



Sheep Creek *E. coli* TMDL and Water Quality Improvement Plan



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Steve Bullock, Governor
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Sheep Creek
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ACRONYM LIST

Acronym	Definition
ARM	Administrative Rules of Montana
AUM	Animal Unit Month
BLM	Bureau of Land Management (U.S.)
BMP	Best Management Practice
CFR	Code of Federal Regulations (U.S.)
cfs	Cubic Feet Per Second
CFU	Colony Forming Unit
CSP	Conservation Stewardship Program
CWA	Clean Water Act
DEQ	Department of Environmental Quality (Montana)
DNRC	Department of Natural Resources & Conservation (Montana)
EPA	Environmental Protection Agency (U.S.)
EQIP	Environmental Quality Incentives Program
FWP	Fish, Wildlife & Parks (Montana)
GIS	Geographic Information System
ID	Identification
IR	Integrated Report (Montana’s Water Quality Integrated Report)
LA	Load Allocation
MCA	Montana Code Annotated
mL	Milliliter
MO	Management Objective
MOS	Margin of Safety
MPDES	Montana Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service (U.S.)
SMZ	Streamside Management Zone
TMDL	Total Maximum Daily Load
USFS	United States Forest Service
USGS	United States Geological Survey
WLA	Wasteload Allocation
WRP	Watershed Restoration Plan

DOCUMENT SUMMARY

This document presents an Escherichia coli (*E. coli*) total maximum daily load (TMDL) and a framework water quality improvement plan for Sheep Creek in the Sheep Creek TMDL Project Area (Project Area). **Figure 1-1** contains a map of the Project Area.

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 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 Project Area is located in central Montana, and is a primary watershed of the Little Belt Mountains. The Sheep Creek watershed (located in hydrologic unit 1003010304) drains a significant portion of the western Little Belts and is a principal tributary to the Smith River (hydrologic unit 10030103). The Project Area encompasses approximately 195 square miles and falls mainly within Meagher County. Although DEQ recognizes that there are other pollutant impairments in the Project Area such as the aluminum impairment of Sheep Creek and Moose Creek, this document only addresses *E. coli* as a cause of impairment in Sheep Creek.

***E. coli* TMDL**

Elevated concentrations of *E. coli* can put humans at risk for contracting water-borne illnesses. Therefore, elevated instream concentrations of *E. coli* and other pathogenic pollutants can lead to impairment of a waterbody's designated beneficial use. DEQ's water quality assessment methods for *E. coli* impairment are designed to evaluate the most sensitive use, thus ensuring protection of all designated uses. For streams in Montana, the most sensitive use assessed for *E. coli* is primary contact recreation. Water quality restoration goals for *E. coli* are established based on Montana's numeric water quality standards. DEQ believes that once these water quality goals are met, all uses currently identified as being affected by *E. coli* will be restored.

This document summarizes *E. coli* loads for all human caused nonpoint sources such as agricultural sources, malfunctioning septic systems and natural background conditions. It also summarizes state and federal programs that guide TMDL development, as well as potential funding resources for private land owners, to address sources of *E. coli* pollution.

Implementation of most water quality improvement measures described in this document is based on voluntary actions of watershed stakeholders. Ideally, 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 TMDL implementation and future monitoring. This plan includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals, and to help refine the strategy during its implementation.

1.0 PROJECT OVERVIEW

This document presents an analysis of water quality information and establishes an *Escherichia coli* (*E. coli*) total maximum daily load (TMDL) for Sheep Creek in the Sheep Creek TMDL Project Area (Project Area). An *E. coli* load is quantified for Sheep Creek accounting for all contributing sources of *E. coli* pollution. The Project Area is located in Meagher County in central Montana, and is a primary watershed of the Little Belt Mountains providing a significant portion of flow to its receiving water, the Smith River (hydrologic unit 10030103). **Figure 2-1** shows the boundaries of the Project Area, Sheep Creek, and its tributaries.

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. Sheep Creek and Moose Creek are the only impaired waters in the Sheep Creek TMDL Project Area from Montana's 2016 303(d) List.

Both Montana state law (Section 75-5-701 MCA of the Montana Water Quality Act) and section 303(d) of the federal CWA require the development of TMDLs 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 **Section 6.0** 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 TMDL ADDRESSED BY THIS DOCUMENT

TMDLs are completed for waterbody – pollutant combinations, and this document contains one *E. coli* TMDL for Sheep Creek. DEQ recognizes that there are other pollutant listings for this Project Area without completed TMDLs, however this document only address the *E. coli* cause of impairment in Sheep Creek. This is because DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or multiple pollutant types. Aluminum impairment causes in Sheep Creek and Moose Creek are not addressed in this document. There are no other impairment causes identified within the Sheep Creek watershed.

1.3 WHAT THIS DOCUMENT CONTAINS

This document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy. In addition to this introductory section, this document includes:

Section 2.0 Sheep Creek Project Area Description:

Describes the physical characteristics and social profile of the Sheep Creek TMDL Project Area.

Section 3.0 Montana Water Quality Standards

Discusses the water quality standards that apply to the Project Area.

Section 4.0 Defining TMDLs and Their Components

Defines the components of TMDLs and how each is developed.

Sections 5.0 *E. coli* TMDL Components:

Includes: (a) a discussion of Sheep Creek and the effect of *E. coli* on designated beneficial uses, (b) a description of the stream segment of concern (Sheep Creek), (c) the information sources and assessment methods used to evaluate stream health and *E. coli* source contributions, (d) *E. coli* water quality targets and existing water quality conditions, (e) an assessment of the sources of *E. coli* pollution and a description of *E. coli* loading from the identified sources, (f) the determined TMDL for Sheep Creek, (g) the allocations of the allowable *E. coli* load to the identified sources, (h) a description of how seasonality and margins of safety are incorporated into the TMDL, (i) an explanation of how uncertainty and adaptive management are integrated into the TMDL.

Section 6.0 Water Quality Improvement Plan and Monitoring Strategy:

Discusses water quality restoration objectives, a strategy to meet the identified objectives and TMDLs, and describes a water quality monitoring plan for evaluating the long-term effectiveness of the “Sheep Creek *E. coli* TMDL and Water Quality Improvement Plan.”

Section 7.0 Public Participation and Public Comment:

Describes other agencies and stakeholders 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 SHEEP CREEK PROJECT AREA DESCRIPTION

This section provides a general description of the physical, ecological, and social characteristics of the Sheep Creek TMDL Project Area (Project Area). This information thus provides context for the more detailed pollutant source assessment presented in **Section 5**.

It is important to note that the figures in this section show Sheep Creek and a number of its tributaries. Sheep Creek is the only waterbody that has been identified as being impaired for *E. coli*. The maps generated for this section show Moose Creek as impaired. While not impaired for *E. coli*, Moose Creek is impaired for aluminum and is identified as being impaired on the maps in this Section. Only the Sheep Creek impairment for *E. coli* will be addressed in this document and all of the maps in this section pertain solely to the Sheep Creek *E. coli* impairment.

2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Project Area. This includes location, topography, climate, hydrology, and geology and soils.

2.1.1 Location

The Sheep Creek TMDL Project Area encompasses the mainstem of Sheep Creek, which flows approximately 41 miles from its headwaters to its confluence with the Smith River (hydrologic accounting unit 10030103). The project area includes the watersheds of all tributaries draining directly to Sheep Creek. The Project Area encompasses approximately 195 square miles (124,500 acres) in central Montana and is located completely within Meagher County (**Figure 2-1**).

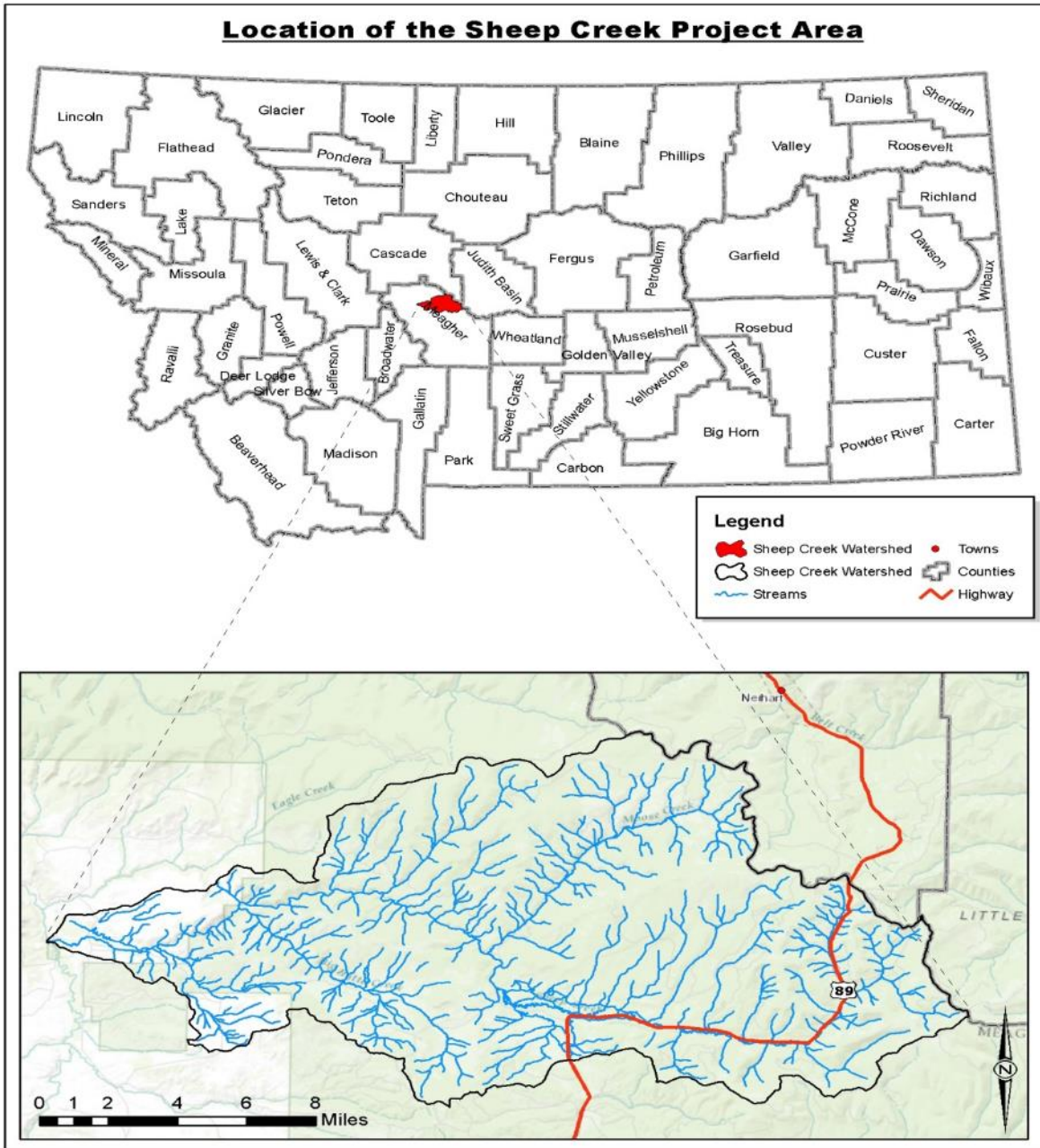


Figure 2-1. Location of the Sheep Creek TMDL Project Area

2.1.2 Topography

The topography is mapped below in **Figure 2-2**. Elevation ranges from 8,192 feet in the headwaters at the top of Porphyry peak to 4,376 feet at the confluence with the Smith River.

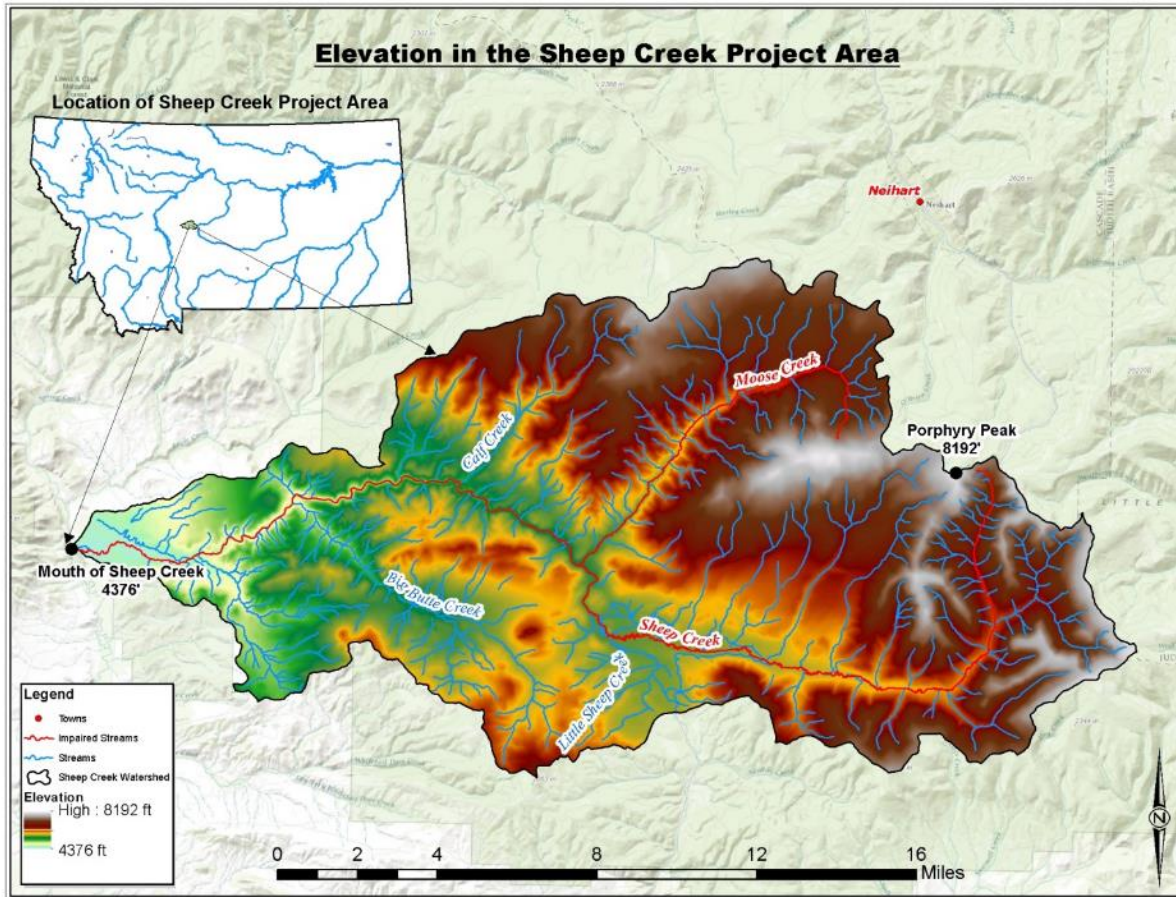


Figure 2-2. Topography of the Sheep Creek TMDL Project Area

2.1.3 Climate

Average precipitation along the Sheep Creek corridor ranges from approximately 11.4 inches per year near the confluence with the Smith River to approximately 28.6 inches per year at Kings Hill near the northeastern edge of the watershed, according to climate summaries provided by the Western Regional Climate Center (<http://www.wrcc.dri.edu/summary/Climsmidwmt.html>). May and June are consistently the wettest months of the year and winter precipitation is dominated by snowfall. Average annual precipitation is mapped below in **Figure 2-3**. Precipitation is highest in the mountains to the north and west of Sheep Creek, along the borders of Cascade, Judith Basin, and Meagher counties.

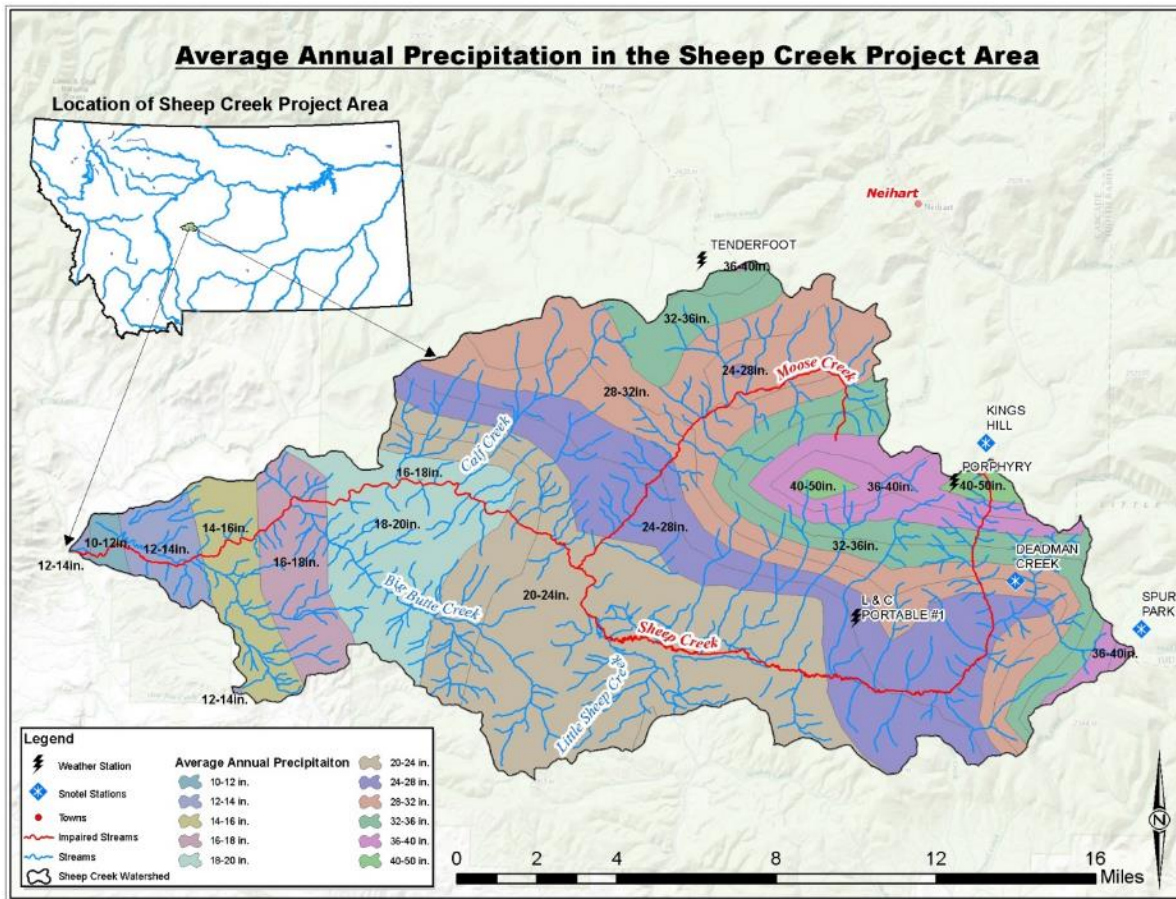


Figure 2-3. Average Annual Precipitation in the Sheep Creek TMDL Project Area

The climate in Sheep Creek tends to be fairly consistent throughout the watershed. This is evident by the average minimum and maximum air temperatures in the headwaters and close to the mouth. Average maximum temperatures in the headwaters and at the mouth are 45.7°C and 51.9°C, respectively. Average minimum temperatures in the headwaters and at the mouth are 23.5°C and 27.0°C, respectively. The Sheep Creek watershed is a typical mid-elevation intermountain basin characterized by cold winters and mild summers, with lower elevations seeing slightly warmer and drier summers than the headwaters that tend to stay cooler and more humid.

2.1.4 Hydrology

The drainage in the Project Area is characterized by the mainstem of Sheep Creek and several smaller tributaries, mapped below in **Figure 2-4**. The watershed is broken into six subwatersheds: Sheep Creek Headwaters, Upper Sheep Creek, Moose Creek, Middle Sheep Creek, Big Butte Creek and Lower Sheep Creek. The watersheds of major tributaries (Moose Creek, Calf Creek, Big Butte Creek and Little Sheep Creek) that join Sheep Creek are important hydrologically, but are not considered impaired for *E. coli* and are not covered in this document.

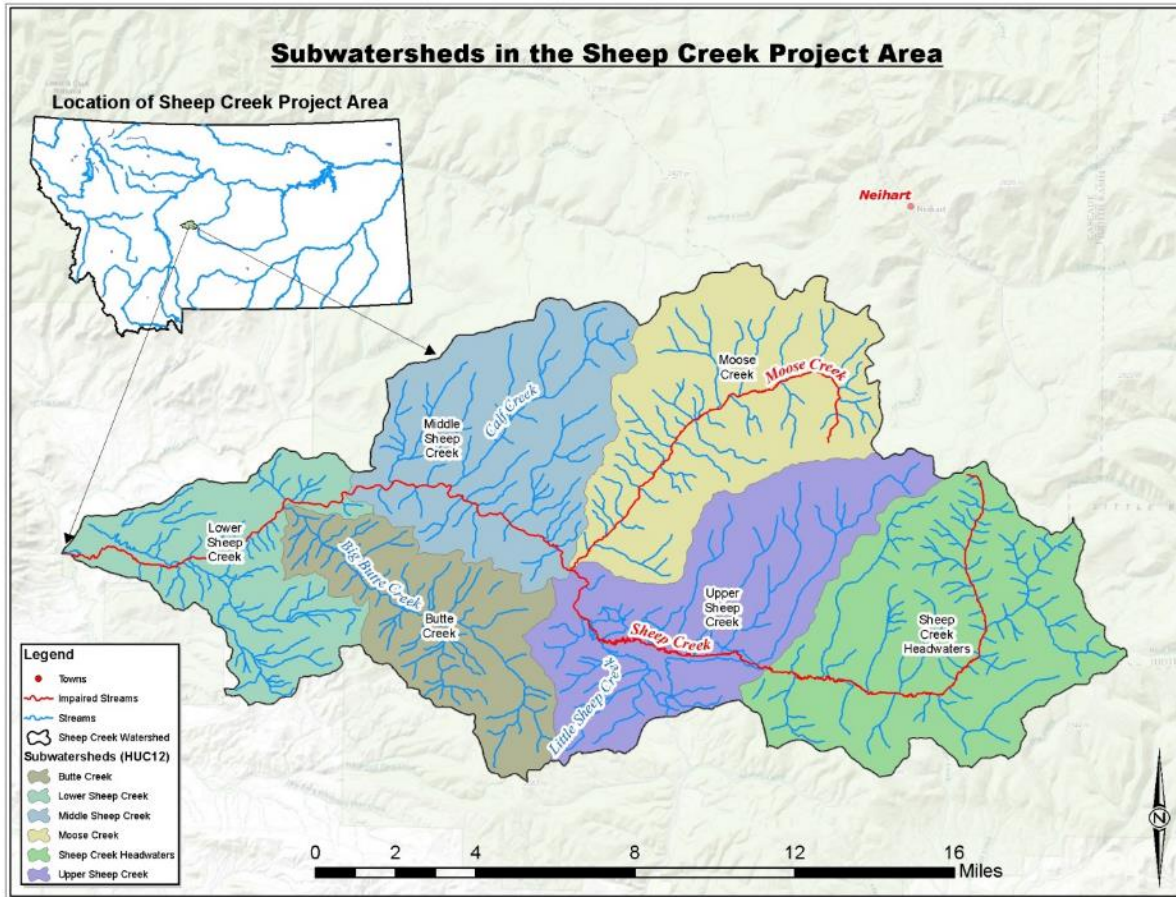


Figure 2-4. Hydrography of the Sheep Creek TMDL Project Area

None of the tributary streams are monitored by U.S. Geological Survey (USGS) gaging stations. Their streamflow generally follows a hydrograph typical for the region, highest in May and June; the months with the greatest amount of precipitation and snowmelt runoff. Streamflow begins to decline in late June or early July, reaching minimum flow levels in September. Streamflow begins to rebound in October and November when fall storms supplement the base-flow levels.

2.1.5 Geology and Soils

The Sheep Creek TMDL Project Area lies on the eastern edge of the Little Belt Mountains of central Montana. The Little Belts were formed in the Cretaceous period as an anticline cored by basement rocks (Baker and others, 1991). Laramide (Eocene) felsic igneous intrusions have resulted in numerous igneous rock intrusions such as sills, dikes, and diatremes. Some of the domal structures are capped by fairly flat-lying sedimentary rocks, primarily the Belt Series’ basal Neihart quartzite but also Cambrian to Cretaceous sedimentary rocks. A portion of the Sheep Creek TMDL Project Area also lies within the sediments from the Precambrian Belt Sea; sediments were deposited in a trough known as the Helena embayment. The Project Area geology is mapped below in **Figure 2-5**.

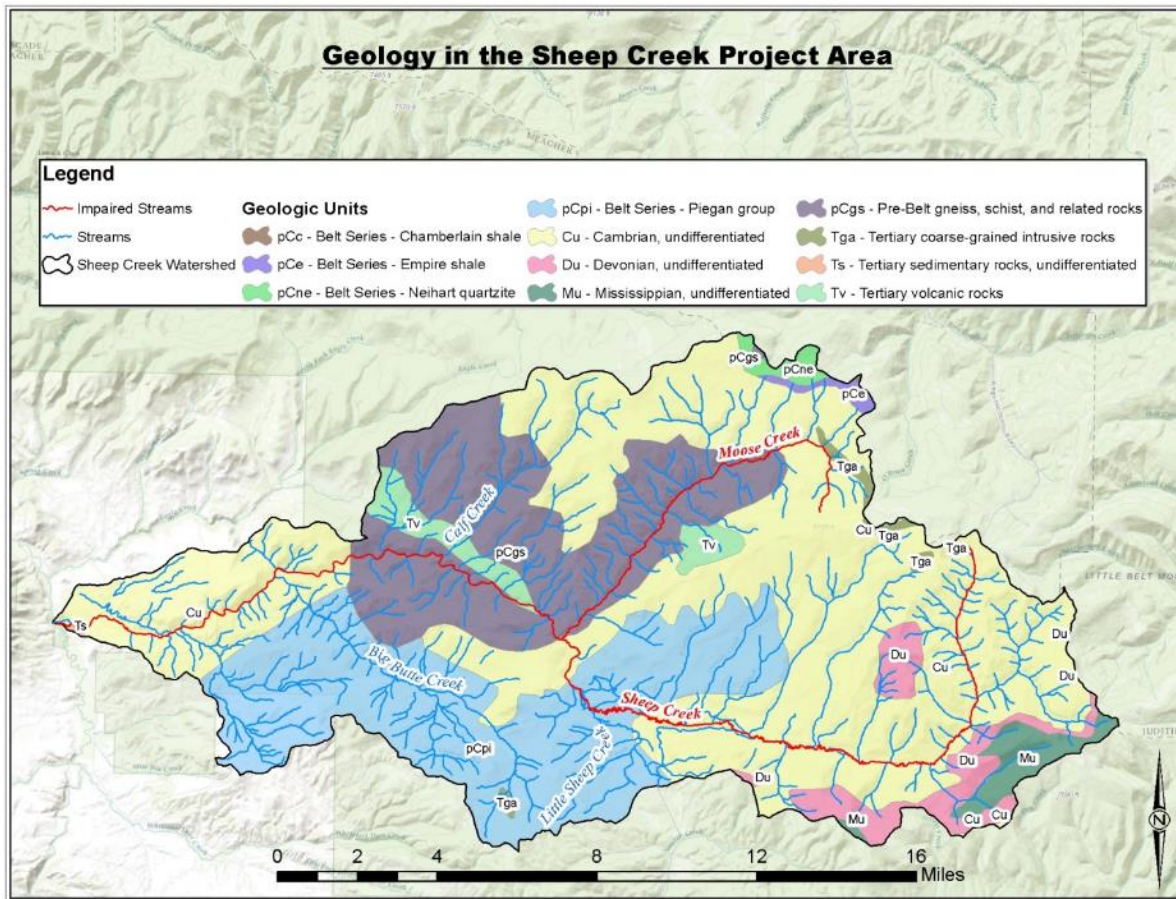


Figure 2-5. Generalized Geology of the Sheep Creek TMDL Project Area

Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier and Smith, 1978). K-factor values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Susceptibility to erosion is mapped below in **Figure 2-6**, with soil units assigned to the following ranges: low (0.0-0.2), moderate-low (0.2-0.29) and moderate-high (0.3-0.4). Values greater than 0.4 are considered highly susceptible to erosion. Despite the steep and rugged topography, the majority of the Project Area is mapped with soils rated as having low and moderate-low erodibility. Soils mapped with moderate-high erodibility are largely localized on the southern portion of the Sheep Creek watershed. No values greater than 0.4 are mapped in the Project Area.

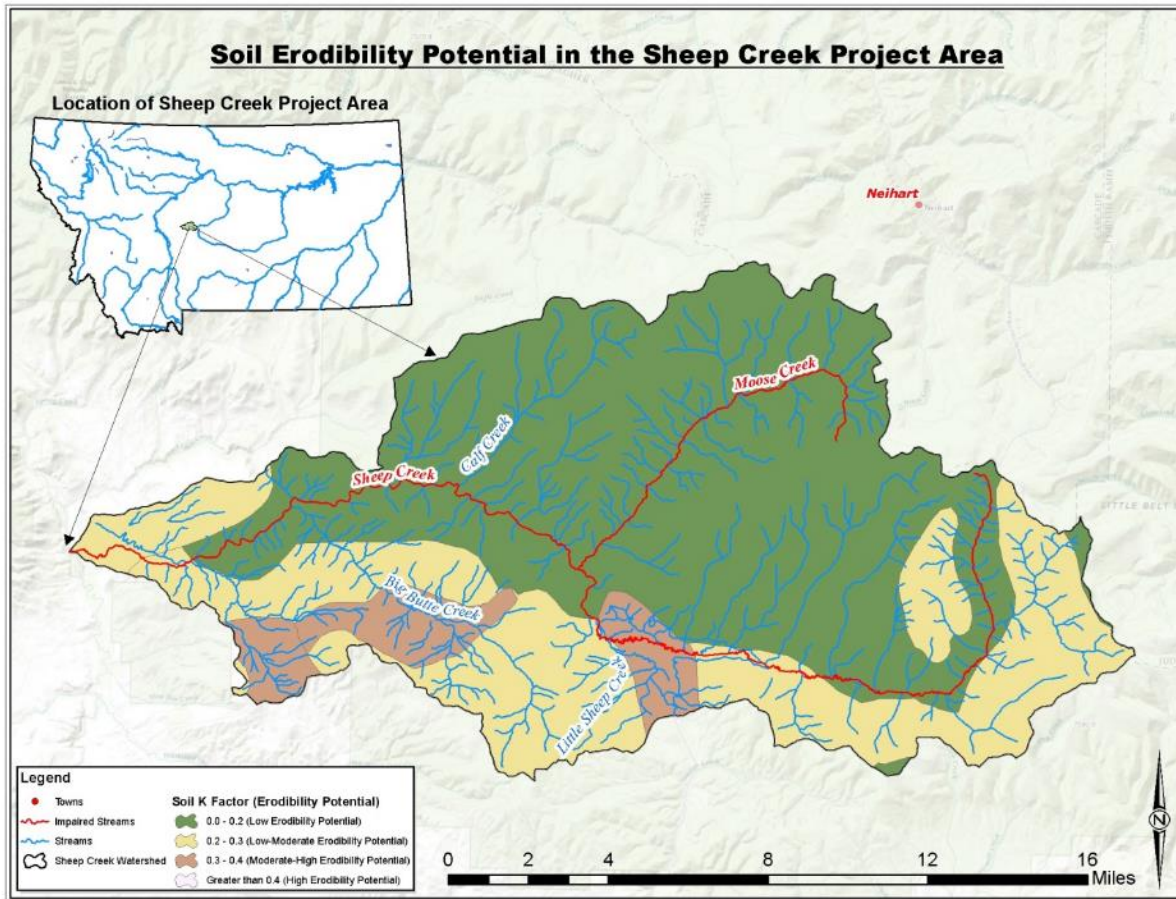


Figure 2-6. Soil Erodibility of the Sheep Creek TMDL Project Area

2.2 ECOLOGICAL PROFILE

This section describes the ecology of the Sheep Creek TMDL Project Area, including ecoregions, land cover, fire history, and species of concern.

2.2.1 Ecoregions

The U.S. Environmental Protection Agency (EPA) defines ecoregions as areas where ecosystems (the type, quality, and quantity of environmental resources) are generally similar. Ecoregions serve as a spatial framework for research, assessment, management, and monitoring of ecosystems and their components. The Sheep Creek TMDL Project Area includes portions of both the Middle Rockies (17q) and the Northern Glaciated Plains Ecoregions (43t) level four ecoregions (Figure 2-7).

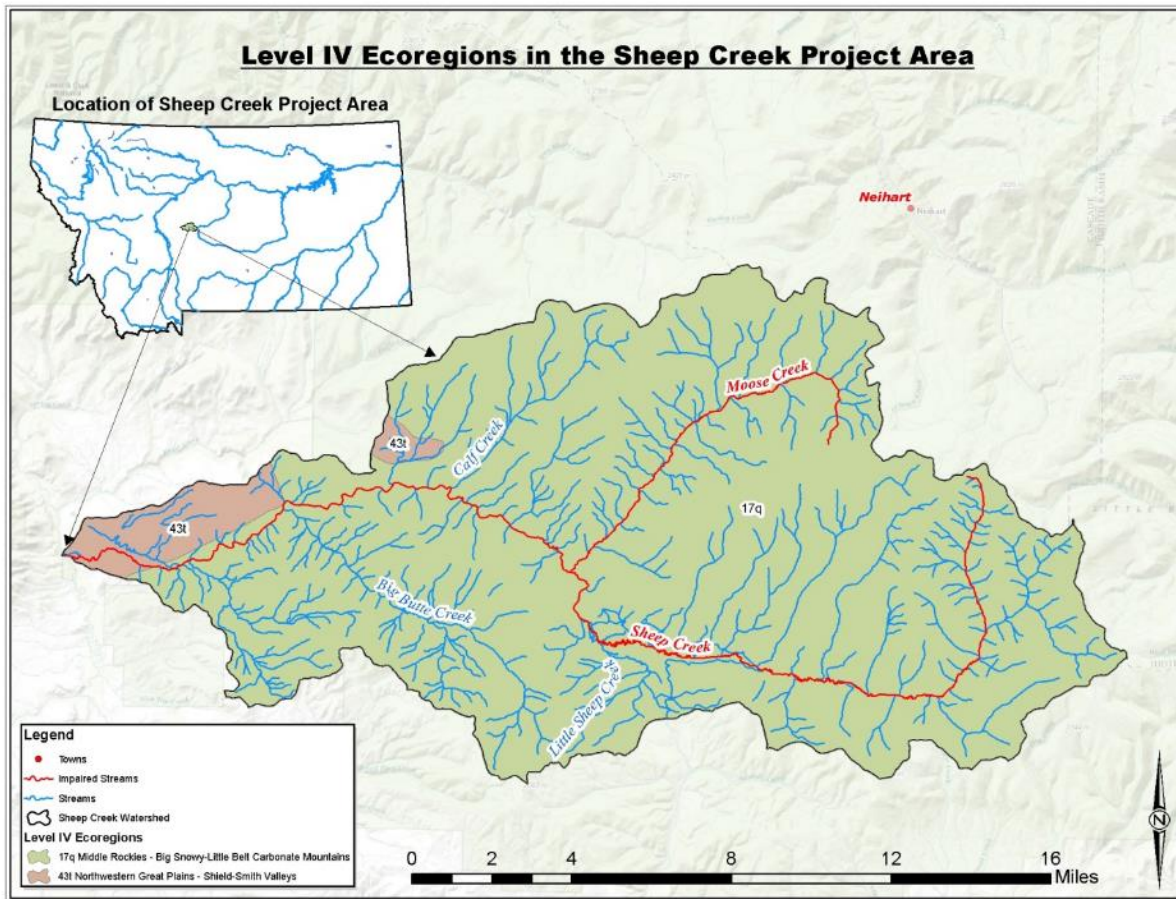


Figure 2-7 Level IV Ecoregions in the Sheep Creek TMDL Project Area

2.2.2 Land Cover

Land cover is mapped below in **Figure 2-8**, based on the USGS National Land Cover Dataset (Homer et al., 2004). As shown in this figure, the Project Area is dominated by evergreen forest (65.4 %) in the uplands, and herbaceous and shrub/scrub cover in the lowlands (25.5 % and 6.6 %, respectively). Hay/pasture and cultivated crops are localized around the middle sections of Sheep Creek, as is most of the area around the mouth. Big Butte Creek and the headwaters of Moose Creek also have a significant area in upland grasses and shrub.

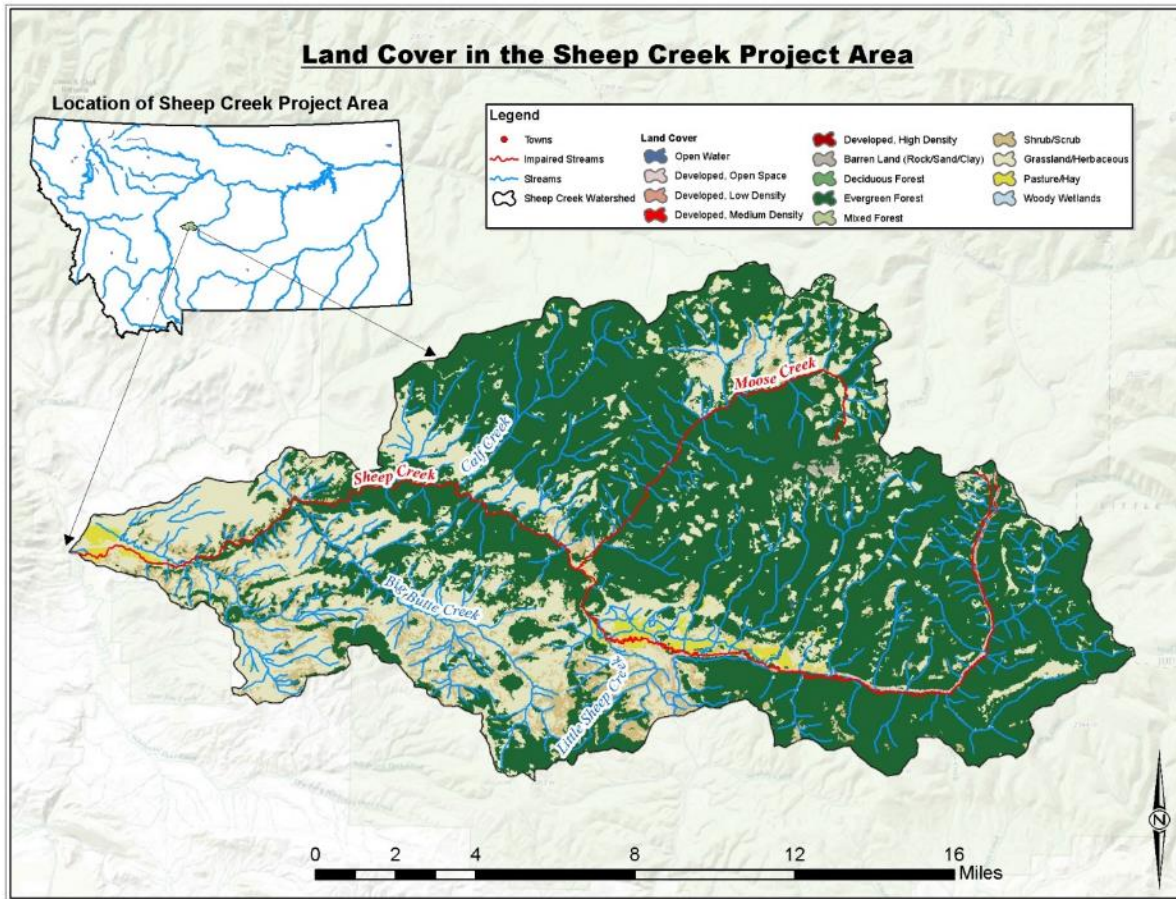


Figure 2-8. Land Cover in the Sheep Creek TMDL Project Area

2.2.3 Fire History

Recent fire history (1985-2013) is mapped below in **Figure 2-8**. The largest fire in the Sheep Creek Project Area in recent history is the coyote fire (1996) which burned approximately 3,425 acres. Other significant fires include the 2011 Elk Park fire that burned approximately 600 acres and the 2003 Iron Butte fire which burned approximately 152 acres. There have also been a number of smaller fires since 2000 that have burned 35 acres or less; these include the McGuire Ranch, Sheep Creek, Allen Park and Moose Mountain fires.

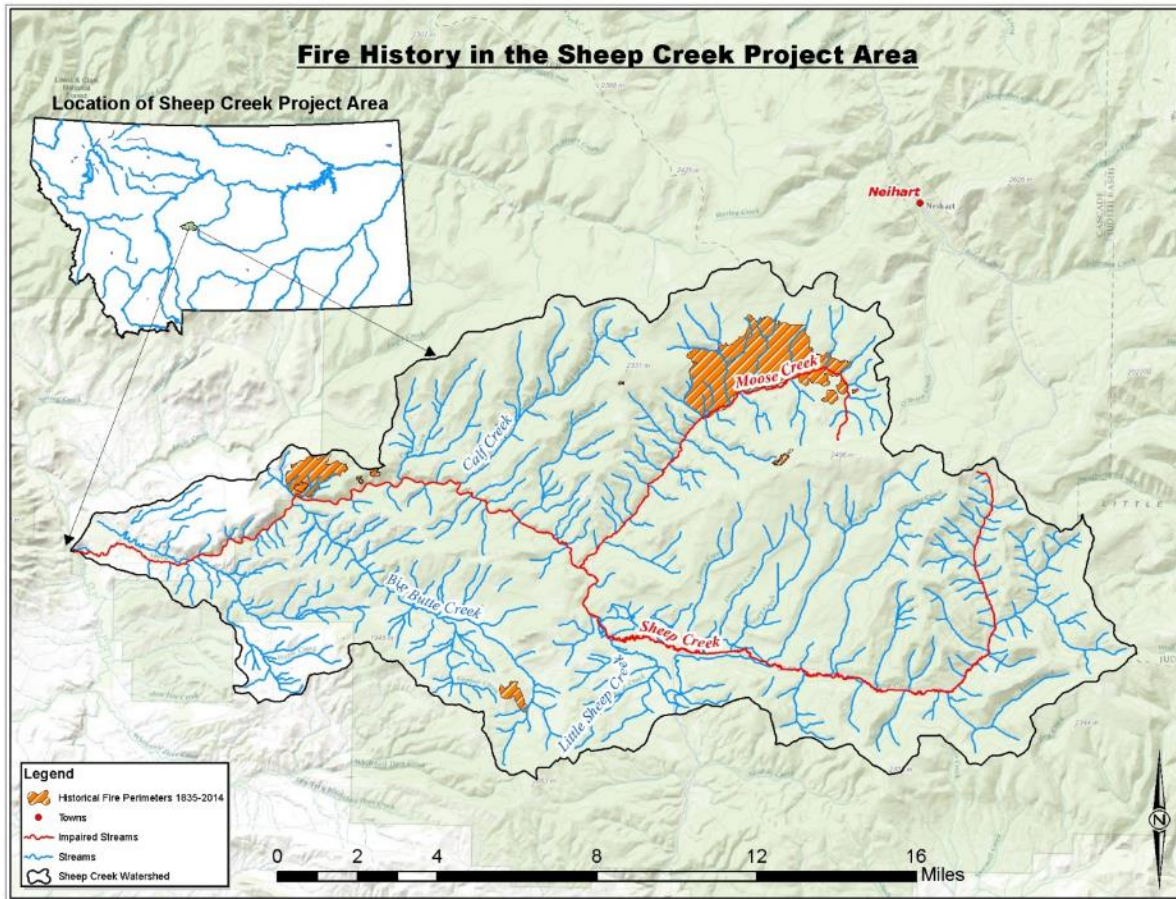


Figure 2-9. Fire History of the Sheep Creek TMDL Project Area

2.2.4 Species of Concern

The Project Area provides habitat for a number of species of concern as noted by the Montana Department of Fish, Wildlife and Parks (FWP). The most noteworthy species is the Westslope Cutthroat Trout. Westslope Cutthroat exist in a number of tributaries to Sheep Creek and in the Headwaters of Sheep Creek The mapped distribution of this and other species of concern is shown below in **Figure 2-10**, based on data provided by FWP (Multi-Resolution Land Characteristics Consortium, 2006).

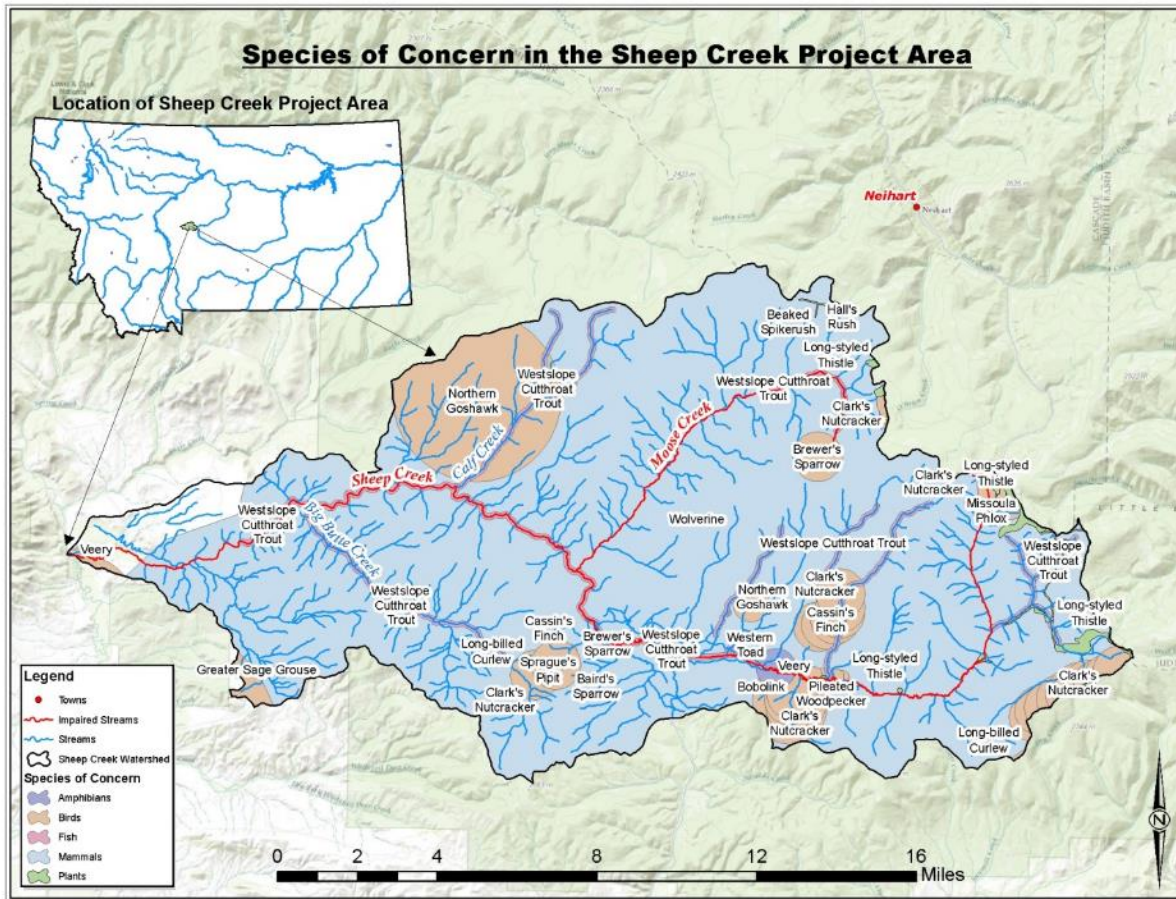


Figure 2-10. Species of Concern Distribution in the Sheep Creek TMDL Project Area

2.3 SOCIAL PROFILE

The following section describes the social characteristics of the Sheep Creek TMDL Project Area. This includes population distribution, land ownership, and land management.

2.3.1 Population Density

The Sheep Creek TMDL Project Area does not contain any significant population centers. Therefore, there are no census geometries that exactly correspond to the Project Area. The closest major population center for the area is the town of White Sulphur Springs, MT, which is located outside of the Sheep Creek TMDL Project Area. The large area of U.S. Forest Service (USFS) land that comprises the majority of the watershed is relatively uninhabited. That being said, there are isolated inholdings. Population density is mapped below in **Figure 2-11**.

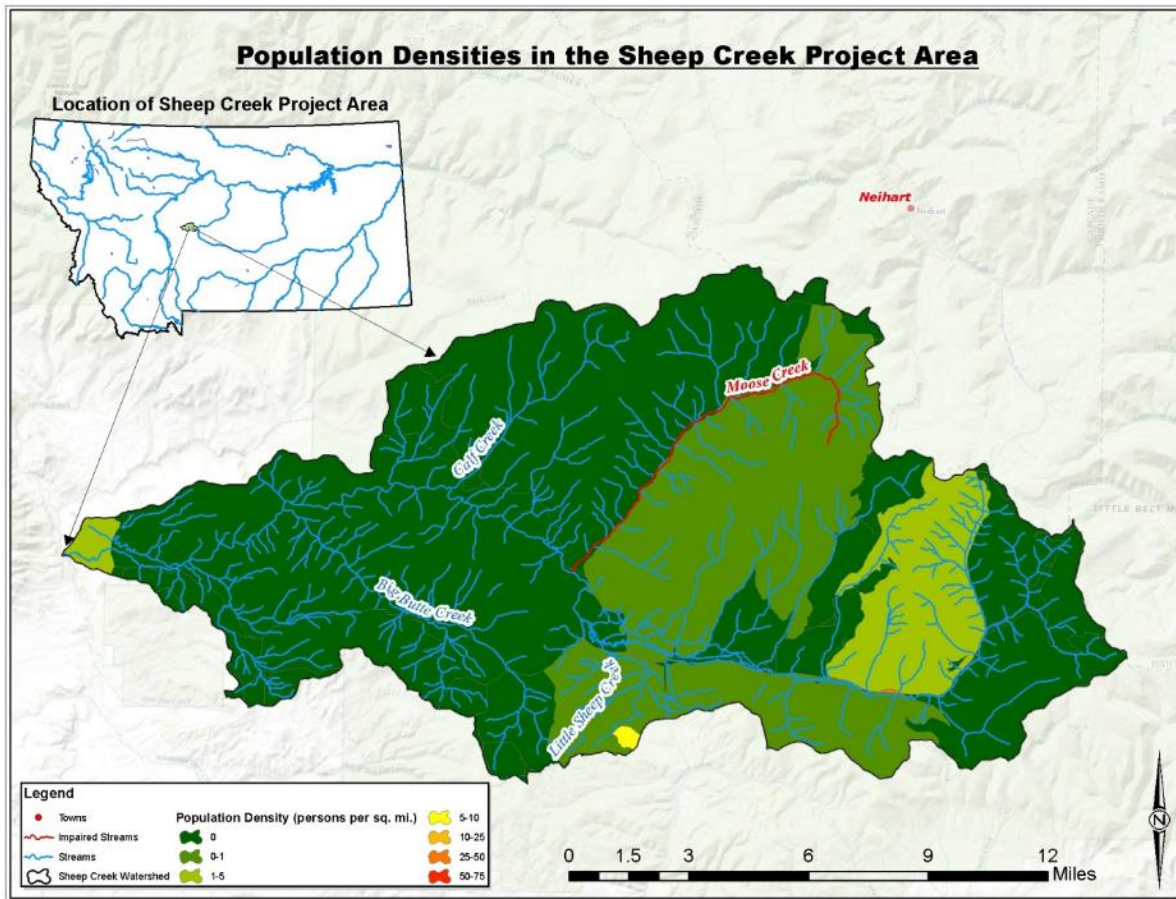


Figure 2-11. Population Density of the Sheep Creek TMDL Project Area

2.3.2 Land Management

Federal lands managed by the USFS dominate the Project Area, and are found mostly in the upland areas. Federal Forest Service land comprises approximately 69% of the Project Area. Private lands dominate the river corridor, valley bottoms, and the area close to the mouth, comprising approximately 30% of the Project Area. The remaining few fractions of a percent are accounted for by State of Montana and Bureau of Land Management property. Land management is mapped below in **Figure 2-12**.

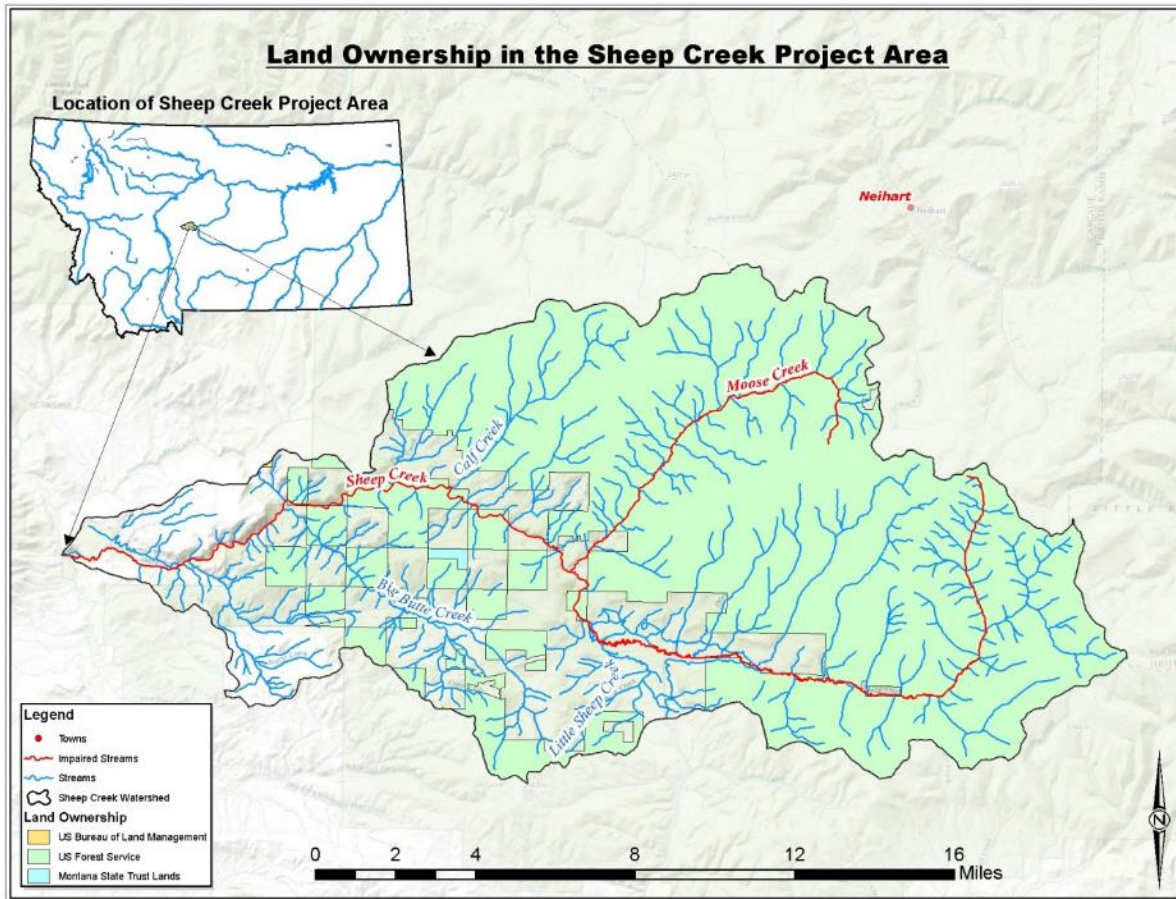


Figure 2-12. Land Management of the Sheep Creek TMDL Project Area

2.3.3 Agricultural Land Use

Agricultural land use in the Sheep Creek TMDL Project Area consists mostly of grazing on public and private land and some hay production. Grazing on public land is concentrated in the upland areas around Sheep Creek. There are small portions of land in the valley bottoms that are used as pasture or for hay production. U.S. Forest Service grazing allotments and major forms of agricultural land use are mapped below in **Figure 2-13**.

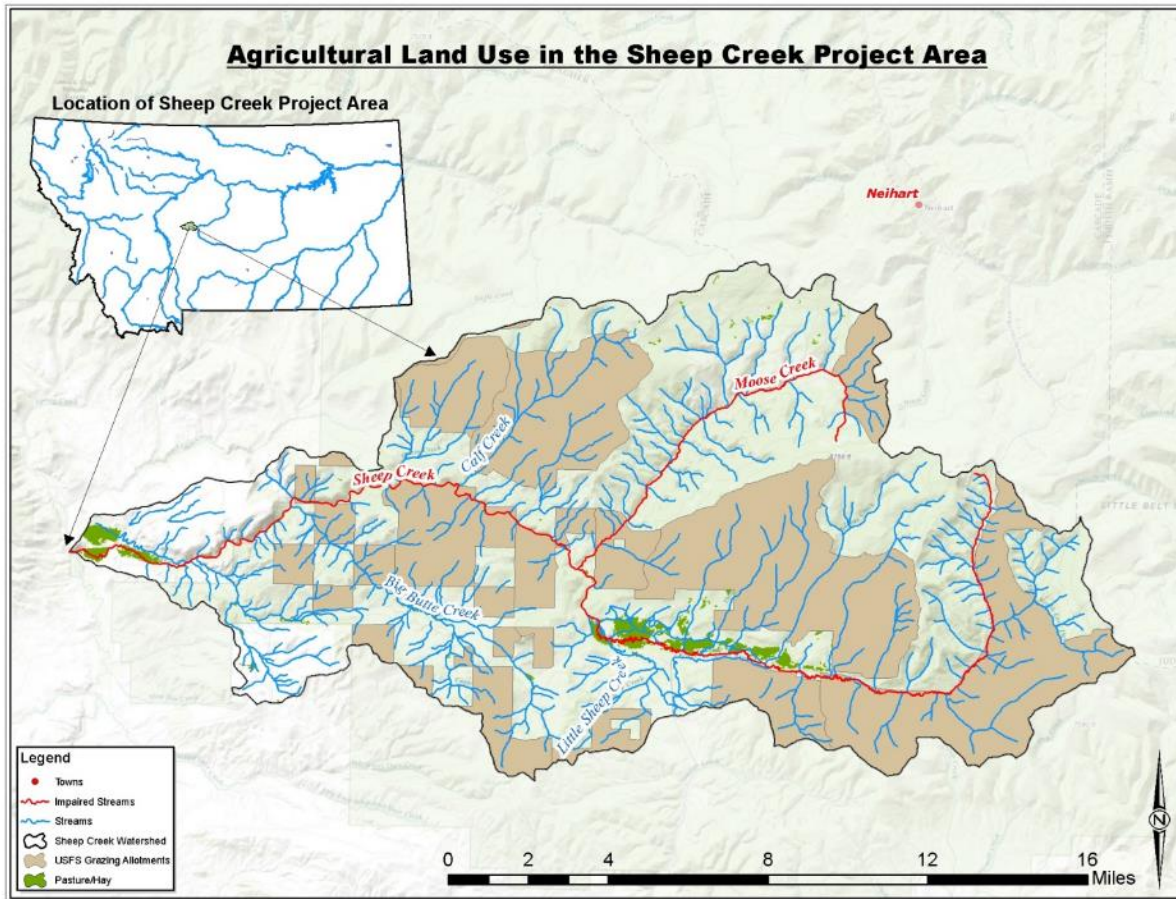


Figure 2-13 Agricultural use and Grazing Allotments in the Sheep Creek TMDL Project Area

2.3.4 Road Networks

There are extensive road networks both in the valley bottoms and in the timbered uplands (**Figure 2-14**). The main transportation corridor is the paved State Highway 89 that crosses the Project Area. However, there is also a well-established network of unpaved county and forest roads. Many of the forest roads were constructed for timber harvesting and may have been decommissioned. The ongoing USFS vegetation project has the potential for temporary road construction, reconstruction and associated maintenance.

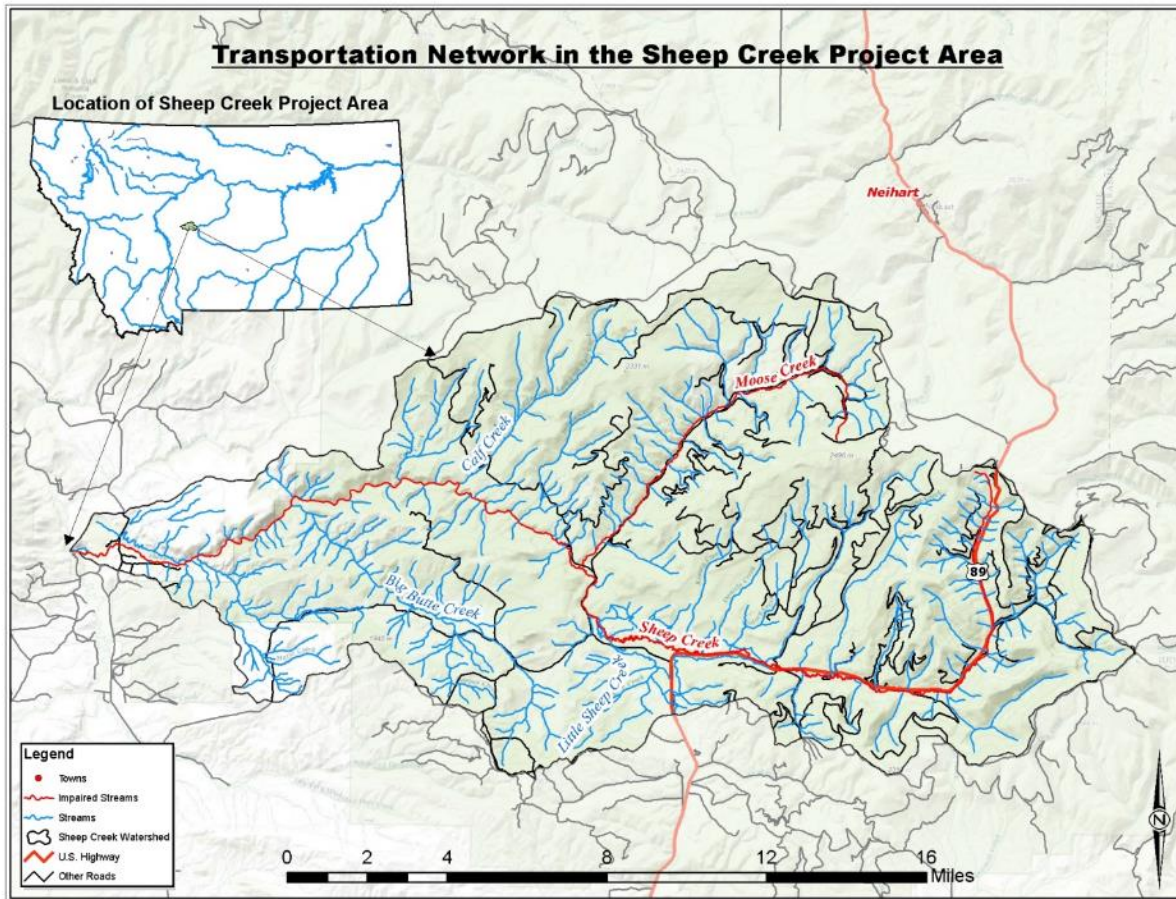


Figure 2-14. Road Networks in the Sheep Creek TMDL Project Area

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 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

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 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.

3.1 STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Stream classification is the assignment (designation) of a single or group of uses to a waterbody based on the potential of the waterbody to support those uses. Designated uses, or beneficial uses, are simple narrative descriptions of water quality expectations or water quality goals. All Montana waters are classified for multiple uses. Sheep Creek is classified as B-1, which specifies that the water must be maintained suitable for all of the following uses (ARM (17.30.623(1)):

- 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

While a particular waterbody might not actually be used for a designated use (e.g., drinking water supply), its water quality still must be maintained suitable for that designated use. DEQ's water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant, thus ensuring protection of all designated uses (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011). For Sheep Creek, the most sensitive use assessed for *Escherichia coli* (*E. coli*) is primary contact recreation. DEQ determined that Sheep Creek, assessment unit MT41J002_030, does not meet the water quality standard for *E. coli*.

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., *E. coli*, metals, nutrients, 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 for aquatic life include chronic and acute values. Chronic aquatic life standards prevent long-term, low level exposure to pollutants. Acute aquatic life standards protect from short-term exposure to pollutants. 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.

E. coli has numeric standards to protect human health relative to primary and secondary contact recreation. For Sheep Creek, these numeric standards (within ARM 17.30.620(2)) are applied as the primary targets for *E. coli* impairment determinations and subsequent TMDL development. These targets address the allowable *E. coli* concentrations found in Sheep Creek. **Section 5.4** defines the water quality criteria for the Sheep Creek TMDL Project Area.

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. The ultimate goal of the TMDL is to identify an approach to achieve and maintain water quality standards.

Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are often linked to community wastewater treatment or industrial facilities with discernible, confined and discrete conveyances, such as pipes or ditches from which pollutants are being, or may be, discharged to a waterbody. Some sources such as return flows from irrigated agriculture are not included in this definition. Pollutant loading sources that do not meet the definition of a point source are considered nonpoint sources. Nonpoint sources are associated with diffuse pollutant loading to a waterbody and are often linked to runoff from agricultural, urban, or forestry activities, as well as streambank erosion and groundwater seepage that can occur from these activities. Natural background loading and atmospheric deposition are both considered types of nonpoint sources.

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: $TMDL = \Sigma WLA + \Sigma LA + MOS$, where:

- ΣWLA is the sum of the wasteload allocation(s) (point sources)
- ΣLA is the sum of the load allocation(s) (nonpoint sources)
- MOS = margin of safety

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation as shown. Alternatively, the MOS can be implicit in the TMDL, meaning that the explicit MOS in the above equation is equal to zero and can therefore be removed from the above equation. 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.

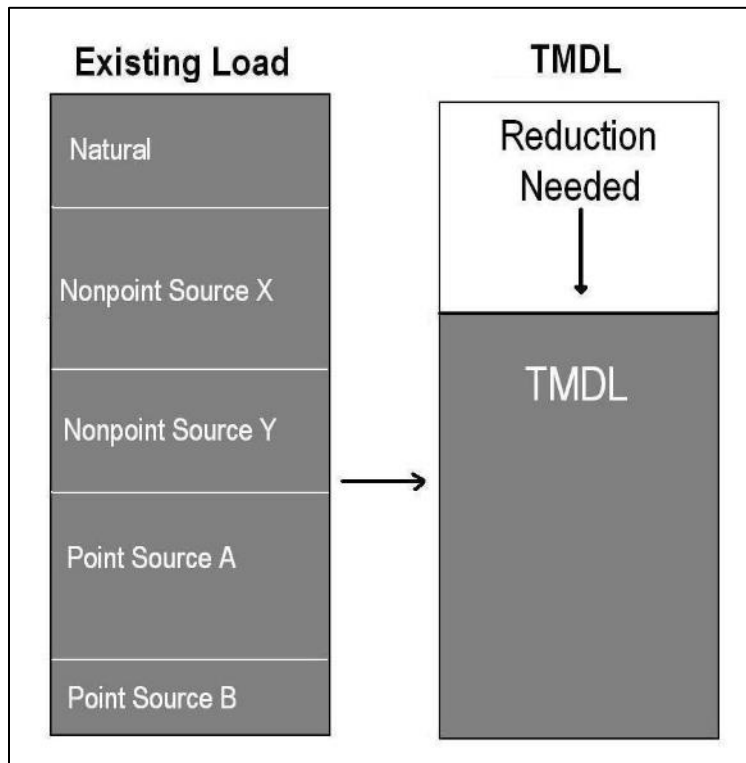


Figure 4-1: Schematic Example of TMDL Development

4.1 DEVELOPING WATER QUALITY TARGETS

For each pollutant, TMDL water quality targets are based on the applicable numeric water quality standard and/or a translation of a narrative water quality standard(s). 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

The goal of TMDL source assessment is to identify all significant pollutant loading sources, including natural background loading, and quantify them 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 includes 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.

Source assessments are conducted on a watershed scale and can vary in level of detail resulting in reasonably accurate estimates or gross allotments, depending on the data availability and the

techniques used for predicting the loading (Title 40 Code of Federal Regulations (CFR) 130.2(l)). Montana TMDL development often includes a combination of approaches, depending on the level of desired certainty for setting allocations and guiding implementation activities.

Nonpoint sources are quantified by source categories (e.g., septic systems) and/or by land uses (e.g., agricultural land use). These source categories and land uses can be divided further by ownership, such as federal, state, or private. Alternatively, most, or all, nonpoint pollutant sources in a sub-watershed or source area can be combined for quantification and TMDL load allocation purposes.

Generally speaking, additional detail is required for assessing pollutant loading from surface water point sources permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. This is because the allowable loading within each MPDES surface water permit conditions must be consistent with the assumptions and requirements of the available WLA developed within the TMDL (40 CFR 122.44). There are no MPDES permitted point sources of *E.coli* pollution in the Sheep Creek watershed.

4.3 ESTABLISHING THE TOTAL ALLOWABLE LOAD

TMDL development requires a determination of the total allowable load over the appropriate time period necessary to comply with the applicable water quality standard(s). Per EPA requirements (40 CFR 130.2), “TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.” Where 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 results in a loading rate per unit time TMDL expression such as pounds per day or colony forming units (CFU) in the case of *E. coli*. This same approach can be applied when a numeric target is developed to interpret a narrative standard.

4.4 DETERMINING POLLUTANT ALLOCATIONS

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources so that the sum of the allocations is equal to the TMDL, consistent with the above TMDL equation. Where a TMDL is variable based on streamflow, nonpoint source load allocations are often variable based on this same receiving streamflow. On the other hand, point source wasteload allocations are often based on conservative streamflow and discharge conditions and/or can be variable based on the point source discharge flow and a discharge concentration limit.

Figure 4-2 illustrates how, for a given streamflow condition, the TMDL is 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. In Montana, nonpoint source allocations are sometimes grouped into one composite allocation. This composite load allocation approach is applied in cases where data is limited, there is significant source assessment uncertainty, and/or DEQ has determined that the best approach is to provide stakeholders with flexibility in addressing sources, allowing them to choose where to focus on improved land management practices and other remediation or restoration efforts.

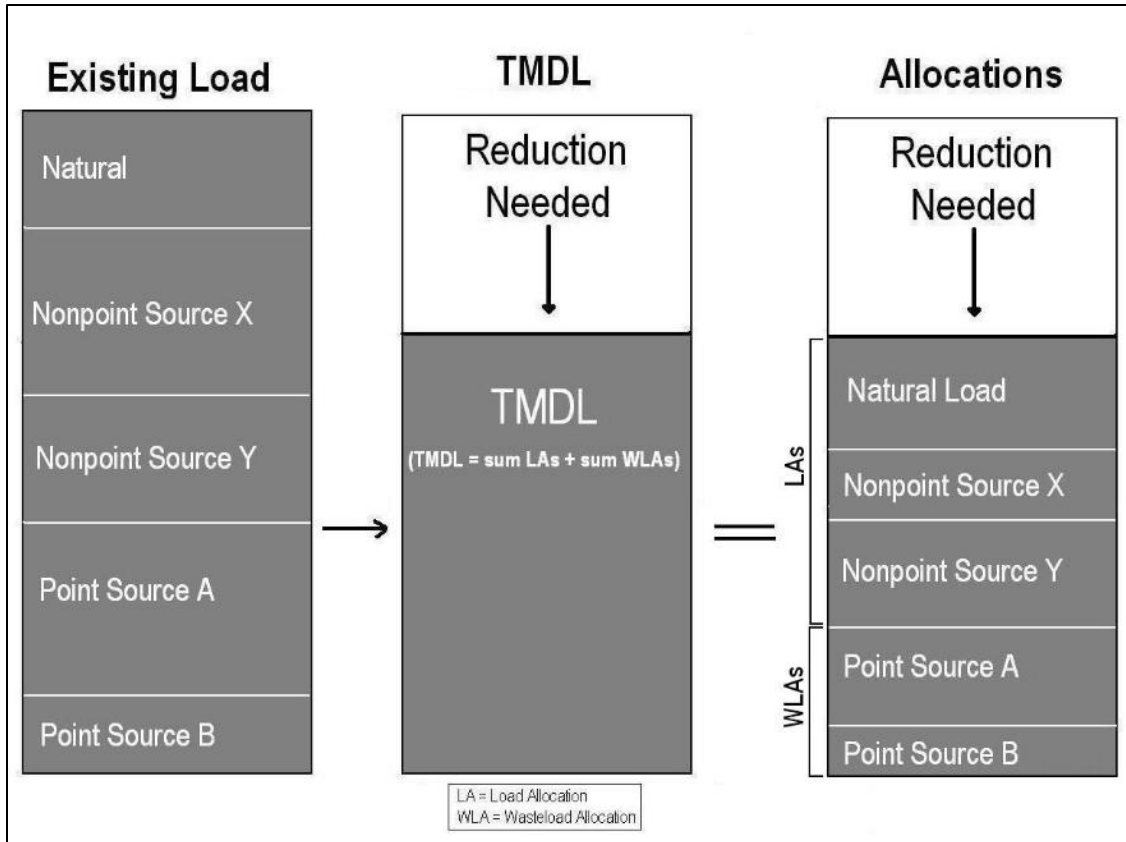


Figure 4-2: Schematic Diagram of a TMDL and its Allocations

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. In the case of this document, there are no WLAs to point sources and only LAs to nonpoint sources will be developed.

4.5 IMPLEMENTING TMDL ALLOCATIONS

The Clean Water Act (CWA) and Montana state law (Section 75-5-703, MCA 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 6.0** provides a water quality improvement plan that discusses restoration strategies and provides recommended best management practices for grazing management, septic maintenance, etc.

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 6.0**). This includes a monitoring strategy and an implementation review that is required by Montana statute (Section 75-5-703, MCA 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 ESCHERICHIA COLI (*E. COLI*) TMDL COMPONENTS

This portion of the document focuses on *E. coli* as a cause of water quality impairment in the Sheep Creek Project Area. It describes: (1) how excess *E. coli* impairs beneficial uses, (2) the affected stream segment, (3) the currently available data pertaining to *E. coli* impairment in the watershed, (4) the identification of *E. coli* targets and the comparison of those targets to the affected stream segment, (5) the sources of *E. coli* based on recent studies, (6) the proposed *E. coli* TMDL and its rationale, (7) the allocations to significant sources, and (8) the seasonality and margin of safety for the TMDL.

5.1 EFFECTS OF EXCESS *E. COLI* ON BENEFICIAL USES

An elevated concentration of *E. coli* can put humans at risk for contracting water-borne illnesses. Therefore, elevated instream concentrations of *E. coli* and other pathogenic pollutants can lead to impairment of a waterbody's beneficial use for primary contact recreation. *E. coli* is a nonpathogenic indicator bacterium that is usually associated with pathogens transmitted by fecal contamination. *E. coli* correlates highly with the presence of fecal contamination (United States Environmental Protection Agency, 2001). While its presence does not always prove or disprove the presence of pathogenic bacteria, viruses, or protozoans, it is an indicator that other pathogenic bacteria are likely present. EPA recommends the use of *E. coli* as the preferred indicator organism for pathogenic bacteria forms due to its strong correlation with swimming-related illness.

5.2 STREAM SEGMENT OF CONCERN

Sheep Creek (Assessment Unit ID MT41J002_030), from its headwater to its mouth at the Smith River, is the only stream segment of concern in the Project Area listed as impaired for *E. coli*. It was listed as impaired in the 2016 Integrated Report (IR). Sheep Creek flows approximately 36.6 miles from its headwaters in the Little Belt Mountains to its confluence with the Smith River **Figure 5-1**. Sheep Creek was first listed as impaired for fecal coliform on the 2000 303(d) List of impaired waterbodies. In the 2012 IR, the fecal coliform impairment listing was changed to *E. coli* due to the adoption of the 2012 *E. coli* standard. In 2015 water quality data were collected on Sheep Creek to reassess the *E. coli* impairment listing for the 2016 IR.

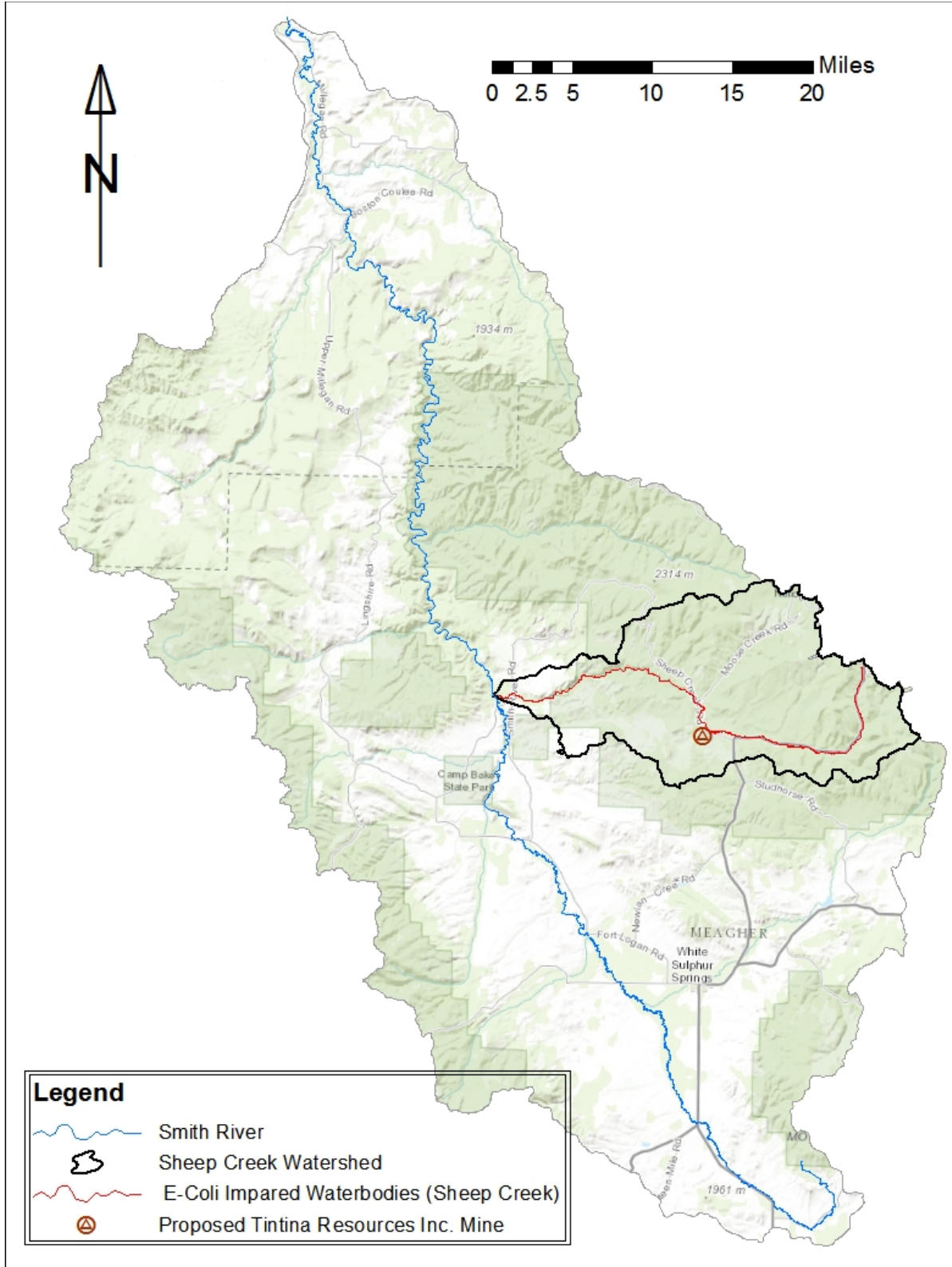


Figure 5-1. Map of the Stream Segment of Concern for *E. coli* in the Sheep Creek Watershed

5.3 INFORMATION SOURCES

Data and information used for impairment determination, source assessment, and TMDL development consisted of:

- Water chemistry, biological, and streamflow data collected by DEQ
- Streamflow data collected by Tintina Resources Inc.
- Streamflow data collected by the United States Geological Survey (USGS)
- Grazing management plans developed by the US Forest Service (USFS)
- Aerial photos
- Geographic Information System (GIS) analysis
- Literature reviews

Water chemistry data collected by DEQ are publicly available through EPA’s STORET database at: http://www.epa.gov/storet/dw_home.html

5.4 WATER QUALITY TARGETS

Water quality targets are numeric indicators used to evaluate attainment of water quality standards. In this section, *E. coli* water quality targets are presented and compared to recently collected *E. coli* data.

5.4.1 *E. coli* Water Quality Standard

The *E. coli* target in Sheep Creek is the Montana water quality standard for *E. coli*. Because the numeric values within the standard and the TMDL target values are equal, the term “standard” and “target” are used interchangeably throughout the remainder of **Section 5**. Sheep Creek is classified as a B-1 stream, as such the Administrative Rules of Montana (ARM) 17.30.623 (2)(a) apply as follows:

The geometric mean number of E. coli may not exceed 126 cfu/100mL and 10% of the total samples may not exceed 252 cfu/100mL during any 30-day period between April 1 through October 31 [ARM 17.30.623 (2)(a)(i)]. From November 1 through March 31, the geometric mean number of E. coli may not exceed 630 cfu/100mL and 10% of the samples may not exceed 1,260 cfu/100mL during any 30-day period [ARM 17.30.623 (2)(a)(ii)].

The *E. coli* bacteria standard is based on a minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period that are analyzed by the most probable number (MPN) or equivalent membrane filter method [ARM 17.30.620(2)]. The geometric mean is the value obtained by taking the Nth root of the product of the measured values, where values below the detection limit are taken to be the detection limit [ARM 17.30.602(13)]. *E. coli* concentration is expressed in colony forming units (CFU), the number of viable bacteria cells, per 100 milliliters (mL).

If either target (geometric mean or 10% exceedance) is exceeded at any sampling location, the waterbody is considered impaired by *E. coli*. The numeric standards identified within **Table 5-1** are the water quality targets. These targets each have an allowable frequency of samples that can be greater than the standard or target, and have specific seasons of applicability. **Table 5-1** provides a summary of how the standard varies by season.

Table 5-1. Montana *E. coli* Water Quality Standard for B-1 Waterbodies

Applicable Period	Magnitude (cfu/100mL)	Measurement Type	Frequency	Dataset Requirement
Summer (4/1 – 10/31)	126	Geometric mean	Not to be exceeded	Minimum five samples obtained during separate 24-hour periods during any consecutive 30-day period
	252	Single sample	< 10% exceedance rate allowed	
Winter (11/1 – 3/31)	630	Geometric mean	Not to be exceeded	
	1,260	Single sample	< 10% exceedance rate allowed	

5.4.2 Existing Conditions and Comparison to Targets

Water quality data were collected by DEQ during a ten day period during July and August of the 2015 field season to evaluate attainment of the *E. coli* target (Table 5-2). Monitoring locations are identified in Figure 5-2. In this portion of the document, target attainment is only evaluated for the summer season because DEQ expects the highest probability of target exceedances and exposure to *E.coli* through primary contact recreation during this time period. Additional seasonality considerations are discussed in Section 5.7.1.

A total of 31 *E. coli* samples were collected from 6 sites in 2015, all samples were collected within the consecutive 30 period required by ARM 17.30.620(2). Individual *E. coli* values ranged from 24.9 cfu/100mL to 1,046 cfu/100mL.

If either target (geometric mean or 10% exceedance) is exceeded at any sampling location, a waterbody is considered impaired. Because concentrations were greater than the geometric mean numeric standard at multiple sites and more than 10% of the samples had concentrations greater than are 252 cfu/100mL target at multiple sites.

Table 5-2. Sheep Creek *E. coli* Target Evaluation Summary

Site ID	Data Collection Date	Sampling Result (cfu/100mL)	Geometric Mean (cfu/100mL)	Targets		Assessment Rational per Site
				Geometric mean < 126 cfu/100mL	10% of <i>E.coli</i> samples < 252 cfu/100mL	
Sheep Creek, at the mouth (1X)	7/27/2015	387.3	75.87	Pass (complies with target)	Fail (violates target)	Fail (not meeting one target)
	7/28/2015	325.5				
	7/29/2015	40.2				
	8/3/2015	26.6				
	8/4/2015	42.0				
	8/5/2015	33.6				
Sheep Creek, near mouth at Sheep Creek	7/27/2015	172.6	50.2	Pass (complies with target)	Pass (complies with target)	Pass (meeting both targets)
	7/29/2015	43.7				
	8/3/2015	47.9				
	8/4/2015	35.5				

Table 5-2. Sheep Creek *E. coli* Target Evaluation Summary

Site ID	Data Collection Date	Sampling Result (cfu/100mL)	Geometric Mean (cfu/100mL)	Targets		Assessment Rational per Site
				Geometric mean < 126 cfu/100mL	10% of <i>E.coli</i> samples < 252 cfu/100mL	
Road bridge (1A)	8/5/2015	24.9				
Sheep Creek, upstream of Calf Creek (1B)	7/27/2015	816.4	129.6	Fail (violates target)	Fail (violates target)	Fail (not meeting both targets)
	7/29/2015	104.3				
	8/3/2015	45.0				
	8/4/2015	108.1				
	8/5/2015	88.4				
Sheep Creek, at the Sheep Creek FAS (1D)	7/27/2015	1046.2	203.4	Fail (violates target)	Fail (violates target)	Fail (not meeting both targets)
	7/29/2015	143.9				
	8/3/2015	62.0				
	8/4/2015	201.4				
	8/5/2015	185.0				
Sheep Creek, about 1 mile upstream of Moose Creek (1E)	7/27/2015	686.7	143.8	Fail (violates target)	Fail (violates target)	Fail (not meeting both targets)
	7/29/2015	101.4				
	8/3/2015	63.8				
	8/4/2015	120.1				
	8/5/2015	115.3				
Sheep Creek, upstream of Coon Creek (1F)	7/27/2015	648.5	171.5	Fail (violates target)	Fail (violates target)	Fail (not meeting both targets)
	7/29/2015	119.1				
	8/3/2015	101.7				
	8/4/2015	137.4				
	8/5/2015	137.5				

5.5 SOURCE ASSESSMENT AND QUANTIFICATION

This section provides the approach used for source assessment, which characterizes the type, magnitude, and distribution of sources contributing to *E. coli* loading to Sheep Creek. It also establishes the approach used to develop TMDLs and allocations to specific source categories in Sheep Creek. Source characterization and the assessment to determine the major sources in Sheep Creek were conducted using monitoring data and information collected as outlined in **Section 5.3**.

Assessment of existing *E. coli* sources is needed to develop Load Allocations (LAs) and load reductions for different source categories. Source characterization links *E. coli* sources, *E. coli* loading to streams, and water quality response, and supports the formulation of the allocation portion of the TMDL.

5.5.1 Sheep Creek Source Assessment

Within the Sheep Creek watershed, there are no surface water point source discharges of *E. coli* covered under Montana Pollutant Discharge Elimination System (MPDES) permits. *E. coli* inputs to Sheep Creek come from several nonpoint sources (i.e., diffuse sources that cannot easily be pinpointed), some of

which are shown in **Figure 5-2**. DEQ identified the following source categories that potentially contribute *E. coli* to Sheep Creek:

- Agriculture (forest and riparian area grazing, irrigated cropping, and pasture/rangeland)
- Subsurface disposal of domestic wastewater and failing septic systems
- Residential development and recreation (domestic pets and recreational use)
- Natural background

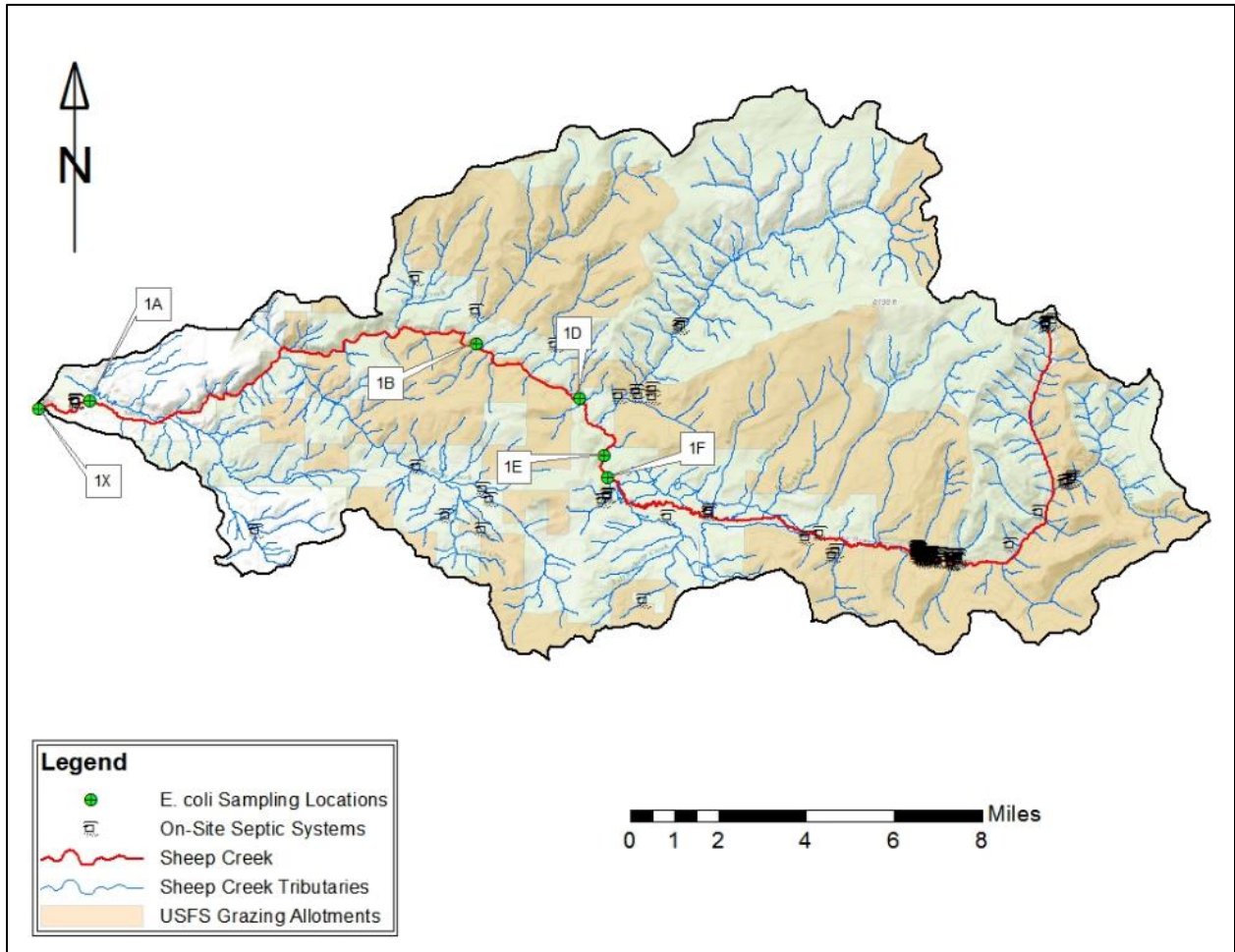


Figure 5-2. Map showing water quality monitoring sites and sources of *E. coli* in the Sheep Creek watershed

Nonpoint Sources of *E. coli*

E. coli is naturally present in the intestinal tracts of warm blooded animals. *E. coli* is released into the environment through the deposition of fecal matter; as such, this bacterium is widely used as an indicator of fecal contamination of waterways. Nonpoint sources of *E. coli* in the Sheep Creek watershed primarily consist of agriculture (rangeland and pasture lands), subsurface disposal of domestic wastewater, failing septic systems, residential development and recreation, and natural background sources.

Agricultural Land Use

E. coli transport to surface water may occur from agricultural areas that have grazing of riparian areas by livestock and through field application of manure. Both of these activities provide a means for excrement to be deposited in and near a waterbody. Overland runoff that results from precipitation events can then transport fecal material into nearby surface waters.

Grazing on public and private rangeland and pastures is common in the Sheep Creek watershed. Pastures are typically managed for hay production during the summer and for grazing during the fall and spring. Livestock manure occurs in higher quantities on pasture ground from October through May because of higher cattle density than that found on range and forested areas. Rangeland differs from pasture in that rangeland has much less available vegetative biomass and does not have as high a density of cattle as pasture. Rangeland is typically grazed during the summer months (June-October) in the watershed.

There are 19 public land grazing allotments in the Sheep Creek watershed; all are located on USFS managed lands (**Figure 5-2**). A summary of the allotments, as provided by the USFS, is found in **Table 5-3**. As can be seen in **Figure 5-2**, grazing allotments are in both the uplands and along the river corridor of Sheep Creek. In the upland areas allotments often encompass whole sub-basins of Sheep Creek. The Calf allotment, Indian Creek allotment, and Moose Mountain allotments were inspected in 2015. While they were meeting the Forest Service’s management objectives, compliance was marginal (USDA Forest Service, 2015). The Forest Service’s 2015 inspection for the Moose Mountain allotment determined that stream bank alteration was in the 20-25% range, indicating that cattle are heavily impacting approximately one quarter of the stream bank. This suggests that cattle in this allotment are spending a significant amount of time in close proximity to the stream and are likely contributing to the increased *E. coli* loading to the stream through direct deposition of excrement, trampling and subsequent erosion of stream banks and reduced riparian buffering capabilities by reduction of riparian vegetation.

Several other allotments were also inspected in 2015 by the USFS. These include the Cabin Creek, Green Mountain, Newlan Creek, and Copper Creek allotments. These allotments were found to be meeting the Forest Service’s management objectives. The vast majority of allotments were not assessed in 2015, and no current information was available as to their compliance with management objectives.

Table 5-3. Public Land Grazing Leases in the Sheep Creek Watershed

Allotment Name	Land Management Agency	Allotment Acres in Watershed	Total Allotment Acres	Percentage of Allotment in Watershed	Total Allotment AUMs*	Meeting Management Objectives (MO)
Moose Mountain	USFS	12839.9	12839.9	100%	899	Yes, but compliance with MOs was marginal
Divide	USFS	488.7	488.7	100%	176	Unknown – not inspected in 2015
Bear Gulch	USFS	402.3	402.3	100%	135	Unknown – not inspected in 2015
Black Butte	USFS	374.7	374.7	100%	131	Unknown – not inspected in 2015
Section 28	USFS	115.3	115.3	100%	55	Unknown – not inspected in 2015
Section 27	USFS	269.0	269.0	100%	67	Unknown – not inspected in 2015

Table 5-3. Public Land Grazing Leases in the Sheep Creek Watershed

Allotment Name	Land Management Agency	Allotment Acres in Watershed	Total Allotment Acres	Percentage of Allotment in Watershed	Total Allotment AUMs*	Meeting Management Objectives (MO)
Wickiup	USFS	3,987.7	3,987.7	100%	339	Unknown – not inspected in 2015
Elk	USFS	1,284.4	1,284.4	100%	333	Unknown – not inspected in 2015
Boundary	USFS	300.0	300.0	100%	98	Unknown – not inspected in 2015
Moose Creek	USFS	1,507.0	1,507.0	100%	69	Yes
Calf & Indian Creek	USFS	7,704.6	7,704.6	100%	396	Yes, but compliance with MOs was marginal
Moose Pass	USFS	1,220.0	1,220.0	100%	119	Unknown – not inspected in 2015
Cabin Creek	USFS	31,86.1	3,673.0	87%	690	Yes
Moose O’Brian	USFS	1,822.3	8,796.9	21%	0	Yes - Allotment is currently vacant
Little Belt Divide	USFS	38,671.1	50,230.9	77%	0	Yes - Allotment is currently vacant
Green Mountain	USFS	2,491.9	6,380.3	39%	362	Yes
Newlan Creek	USFS	958.6	8,524.4	11%	886	Yes
Copper Creek	USFS	2,132.5	7,280.1	29%	1,869	Yes
Sheep Mountain	USFS	1,134.7	1,339.3	85%	311	Unknown – not inspected in 2015

AUM = Animal Unit Month which is the amount of forage needed by an “animal unit” (AU) grazing for one month

While not a significant source of *E. coli*, cropland in the Sheep Creek watershed does have potential to contribute *E. coli* to adjacent surface waters. **Section 2.2.2** discusses in depth the percentages of land cover as well as discussing hay/pasture land locations throughout the watershed. Manure applied to cropland can be a source of *E. coli* to surface water if it is not incorporated into the soil correctly or if it is not applied at agronomic rates. When properly applied, manure can provide an excellent source of fertilizer for crops, but improper application can leave excess manure on the soil surface, which makes it susceptible to being transported off-site via overland runoff that results from precipitation or irrigation.

Subsurface Disposal of Wastewater and Failing Septic Systems

Wastewater sources with the potential to contribute *E. coli* loads to surface waters include residential septic systems, aging and failing septic systems, improperly designed or maintained systems, and faulty residential service connections. Properly designed, installed, and maintained, these systems pose no significant loading threat to surface waters. As such loading from properly functioning systems will not be considered a potential source of *E. coli*. However, improperly installed systems, unmaintained systems and failing systems have the potential to contribute *E. coli* loads where they are in close proximity to surface waters.

Failing and malfunctioning septic systems are defined as any individual or community wastewater disposal systems that are not providing adequate treatment before discharges reach surface waters. There are no community wastewater treatment systems in the Sheep Creek watershed; therefore, the discussion of failing septic systems will be limited to individual systems. Typically failing systems exhibit

evidence of failure such as surface ponding and routing of effluent. In most circumstances, these symptoms are easily identifiable by the owner of the system. Malfunctioning systems may also include improperly installed systems or those that intercept groundwater or are susceptible to flooding. With the aid of GIS coverages based on the Montana State Library Cadastral Mapping Project, DEQ has identified 103 designated living structures (homes) in the Sheep Creek watershed. The Cadastral Mapping Project assumes that each designated living structure has a septic system associated with it. The septic systems mapped in **Figure 5-2** show this assumption in detail. Septic systems in the Sheep Creek watershed are at low densities throughout the watershed, but densities are relatively high in the upper third of the watershed where there is a small concentrated assemblage of homes (and associated subsurface wastewater treatment systems) upstream of monitoring locations 1E and 1F (**Figure 5-2**).

No information is kept by the State of Montana or Meagher County regarding the number of failing septic systems in the Sheep Creek watershed. This makes estimating potential loads of *E. coli* difficult, however a simple approach can be applied to get an indication of potential septic system loading from failing systems. In this attempt, a worst case scenario is used to develop a load from failing septic systems.

To consider a failing septic system as a source, it would need to produce an effluent stream capable of reaching a waterbody in order to provide a significant *E. coli* load. For this to occur, a septic system would need to be in close proximity to the waterbody to receive overland flow and contribute a load. Only 10 of the 103 identified septic systems are within 250 feet of Sheep Creek. Two hundred fifty feet being a conservative estimate of distance an effluent stream could (without infiltrating into surface soils or becoming diluted by other means) be expected to persist and reach Sheep Creek. A somewhat conservative rate of failure for septic systems is from 10-20% (USEPA, 2000). Therefore, it could be assumed that of the 10 septic systems within 250 feet, only 1 or 2 of these systems might be failing and have the capability of contributing an *E. coli* load. That being said, the likely contributing load from failing septic systems is low.

It is reasonable to assume that loading from failing septic systems could be a significant source. However, if this was the case, DEQ monitoring results would have indicated higher concentrations of *E. coli* downstream of those areas with the highest concentration of septic systems (highest probability of a failing system). The highest reported concentrations of *E. coli* were not close to areas with high concentrations of septic systems. The timing of sample collection also seems to indicate that failing systems are not a significant source. Those samples collected earliest in the sampling regime had higher flows, and higher concentrations (**Section 5.5.2**). There were also significant spikes in *E. coli* concentrations associated with rain events (**Section 5.5.2**). *E. coli* contributions from failing septic systems would present themselves as consistently high concentrations throughout the watershed instead of we see fluctuating concentrations at multiple locations (**Figures 5-3 and 5-4**).

Residential Areas, Pets and Recreation

Developed areas contribute *E. coli* to surface waters by means of precipitation runoff from impervious surfaces and overland flow through areas with *E. coli* sources resulting in deposition of fecal material in or near surface water. As there are not many impervious surfaces in the rural areas in the Sheep Creek watershed (other than highway surfaces and residential driveways), there is limited runoff from these surfaces. Therefore, this source is not expected to be a significant contributor of *E. coli* to Sheep Creek.

Domestic pets such as dogs and recreational livestock are common in areas along Sheep Creek and have the potential to contribute *E. coli*. It is likely a safe assumption that contributions from pets and

recreational livestock within the residential area and areas used for recreation are insignificant because the number of pets and recreational livestock is low when compared to the number of cattle, the largest contributing sources of *E. coli*. Given the lower number of pets and recreational livestock and the resulting lower volume of excrement this source is not expected to be a significant contributor of *E. coli* to Sheep Creek.

Re-suspension of *E. coli* in substrate sediments as a result of recreational usage or general disturbance (fishing, swimming, stream crossing, domestic pets, etc.) may contribute to instream *E. coli* loads during the summer recreation season. A study conducted in Oak Creek, Arizona found that water quality violations occurred when sediments were found to have high levels of fecal coliform in the sediments (Cabrill et al., 1999). The largest potential contributor of *E. coli* in this category includes recreational stock, which may be maintained by individuals and businesses. Limited information regarding the specific contribution from recreational activities in the Sheep Creek watershed is available. However, this source is not expected to be a significant contributor of *E. coli* to Sheep Creek.

Natural Background

Natural background sources of *E. coli* are primarily from wildlife, mainly from species that utilize riparian and stream corridors. Wildlife concentrations in Sheep Creek are expected to be similar to those in other portions of Montana with comparable characteristics. As such, *E. coli* contributions from wildlife are expected to be the same. Historical/pre-development *E. coli* data with which to estimate natural background levels is limited for the Sheep Creek watershed. Therefore, data from DEQ reference sites were used to estimate natural background *E. coli* concentrations.

E. coli reference data were collected from 2003-2005 at several sampling sites identified as ‘reference’ sites by DEQ’s water quality standards section (**Table 5-4**). These sites include lightly developed areas of the Blackfoot River near Bonner and Rock Creek near Clinton. For purposes of estimating natural background concentrations for TMDL development, the 90th percentile reference value of 48.3 cfu/100mL is used as an estimate of natural background sources for the calculation of load allocations in **Section 5.6**. This represents about 38% of the “summer” standard of 126 cfu/100mL, and 7.6% of the “winter” standard of 630 cfu/100mL assuming a constant *E. coli* contribution from natural background during both seasons.

Table 5-4. *E. coli* Reference Site Data and Summary Statistics

Station ID	Site Name	2003 (CFU/100mL)	2004 (CFU/100mL)	2005 (CFU/100mL)
C02ROCKC01	Rock Creek near Clinton	48.7	28.4	47.9
C03BLACR01	Blackfoot River near Bonner	1.0	10.8	5.2
	Minimum		1.0	
	Mean		23.7	
	Maximum		48.7	
	90 th Percentile		48.3	

5.5.2 Data Quantification and Discussion

The number of *E. coli* sampling sites in the Sheep Creek watershed was limited; as such sample results do not encompass the entire watershed and were only collected during one field season. Specific sample locations are identified within **Figure 5-2**. Note that the most upstream sites are located

approximately in the middle of the watershed. Circumstances such as this make it difficult to discern a spatial or temporal pattern, nevertheless *E. coli* concentrations are generally declining downstream, as can be seen in **Tables 5-2 and 5-5** and **Figures 5-3 and 5-4**.

E. coli concentrations tend to stay constant for several days after introduction to a waterbody, with temperature and nutrient availability being the suggested factors that affect its survivability (Flint 1987). Flint (1987) also notes that *E. coli* can survive for up to 260 days in water temperature from 4 °C - 25 °C. This equates to 39.2°F and 77°F, respectively. Based on continuous water temperature data collected in Sheep Creek during the summer of 2015, temperatures at monitoring site 1F only got below 39.2 degrees for two hours on the morning of September 8, and never exceeded 77°F. At monitoring site 1A (the downstream most sampling site with temperature data), data indicated that the temperature was never below 39.2°F or above 77°F. Nutrient data collected during the summer 2015 field season did not reveal concentrations that were in violation of the water quality standard and were within reasonable concentrations for a waterbody in this region, experiencing this type of land use.

Given that temperatures do not fluctuate outside the range that would be detrimental to *E. coli* and nutrient concentrations remain fairly constant, there is little reason to expect *E. coli* concentrations to change significantly once they have entered Sheep Creek. Consequently, any rise in concentration will likely indicate a nearby source.

Flow data were not collected during the *E. coli* sampling efforts, so there is no flow data that directly corresponds with the *E. coli* data. Nevertheless, some seasonal correlations can be made between *E.coli* sampling results and the general flow regime at the time of sample collection. Generally speaking, flows measured as part of nutrient and metals sampling (**Section 5.6.1.1**) indicated that there was an average 10 cubic feet per second (cfs) decrease from the middle of July to the first week in August of 2015. Under higher flow conditions (7/27/2015), *E. coli* concentrations were higher than those during lower flow conditions (8/5/2015), as can be seen in **Table 5-5**.

Table 5-5. Seasonal Correlations of *E. coli* Data

Site ID	Sampling Result Value (cfu/100mL) and Date of Sample Collection					
	7/27/2015	7/28/2015	7/29/2015	8/3/2015	8/4/2015	8/5/2015
1F, Sheep Creek, upstream of Coon Creek	648.5	No Sample Collected	119.1	101.7	137.4	137.5
1E, Sheep Creek, about 1 mile upstream of Moose Creek	686.7	No Sample Collected	101.4	63.8	120.1	115.3
1D, Sheep Creek, at the Sheep Creek FAS	1046.2	No Sample Collected	143.9	62.0	201.4	185.0
1B, Sheep Creek, upstream of Calf Creek	816.4	No Sample Collected	104.3	45.0	108.1	88.4
1A, Sheep Creek, near mouth at Sheep Creek Road bridge	172.6	No Sample Collected	43.7	47.9	35.5	24.9
1X, Sheep Creek, at the mouth	387.3	325.5	40.2	26.6	42.0	33.6

Table 5-5 also shows that the highest *E. coli* concentrations occurred on July 27 and July 28, 2015. A National Resources and Conservation Service (NRCS) weather station located at Deadman Creek (headwaters tributary to Sheep Creek) indicated a 1.1 inch rain event that occurred between July 25 and July 28, 2015. Furthermore, two nearby Snotel sites (Stringer Creek and Onion Park) show more than one inch of rainfall between July 27 and July 28, 2015. This rain event and the associated high *E. coli* concentrations indicate that the source is likely the result of precipitation runoff from areas with high concentrations of fecal matter on the surface.

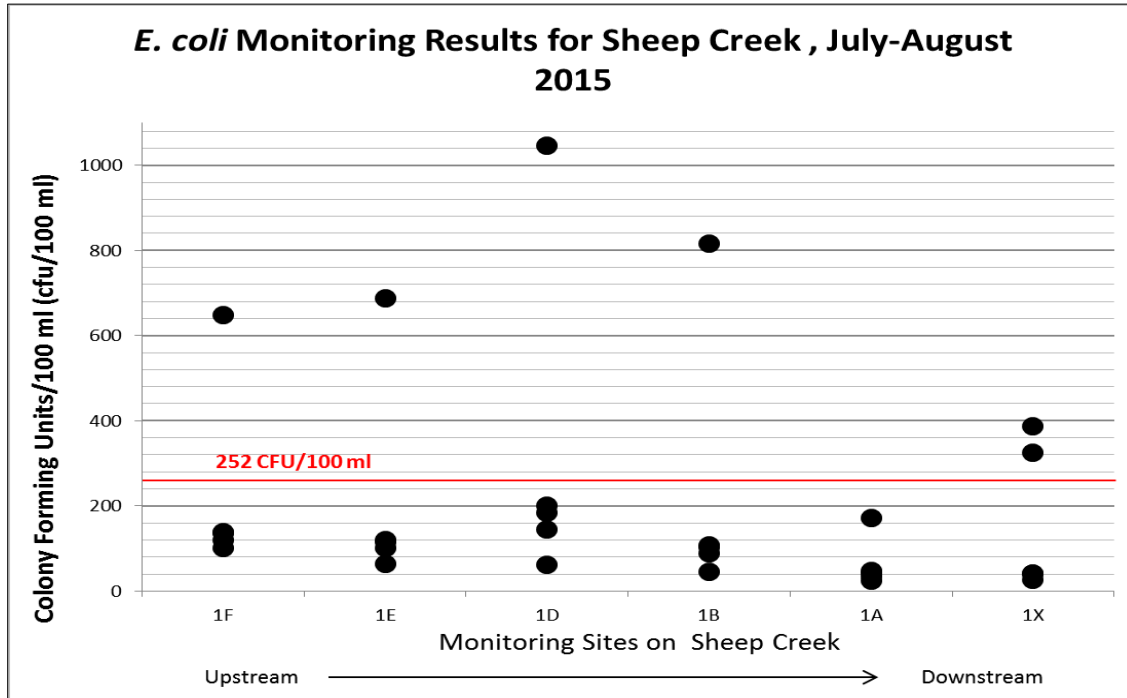


Figure 5-3. *E. coli* data collected on Sheep Creek by the Montana DEQ

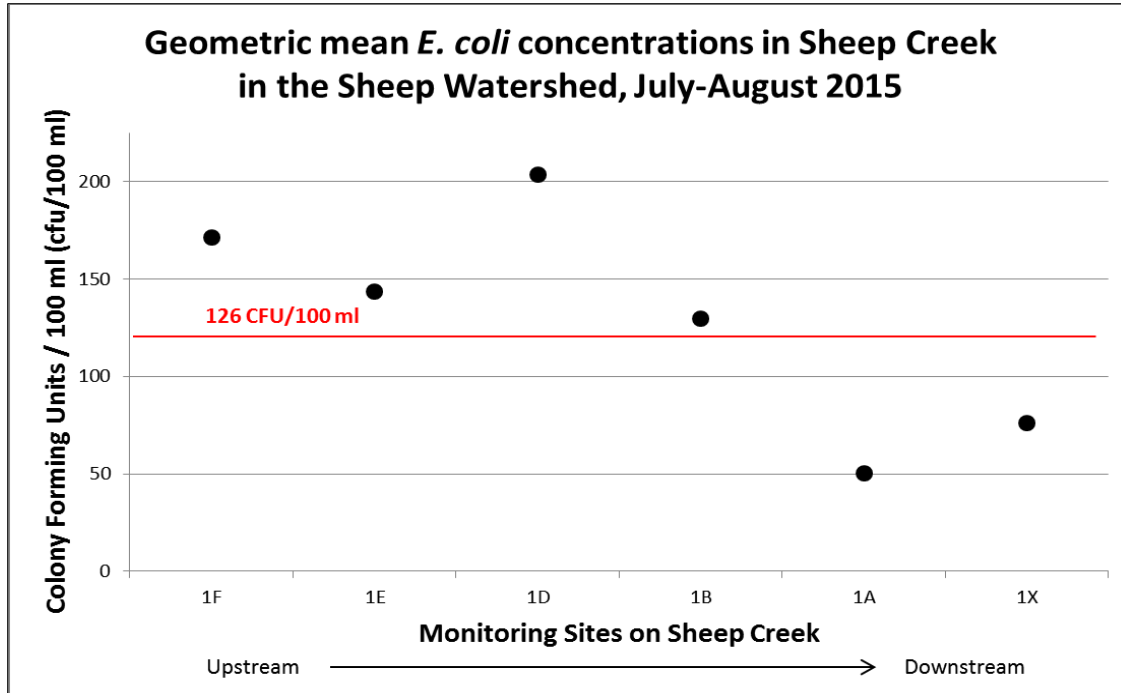


Figure 5-4. 30-Day geometric means of *E. coli* data collected on Sheep Creek by the Montana DEQ

Figure 5-5 displays the percent of exceedance of the *E. coli* standard at each individual monitoring site as compared to the median flow at each individual monitoring site as derived from DEQ’s streamflow dataset measured during 2015 site visits for metals, nutrient, and temperature monitoring. Data in this figure are expressly from the 2015 field season. It is important to keep in mind that this figure compares individual sample results against the geometric mean target. This was done to gain further insight into spatial difference of *E. coli* loading along Sheep Creek. Comparison of these values was not used in the assessment determination process (Section 5.4.2).

Monitoring sites 1F and 1E are upstream of the confluence with Moose Creek and the USFS Sheep Creek fishing access site. The percent exceedance seen at monitoring site 1F and 1E are likely attributable to the combination of human sources and naturally occurring *E. coli*. Monitoring site 1D is down stream of the confluence with Moose Creek and the USFS Sheep Creek fishing access site and primitive camping area. There was a 60% increase in the exceedance rate from monitoring site 1E to 1D. This is likely attributable to the presence of cattle and the proximity of a recreational area in this stream segment. Cattle were witnessed in this area by DEQ field staff during all sampling efforts of the 2015 field season. The general decrease in *E. coli* concentrations at the lower monitoring sites (1B and 1A) is likely attributable to the more diffuse concentration of cattle in proximity to Sheep Creek and the dilution of Sheep Creek by its tributaries. The slight rise in concentration and exceedance rates at monitoring location 1X is likely attributable to the higher concentration of cattle in the area and the lack of significant dilution from tributaries such as occurs in the lower portion of Sheep Creek.

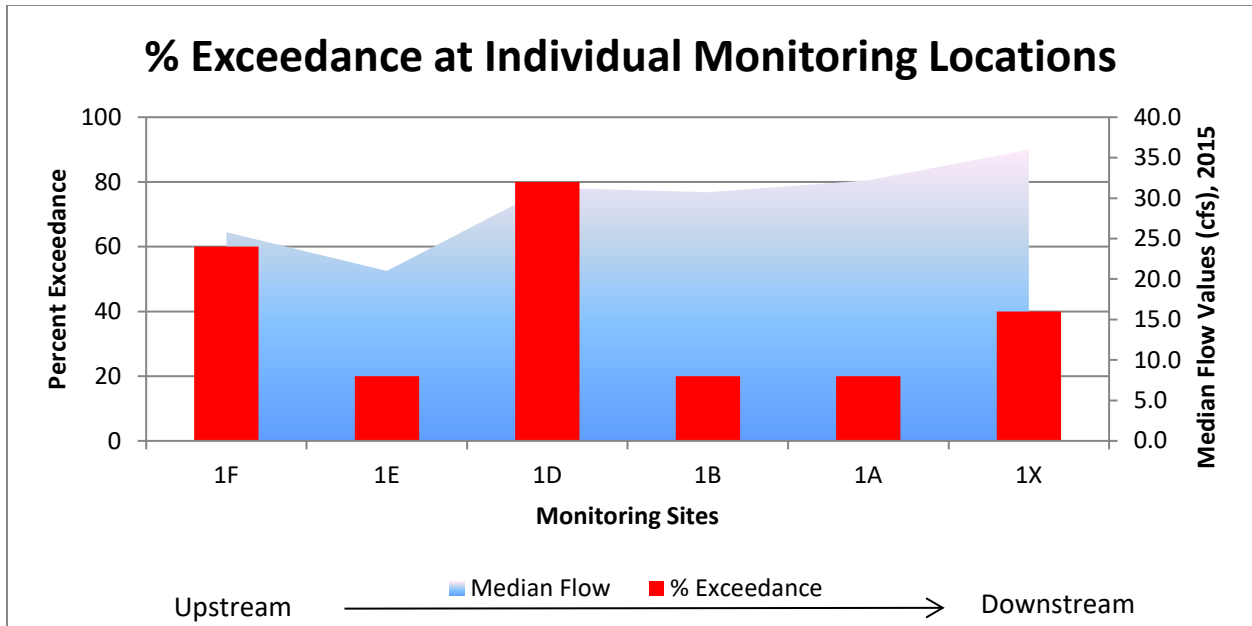


Figure 5-5. Loading and TMDL comparison for *E. coli*, Sheep Creek

On four out of five sample dates, there was a significant spike in *E. coli* concentrations at sample location 1D (Figure 5-3 and Figure 5-4). This sample location is immediately downstream of the Sheep Creek USFS fishing access site and primitive camping area. This spike in *E. coli* concentrations can be seen in both the concentration values and the geometric mean concentration. Spikes in concentration such as this would not be expected in waterbodies where the sources were solely naturally occurring or via groundwater. This spike indicates that there is a likely a contributing source of *E. coli* nearby to this sampling location. Agricultural land use is the most likely source contributing to *E. coli* at this location as cattle are routinely concentrated in this area and where witnessed in this area by DEQ field staff during all sampling efforts during the 2015 field season.

The most significant contribution of *E. coli* loading to Sheep Creek during this investigation appears to be from overland flow during the runoff events linked to the high rainfall that occurred between July 27 and July 28. Those areas with agriculture land use are most likely to be contributing this loads occurring under these conditions. While agricultural land use appears to be the most likely source of *E. coli*, without a more exhaustive spatial and temporal sampling effort it is difficult to discount domestic wastewater treatment systems and other human caused sources (Section 5.5.1) as potential sources. Therefore, all human caused sources of *E. coli* will be composited when they are accounted for in the TMDL.

5.6 TMDLS AND ALLOCATIONS

This section summarizes the approach used for the TMDL and allocations, and then presents the TMDL, source allocations, and estimated reductions necessary to meet water quality targets for *E. coli*. An *E. coli* TMDL has been developed from Sheep Creek from the headwaters to mouth.

Loading estimates and load allocations are established for the summer time period, when contact recreation (swimming, fishing, etc.) is most likely to occur, and are based on water quality data and flow conditions measured on Sheep Creek. It is important to note that seasonal flow data were collected

during sampling efforts not associated with *E. coli* sampling. Loading estimates are conservative and should be protective of the beneficial use during other times of the year as well, given the nonpoint source or diffuse nature of the *E. coli* loading.

Because streamflow varies seasonally, a TMDL is not expressed as a static value, but as an equation of the appropriate target concentration multiplied by a typical flow as shown in **Equation 5-1**.

Furthermore, the TMDL is not expressed as a load or mass, but instead expressed as the number of colony forming units per day due to the nature of the pollutant. This approach is consistent with EPA's recommended analytical method for measuring *E. coli* in ambient waters and the flexibility offered in 40 CFR §130.3(i) to express TMDLs in other appropriate, non-mass based, measures. TMDL calculations for *E. coli* are based on the following formula:

Equation 5-1: TMDL = (X) (Y) (2.44×10^7)

TMDL = Total Maximum Daily Load in cfu/day

X = *E. coli* water quality target (126 cfu/100mL)

Y = streamflow in cubic feet per second (cfs)

(2.44×10^7) = conversion factor

DEQ conducted water quality sampling during the summer (July and August 2015). Water quality data results are compared to the water quality standard that corresponds with the collection time. This comparison and the resulting TMDL are based on the 'summer' season *E. coli* target value that applies from April 1 through October 31. This target is appropriate, because it applies during the season when most potential impacts may be likely to occur (via contact recreation) and as it is the lowest *E. coli* standard, it is the most protective of water quality.

The target value is the geometric mean of *E. coli* not exceeding 126 colony forming units per 100 milliliters (126 cfu/100mL). If this target value is adhered to, it will be protective all seasons of the year. A comparison of the seasonal TMDL is provided in **Figure 5-6**. **Figure 5-6** shows the lower 'summer' TMDL that is more protective of water quality and that as flow increases, the allowable load (TMDL) also increases. Note that the concentration remains static.

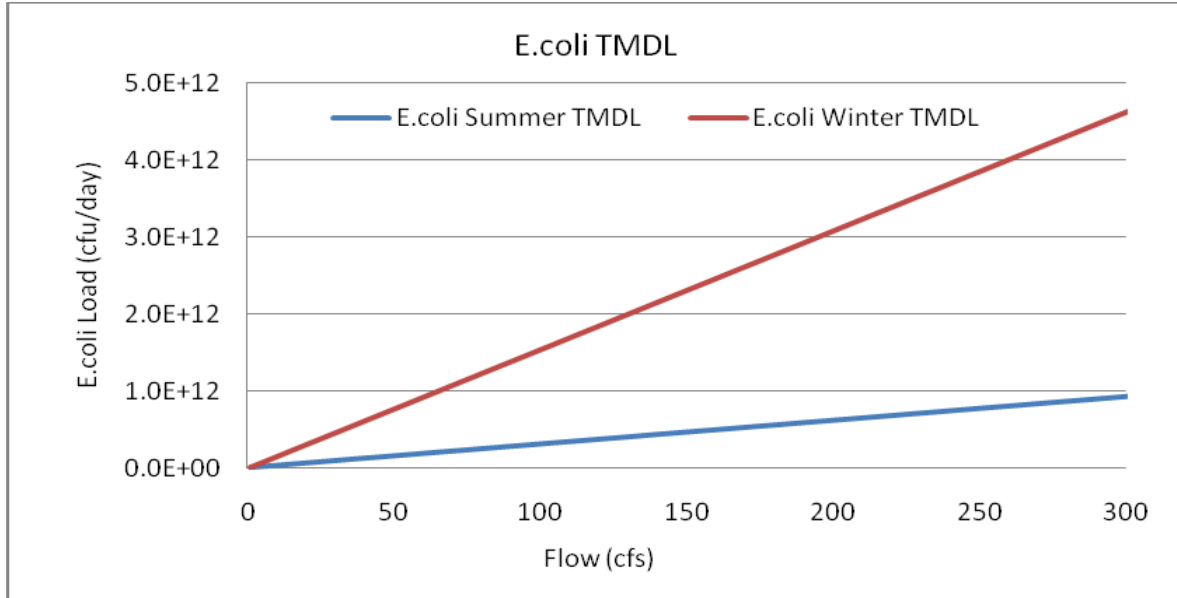


Figure 5-6. Seasonal *E. coli* TMDLs as a function of flow

5.6.1 TMDL Allocations

As discussed in Section 4.0, the *E. coli* TMDL consists of the sum of load allocations (LAs) to individual sources and source categories (Table 5-6). Because there are no surface water point source discharges of *E. coli*, no wasteload allocation (WLA) has been established and the allowable WLA is considered zero. For Sheep Creek *E. coli*, the TMDL is broken into a load allocation to natural background and a load allocation to all human-caused nonpoint sources (Equation 5-2). Under most circumstances DEQ provides an implicit MOS by using assumptions known to be conservative, and are discussed in depth in Section 5.7. Where an implicit MOS is applied, the MOS in the below equation is equal to zero and not necessarily include in the equation provided below. In the absence of individual wasteload allocations and an explicit margin of safety, the TMDL for *E. coli* is calculated as follows:

Equation 5-2: $TMDL = LA_{NB} + COMP LA_H$

LA_{NB} = Load Allocation to natural background sources

$COMP LA_H$ = Load Allocation to human-caused nonpoint sources

Table 5-6. *E. coli* Source Categories and Descriptions for the Sheep Creek TMDL Project Area

Source Category	Source Descriptions
Natural Background	<ul style="list-style-type: none"> • Wild animal waste
Human Caused Nonpoint Sources	<ul style="list-style-type: none"> • Livestock manure • Agriculture practices • Domestic wastewater • Other Human caused sources

5.6.1.1 Natural Background Allocation

Natural background is a noteworthy source of *E. coli* loading in the Sheep Creek Project Area. Natural background loading (LA_{NB}) of *E. coli* is assumed to be the result of normally occurring events from lightly developed areas. No reductions are expected for the natural background component of *E. coli* loading to Sheep Creek. LAs for natural background sources in Sheep Creek are based on 90th percentile

concentration values from reference sites (48.3 cfu/100mL) (**Table 5-4**). Reference sites were chosen to represent stream conditions where human activities are present, but do not negatively harm beneficial uses. Natural background loads are calculated by multiplying the 90th percentile reference concentration by the measured flow in Sheep Creek. As discussed in **Section 5.1**, the natural background concentration is about 38% of the “summer” standard and 7.6% of the “winter” standard. This translates to a load allocation that represents 38% of the TMDL during all “summer” flow conditions and 7.6% during all “winter” flow conditions.

The natural background load allocation is calculated as follows (**Equation 5-3**):

Equation 5-3: $LA_{NB} = (X_{CNC}) (Y_{FLW}) (2.44 \times 10^7)$

LA_{NB} = load allocation to natural background sources in cfu/day

X_{CNC} = natural background concentration in cfu/100mL = 48.3 cfu/100mL

Y_{FLW} = streamflow in cfs

2.44×10^7 = conversion factor

5.6.1.2 Allocations for Human-Caused Sources

The composite load allocation (COMP LA_H) to human-caused nonpoint sources is calculated as the difference between the allowable daily load (TMDL) and the natural background load allocation (LA_{NB}) (**Equation 5-4**):

Equation 5-4: $COMP LA_H = TMDL - LA_{NB}$

$COMP LA_H$ = Load Allocation to human-caused nonpoint sources

Note that $COMP LA_H$ will change proportionally with flow consistent with how both the TMDL and natural background load allocations change with flow. The $COMP LA_H$ will always represent the remaining percentage of available load after subtracting the LA_{NB} from the TMDL. This means that the $COMP LA_H$ represents about 62 % of the allowable loading during “summer season” flows.

5.6.1.3 Allocation Approach and Best Management Practices

The first critical step toward meeting the *E. coli* load to human caused sources involves applying and maintaining land management practices or best management practices (BMPs) that will reduce *E. coli* loading. Once these actions have been completed, land managers will have taken action consistent with the intent of the *E. coli* allocation for that location.

BMPs may include efforts that reduce direct pathogen inputs to streams and increase the overall health of Sheep Creek. Some of those BMPs that pertain directly to those activities that are suspected of causing *E. coli* to not meet the standard in Sheep Creek are as follows:

- improved riparian buffers;
- limit livestock access to streams via fencing;
- installation of hardened stream crossings and off-stream water sources;
- rotational grazing;
- effective manure management on those fields adjacent to surface water.

Other BMPs may include repairing or replacing aging or failing septic systems. *E. coli* loading reductions can be achieved through a combination of BMPs that meet site-specific conditions.

For many nonpoint source activities, it may take several years to achieve the full load reduction, even with full BMP implementation. For example, it might take several years for riparian areas to fully recover and become effective at reducing *E. coli* loading after implementing grazing BMPs. 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 increased *E. coli* loading. **Section 6.0** provides additional information on applicable BMPs for improving water quality with regard to *E. coli* pollution. Progress towards TMDL and individual allocation achievement can be gauged by BMP implementation and improvement in or attainment of water quality targets defined in **Section 5.4.1**.

Although the needed reductions (based on sample data) apply to the growing season for nonpoint sources, it is anticipated that us of BMPs will result in year-round reductions in *E. coli* loading. This will address sources of *E. coli* that tend to enter streams in the spring during runoff, as well as those sources that may be contributing *E. coli* during the summer months when flows are lower.

5.6.2 *E. coli* TMDLs for Sheep Creek under Typical Summer Flow Condition

Sheep Creek *E. coli* TMDL is calculated using a typical flow to provide the reader additional clarification on how to apply the TMDL and allocations.

The steps taken to establish a value for the *E. coli* TMDL and the allocations during a typical flow in Sheep Creek are provided below. The field flow data used for this example calculation correspond to the median of measured flows from the 2015 field season (32.0 cfs).

Establish TMDL using the typical Sheep Creek flow (see Equation 5-1)

$$\text{TMDL} = (126 \text{ cfu}/100\text{mL}) \times (32.0 \text{ cfs}) \times (2.44 \times 10^7) = 9.84 \times 10^{10} \text{ cfu}/\text{day}$$

Calculate LA_{NB} (see Equation 5-3)

$$\text{LA}_{\text{NB}} = (48.3 \text{ cfu}/100\text{mL}) (32.0 \text{ cfs}) (2.44 \times 10^7) = 3.77 \times 10^{10} \text{ cfu}/\text{day}$$

Calculate COMP LA_H (see Equation 5-4)

$$\text{COMP LA}_{\text{H}} = 9.84 \times 10^{10} \text{ cfu}/\text{day} - 3.77 \times 10^{10} \text{ cfu}/\text{day} = 6.07 \times 10^{10} \text{ cfu}/\text{day}$$

Table 5-7 provides a summary of the TMDL and the allocation for a typical flow of 32.0 cfs. It is important to note that the TMDLs and their allocations calculated below only apply at the flow of 32.0 cfs. The Sheep Creek *E. coli* TMDL and allocations must always be based on **Equations 5-1** through **5-4** for any flow conditions in Sheep Creek.

Table 5-7. Sheep Creek *E. coli* TMDL and Load Allocation at a Typical Flow of 32 cfs

Typical Flow (cfs)	TMDL (cfu/day)	Load Allocation to Natural Background (LA _{NB}) (cfu/day)	Composite Load Allocation to Human Caused (COMP LA _H) (cfu/day)
32.0	9.84 × 10 ¹⁰	3.77 × 10 ¹⁰	6.07 × 10 ¹⁰

Based on the existing conditions in Sheep Creek (information presented in **Table 5-2** and **5-3**), the percent load reductions required to meet the TMDL range from about 0 to 38 percent. These reductions are calculated by comparing the highest geometric mean of the sampling results (**Table 5-2**) to the “summer” *E. coli* standard (126 cfu/100ml) used to compute the TMDL.

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), Wasteload Allocations (WLAs) and Load Allocations (LAs). TMDL development must also incorporate a margin of safety (MOS) 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 MOS in the Sheep Creek *E. coli* TMDL development process.

5.7.1 Seasonality

Addressing seasonal variations is an important and required component of this TMDL. Water quality is recognized to have seasonal cycles. Specific examples of how seasonality has been addressed within this document include:

- Water quality standards and consequent *E. coli* water quality targets are developed based on application of seasonal beneficial uses (recreational use). The TMDL is calculated using the 126 cfu/100mL value for the summer months, which is also considered protective during the winter months.
- TMDL analysis was focused on the summer timeframe when primary contact recreation (the most effected beneficial use) is at risk.
- Water quality data were collected during the period of highest probability of target exceedance in the Sheep Creek watershed, which occurs during higher summer flow conditions (some of which were associated with a runoff event)
- *E. coli* data and sources were evaluated based on and understanding of local seasonal source prevalence and seasonal pathways.

5.7.2 Margin of Safety

A margin of safety (MOS) is a required component of TMDL development. The MOS 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, 1999). This plan addresses MOS implicitly in the following ways:

- The geometric mean value of 126 cfu/100mL (summer) is used to calculate TMDLs and load allocations. Use of the geometric mean allows for individual reported values to be above 126 cfu/100mL and assures that as long as the geometric mean of all the reported values is less than or 126 cfu/100mL the standard is being met
- By setting the target at 126 cfu/100mL and using this to calculate the TMDL and allocation this provides a margin of safety by ensuring that allowable daily load allocations do not result in the exceedance of water quality targets.
- The 90th percentile value of summer natural background concentrations was used to establish a natural background concentration for load allocation purposes. This is a conservative approach, and provides an additional MOS for anthropogenic *E. coli* loads during most conditions. This is because the application of a higher natural background load allocation equates to a higher percent load reduction from nonpoint sources needed to meet the TMDL.

5.8 UNCERTAINTY AND ADAPTIVE MANAGEMENT

Uncertainties in the accuracy of field data, source assessments, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. However, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. The process of adaptive management is predicated on the premise that TMDL targets, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood. As further monitoring of water quality and source loading conditions is conducted, uncertainties associated with these assumptions and considerations may be mitigated and loading estimates may be refined to more accurately portray watershed conditions.

Uncertainty in Water Quality Data

It was assumed that sampling data for each segment of the waterbody are representative of conditions in that segment. All 31 water quality samples met the minimum requirement of five samples obtained during separate 24-hour periods during any consecutive 30-day period. That being said, special distribution of sample locations was limited by access to some areas, and the ability to collect samples within the allotted timeframes. Additional water quality monitoring should help reduce any uncertainty regarding data representativeness, clarify the role *E. coli* has in impairing beneficial uses, improve the understanding of the effectiveness of Best Management Practice (BMP) implementation, and increase the understanding of load reductions needed to meet the TMDL.

It was also assumed that background concentrations are less than the target values in Sheep Creek, as *E. coli* monitoring was not conducted in all portions of Sheep Creek. It is possible that target values are naturally exceeded during certain times or at certain locations in the watershed. It is also assumed that *E. coli* data collected from reference sites are representative of the conditions in Sheep Creek. Future monitoring should help reduce uncertainty regarding background *E. coli* concentrations.

Adaptive Management

As part of an adaptive management approach, land use activities should be tracked. Changes in land use may trigger a need for additional monitoring. The extent of monitoring should be consistent with the extent of potential impacts, and can vary from basic BMP assessments to a complete measure of target parameters above and below the Project Area before and after project completion. Cumulative impacts from multiple projects must also be a consideration. This approach will help track the recovery of the system and the effects of ongoing management activities in the watershed.

Uncertainties in assessments and assumptions should not paralyze, but should point to the need to be flexible in our understanding of complex systems, and to adjust our thinking and analysis in response to this need. Implementation and monitoring recommendations presented in **Section 6** and **Section 7** provide a basic framework for reducing uncertainty and furthering understanding of these issues

6.0 WATER QUALITY IMPROVEMENT PLAN AND MONITORING STRATEGY

This section describes an overall strategy and conservation practices (e.g., best management practices (BMPs)) designed to restore water quality beneficial uses and attain *E. coli* water quality standards in the Sheep Creek TMDL Project Area (Project Area).

6.1 IMPROVEMENT AND MONITORING STRATEGY OVERVIEW

The strategy includes general measures for reducing loads from identified nonpoint sources of *E. coli* as well as approaches to further evaluate *E. coli* conditions in the Sheep Creek watershed. Effective monitoring is integral for evaluating conservation practices and provides a foundation of an adaptive management approach. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities, pollutant load reductions and status of TMDL target attainment. This strategy can also help determine if all significant sources have been identified. Data from long-term monitoring also provides technical justification to modify restoration strategies, targets, or allocations if appropriate.

This section is intended to help stakeholders develop a watershed restoration plan (WRP), if desired, that provides a locally-developed voluntary action plan to reduce *E. coli* loads in the Sheep Creek watershed. The WRP may encompass broader goals than the water quality improvement strategy outlined in this document, such as goals related to other pollutant sources or weed management. The intent of the WRP is to serve as a locally-supported “road map” for watershed activities that prioritizes projects to achieve watershed goals.

6.2 ROLE OF DEQ, OTHER AGENCIES, AND STAKEHOLDERS

DEQ does not implement TMDL pollutant-reduction projects for nonpoint source activities, but does provide technical assistance to stakeholders interested in addressing nonpoint source pollution. Successful implementation of TMDL pollutant-reduction projects often requires collaboration among private landowners, land management agencies, and other stakeholders. DEQ works with interested participants to use TMDLs as a basis for developing locally driven WRPs, provides funding to help support water quality improvement and pollution prevention projects, and helps identify other sources of funding.

Because most nonpoint source pollution 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 meet TMDL targets and load reductions. Specific stakeholders and agencies that may be involved with restoration efforts for streams discussed in this document include:

- U.S. Forest Service (USFS)
- Bureau of Land Management (BLM)
- Natural Resources Conservation Service (NRCS)
- Montana Department of Natural Resources & Conservation (DNRC)
- Montana Fish, Wildlife & Parks (FWP)
- Montana Department of Environmental Quality (DEQ)
- Montana Trout Unlimited

- Tintina Resources Inc.
- Meagher County Conservation District
- Montana State University Extension Water Quality Program

6.3 ADAPTIVE MANAGEMENT AND UNCERTAINTY

The TMDL implementation goals and monitoring strategy presented in this section provide a starting point for the development of more detailed planning. Recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate plans to meet the water quality improvement goals outlined in this document.

In accordance with the Montana Water Quality Act (75-5-703 (7) and (9), Montana Code Annotated (MCA)), DEQ is required to assess the waters for which TMDLs have been completed and restoration measures or BMPs have been applied to determine whether compliance with water quality standards has been attained, water quality is improving, or if revisions to current goals are necessary. This aligns with an adaptive management approach that is incorporated into DEQ’s assessment and water quality impairment determination process. DEQ’s Watershed Protection Section administers and monitors TMDL implementation and works with local watershed groups to identify waterbodies where there have been sufficient activities to warrant an evaluation of current stream conditions.

Adaptive management, as discussed throughout this document, is a systematic approach for improving resource management by learning from management outcomes, and allows for flexible decision making. There is an inherent amount of uncertainty involved in the TMDL process, such as quantifying source contributions (e.g., determining natural background) and characterizing spatial and seasonal loading conditions. Use of an adaptive management approach based on continued monitoring of project implementation helps manage resource commitments and achieve success in meeting the water quality standards and supporting water quality beneficial uses. This approach further allows for adjustments to restoration goals and/or allocations, as necessary.

Figure 6-1 below is a visual explanation of the iterative process of adaptive management (Williams et al., 2009).

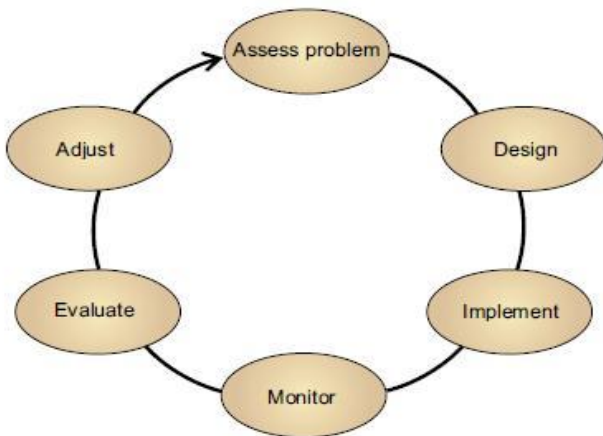


Figure 6-1. Diagram of the Adaptive Management Process

Prioritizing restoration and monitoring activities depends on funding opportunities and stakeholder priorities. Once restoration measures have been implemented for a waterbody with an approved TMDL and given time to take effect, DEQ will conduct a formal evaluation of the waterbody's impairment status and determine whether water quality standards (TMDL targets) are being met.

6.4 WATER QUALITY RESTORATION OBJECTIVES

The water quality restoration objective for the Sheep Creek *E. coli* TMDL is to reduce *E. coli* loads to meet the water quality standards (TMDL targets) for recovery of beneficial uses for Sheep Creek. Based on the assessment provided in this document, the TMDL can be achieved through implementation of appropriate BMPs for nonpoint sources.

Specific objectives for watershed restoration activities could be identified by local stakeholders through the development of a WRP or similar approach. A WRP can provide a strategy for water quality restoration and monitoring in the Sheep Creek watershed, focusing on how to achieve the TMDL presented in this document, as well as other water quality issues of interest to the local community and stakeholders. WRPs identify considerations that should be addressed during TMDL implementation. A WRP serves as a locally organized “road map” for watershed activities, prioritizing projects, and identifying funding and technical resources 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 federal Clean Water Act Section 319 (nonpoint source management programs) provides authority for congressional funding to Montana. The funds for nonpoint source projects have to be used to implement WRPs. If there is local interest in access to federal 319 funding, a WRP is necessary in order to access those funds.

The EPA requires nine minimum elements for a WRP. A complete description can be found at <http://www.epa.gov/region9/water/nonpoint/9elements-WtrshdPlan-EpaHndbk.pdf> and are 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 TMDL document provides, or can serve as an outline, for many of the WRP required elements for addressing the *E. coli* water quality impairment. For example, information to address elements 1, 2 and 3 is provided in **Section 5.0**.

6.5 *E. COLI* RESTORATION APPROACH

Cattle grazing in riparian areas is identified as the most likely cause of elevated *E. coli* loading to Sheep Creek. Manure management and septic systems are also identified as a potential source of *E. coli* loading.

General recommendations for the management of grazing management and septic systems and other sources of human caused *E. coli* loading to Sheep Creek are outlined below. A WRP developed by local stakeholders would contain more detailed information on restoration priorities, milestones and specific BMP recommendations to address key pollutant sources. Monitoring is an important part of the restoration process and for evaluating BMP effectiveness. Specific monitoring recommendations are outlined in **Section 6.6**.

6.5.1 Grazing and Manure Management

In watersheds that contain livestock, the goal of the *E. coli* restoration strategy is to reduce source input to stream channels by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, limiting the transport of *E. coli* (from manure on rangeland and cropland) to waterbodies. Specific BMPs include grazing management to improve riparian health by reducing livestock direct access to waterbodies and cropland filter strips. Grazing management that intends to increase vegetative post-grazing ground cover should be considered when the goal is to decrease *E. coli* loading from rangelands and cropland.

6.5.2 Septic and Other Residential Sources

For areas where there are septic systems, efforts to monitor and maintain them are necessary to minimize the loading to surface waters. In addition, BMPs that include education and outreach to inform the public to the proper way to maintain their septic systems could reduce the total loading of *E. coli* and other pathogens to the nearby waterbodies.

6.6 STRENGTHENING SOURCE ASSESSMENT AND INCREASING AVAILABLE DATA

In order to better understand conditions contributing to *E. coli* loading, it is recommended that *E. coli* sampling be continued in areas where elevated *E. coli* concentrations were observed, and to note specific land uses and conditions at the time of sampling that could be contributing to elevated instream concentrations. Additionally, *E. coli* sampling events timeframes could be expanded to include late summer low-flow conditions in order to allow analysis of load contributions during times when water quality is most susceptible to impacts from *E. coli* contributions.

The identification of pollutant sources in the Project Area was conducted through a combination of field observations, assessments of aerial photographs and GIS information, analyzing data, and the review of published scientific studies. Strategies for strengthening source assessments for *E. coli* are outlined below.

DEQ's water quality sampling for *E. coli* was distributed spatially along Sheep Creek in order to delineate pathogen sources. Samples were collected over the course of one summer field season. The level of detail of the source assessment for this project resulted in allocations to broad source categories. Therefore, additional monitoring may be helpful to better partition pollutant loading in areas with

multiple sources. The following monitoring would help improve the understanding of *E. coli* loading in Sheep Creek:

- Additional monitoring of *E. coli* for all of Sheep Creek, to span multiple field seasons.
- Additional sampling on Sheep Creek including locations upstream of sampling site 1F (**Figure 5-2**). Preferably one around the area of Deadman Creek, and one just downstream of the concentrated residential area.
- Additional monitoring of *E. coli* for the tributaries of the Sheep Creek where there is significant impacts from grazing to riparian areas. Additional monitoring will yield a better understanding of the *E. coli* sources located throughout the watershed.
- Monitoring during both high and low flow conditions. As *E. coli* exceedances occurred during a summer storm event more concerted sampling efforts could be made to collect samples during this type of events.

Below is information that could help strengthen the source assessment and help guide monitoring activities.

- Thorough analysis of the number of septic systems in the watershed, their proximity to surface water and their state of repair.
- A better understanding of waste management relative to campgrounds and other recreational activities.
- A more detailed understanding of grazing and manure management practices within the watershed.

6.7 CONSISTENT DATA COLLECTION AND METHODOLOGIES

For those stakeholders that monitor water quality, it is recommended that the same analytical methods, procedures and reporting limits are used in order that *E. coli* data be comparable to TMDL targets (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2014). It is important to note that *E. coli* sampling can be complicated by the 6-hour holding time restriction (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2014, Section 2.1.4). In addition, stream discharge should be measured at time of sampling.

DEQ is the lead agency for developing and conducting impairment status monitoring; however, other agencies or entities may work with DEQ to provide compatible data. Water quality impairment determinations are made by DEQ, but data collected by other sources can be used in the impairment determination process and to help evaluate overall progress of restoration efforts.

6.8 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.

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, 2012a) and information regarding additional funding opportunities can be found at <https://www.fedcenter.gov/opportunities/grants/>

6.8.1 Section 319 Nonpoint Source Grant Program

DEQ issues a call for proposals every year to award Section 319 grant funds administered under the federal CWA. 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 WRP 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/Water/WPB/Nonpoint-Source-Program/NPS-319-Project-Funding>.

6.8.2 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. For additional information about the program and how to apply, please visit <http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/>.

6.8.3 Renewable Resource Project Planning Grants

The DNRC administers watershed grants to pay for contracted costs associated with the development of a watershed assessment. 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/divisions/cardd>.

6.8.4 NRCS Environmental Quality Incentives Program

The National Resources and Conservation Service (NRCS) offers a number of voluntary programs to eligible landowners and agricultural producers that provide financial and technical assistance to help manage natural resources. Through these programs the NRCS approves contracts to provide financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Information regarding specific financial assistance programs is provided below.

- The Conservation Stewardship Program (CSP) helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn CSP payments for conservation performance—the higher the performance, the higher the payment. CSP website: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/programs/financial/csp/>

- The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat. EQIP website: <https://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/programs/financial/eqip/>
 - EQIP special initiatives target some of the available EQIP financial and technical assistance to address specific priorities.
 - National Water Quality Initiative, which focuses funding in select watersheds to address agricultural sources of pollution
<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/?cid=stelprdb1047761>
 - Regional Conservation Partnership Program, which focuses funding to address regional or larger watershed issues. The NRCS special initiatives vary in location and focus from year to year. More information regarding this program can be found here:
<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmland/cpp/>
- The Agricultural Conservation Easement Program (ACEP) and Wetland Reserve Easements (WRE) program provides financial and technical assistance to help conserve wetlands and their related benefits. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands. ACEP-WRE website:
<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/programs/easements/acep/?cid=nrcseprd400837>
- The Conservation Reserve Program is a voluntary program that contracts with agricultural producers, who are complying with Federal and State laws, to protect environmentally sensitive cropland by planting trees, shrubs, grass, and other long-term cover types. This program is funded through the Commodity Credit Corporation, administered by the Farm Service Agency, and NRCS provides the technical land eligibility and conservation planning. More information regarding this program can be found at:
<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/technical/cp/?cid=nrcseprd1311064>

6.8.5 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 Sheep Creek watershed or Upper Missouri Basin, please visit: <http://www.fws.gov/mountain-prairie/pfw/montana/>.

6.8.6 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: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep/>.

6.8.7 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://wetlands.mt.gov>

6.8.8 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.

6.8.9 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>.

7.0 PUBLIC PARTICIPATION AND PUBLIC COMMENTS

Stakeholder and public involvement is a component of TMDL planning supported by U.S. Environmental Protection Agency (EPA) guidelines, and by Montana state law (Montana Code Annotated (MCA) 75-5-703, 75-5-704) which directs the Montana Department of Environmental Quality (DEQ) to consult with a watershed advisory group and local conservation districts during the TMDL development process. Technical advisors, stakeholders, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process in the Sheep Creek TMDL Project area.

7.1 PARTICIPANTS AND ROLES

Throughout completion of the *E. coli* TMDL in this document, DEQ 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 TMDL in this document is contained below.

Montana Department of Environmental Quality

Montana state law (75-5-703, MCA) directs DEQ to develop all necessary TMDLs. DEQ has provided resources toward completion of this *E. coli* TMDL 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 reviewing and evaluating TMDLs to see that they meet all federal requirements.

Conservation Districts

The project area for this TMDL falls within Meagher County, and DEQ provided the Meagher County Conservation District with consultation opportunity during this project. This included opportunities to provide comment during the various stages of TMDL development, and an opportunity for participation in the advisory group discussed below.

Sheep Creek Watershed Advisory Group

The TMDL advisory group for this project consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Sheep Creek watershed, and also representatives of applicable interest groups. All members were solicited to participate in an advisory capacity per Montana state law. DEQ requested participation from the interest groups defined in MCA 75-5-704 and included municipalities and county representatives; livestock-oriented and farming-oriented agriculture representatives; mining industry representatives; state and federal land management agencies; and representatives of fishing-related business, recreation, and tourism interests. The advisory group also included additional 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 for the purpose of soliciting feedback on project planning.

Communications with the group members was typically conducted through e-mail, and draft documents were made available through DEQ's wiki for water quality planning projects: (<http://mtwaterqualityprojects.pbworks.com>). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including opportunity for review of the draft TMDL document prior to the public comment period.

7.2 RESPONSE TO PUBLIC COMMENTS

Upon completion of a draft TMDL document, DEQ issues a press release and enters into a public comment period. During this timeframe, the draft TMDL document is made available for general public comment; DEQ then addresses and responds to all formal public comments.

The public comment period for the draft Sheep Creek *E. coli* TMDL document was initiated on May 5, 2017 and closed on June 5, 2017. Electronic copies of the draft document were made available at the Meagher County, Great Falls, and Lewis and Clark public libraries. A public informational meeting was held in White Sulphur Springs, Montana on May 17, 2017. At the meeting, DEQ provided an overview of the *E. coli* TMDL, answered questions, solicited input and comment on the document, and made copies of the document available. The public comment period and public meeting were announced in a May 4, 2017 press release from DEQ which was published on DEQ's website and was distributed to multiple media outlets across Montana. A public notice advertising the public comment period and public meeting was published in the following newspapers: the Times Clarion, Great Falls Tribune, the Helena IR, Townsend Star, and the Meagher County news. Additionally, the announcement was distributed to the project's TMDL watershed advisory group, the Statewide TMDL Advisory Group, and other identified additional contacts via e-mail.

Formal written comments were received from one person representing Trout Unlimited. No other comments were received. DEQ evaluates all comments and related information to ensure no critical information was excluded from the document. Excerpts of the public comments received are contained below, and responses follow each comment. The original comment letters are located in the project files at DEQ and may be reviewed upon request.

Comment 1: According to U.S. code 33 USC 1313 303 (d) - Water quality standards and implementation plans, subsection (d) Identification of areas with insufficient controls; maximum daily load; certain effluent limitations revision "Each State shall estimate for the waters identified in paragraph (1)(B) of this subsection the total maximum daily thermal load required to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife. Such estimates shall take into account the normal water temperatures, flow rates, seasonal variations, existing sources of heat input, and the dissipative capacity of the identified waters or parts thereof. Such estimates shall include a calculation of the maximum heat input that can be made into each such part and shall include a margin of safety which takes into account any lack of knowledge concerning the development of thermal water quality criteria for such protection and propagation in the identified waters or parts thereof."

We are concerned that sampling occurring only in May, July, August and September of 2015 was not a sufficient sample period in order to take into account the estimates required in the TMDL code. 2015 was an especially low flow year, and so we are concerned that it may not have been a good indicator of Sheep Creek water quality, especially during a high flow event.

Response 1: The above “TMDL code” refers to Section 303(d)(1)(D), which relates to temperature TMDL development. This document addressed e-coli TMDL development which is covered under a different section of the above-referenced Clean Water Act (Section 303(d)(1)(C)). The sampling and analysis methods used for this *E. coli* TMDL satisfy all Clean Water Act requirements.

Neither Section 303(d) of the Clean Water Act or 75-5-703 of Montana Code Annotated (MCA) identify specific criteria or methods to be employed by DEQ when identifying waters that need TMDL development or for conducting source assessments for TMDLs. MT DEQ bases sampling locations and frequency on the Montana water quality standards for *E. coli*, standard operating procedures for sampling, knowledge of land use/sources in a watershed and best professional judgement.

Section 5.4 discusses the data collected in Sheep Creek, how and why it is compared to the water quality standard for *E. coli* and why the sampling time frame of July and August was chosen. Sampling to evaluate impairment was conducted in July of August of 2015 when DEQ determined that impacts to primary contact recreation use was most likely to occur.

While 2015 may have been a low flow year across Montana, Sheep Creek did not exhibit lower than average flows for May through August. It is important to note that water quality sampling did occur during a high flow event during the 2015 field season and the impairment listing for *E. coli* is a result of the *E. coli* sampling that took place during this event.

Comment 2: We agree that the most likely source of the high levels of *E. coli* comes from livestock defecating in Sheep Creek. However, we are concerned with the lack of samples in the upper section and headwaters of Sheep Creek, the lack of sampling in the tributaries at the upper end and headwaters of Sheep Creek and the fact that all the sampling was done in one season of one year. In the case of the *E. coli* samples, 10 days in July and August of 2015.

Since domestic waste water, failing septic tanks and recreational areas were listed as a possible source of *E. coli*, we believe there should have been samples taken near the following areas:

1. Showdown Ski area (46.838692,-110.698961). A high use recreation area with septic tanks right at the head waters of Sheep Creek.
2. Lamb Creek campground (46.760022, -110.716988) and Jumping Creek campground (46.764290, -110.785135) are established campgrounds that Sheep Creek runs directly by.
3. Forest Green Resort (46.760764, -110.753154). This is a small community with multiple cabins and residents all on septic tanks. Sheep Creek runs right through this community, while Ranch

Creek and Cascade Creek also run right through the community before dumping into Sheep Creek.

Response 2: DEQ acknowledges that additional sampling may be desirable to more accurately characterize *E. coli* concentrations in Sheep Creek. However, DEQ has provided sufficient information to address the most likely source of elevated *E. coli*. If stakeholders were interested in this greater level of evaluation, **Section 6.6** of the TMDL document includes recommendations to better partition pollutant loading and improve the understanding of *E. coli* loading in Sheep Creek.

The highest concentration of *E. coli* consistently occurred in those areas that were in close proximity to higher concentrations of grazing cattle. Provided that Showdown ski area, Forest Service campgrounds, the Sheep Creek fishing access and the users of the Forest Green Resort are discharging to properly operated and maintained septic systems, there should not be a reason for concern for *E. coli* pollution from these sources.

Comment 3: Understanding it is difficult to sample during the winter months, it would seem to make sense to sample these areas in the early spring or during the high water runoff. Specifically Showdown ski area at the headwaters, sampling directly after the ski season, the highest use time of year, one would probably be able to see a higher level of *E. coli* in the stream if there were any septic or waste water issues coming from that area.

Response 3: The Showdown ski area discharges to a subsurface wastewater treatment system (septic tank drainfield). These systems are designed to discharge at fairly constant rates and concentrations. Additional pathogens treatment occurs within the soils after discharge. Provided the system is properly operated and maintained, there should not be any excess *E. coli* from this system (see responses 2 and 4). The Showdown ski area likely sees its peak use during the January-February time frame. Sampling of the headwaters of Sheep Creek is not practical until April-May as this is the only time there would be flowing water originating from the ski area. Any surface flow from the ski area is dependent primarily on snow melt. These runoff periods are outside of the timeframe for peak use of the system and when the use of primary contact recreation in Sheep Creek is most likely to occur (see response 1). However, Section 6.6 does acknowledge the potential for this type of additional *E. coli* sampling to further characterize potential sources as discussed in the response to Comment 2.

Comment 4: We understand that those areas with the greatest concentrations of agricultural land were targeted and that use occurs lower in the watershed and as such that is where sampling locations were established. More samples means more staff time, which can logistically be a challenge. However, we believe that the number of sample sites and the duration of time samples were taken are insufficient. In order to have complete data for the water quality of Sheep Creek, from the headwaters to the mouth of the Smith River, more samples along the entirety of Sheep Creek need to be taken.

Response 4: The *E. coli* TMDL in this document provides information on the magnitude of the problem and likely sources in a form that allows one to further focus assessment and water quality improvement activities. We agree that more data collection and analysis may be

desirable, but the goal is to move onward toward addressing the major *E. coli* sources and we believe that this can be accomplished through the TMDL and sampling that took place.

If stakeholders implementing the TMDL want additional detail, then more sampling consistent with the TMDL recommendations can be pursued, but it may be preferable to expend resources toward grazing management BMPs as well as ensuring that there are no failing septic systems resulting in a direct pathogen pathway.

Comment 5: Trout Unlimited has always been an active stakeholder in the Sheep Creek watershed, and will continue to be through the entire process. We are more than willing to work with the other stakeholders, landowners, Forest Service, Conservation District etc. in order to make Sheep Creek as healthy as possible. Some possible BMPs we would recommend:

1. Agriculture and livestock will always be a part of this watershed. It is extremely important that a BMP be designed to address livestock and grazing management. Fencing projects and riparian zone restoration would be two effective ways to limit the amount of time livestock spend in the creek.
2. Work with the residents, landowners and cabin owners along Sheep Creek to make sure all of their septic systems or latrines are functioning properly and that waste water and sewage is not leaking into the groundwater, tributaries or Sheep Creek.
3. Educate anglers, campers and recreationalists using the campgrounds and access sites along Sheep Creek of the importance of proper disposal of human waste and how human waste it can affect the health of the stream.

Response 5: DEQ recognizes the importance of stakeholders in any watershed and appreciates their commitment to Sheep Creek. Regarding the recommended BMPs, a response is provided to each of the numbered comments in order of how they are listed in the above comment:

1. **Section 6.5.1** specifically identifies BMPs should include grazing management options that improve riparian health by reducing livestock access to waterbodies and cropland filter strips.
2. **Section 6.5.2** identifies potential BMPs such as education and outreach to inform the public as to the proper way to maintain their septic systems. Outreach of this nature could help to reduce the total loading of *E. coli* and other pathogens to Sheep Creek.
3. **Section 6.6** acknowledges that a better understanding of waste management relative to campgrounds and other recreational activities would strengthen the source assessment and help guide future monitoring activities.

8.0 REFERENCES

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