations for the Flathead-Stillwater TMDL Planning Area are riparian buffers, wetland restoration, and vegetated filter strips, where appropriate. These methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept pollutants. Filter strips and buffers are even more effective for reducing upland agricultural related sediment when used in conjunction with BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, and strip-cropping. Additional BMP information, design standards and effectiveness, and details on the suggested BMPs can be obtained from your local USDA Agricultural Service Center and in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012).

An additional benefit of reducing sediment input to the stream is a decrease in sediment-bound nutrients. Reductions in sediment loads may help address some nutrient related problems. Nutrient management considers the amount, source, placement, form, and timing of plant nutrients and soil amendments. Conservation plans should include the following information (NRCS Conservation Practice Standard 590 and 590-1, Nutrient Management (United States Department of Agriculture, Natural Resources Conservation Service, 2005):

- Field maps and soil maps
- Planned crop rotation or sequence
- Results of soil, water, plant, and organic materials sample analysis
- Realistic expected yields
- Sources of all nutrients to be applied
- A detailed nutrient budget

- Nutrient rates, form, timing, and application method to meet crop demands and soil quality concerns
- Location of environmentally sensitive areas, including streams, wetlands, springs, or other locations that deliver surface runoff to groundwater or surface water
- Guidelines for operation and maintenance

9.5.1.1 Grazing

Grazing has the potential to increase sediment and nutrient loads, as well as stream temperatures (by altering channel width and riparian vegetation), but these effects can be mitigated with appropriate management. Development of riparian grazing management plans should be a goal for any landowner who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county, federal, and local conservation groups to establish and implement appropriate grazing management plans. Note that riparian grazing management does not necessarily eliminate all grazing in riparian corridors. In some areas however, a more limited management strategy may be necessary for a period of time in order to accelerate reestablishment of a riparian community with the most desirable species composition and structure.

Every livestock grazing operation should have a grazing management plan. The NRCS Prescribed Grazing Conservation Practice Standard (Code 528) recommends the plan include the following elements (Natural Resource Conservation Service, 2010):

- A map of the operation showing fields, riparian and wetland areas, winter feeding areas, water sources, animal shelters, etc.
- The number and type of livestock
- Realistic estimates of forage needs and forage availability
- The size and productivity of each grazing unit (pasture/field/allotment)
- The duration and time of grazing
- Practices that will prevent overgrazing and allow for appropriate regrowth
- Practices that will protect riparian and wetland areas and associated water quality
- Procedures for monitoring forage use on an ongoing basis
- Development plan for off-site watering areas

Reducing grazing pressure in riparian and wetland areas and improving forage stand health are the two keys to preventing nonpoint source pollution from grazing. Grazing operations should use some or all of the following practices:

- Minimizing or preventing livestock grazing in riparian and wetland areas
- Providing off-stream watering facilities or using low-impact water gaps to prevent 'loafing' in wet areas
- Managing riparian pastures separately from upland pastures
- Installing salt licks, feeding stations, and shelter fences in areas that prevent 'loafing' in riparian areas and help distribute animals
- Replanting trodden down banks and riparian and wetland areas with native vegetation (this should always be coupled with a reduction in grazing pressure)
- Rotational grazing or intensive pasture management that takes season, frequency, and duration into consideration

The following resources provide guidance to help prevent pollution and maximize productivity from grazing operations:

- Plum Creek Timber Company's Native Fish Habitat Conservation Plan (http://www.plumcreek.com/Environment/nbspSustainableForestrySFI/nbspSFIImplementation/HabitatConservationPlans/tabid/153/Default.aspx)
- USDA, Natural Resources Conservation Service
  The office serving Flathead County is located in Kalispell (find your local USDA Agricultural Service Center listed in your phone directory or on the Internet at www.nrcs.usda.gov)
- Montana State University Extension Service (www.extn.msu.montana.edu)
- DEQ Watershed Protection Section (Nonpoint Source Program): Nonpoint Source Management Plan (http://deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx)

The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian and wetland vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the Flathead-Stillwater TMDL Planning Area are limiting livestock access to streams and stabilizing the stream at access points, providing off-site watering sources when and where appropriate, planting native stabilizing vegetation along streambanks, and establishing and maintaining riparian buffers. Although bank revegetation is a preferred BMP, in some instances bank stabilization may be necessary prior to planting vegetation.

9.5.1.2 Cropland

The primary strategy of the recommended cropland BMPs is to reduce sediment inputs. The major factors involved in decreasing sediment loads are reducing the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil before it enters waterbodies. The main BMP recommendations for the Flathead-Stillwater TMDL Planning Area are vegetated filter strips and riparian buffers. Both of these methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept sediment. Effectiveness is typically about 70% for the filter strips and 50% for the buffers (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012). Filter strips and buffers are most effective when used in conjunction with agricultural BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, strip cropping, and precision farming. Filter strips along streams should be composed of natural vegetative communities. Additional BMPs and details on the suggested BMPs can be obtained from NRCS and in Appendix A of Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012).

9.5.1.3 Water Management and Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow can have a profound effect on the ability of a stream to attenuate pollutants, especially nutrients, metals, and heat. Flow reduction may increase water temperature, allow pollutants to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced (Andrews and Nankervis, 1995; Schmidt and Potyondy, 2004). In addition to the BMPs recommended in Appendix A of Montana's Nonpoint Source (NPS) Management Plan (Montana Department of Environmental Quality, 2012c), local coordination and planning are especially important for flow management because State law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (Montana Code Annotated (MCA) 75-5-705).

Irrigation management is a critical component of attaining both coldwater fishery conservation and TMDL goals. Understanding irrigation water, groundwater, and surface water interactions is an important part of understanding how irrigation practices will affect streamflow during specific seasons. Improvements should focus on how to reduce the amount of stream water diverted during July and August, while still growing crops on traditional cropland. It may be desirable to investigate irrigation practices earlier in the year that promote groundwater return during July and August.

Some irrigation practices in western Montana are based on flood irrigation methods. Occasionally head gates and ditches leak, which can decrease the amount of water in diversion flows. The following recommended activities could potentially result in notable water savings:

- Install upgraded head gates for more exact control of diversion flow and to minimize leakage when not in operation
- Develop more efficient means to supply water to livestock
- Determine necessary diversion flows and timeframes that would reduce over watering and improve forage quality and production
- Where appropriate, redesign or reconfigure irrigation systems
- Upgrade ditches (including possible lining, if appropriate) to increase ditch conveyance efficiency

Some water from spring and early summer flood irrigation likely returns as cool groundwater to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer groundwater returns to the river should be identified as areas where year round irrigation efficiencies could be more beneficial than seasonal management practices. Winter baseflow should also be considered during these investigations.

9.5.1.4 Animal Feeding Operations

Animal feeding operations (AFOs) can pose a number of risks to water quality. To minimize water quality effects from AFOs, the USDA and EPA released the Unified National Strategy for AFOs in 1999 (U.S. Department of Agriculture and U.S. Environmental Protection Agency, 1999). This plan is a written document detailing 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 meets certain specified criteria is referred to as a 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, in some cases no direct regulation is necessary through a permit. Operators of AFOs may take advantage of effective, low cost practices to reduce potential runoff to state waters, which additionally increase property values and operation productivity. Properly installed vegetative filter strips, in conjunction with other practices to reduce wasteloads and runoff volume, are very effective at trapping and detaining sediment and reducing transport of nutrients and pathogens to surface waters, with removal rates approaching 90 percent (U.S. Department of Agriculture and U.S. Environmental Protection Agency, 1999). Other options may include clean water diversions, roof gutters, berms, sediment traps, fencing, structures for temporary manure storage, shaping, and grading. Animal health and productivity also benefit when clean, alternative water sources are installed to prevent contamination of surface water.

Opportunities for financial and technical assistance (including comprehensive nutrient management plan development) in achieving voluntary AFO and CAFO compliance are available from conservation districts and NRCS field offices. Voluntary participation may aide in preventing a more rigid regulatory program from being implemented for Montana livestock operators in the future. Further information may be obtained from the DEQ website at: http://www.deq.mt.gov/wqinfo/mpdes/cafo.asp.

Montana's nonpoint source pollution control strategies for addressing AFOs are summarized in the bullets below:

- Work with producers to prevent NPS pollution from AFOs
- Promote use of State Revolving Fund for implementing AFO BMPs
- Collaborate with Montana State University (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 potential to discharge nonpoint source pollutants from animal management activities. This includes assistance from the DEQ Permitting Division, as well as external entities such as DNRC, local watershed groups, conservation districts, and MSU Extension.

9.5.1.5 Small Acreages

The number of small acreages is growing rapidly, and many small acreage owners own horses or cattle. Animals grazing on small acreages can lead to overgrazing and a shortage of grass cover, leaving the soil subject to erosion and runoff to surface waters. General BMP recommendations for small acreage lots with animals include creating drylots, developing a rotational grazing system, and maintaining healthy riparian buffers. Small acreage owners should collaborate with MSU Extension Service, NRCS, conservation districts and agriculture organizations to develop management plans for their lots. Further information may be obtained from the Montana Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012c) or the MSU extension website at: http://animalrangeextension.montana.edu/articles/NatResourc/main-smallacre-links.htm.

9.5.2 Riparian Areas, Wetlands, and Floodplains

Healthy and functioning riparian areas, wetlands, and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. The performance of these functions is dependent on the connectivity of riparian areas, wetlands, and floodplains to both the stream channel and upland areas. Human activities affecting the quality of these transitional habitats or their connectivity can alter their performance and greatly affect the transport of water, sediments, and contaminants (e.g., channelization, increased stream power, bank erosion, and habitat loss or degradation). Therefore, restoring, maintaining, and protecting riparian areas, wetlands, and floodplains within the watershed should be a priority of TMDL implementation in the Flathead-Stillwater TMDL Planning Area, and the Flathead River watershed as a whole.

Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation and maintenance of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e., plantings) may be necessary in some instances. The primary advantage of riparian and wetland plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property. Weed management should also be a dynamic component of managing riparian areas.

Factors influencing the appropriate riparian and wetland restoration would include severity of degradation, site-potential for various species, and availability of local sources for native transplant materials. In general, riparian and wetland plantings would promote establishment of functioning stands of native species. The following recommended restoration measures would allow for stabilization of the soil, decrease sediment delivery to the stream, and increase absorption of nutrients from overland runoff:

- Harvesting and transplanting locally available sod mats with an existing dense root mass provides immediate promotion of bank stability and filtering nutrients and sediments
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity at locations where lower bank shear stresses would be unlikely to cause erosion
- Willow sprigging expedites vegetative recovery, but involves harvest of dormant willow stakes from local sources
- Transplanting mature native shrubs, particularly willows (*Salix* sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading, as well as uptake of nutrients

Note: Before transplanting *Salix* from one location to another it is important to determine the exact species so that we do not propagate the spread of non-native species. There are several non-native willow species that are similar to our native species and commonly present in Montana watersheds.

In addition to the benefits described above, it should be noted that in some cases, wetlands act as areas of shallow subsurface groundwater recharge and/or storage areas. The captured water via wetlands is then generally discharged to the stream later in the season and contributes to the maintenance of base flows and stream temperatures. Restoring ditched or drained wetlands can have a substantial effect on the quantity, temperature, and timing of water returning to a stream, as well as the pollutant filtering capacity that improved riparian and wetlands provide.

Initiatives to protect riparian areas and floodplains will help protect property, increase channel stability, and buffer waterbodies from pollutants. However, in areas with a much smaller buffer or where historical vegetation removal and development have shifted the riparian vegetation community and limited its functionality, a tiered approach for restoring stream channels and adjacent riparian vegetation should be considered that prioritizes areas for restoration based on the existing condition and potential for improvement. In non-conifer dominated areas, the restoration goals should focus on restoring natural shrub cover on streambanks. As discussed above, passive riparian restoration is preferable, but in areas where stream channels are unnaturally unstable or streambanks are eroding excessively, additional active restoration approaches, such as channel design, woody debris and log vanes, bank sloping, seeding, and shrub planting may be desired to speed up the rate of recovery. Bank stabilization using natural channel design techniques can provide both bank stability and aquatic habitat potential. The primary recommended structures include natural or “natural-like” structures, such as large woody debris jams. These natural arrays can be constructed to emulate historical debris assemblages that were introduced to the channel by the adjacent cottonwood-dominated riparian community types. When used together, woody debris jams and straight log vanes can benefit the stream and fishery by improving bank stability, reducing bank erosion rates, adding protection to fillslopes and/or embankments, reducing near-bank shear stress, and enhancing aquatic habitat and lateral channel margin complexity.

The use of riprap or other “hard” approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although they may be absolutely necessary in some instances, these “hard” approaches generally redirect channel energy and exacerbate erosion in other places. Bank armoring should be limited to areas with a demonstrated infrastructure threat. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat. Limit threats to infrastructure by reducing floodplain development through local land use planning initiatives.

9.5.3 Beaver Populations and Sediment Yields

Historic heavy trapping of beavers has likely had an effect on sediment yields in the watershed. Before the removal of beavers, many streams had a series of catchments that moderated flow, with smaller un-incised multiple channels and frequent flooding. Now some stream segments have incised 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. Beaver ponds also capture and store sediment and there can be large reductions in total suspended solids (TSS) concentrations below a beaver impoundment in comparison to TSS concentrations above the beaver impoundment (Bason, 2004).

Management of headwaters areas should include consideration of beaver habitat. Long-term management could include maintenance of beaver habitat in headwaters protection areas and even allowing for increased beaver populations in areas currently lacking the beaver complexes that can trap sediment, reduce peak flows, and increase summer low flows. Allowing for existing and even increased beaver habitat is considered consistent with the sediment TMDL water quality goals.

9.5.4 Roads

Unpaved roads contribute sediment (as well as nutrients and other pollutants) to streams in the Flathead-Stillwater TMDL Planning Area. The road sediment reductions in this document represent an estimation of the sediment load that will remain once appropriate road BMPs are applied and maintained at all locations. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Road BMPs can be found on the Montana DEQ or DNRC websites and within Montana’s Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012c). Examples include:

- Providing adequate ditch relief up-grade of stream crossings
- Constructing waterbars, where appropriate, and up-grade of stream crossings
- Instead of cross pipes, using rolling dips on downhill grades with an embankment on one side to direct flow to the ditch. When installing rolling dips, ensure proper fillslope stability and sediment filtration between the road and nearby streams.
- Insloping roads along steep banks with the use of cross slopes and cross culverts
- Outsloping low traffic roads on gently sloping terrain with the use of a cross slope
- Using ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches

- For maintenance, grade materials to the center of the road and avoid removing the toe of the cutslope
- Preventing disturbance to vulnerable slopes
- Using topography to filter sediments; flat, vegetated areas are more effective sediment filters
- Where possible, limit road access during wet periods when drainage features could be damaged
- Limit new road stream crossings and the length of near-stream parallel segments to the extent practicable

9.5.4.1 Culverts and Fish Passage

Undersized and improperly installed and maintained culverts can be a substantial source of sediment to streams, and a barrier to fish and other aquatic organisms. There are many factors associated with culvert failure and it is difficult to estimate the true at-risk load. The allocation strategy for culverts is that, regardless of road use status, there should be no loading from culverts as a result of being undersized, improperly installed, or inadequately maintained. It is recommended that culverts be assessed so that a priority list may be developed for culvert replacement. As culverts fail, they should be replaced by culverts that pass a 100 year flood on fish-bearing streams and at least 25 year events on non-fish bearing streams. Some road crossings may not pose a feasible situation for upgrades to these sizes because of road bed configuration; in those circumstances, the largest size culvert feasible should be used. If funding is available, culverts should be prioritized and replaced prior to failure.

Another consideration for culvert upgrades should be fish and aquatic organism passage. Each culvert that is deemed a fish barrier should be assessed individually to determine if it functions as an invasive species and/or native species barrier. These two functions should be weighed against each other to determine if each culvert acting as a fish passage barrier should be mitigated. Montana FWP can aid in determining if a fish passage barrier should be mitigated, and, if so, can aid in culvert design.

9.5.4.2 Traction Sand

Severe winter weather and mountainous roads in the Flathead-Stillwater TMDL Planning Area will require the continued use of relatively large quantities of traction sand. Even so, closer evaluation of and adjustments to existing practices should be done to reduce traction sand loading to streams to the extent practicable. The necessary BMPs may vary throughout the watershed and particularly between state and private roads but may include the following:

- Use a snow blower to directionally place snow and traction sand on cut/fillslopes away from sensitive environments
- Increase the use of chemical deicers and decrease the use of road sand, as long as doing so does not create a safety hazard or cause undue degradation to vegetation and water quality
- Improve maintenance records to better estimate the use of road sand and chemicals, as well as to estimate the amount of sand recovered in sensitive areas
- Continue to fund Montana Department of Transportation research projects that will identify the best designs and procedures for minimizing road sand impacts to adjacent bodies of water and incorporate those findings into additional BMPs
- Street sweeping and sand reclamation
- Identify areas where the buffer could be improved or structural control measures may be needed
- Improved maintenance of existing BMPs
- Increase availability of traction sand BMP training

9.5.5 Forestry and Timber Harvest

Timber harvest activities should be conducted by all landowners according to Forestry BMPs for Montana (Montana State University Extension Service, 2001) and the Montana Streamside Management Zone (SMZ) Law (77-5-301 through 307 Montana Code Annotated (MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, road building including culvert design, 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 waterbody), the riparian protection principles behind the law should be applied to numerous land management activities (e.g., timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. DNRC is 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.

The SMZ Law protects against excessive erosion and therefore is appropriate for helping meet sediment and nutrient (especially forms bound to sediments) load allocations. On USFS Lands, Inland Native Fish Strategy (INFISH) Riparian Habitat Conservation Area guidelines provide significant sediment protection as well as protection from elevated thermal loading (i.e., elevated temperature) by providing adequate shade. This guidance improves upon Montana's SMZ law and includes an undisturbed 300 foot buffer on each side of fish bearing streams and 150 foot buffer on each side of non-fish bearing streams with limited exclusions and BMP guidance for timber harvest, roads, grazing, recreation and other human sources (U.S. Department of Agriculture, Forest Service, 1995). The Native Fish Habitat Conservation Plan developed by Plum Creek Timber includes a riparian management section that supplements the SMZ riparian buffer rules to help Plum Creek minimizes impacts from timber harvest in riparian areas. It includes specific commitments to leave more trees in locations that provide the maximum benefit, such as channel migration zones and provide for an additional caution area outside of the SMZ.

In addition to the BMPs identified above, effects that timber harvest may have on yearly streamflow levels, such as peak flow, should be considered. Timber harvest plans should evaluate the potential for cumulative effects on water yield and peak flow increases and implement BMPs to reduce sediment and nutrients loading. Finally, noxious weed control should be actively pursued in all harvest areas.

9.5.6 Storm Water Construction Permitting and BMPs

Construction activities disturb the soil, and if not managed properly, they can be substantial sources of sediment. Construction activity disturbing one acre or greater is required to obtain permit coverage through DEQ under the Storm Water General Permit for Construction Activities. A Storm Water Pollution Prevention Plan (SWPPP) must be developed and submitted to obtain a permit. A SWPPP identifies pollutants of concern (most commonly sediment), construction related sources of those pollutants, any nearby waterbodies that could be affected by construction activities, and BMPs that will be implemented to minimize erosion and discharge of pollutants to waterbodies. The SWPPP must be implemented for the duration of the project, including final stabilization of disturbed areas, which is a vegetative cover of at least 70% of the pre-disturbance level or an equivalent permanent stabilization measure. Development and implementation of a thorough SWPPP should ensure wasteload allocations within this document are met.

Land disturbance activities that are smaller than an acre (and exempt from permitting requirements) also have the potential to be substantial pollutant sources, and BMPs should be used to prevent and control erosion consistent with the upland erosion allocations. Potential BMPs for all construction activities include construction sequencing, permanent seeding with the aid of mulches or geotextiles, check dams, retaining walls, drain inlet protection, rock outlet protection, drainage swales, sediment basin/traps, earth dikes, erosion control structures, grassed waterways, infiltration basins, terraced slopes, tree/shrub planting, and vegetative buffer strips. An EPA support document for the construction permits has extensive information about construction related BMPs, including limitations, costs, and effectiveness (U.S. Environmental Protection Agency, 2009).

9.5.7 Residential/Urban Development

There are multiple sources and pathways of pollution to consider in residential and urban areas. Destruction of riparian areas, pollutants from both functioning and failing septic systems, and stormwater generated from impervious areas and construction sites are discussed below.

9.5.7.1 Riparian Degradation

Residential development adjacent to streams can affect the amount and health of riparian vegetation, the amount of large woody debris available in the stream, and might result in placement of riprap on streambanks (see **Section 10.5.5**). As discussed in Riparian Areas, Wetlands, and Floodplains in **Section 9.5.2** above, substantially degraded riparian areas do not effectively filter pollutants from upland runoff. Riparian areas that have been converted to lawns or small acreage pastures for domestic livestock may suffer from increased contributions of nutrients, sediment, and bacteria, as well as increased summer stream temperatures, increased channel erosion, and greater damage to property from flooding (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012). Of consideration, conservation easements can be a viable alternative to subdividing land, reducing residential development, and can be facilitated through several organizations such as The Nature Conservancy, the Trust for Public Land, and FWP. Further information on conservation easements and other landowner programs can be obtained from FWP (http://fwp.mt.gov/fishAndWildlife/habitat/wildlife/programs/landownersGuide.html).

DEQ encourages the consideration of adopting local zoning or regulations that protect the functions of floodplains and riparian and wetland areas where future growth may occur. Requirements for protecting native vegetation riparian buffers can be an effective mechanism for maintaining or improving stream health. Local outreach activities to inform new residential property owners of the effects of riparian degradation may also prevent such activities from occurring, including providing information on: appropriate fertilizer application rates to lawns and gardens, regular septic system maintenance, preserving existing riparian vegetation, native vegetation for landscaping, maintaining a buffer to protect riparian and wetland areas, and practices to reduce the amount of stormwater originating from developed property. Montana's Nonpoint Source Management Plan contains suggested BMPs to address the effects of residential and urban development, and also contains an appendix of setback regulations that have been adopted by various cities and counties in Montana (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012). Planning guides and informational publications related to wetlands and native plant species in Montana can be found on DEQ's Wetlands Conservation website at: http://deq.mt.gov/wqinfo/Wetlands/default.mcpx.

9.5.7.2 Septic

BMPs for septic systems include regular inspection and cleaning and repair of leaking or otherwise malfunctioning systems. As large acreages are subdivided into smaller lots, the number of septic systems will increase. Plans for development of lands within the Flathead-Stillwater TMDL Planning Area should consider the effects of additional septic systems to watersheds and consider ways of minimizing septic impacts to water quality such as installing type II systems to decrease nitrogen loading, installing systems further away from streams to allow for more nutrients attenuation, connecting to an existing WWTP, and/or constructing new WWTPs to connect multiple wastewater systems.

9.5.7.3 Urban Area Stormwater

Buildings and other impervious surfaces associated with land development prevent water from infiltrating into the ground and can alter watershed hydrology and transport built-up pollutants into nearby waterbodies. An important component to effectively managing stormwater is comprehensive planning that integrates land and infrastructure management. Smart growth and low impact development are two closely related planning strategies that help reduce stormwater volume, slow its transport to surface waterbodies, and improve groundwater recharge. Smart growth emphasizes structuring development to preserve open space, reduce the use of impervious surfaces, and improve water detention so more precipitation can be retained on the landscape before runoff occurs. Low impact development mimics natural processes of water storage and infiltration and can limit the harmful effects that increased percentages of impervious surface have on surface waters. Both concepts focus on applying simple, non-structural, and low cost methods to treat stormwater on the landscape and they can be used to retrofit existing development and also applied to new development.

Starting in 2012, Montana’s MS4 general permit requires that to the extent practicable, new development or redevelopment projects greater than one acre implement low impact development practices that “infiltrate, evapotranspire, or capture for reuse the runoff generated from the first 0.5 inches of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation.” Generally, newer developments in the watershed have better BMP implementation than older developments, and although planning for future development and retrofitting older developments with better levels of treatment are important, consistent maintenance and effectiveness evaluation of new and recently implemented stormwater BMPs is also an important component of effective stormwater management and TMDL implementation. Examples of low impact development and smart growth practices include drain chains, rain barrels, vegetated swales, sidewalk storage, permeable pavers, native landscaping, reducing parking areas, and mixed-use development. Parking lot drainage into a swale and a mixed use development are shown in **Figure 9-1**. Additional information about smart growth and low impact development can be found in Montana’s Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012c) and at the EPA’s website (www.epa.gov/nps/lid; www.epa.gov/dced).

Figure 9-1. Stormwater BMPs: Parking lot designed to drain into a swale and a mixed use development

9.5.8 Nonpoint Source Pollution Education

Because most nonpoint source pollution (NPS) is generated by individuals, a key factor in reducing NPS is increasing public awareness through education. Local watershed groups can provide educational opportunities to both students and adults through water quality workshops and informational meetings. Continued education is key to ongoing understanding of water quality issues in the Flathead-Stillwater TMDL Planning Area, and the Flathead River watershed as a whole, and to the support for implementation and restorative activities.

9.6 Potential Funding and Technical Assistance Sources

Prioritization and funding of restoration or water quality improvement projects is integral to maintaining restoration activities and monitoring project successes and failures. Several government agencies and also a few non-governmental organizations fund or can provide assistance with watershed or water quality improvement projects or wetlands restoration projects. Below is a brief summary of potential funding sources and organizations to assist with TMDL implementation. Note that some programs or funding sources summarized below may be discontinued in the future, and new sources of funding could possibly become available. Be sure to inquire with these agencies and organizations for the most current information.

In addition to the information presented below, numerous other funding opportunities exist for addressing nonpoint source pollution. Additional information regarding funding opportunities from state agencies is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2012) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

9.6.1 Section 319 Nonpoint Source Grant Program

DEQ issues a call for proposals every year to award Section 319 grant funds administered under the federal Clean Water Act. The primary goal of the 319 program is to restore water quality in waterbodies whose beneficial uses are impaired by nonpoint source pollution and whose water quality does not meet state standards. 319 funds are distributed competitively to support the most effective and highest priority projects. In order to receive funding, projects must directly implement a DEQ-accepted watershed restoration plan and funds may either be used for the education and outreach component of the WRP or for implementing restoration projects. The recommended range for 319 funds per project proposal is $10,000 to $30,000 for education and outreach activities and $50,000 to $300,000 for implementation projects. All funding has a 40% cost share requirement, and projects must be administered through a governmental entity such as a conservation district or county, or a nonprofit organization. For information about past grant awards and how to apply, please visit http://deq.mt.gov/wqinfo/nonpoint/319GrantInfo.mcpx.

9.6.2 Future Fisheries Improvement Program

The Future Fisheries grant program is administered by FWP and offers funding for projects that focus on habitat restoration to benefit wild and native fish. Anyone ranging from a landowner or community-based group to a state or local agency is eligible to apply. Applications are reviewed annually in December and June. Projects that may be applicable to the Flathead-Stillwater TMDL Planning Area include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats. For additional information about the program and how to apply, please visit http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/.

9.6.3 Renewable Resource Project Planning Grants

The DNRC administers watershed grants to pay for contracted costs associated with the development of a watershed assessment. Grant are available for a maximum of $75,000 per project. Eligible applicants include conservation districts and irrigation districts, among many others. For additional information about the program and how to apply, please visit http://dnrc.mt.gov/cardd/ResourceDevelopment/ProjectPlanningGrants.asp.

9.6.4 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is administered by NRCS and offers financial (i.e., incentive payments and cost-share grants) and technical assistance to farmers and ranchers to help plan and implement conservation practices that improve soil, water, air and other natural resources on their land. The program is based on the concept of balancing agricultural production and forest management with environmental quality, and is also used to help producers meet environmental regulations. EQIP offers contracts with a minimum length of one year after project implementation to a maximum of 10 years. Each county receives an annual EQIP allocation and applications are accepted continually during the year; payments may not exceed $300,000 within a six-year period. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.

9.6.5 Montana Partners for Fish and Wildlife

Montana Partners for Fish and Wildlife is a program under the U.S. Fish & Wildlife Service that assists private landowners to restore wetlands and riparian habitat by offering technical and financial assistance. For additional information about the program and to find your local contact for the Flathead River watershed, please visit: http://www.fws.gov/mountain-prairie/pfw/montana/.

9.6.6 Wetland Reserve Easements

The NRCS provides technical and financial assistance to private landowners and Indian tribes to restore, enhance, and protect wetlands through permanent easements, 30 year easements, or term easements. Land eligible for these easements includes farmed or converted wetland that can be successfully and cost-effectively restored. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep/.

9.6.7 Montana Wetland Council

The Montana Wetland Council is an active network of diverse interests that works cooperatively to conserve and restore Montana's wetland and riparian ecosystems. Please visit their website to find dates and locations of upcoming meetings, wetland program contacts, and additional information on potential grants and funding opportunities: http://deq.mt.gov/wqinfo/wetlands/wetlandscouncil.mcpx.

9.6.8 Montana Natural Heritage Program

The Montana Natural Heritage Program is a valuable resource for restoration and implementation information including maps. Wetlands and riparian areas are one of the 14 themes in the Montana Spatial Data Infrastructure. The Montana Wetland and Riparian Mapping Center (found at: http://mtnhp.org/nwi/) is creating a statewide digital wetland and riparian layer as a resource for management, planning, and restoration efforts.

9.6.9 Montana Aquatic Resources Services, Inc.

Montana Aquatic Resources Services, Inc. (MARS) is a nonprofit organization focused on restoring and protecting Montana's rivers, streams and wetlands. MARS identifies and implements stream, lake, and wetland restoration projects, collaborating with private landowners, local watershed groups and conservation districts, state and federal agencies, and tribes. For additional information about the program, please visit http://montanaaquaticresources.org/.

10.0 Monitoring Strategy and Adaptive Management

The monitoring strategies discussed in this section are an important component of watershed restoration, and a requirement of total maximum daily load (TMDL) implementation under the Montana Water Quality Act (Montana Code Annotated (MCA) 75-5-703(7)), and the foundation of the adaptive management approach. Water quality targets and allocations presented in this document are based on available data at the time of analysis. The scale of the watershed analysis, coupled with constraints on time and resources, often result in necessary compromises that include estimations, extrapolation, and a level of uncertainty in TMDLs. The margin of safety (MOS) (**Section 4.4**) 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, the amount of reduction of instream pollutants (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.

The monitoring strategy presented in this section provides a starting point for the development of more detailed 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 the water quality improvement goals outlined in this document. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on funding opportunities and stakeholder priorities for restoration. Once restoration measures have been implemented for a waterbody with an approved TMDL and given time to take effect, Department of Environmental Quality (DEQ) will conduct a formal evaluation of the waterbody’s impairment status and whether TMDL targets and water quality standards are being met.

The objectives for future monitoring in the Flathead-Stillwater TMDL Planning Area (TPA) include: 1) tracking and monitoring restoration activities and evaluating the effectiveness of individual and cumulative restoration activities, 2) baseline and impairment status monitoring to assess attainment of water quality targets and identify long-term trends in water quality, and 3) refining the source assessments. Each of these objectives is discussed below.

10.1 Adaptive Management and Uncertainty

An adaptive management approach is used to manage resource commitments as well as achieve success in meeting the water quality standards and supporting all beneficial uses. This approach works in cooperation with the monitoring strategy and allows for adjustments to the restoration goals or pollutant targets, TMDLs, and/or allocations, as necessary. These adjustments would take into account new information as it arises.

The adaptive management approach is outlined below:

- TMDLs and Allocations: The analysis presented in this document assumes that the load reductions proposed for each of the listed streams will enable the streams to meet target conditions and that meeting target conditions will ensure full support of all beneficial uses. Much of the monitoring proposed in this section of the document is intended to validate this assumption. If it looks like greater reductions in loading or improved performance is necessary

to meet targets, then updated TMDL and/or allocations will be developed based on achievable reductions via application of reasonable land, soil, and water conservations practices.
- Water Quality Status: As new stressors are added to the watershed and additional data are collected, new water quality targets may need to be developed or existing targets/allocations may need to be modified.

10.2 Tracking and Monitoring Restoration Activities and Effectiveness

Monitoring should be conducted prior to and after project implementation to help evaluate the effectiveness of specific practices or projects. This approach will help track the recovery of the system and the effects, or lack of effects, from ongoing management activities in the watershed. At a minimum, effectiveness monitoring should address the pollutants that are targeted for each project. Information about specific locations, spatial extent, designs, contacts, and any effectiveness evaluation should be compiled about each project. Information about all restoration projects along with tracking overall extent of best management plans (BMP) implementation and maintenance should be compiled in one location for the entire watershed.

For nutrients, loading reductions and BMP effectiveness can be evaluated with water quality samples and comparing them to the targets. For sediment, which has no numeric standard, and temperature, which was evaluated using a water quality model, loading reductions and BMP effectiveness may be estimated using the approaches used within this document. However, tracking BMP implementation, maintenance, and project-related measurements will likely be most practical for sediment and temperature. For instance, for road improvements, it is not anticipated that post-project sediment loads will be measured. Instead, documentation of the BMP, reduced contributing length, and before/after photos documenting the presence and effectiveness of the BMP will be most appropriate. For installation of riparian fencing, before/after photo documentation of riparian vegetation and streambank, and a measurement such as greenline that documents the percentage of bare ground and shrub cover, may be most appropriate. Evaluating instream parameters used for sediment targets will be one of the tools used to gage the success of implementation when DEQ conducts a formal assessment but may not be practical for most projects since the sediment effects within a stream represent cumulative effects from many watershed scale activities and because there is typically a lag time between project implementation and instream improvements (Meals et al., 2010).

If sufficient implementation progress is made within a watershed, the Montana Department of Environmental Quality (DEQ) will conduct a TMDL Implementation Evaluation (TIE). During this process, DEQ compiles recent data, conducts monitoring (if necessary), may compare data to water quality targets (typically a subset for sediment), summarizes BMP implementation since TMDL development, and evaluates data to determine if the TMDL is being achieved or if conditions are trending one way or another. If conditions indicate the TMDL is being achieved, the waterbody will be recommended for reassessment and may be removed from the 303(d) list. If conditions indicate the TMDL is not being achieved, according to Montana State Law (75-5-703(9)), the evaluation must determine if:
- The implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practices is necessary,
- Water quality is improving, but more time is needed for compliance with water quality standards, or
- Revisions to the TMDL are necessary to achieve applicable water quality standards.

10.3 BASELINE AND IMPAIRMENT STATUS MONITORING

In addition to effectiveness monitoring, watershed scale monitoring should be conducted to expand knowledge of existing conditions and to provide data that can be used during the TMDL implementation evaluation. Although DEQ is the lead agency for conducting impairment status monitoring, other agencies or entities may collect and provide compatible data. Wherever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent with DEQ methodology so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals. The information in this section provides general guidance for future impairment status monitoring.

10.3.1 Nutrients

Water quality sampling for nutrients were distributed spatially along an assessment unit in order to best delineate nutrient sources. Additional sampling will help refine nutrient source assessment and loading dynamics.

For those watershed groups and/or government agencies that monitor water quality, it is recommended that the same analytical procedures and reporting limits are used in order that water quality data may be compared to TMDL targets (**Table 10-1**). In addition, stream discharge should be measured at time of sampling. Field procedures for sample collection and discharge monitoring can be found in DEQ's Field Procedures Manual (Montana Department of Environmental Quality, 2012e) at: http://deq.mt.gov/wqinfo/qaprogram/sops.mcpx.

Table 10-1. DEQ Nutrient Monitoring Parameter Requirements

<table>
<tr><th>Parameter</th><th>Preferred Method</th><th>Alternate Method</th><th>Required Reporting Limit (µg/L)</th><th>Holding Time (days)</th><th>Bottle</th><th>Preservative</th></tr>
<tr><td>Total Persulfate Nitrogen</td><td>A4500-NC</td><td>A4500-N B</td><td>40</td><td rowspan="3">28</td><td rowspan="3">250mL HDPE</td><td>≤ 6°C (7d HT); Freeze (28d HT)</td></tr>
<tr><td>Total Phosphorus as P</td><td>EPA-365.1</td><td>A4500-P F</td><td>3</td><td rowspan="2">H2S04, ≤ 6°C or Freeze</td></tr>
<tr><td>Nitrate-Nitrite as N</td><td>EPA-353.2</td><td>A4500-N03 F</td><td>10</td></tr>
</table>

DEQ-required analytical methods and reporting limits may change in the future (e.g., become more stringent); consult with DEQ prior to monitoring in order to ensure you use the most current methods.
HT = holding time, HDPE = high-density polyethylene

It will be important to continually assess nutrient sources in a watershed with changing land uses and/or new Montana Pollutant Discharge Elimination System (MPDES) permitted discharges to surface waters. As discussed in **Sections 5.5.3.8** and **5.8**, there is uncertainty regarding the source of nutrients in the area around and upstream of Smith Lake. As discussed in **Section 5.8.2**, Ashley Creek and Spring Creek appear to be unique within the region with Ashley Creek having in-channel wetland complexes and lakes, and Spring Creek originating from a low-elevation spring as opposed to a mountainous headwater region. Additional monitoring should focus on defining the delivered nutrient load to upper Ashley Creek in the Smith Lake area. This includes synoptic high- and low-flow monitoring in Ashley Creek and its tributaries. This data, in conjunction with the LSPC model, could be used to better define natural background nutrient levels and evaluate the appropriateness of site-specific criteria. If site-specific criteria are developed for Ashley Creek and/or Spring Creek, TMDL targets could be adjusted accordingly.

Additional monitoring should also be conducted to better understand the linkage of Dissolved Oxygen (DO) to nutrients in Ashley Creek. Multi-day diel studies would help to define the extent of the DO problem and to define the magnitude of DO concentrations.

10.3.2 Sediment

Each of the sediment streams of interest was stratified into unique reaches based on physical characteristics and anthropogenic influence. The assessed sites represent only a percentage of the total number of stratified reaches. Sampling additional monitoring locations could provide additional data to assess existing conditions, and provide more specific information on a per stream basis as well as the TPA as a whole.

It is acknowledged that various agencies and entities have differing objectives, as well as time and resources available to achieve those objectives. However, when possible, it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:

- Riffle pebble count (using Wolman Pebble Count methodology and/or 49-point grid tosses)
- Residual pool depth measurements

Additional information will undoubtedly be useful and assist impairment status evaluations in the future and may include total suspended solids; identifying percentage of eroding banks, human sediment sources, and areas with a high background sediment load; macroinvertebrate studies; McNeil core sediment samples; and fish population surveys and redd counts.

An important part of impairment determination and adaptive management is determining when a stream has fully recovered from past management practices where recovery is still occurring from historical improvements in management but recent BMPs were not applied. Particularly within the Flathead National Forest, ongoing PIBO monitoring can provide critical insight into the extent of recovery from past practices via comparisons between reference and managed sites.

10.3.3 Temperature

Habitat and shade sampling for temperature was distributed spatially along an assessment unit in order to best delineate shade condition. The information used for the QUAL2K temperature model (**Appendix E**) can help inform restoration planning and serve as the baseline to compare against in any analyses that track changes in riparian vegetation and shade along Ashley Creek and the Whitefish River.

10.4 Source Assessment Refinement

In many cases, the level of detail provided by the source assessments only provides broad source categories need reduced pollutant loads. Strengthening source assessments for each of the pollutants may include more thorough sampling or field surveys of source categories and are described in this section. To refine source assessment of impaired waterbodies in the Flathead-Stillwater TPA, resources could be used to focus on identifying the most significant source areas within each impaired stream's watershed to determine where implementation will be most effective.

10.4.1 Nutrients

The following could help strengthen nutrients source assessment and may better characterize where restoration activities should be focused within a watershed:

- More data to characterize background conditions,

- Better understanding of septic contributions,
- Better understanding of nutrient concentrations and spatial variability in groundwater,
- Detailed understanding of fertilization practices within the watershed,
- Review of land management practices specific to subwatersheds of concern to determine where the greatest potential for improvement can occur for the major land use categories,
- Synoptic sampling at locations upstream, within, and downstream of all lakes and wetland complexes in upper Ashley Creek and all tributaries to this segment.

10.4.2 Sediment

Evaluation of the following could help strengthen sediment source assessment and may better characterize where restoration activities should be focused within a watershed:

- Eroding bank sources and sediment and habitat data collection (included potential stream type) in upper Ashley Creek,
- Eroding bank sources and sediment and habitat data collection in lower Ashley Creek,
- Eroding bank sources and sediment and habitat data collection (included potential stream type) in Haskill Creek,
- Eroding bank sources and sediment and habitat data collection in the upper and Star Meadow portions of Logan Creek,
- Eroding bank sources and sediment and habitat data collection in the Star Meadow portion of Sheppard Creek,
- Sources and loading rates of eroding banks on the Stillwater River from Logan Creek to Kalispell, and
- Sediment and habitat data collection in B and C stream-type reaches of the Stillwater River.

10.4.3 Temperature

The following could help strengthen temperature source assessment and may better characterize where restoration activities should be focused within a watershed:

- Further characterization of tributaries to the stream segments where TMDLs are provided within this document,
- Analysis of current irrigation practices in the Ashley Creek watershed including the quantity, temperature, and timing of water withdrawn and returned,
- Temperature monitoring of urban runoff, and
- As mentioned in **Section 7.6.3**, a detailed evaluation of the effects of the Kalispell wastewater treatment plant (WWTP) on temperatures in lower Ashley Creek.

11.0 STAKEHOLDER AND PUBLIC PARTICIPATION

Stakeholder and public involvement is a component of total maximum daily load (TMDL) planning supported by U.S. Environmental Protection Agency (EPA) guidelines and required by Montana state law (Montana Code Annotated (Montana Code Annotated (MCA) 75-5-703 and 75-5-704) which directs the Department of Environmental Quality (DEQ) to consult with a watershed advisory group and local conservation districts during the TMDL development process. Technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process for this project in the Flathead-Stillwater TMDL Planning Area, and for development of a water quality model for the entire Flathead Lake watershed.

11.1 PARTICIPANTS AND ROLES

This project was a collaborative effort between Montana DEQ and the U.S. EPA. Throughout completion of the Flathead-Stillwater nutrient, sediment, and temperature TMDLs, DEQ and EPA worked to keep stakeholders apprised of project status and solicited input from a TMDL watershed advisory group. A description of the participants and their roles in the development of the TMDLs in this document is contained below.

Montana Department of Environmental Quality
Montana state law (MCA 75-5-703) directs DEQ to develop all necessary TMDLs. DEQ provided resources toward completion of these TMDLs in terms of staff, funding, internal planning, data collection, technical assessments, document development, and stakeholder communication and coordination. DEQ has worked with other state and federal agencies to gather data and conduct technical assessments.

United States Environmental Protection Agency
EPA is the federal agency responsible for administering and coordinating requirements of the Clean Water Act (CWA). Section 303(d) of the CWA directs states to develop TMDLs (see **Section 1.1**), and EPA has developed guidance and programs to assist states in that regard. EPA has provided funding and technical assistance to Montana's overall TMDL program and is responsible for final TMDL approval. Project management support for the Flathead-Stillwater TMDLs was provided by the EPA Regional Office in Helena, MT, including funding; project planning; data collection, analysis, and hydrologic modeling; communicating and coordinating with the Flathead TMDL Watershed Advisory Group and other stakeholders; document development; and providing technical review.

Conservation Districts
DEQ and EPA consulted with both the Flathead and Lake Conservation Districts during development of the TMDLs in this document, which included opportunities to provide comment during the various stages of TMDL development and an opportunity for participation in the watershed advisory and technical advisory groups described below.

Flathead TMDL Watershed Advisory Group
The Flathead TMDL Watershed Advisory Group consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Flathead Lake watershed, and representatives of applicable interest groups. All members were solicited to participate and work with DEQ in an advisory capacity per Montana state law (75-5-703 and 704). DEQ, in collaboration with EPA,

requested participation from the interest groups defined in MCA 75-5-704 and included local city and county representatives; livestock-oriented and farming-oriented agriculture representatives; conservation groups; watershed groups; timber industry representatives; state and federal land management agencies, tribal representatives; and representatives of fishing, recreation, and tourism interests. The advisory group also included the Flathead Basin Commission, additional state and federal agency professionals, local action groups, and stakeholders with an interest in maintaining and improving water quality and riparian resources.

Advisory group involvement was voluntary and the level of involvement was at the discretion of the individual members. Members had the opportunity to provide comment and review of technical TMDL assessments and reports and to attend meetings organized by DEQ and EPA for the purpose of soliciting feedback on project planning. Typically, draft documents were released to the advisory group for review under a limited timeframe, and their comments were then compiled and evaluated. Final technical decisions regarding document modifications resided with DEQ.

Communication with advisory group members was conducted through a series of group meetings, conference calls, and e-mails. Draft documents, project status updates, and meeting agendas and presentations were made available both via e-mail and through DEQ's website for TMDL development projects (http://montanatmdlflathead.pbworks.com). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including a two-week review and comment period for a draft version of this TMDL document prior to the public comment period. Members' comments were incorporated into this version of the draft document. The draft TMDLs were also presented to and discussed with the group at a meeting in Kalispell, MT in September 2014.

Flathead Technical Advisory Group

A technical advisory group was created for this project to help develop the Flathead Lake watershed model. The group was composed of local resource professionals, hydrologists, ecologists, and scientists; Montana collegiate professors and research scientists; and local, state, and federal water quality modelers. The group met in a series of in-person meetings and conference calls from 2011 to 2014. Members were asked to provide input on the Flathead Lake watershed's characteristics and pollutant sources, review model inputs, and review model calibration results. Model technical reports, model results, and technical advisory group presentations were made available on DEQ's website for TMDL development projects (http://montanatmdlflathead.pbworks.com).

11.2 Response to Public Comments

Upon completion of a draft TMDL document, and prior to submittal to EPA, DEQ issues a press release and enters into a public comment period. During this timeframe, the draft TMDL document is made available for public comment, and DEQ addresses and responds to all formal public comments.

The formal public comment period for the "Flathead-Stillwater Planning Area Nutrient, Sediment, and Temperature TMDLs and Water Quality Improvement Plan" was initiated on October 10, 2014 and closed on November 12, 2014. Electronic copies of the draft document were made available at the Big Fork, Columbia Falls, Kalispell, Missoula, Polson, and Whitefish public libraries and at the State Library in Helena, MT. Electronic copies of the final document are also available at these libraries.

A public informational meeting was held in Kalispell, MT on October 30, 2014. DEQ and EPA provided an overview of the document, answered questions, and solicited public input and comment on the TMDLs in this document. The announcement of both the public comment period and the public meeting was distributed to the Flathead TMDL watershed and technical advisory groups, which included the Flathead and Lake conservation districts; the Statewide TMDL Advisory Group; and other identified interested parties via e-mail. Notice of the public comment period and public meeting was posted on the DEQ webpage and DEQ wiki for TMDL development projects, and also advertised in the Daily Interlake, Missoulian, Bigfork Eagle, Flathead Beacon, Hungry Horse News, and Whitefish Pilot newspapers.

Several public comments were received and responses are included in **Appendix F**. Original comment letters and submissions are held on file at DEQ and may be viewed upon request.

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