ROCK CREEK WATERSHED RESTORATION PLAN

TROUT UNLIMITED

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- Beaverhead Deerlodge National Forest
- Five Valleys Land Trust
- Granite County
- Granite Conservation District
- Granite Headwaters Watershed Group
- Lolo National Forest
- Montana Department of Environmental Quality
- Montana Fish, Wildlife and Parks
- Natural Resource Conservation Service
- Powell County
- Residents of Rock Creek, public meeting participants and survey participants
- Soil and Water Conservation Districts of Montana
- United States Bureau of Land Management
- United States Environmental Protection Agency
- United States Fish & Wildlife Service

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Acronyms

BMP – Best Management Practices

BLM –Bureau of Land Management

BHBLNF –Beaverhead Deerlodge National Forest

DEQ –Department of Environmental Quality

EPA –Environmental Protection Agency

FWP –Fish, Wildlife, & Parks

LNF- Lolo National Forest

NDPES –National pollution discharge elimination system

TMDL –Total Maximum Daily Load

TU –Trout Unlimited

USFS –United States Forest Service

USFWS –United States Fish & Wildlife Service

WRP –Watershed Restoration Plan

1.0 Introduction

The following document is a comprehensive watershed restoration plan (WRP) to help attain water quality standards and protect and restore the natural resource values of the Rock Creek watershed. The main objectives of this plan are:

- Protect water quality
- Support multiple water supply needs
- Protect and conserve fish and aquatic life
- Protect and conserve wildlife habitat
- Provide education and outreach to local and surrounding communities

The impetus to develop this plan came from the Montana Department of Environmental Quality (DEQ) and the Environmental Protection Agency (EPA). DEQ identifies 13 waterbodies in the Rock Creek watershed as impaired with 11 pollutant impairments and two with habitat alteration impairments (DEQ, 2016). The *Rock Creek Watershed Total Maximum Daily Loads and Water Quality Improvement Plans (TMDL)* characterizes the impaired waterbodies, describes pollutant sources, and estimates current pollutant loadings and potential reductions (DEQ, 2013).

The two agencies can grant "319 funds" to watershed groups with a WRP that includes specific elements required by EPA. The funding comes from the Clean Water Act (CWA) section 319, which supports watersheds in attaining water quality standards by implementing activities described in a WRP. This WRP fulfils the required elements by the Environmental Protection Agency (EPA) and outlines a plan for water quality improvement.

This Rock Creek WRP does not only address water quality but multiple resource needs. As such, it: (a) provides key information on the conditions and resources in the watershed; (b) describes specific management, research, monitoring, and education-based activities to ensure that the watershed can support its designated uses; and (c) identifies the partnerships and financial funding necessary to meet these needs now and in the future. Ultimately, it is a tool for Trout Unlimited and partners to use and update as necessary to guide restoration and management in the Rock Creek watershed.

1.1 Plan Organization

This watershed restoration plan begins by characterizing the watershed and its resources in Sections 2 and 3. Sections 4 and 5 then describe existing conditions, sources of impairments and information gaps. Previous TMDL evaluations of pollutant loading and potential loading reductions by pollutant source are included in Section 5. Finally, Sections 6 and 7 lay out the path to improvement including (a) goals and objectives for the watershed, (b) specific actions to achieve those goals and objectives, (c) how progress will be measured and monitored, (e) a list of key partners and sources of technical and financial assistance.

1.2 A Historical Note

Long recognized for its incredible array of natural resources- from fisheries, scenery, and wildlife to forests, ranch lands, and minerals- the Rock Creek watershed has inspired several cooperative management efforts. The watershed most notably became focus for people with fishing and hunting interests in the late 1960s, when the United States Forest Service (USFS) planned extensive logging in the drainage (Knight, 1998). In 1971, the Montana Sierra Club Group and the West Slope Chapter of Trout Unlimited filed an appeal of timber sales. In response, the United States Department of Agriculture chartered the Rock Creek Advisory Committee in 1972 to advise the USFS on Rock Creek management. The Committee and the USFS came to an agreement on water quality monitoring requirements for logging, building roads, and grazing activities, and the committee disbanded in 1976 (Knox et al., 1991).

In 1985, the Deerlodge National Forest announced timber sales in the drainage and citizens protested the lack of monitoring in the drainage. The Rock Creek Advisory Committee informally reconvened, and Forest Service Officials agreed to resume and improve monitoring in accordance with the previous agreement (Knox et al., 1991). In the same period, the Montana Wildlife Federation, National Wildlife Federation, and West Slope Chapter of Trout Unlimited appealed the proposed routing of power lines across the lower part of the watershed in addition to five potential wilderness areas. While the groups failed to reroute the lines, the Rock Creek Advisory Council was created in 1985 to administer a $1.65 million trust fund for the conservation of Rock Creek, with an emphasis on acquiring conservation easements (Knight, 1998). The Rock Creek Trust officially became a project of Five Valleys Land Trust in 1995. To date, over 13,000 acres and more than 20 miles of river frontage have been protected with 24 conservation easements and several public acquisitions and land trades (FVLT, 2016).

Historical efforts to preserve and protect the renowned Rock Creek landscape and its waters are indicative of an immense undercurrent of concern for the integrity of resources in the watershed. With this watershed restoration plan, we hope to establish a path to continue the legacy of collaborative natural resource conservation in the Rock Creek watershed, so that future generations may enjoy its magnificence.

1.3 Key Information Sources

- **Montana Department of Environmental Quality:**

  The Montana Department of Environmental Quality (DEQ) biennially identifies waterbody segments that do not support designated uses, or are otherwise "impaired". For each impaired waterbody DEQ determines the impairment causes, which fall into two categories: pollutant and non-pollutant. Waterbody segments impaired by a pollutant are included on the state's Section 303 (d) list and require development of a Total Maximum Daily Load. In the *2016 Water Quality Integrated Report*, DEQ identified 11 waterbodies in the Rock Creek watershed that are impaired by pollutants (sediment, nutrients, metals, and/or temperature) and two by non-pollutants (low flow alterations, fish passage barriers, habitat alterations, and/or vegetative cover alterations) (DEQ, 2016). The *Rock Creek Watershed Total Maximum Daily Loads and Water Quality Improvement Plans (TMDL)* (DEQ, 2013) characterizes impaired waterbodies, describes pollutant sources, and estimates current pollutant loadings and potential reductions based on a combination of empirical data and modeling. The TMDL document establishes loading limits for each waterbody-pollutant combination and then allocates loading among sources. Restoration strategies and monitoring recommendations are also incorporated into the TMDL.

- **Private Landowners and Other Interested Stakeholders:**

  On June 26th, 2017 Trout Unlimited and the Granite Conservation District hosted a public meeting at the Stony Creek Campground to solicit input on key issues and restoration opportunities in the watershed. All landowners in the watershed were invited to the meeting in a letter that was sent out two weeks prior. More than 20 people attended the meeting. By mail, all residents were also given the opportunity to complete and return a survey to express their concerns and ideas about opportunities for improvement in the Rock Creek watershed.

- **Lolo and Beaverhead-Deerlodge National Forests:**

  The Lolo and Beaverhead-Deerlodge National Forests manage more than 80% of the watershed area and have completed several projects, monitoring efforts, and prioritization efforts. Relevant information sources include the following:

  - *Rock Creek Subbasin Review* (USFS & BLM, 1998): this document is a review of ecological, social, and economic conditions in the Rock Creek subbasin.
  - *Rock Creek Section 7 Watershed Baseline* (USFS, 2000): A response to the listing of bull trout as a federally endangered species, this report describes and rates baseline environmental conditions in subbasins within the Rock Creek watershed. Ratings were updated in 2010.
  - *Beaverhead-Deerlodge National Forest Land and Resource Management Plan (*USFS, 2009).
  - Paper and electronic files from the Lolo National Forest (LNF) and Beaverhead Deerlodge National Forest (BHDLNF): Files include historical and cultural information, project documentation, and stream monitoring data.

- **Montana Fish, Wildlife, and Parks:**

  Montana Fish, Wildlife, & Parks (FWP) both collects monitoring data and prioritizes areas for management and conservation of fish and wildlife in the state of Montana. Information from FWP incorporated into this WRP includes:

  - Data from the Montana Fisheries Information System (M-FISH): The MFISH database includes information regarding fish population surveys, dewatered areas of concern, habitat measurements, and special regulations.
  - *Montana State Wildlife Action Plan* (FWP, 2015): In January 2015, FWP completed a revised version of its State Wildlife Action Plan (SWAP). The plan incorporates input from biologists, ecologists, and species experts and identifies regional Focal Areas- those areas that are in greatest need of conservation- in order to help focus conservation efforts in an increasingly inadequate funding environment.
  - Crucial Areas Planning System (FWP, 2015b; FWP, 2017). The Crucial Areas Planning System (CAPS) dataset contains crucial habitat rankings with a resolution of 1 square mile. Habitat rankings were developed considering the following: habitat for both species of concern and game species, large natural areas, landscape connectivity, and wetland and riparian areas. The CAPS database also contains supporting layers, including information on watershed integrity, aquatic connectivity, and fish native species richness. (FWP, 2015b; FWP 2017).
  - *Statewide Fisheries Management* Plan (FWP, 2013)

- **U.S. Bureau of Land Management:**

  The U.S. Bureau of Land Management (BLM) manages nearly 2% of the Rock Creek watershed, mainly for rangeland uses. In 2008 the BLM completed an assessment of *Resource conditions and management opportunities on BLM-administered lands in the Rock Creek watershed* (BLM, 2008). The BLM also maintains the Land & Mineral Legacy Rehost 2000 System ("LR200"), which allows the user to query unpatented mining claim records and authorizations for mineral patents, oil and gas, and other activities (BLM, 2017).

- **Montana Natural Heritage Program:**
  The Montana Natural Heritage Program (MTNHP) houses information about wetland and land cover types in addition to the distribution of plant and animal species statuses and distributions.

- **Geospatial Information:**

  A variety of geospatial layers were obtained from the sources listed below:

  - Montana Geographic Information Clearinghouse (Montana State Library, 2017).
  - FWP Open GIS Data (FWP, 2017).
  - USDA Forest Service Geodata Clearinghouse (USFS, 2017).
  - USDA Forest Service Northern Region Geospatial Library Region 1 Office Data (USFS Region 1, 2017).
  - Montana Natural Heritage Program Information Request (Montana State Library, 2017b).

2.0 Watershed Characteristics

2.1 Geography

The Rock Creek watershed is located in the Clark Fork River Basin of western Montana and is bound by the John Long Mountains to the east, the Anaconda Range to the south, and the Sapphire Range to the west. **Appendix A** presents a map of the watershed and its major subbasins. Rock Creek flows northwards for roughly **55 linear miles** from the Anaconda Mountain Range to its confluence with the Clark Fork River near Clinton, Montana. Rock Creek and its tributaries drain approximately **596,055 acres** (890 square miles).

Topography in the Rock Creek watershed is characterized by alpine terrain at the south end and lower elevation mountains along the axis of Rock Creek. The lowest point in the watershed is 3520 feet above mean sea level and is located at the confluence of Rock Creek and the Clark Fork River. The highest point is Warren peak, at 10,462 feet above sea level.

2.2 Climate

Climate in the watershed is typical of mid-elevation intermontane valleys in western Montana. Summer highs are often recorded at above 90 degrees Fahrenheit, while winter temperatures regularly fall below 0 degrees Fahrenheit. Precipitation is more abundant in May and June. The nearest climate station, in Philipsburg, receives an average of 14.8 inches of precipitation a year, while the mountains may exceed 40 inches of average annual moisture.

Temperature and precipitation are becoming more uncertain in the face of changing weather patterns. The Rock Creek watershed is part of the Columbia River Basin, where minimum air temperatures increased by 1°C (~2°F) and maximum temperatures have increase by 1.3°C(~2.3°F) during the period from 1970 to 2006. Precipitation has shown indications of decline during the same period (Littell et al. 2010). Climate change projections for the Pacific Northwest suggest that average annual air temperatures will increase by 1.8°C (3.2°F) by the decade of the 2040s and by 3.0°C (5.3°F) by the 2080s, relative to average temperatures from 1970-1999. Average annual precipitation levels are not likely to vary as much, though seasonal precipitation patterns may shift (CIG, 2008).

2.3 Geology and Soils

The geology of the Rock Creek watershed is complex. Unlike many valleys in western Montana that occupy fault-bounded basins between uplifted mountains, much of the watershed is underlain by a structural unit called the Sapphire Block, a slab of Middle Proterozoic Belt Supergroup rocks. As a result, there is a relatively shallow, continuous bed rock beneath the valley floor.

The Sapphire Block includes the Sapphire Mountains and John Long Mountains. Dominant lithologies are siltstone, sandstone, and limestone (and their metamorphic equivalents), which more erosive than the granitic rocks in the surrounding mountain ranges. Younger Paleozoic sedimentary rocks are found only along the northern margin of the Anaconda Range. These rocks have been intruded by several generations of Cretaceous and Tertiary igneous rocks; metamorphism and hydrothermal activity associated with these rocks produced economically significant ores. Volcanic rocks of tertiary age are also present. Tertiary sediments are found mostly in the Upper Willow Creek drainage and the upper half of the Rock Creek watershed. These sediments are found on terraces and on higher elevations than modern alluvium (MDEQ, 2013).

There is widespread evidence of two recent episodes of glacial activity: Bull Lake (~130,000 years ago) and Pinedale (23,000-16,000 years ago) (Chadwick et al., 1997, Pierce et al, 1976). Glacial deposits are widespread in the southern portion of the watershed along the Anaconda Range (Lonn et al., 2003). The nature of sedimentary deposits varies; areas underlain by till tend to be swampy and poorly drained and commonly have springs. In contrast, deposits from streams flowing on or adjacent to glaciers tend to be well drained and well-sorted (MDEQ, 2013).

Soil data for the Rock Creek watershed is available at fine scales from the Natural Resources Conservation Service (NRCS), Soil Survey Geographic database (SSURGO). Additionally, the United States Geological Survey (USGS) created a dataset of hydrology-relevant soil attributes based on the NRCS State Soil Geographic (STATSGO) soil database (Schwarz and Alexander, 1995). This dataset is applied to watersheds of larger scale mapping. Soil erosion susceptibility within the watershed is described as follows: 39% low-susceptibility, 53% moderate susceptibility, 8% moderate-high susceptibility. Low susceptibility soils area associated with the Sapphire batholith and other granitic plutons, as well as the higher-elevation areas of the Anaconda and Sapphire Ranges. Moderate-high susceptibility soils are strongly associated with Tertiary sediments. The Rock Creek watershed is considerably steeper below the confluence with Upper Willow Creek, with slopes of greater than 30° common. Above Upper Willow Creek, the watershed exhibits broader valleys with steep slopes on the flank of the Anaconda Range (MDEQ, 2013).

2.4 Land Ownership

An estimated 552 people live in the Rock Creek watershed as of 2010 (United State Census Bureau, 2010). About 500 private landowners- many of whom have mailing addresses outside of the watershed- own land in the Rock Creek watershed. Over 80% of the area is administered by the United States Forest Service (USFS). Private landowners own 16% of the watershed, while United States Bureau of Land Management (BLM) owns 1.9% and the Montana State Land Trust owns 1.2%. A large majority of the Rock Creek watershed is in Granite County, with a small portion in Missoula County. 9,484 acres in the watershed are under conservation easement.

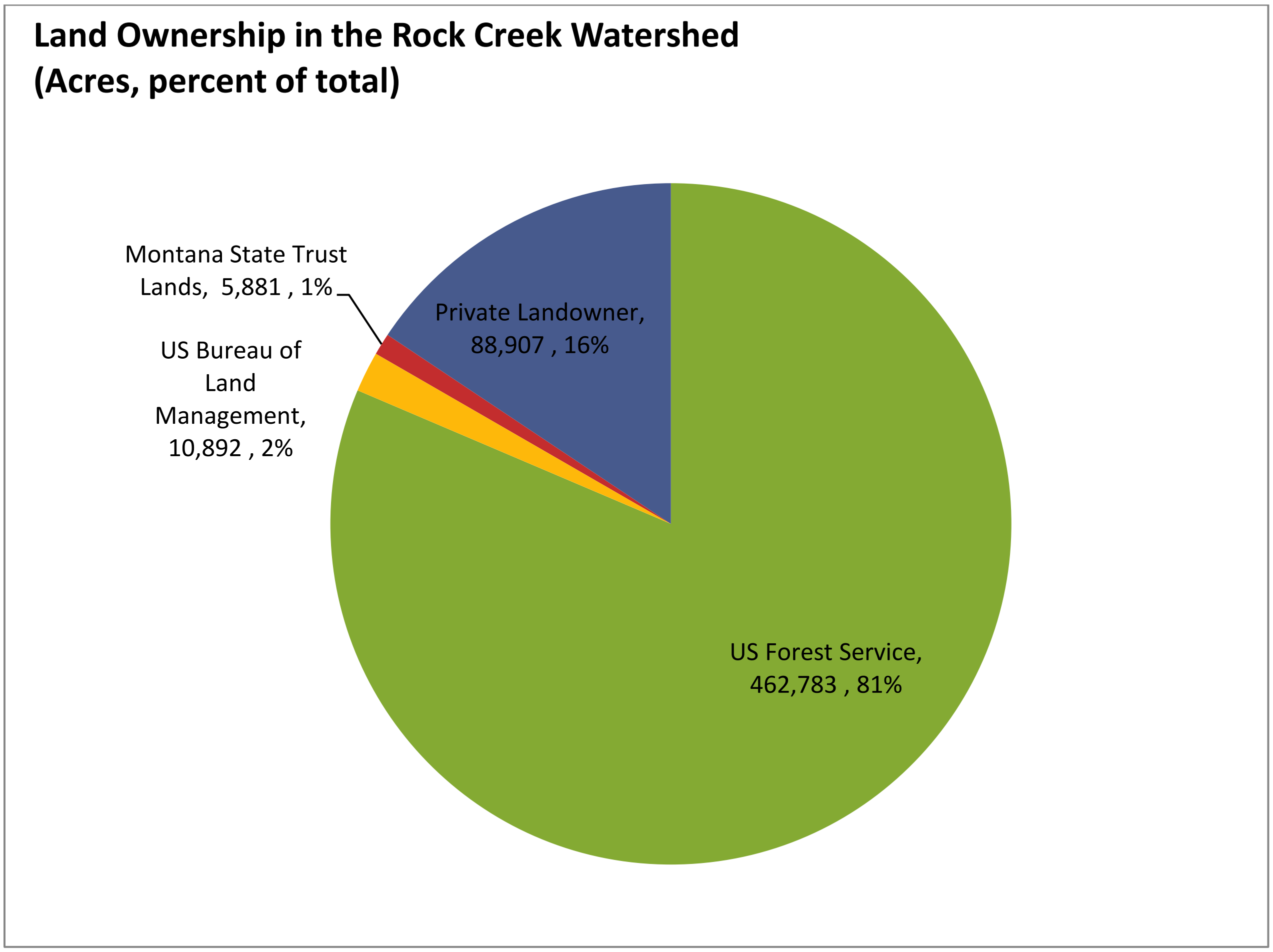


FIGURE 1. LAND OWNERSHIP IN ROCK CREEK

2.5 Land Cover

Land use in the watershed is dominated by forest and agriculture. Other primary land use classes are silviculture and historical mining. The Montana Natural Heritage Program (MTNHP) compiles land use/land cover data adapted from the Northwest ReGAP project land cover classification, which used 30-meter resolution satellite imagery acquired between 1999 and 2001 (MTNHP, 2016). Land cover classifications comprising more than 0.5% of the watershed area are shown below. **Appendix B** presents a map of landcover in the Rock Creek watershed.

Conifer-dominated forest and woodland (xeric-mesic)

274,560 acres (48.3%)

Recently burned

99,333 acres (17.5 %)

Montane Grassland

63,844 acres (11.2%)

Conifer-dominated forest and woodland (mesic-wet)

50,013 acres (8.8%)

Sagebrush Steppe

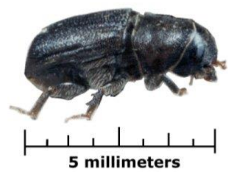
16,986 acres (3.0 %)

Floodplain and Riparian

13,599 acres (2.4%)

Harvested Forest

12,575 acres (2.2%)



Source: https://en.wikipedia.org/wiki/Dendroctonus

Insect-Killed Forest

9,018 acres (1.6%)

Deciduous dominated forest and woodland

7,086 acres (1.2 %)

Deciduous Shrubland

5,249 acres (0.9%)

Developed

4,914 acres (0.9%)

Agriculture

3,405 acres (0.6%)

FIGURE 2 PRIMARY LAND COVER CLASSES IN THE ROCK CREEK WATERSHED

Primary vegetative cover in the uplands is conifer forest with most communities consisting of large blocks of mature forest. At lower elevations, vegetation is dominated by ponderosa pine and Douglas-fir forests.

Lodgepole pine begins to dominate at higher elevations, with Douglas-fir growing on sunnier south and west facing slopes, and subalpine fir and Engelmann spruce grow along stream bottoms and shadier north and east aspects. At the highest elevations, subalpine larch and whitebark pine join subalpine fir. Alpine tundra is found on the very highest peaks. Mixed with coniferous forests are aspen clones both in upland and riparian areas. Riparian areas vary from cottonwood at lower elevations to willow and sedge communities at moderate and high elevations (USFS and BLM, 1998; USFS, 2009). Valleys are characterized by grassland vegetation and irrigated agricultural land, with minor shrublands. (USFS and BLM, 1998; USFS, 2009). Human activities, primarily livestock production, have altered species composition to non-native grasses such as bluegrass and timothy and less vigorous non-native species (USFS, 2000).

2.6 Wilderness and Roadless Areas

The Rock Creek watershed contains portions of both the Lolo National Forest and the Beaverhead-Deerlodge National Forest including the Welcome Creek Wilderness Area, Anaconda-Pintler Wilderness Area, Sapphire Wilderness Study Area, Ermine Roadless Area, and Stony Mountain Roadless Area.

2.7 Recreational Areas

Many people place recreation and aesthetics as the highest value of the Rock Creek landscape. Rock Creek is a destination for a wide range of recreational pursuits, including angling, camping, hiking, big game hunting, wildlife viewing, horseback riding, pleasure driving, and snowmobiling (USFS, 2009). **Appendix C** is a map of recreation access points, including Fishing Access Sites, trails and roads.

2.8 Transportation Networks

The principal transportation route in the Rock Creek watershed is Montana Highway 38, which connects Philipsburg to Hamilton via Skalkaho Pass. Granite County Road 102 ("Rock Creek Road") runs from Highway 308 to Clinton, along Rock Creek.

According to the Montana transportation framework data, there are a total of 809 miles of road and 410 miles of trail in the Rock Creek watershed. A total of 691 stream crossings were identified using a geographic information system (GIS) to find intersections between roads and high-resolution National Hydrography Dataset (NHD). At least 38 bridges and 110 culverts are documented within the watershed. There are no active or abandoned railways present in the watershed (MDEQ, 2013).

TABLE 1 TRANSPORTATION NETWORKS IN THE ROCK CREEK WATERSHED

Transportation Networks	Miles
Road: Asphalt	29
Road: Dirt or Native Material	490
Road: Crushed Aggregate or Gravel	276
Road: Unspecified Material	14
TOTAL ROADS	809

Infrastructure	Count
Railways	0
Documented Bridges	38
Documented Culverts	110
Total Road and Stream Crossings Identified	691

3.0 Natural Resources and Resource Use

3.1 Agriculture

Agriculture in the valley is predominately irrigated hay and grazing for cattle. A total of 3,405 acres in the watershed are classified as agricultural lands (grazing, irrigated hay production, or crop production) (MTNHP, 2016). Grazing allotments managed by the USFS and BLM cover 202,240 acres (36% of watershed) and 30,883 acres (5% of watershed), respectively. Irrigated agricultural production is concentrated in the lower halves of Upper Willow Creek, East Fork Rock Creek, Middle Fork Rock Creek, and the Ross Fork Rock Creek subbasins, and the upper half of the Upper Rock Creek subbasin.

Estimates of total irrigated acreage in the watershed vary. Cursory analysis of Google Earth aerial imagery indicates that irrigation water is applied to an estimated 6,340 acres in the watershed. The Department of Revenue reports nearly 3,000 acres of irrigated land. Berkas et al. (2005) reports that diversions from the Rock Creek watershed irrigate nearly 16,100 acres, presumably including land in the Flint Creek watershed irrigated by thetransbasin diversion water that originates in the East Fork Rock Creek Reservoir. The Montana Department of Natural Resources (DNRC) water rights database indicates that about 28,000 acres or land in the watershed are legally irrigable.

3.2 Mining

The Rock Creek watershed was the scene of considerable mining activity. Mining began with the discovery of placer gold and later sapphire deposits in a number of upper Rock Creek tributaries beginning in the early 1860s and lasting as late as the 1940s (MDEQ 2013). Lode mines were also developed and milling activities were performed at many locations. Remnant waste rock and tailings piles are present throughout the watershed.

Placer mining still exists in limited amounts in the Rock Creek watershed. Placer mining for sapphires is focused in several ephemeral drainages in lower West Fork Rock Creek. Placer mining for gold deposits is taking place in Eureka Gulch under three Small Mine Exclusions Statements issued by DEQ.

3.3 Timber

Prior to settlement, the Rock Creek watershed experienced moderately frequent, mixed severity fires and infrequent high intensity fires, creating a landscape of large blocks of old and mature forest with smaller areas of younger ages classes. Fire prevention and suppression led to fuel buildup and changes in vegetation composition in the latter half of the 20th century (USFS and BLM, 1998). In recent decades, the

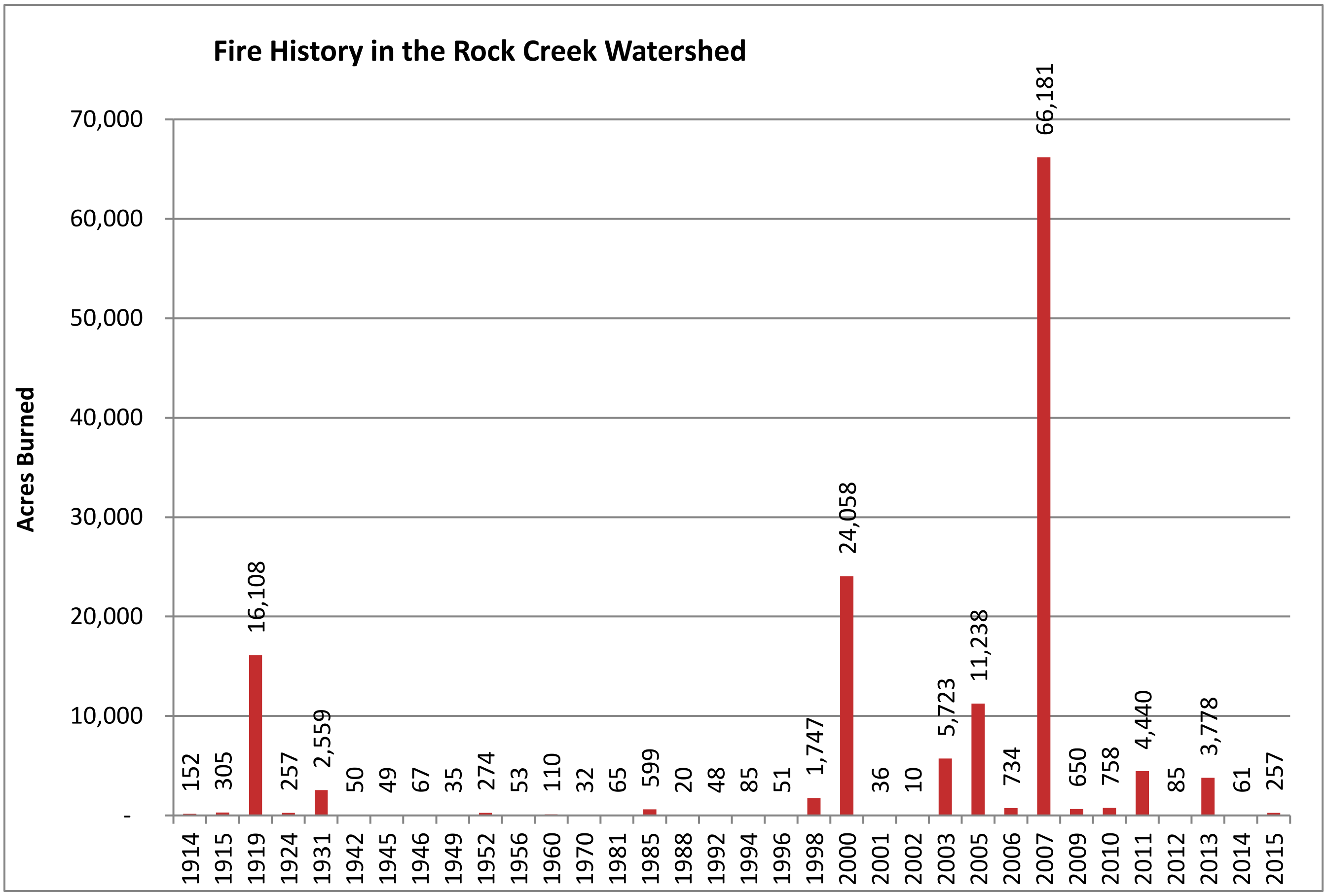


FIGURE 3 ACRES BURNED BY YEAR IN THE ROCK CREEK WATERSHED, 1914-2015

forest has experienced several significant burns. Nearly 66,400 acres burned in 2007, 24,000 acres in 2000 and over 43,000 acres in 2017

Insects and disease occur naturally in all forest types within the watershed. Major pathogens include mountain pine beetle, western pine beetle, western spruce budworm, various root rots, dwarf mistletoe, white pine blister rust, and spruce beetles (USFS, 2000). According to recently updated land cover data, insect-killed forest comprises 9018 acres, or 1.6% of the watershed.

Timber production in the Rock Creek watershed began to ramp up in the early 1960's with hundreds of acres harvested each year. In the late 1960s and early 1970s, timber production increased further with thousands of acres harvested annually. Production remained relatively steady from 1980 to 2000; an average of 340 was harvested each year during this period. Since 2000 production has been limited, except for one large harvest completed in 2006.

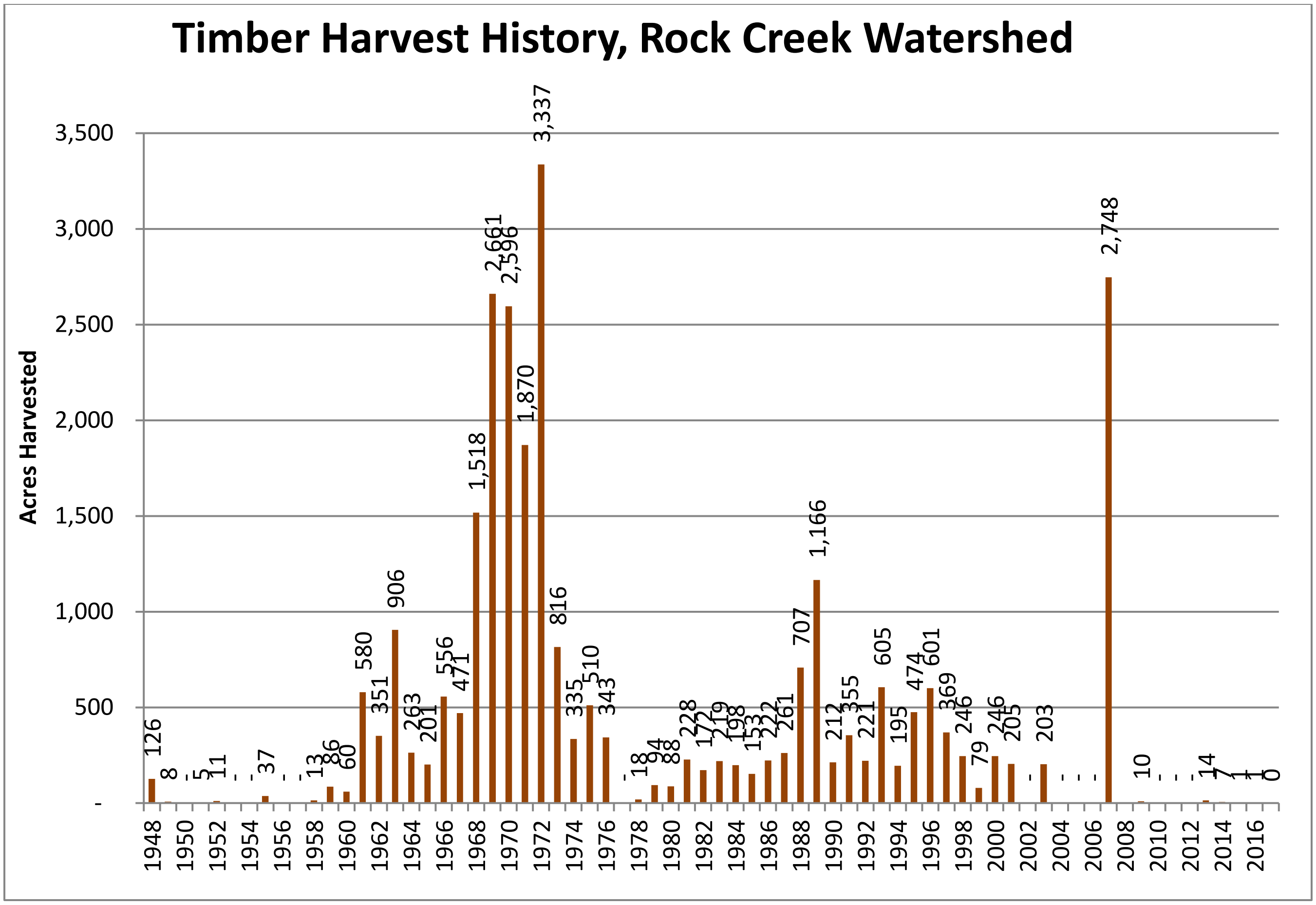


Figure 4 Acres harvested for timer each year in the Rock Creek Watershed, 1948-2016

3.4 Water Supply

3.41 Surface Water

There are five significant tributaries in Rock Creek: East Fork, Middle Fork, Ross Fork, and West Fork of Rock Creek, and Upper Willow Creek. The high-resolution (1:24K scale) National Hydrography Dataset (NHD) maps 1,923 miles of streams, and the medium-resolution (1:10K scale) NHD maps 184.5 miles of streams in the watershed. The high-resolution NHD includes 483 lakes covering 1,236 acres, including 52 named lakes. The largest waterbody is the East Fork Rock Creek Reservoir; the other named lakes are generally tarns present in the higher portions of the Anaconda Range.

The hydrology of the Rock Creek basin is driven by accumulation and melt of winter snowpack. Flows in Rock Creek and its tributaries vary considerably during the year and from one year to the next. All annual peak discharges measured in Rock Creek have occurred in May or June, driven by high amounts of precipitation during these months and spring snowmelt. Typically, more than half of annual runoff occurs during this 60-day period. By mid to late July, a return to base flow occurs. The low flow period occurs from September to March with January often having the lowest flow. Climate and streamflow models indicate that future seasonal shifts in precipitation and increased temperatures will most likely result in lower summer streamflows and, in lower elevation streams, potentially higher and more frequent peak flows (Mantua et al., 2010; Wu et al. 2012).

The USGS has two active gaging stations in the watershed at the mouth of Rock Creek near Clinton and in the Middle Fork of Rock Creek near Phillipsburg. Historical gaging stations on Ranch Creek and Rock Creek near Quigley, Montana and on the East Fork of Rock Creek near Phillipsburg provide limited streamflow data from 1910 to 1943.

TABLE 2. AVERAGE MONTHLY DISCHARGE IN ROCK CREEK 1973- 2016

Average Monthly Discharge, Rock Creek near Clinton, MT, 1973-2016		
Month	**Average Discharge (cfs)**	**Percent of Annual Discharge**
January	184	3%
February	193	3%
March	252	4%
April	538	9%
May	1,516	24%
June	1,673	27%
July	653	10%
August	305	5%
September	255	4%
October	246	4%
November	227	4%
December	195	3%

4.42 Groundwater

Groundwater flow within the valleys of the Rock Creek watershed is presumed to be typical of intermontane basins. Groundwater flows toward the center of the basin from the head and sides, and then down the valley along the central axis. Aquifer recharge occurs from infiltration of precipitation, stream loss, flow out of adjacent bedrock aquifers, and flood irrigation (DEQ, 2013).

Considerable groundwater is held in alluvial deposits that fill the majority of the valley bottom, but the groundwater reservoir would not be available to sustain surface runoff for long. A gain-loss survey completed by USGS in the 1970's showed Rock Creek to be a "gaining stream"; the volume of water flowing in the main channel increases with distance downstream from the headwaters. Flows from the numerous tributaries swell the size of the discharge volume in contrast to some streams that continually lose water to the groundwater table (USFS, 2000).

The Montana Bureau of Mines and Geology (MBMG), Groundwater Information Center (GWIC) monitors and samples a statewide network of wells. As of June 2017, the GWIC database contains 410 wells located within the Rock Creek watershed; 347 wells are for domestic use, 22 for stockwater, 5 for irrigation, and 14 for public water supply (MBMG, 2017). There are at least 3 additional public water supplies within the watershed. Most of the wells are small, transient, non-community use systems that use groundwater and are all located near the mouth of Rock Creek (DEQ, 2013).

3.43 Water rights

Most of the water rights in the basin are for stock and irrigation purposes, but other, instream water rights exist as well. The figures below show the distribution of water right types for each subbasin.

According to the Montana Water Rights database, there are 569 active surface water and 431 active groundwater water rights within the Rock Creek watershed. These rights are associated with 1603 and 434 points of diversion for surface water and groundwater, respectively; however, many of the "points of diversion" in the database are redundant or non-representative of literal diversions. At least 92 distinct diversions are identifiable with aerial imagery.

In addition to water right diversions, FWP holds "Murphy Rights", or instream flow water rights for fisheries, for two reaches of Rock Creek: the headwaters to Ranch Creek, and Ranch Creek to the mouth. The priority date for all Murphy Rights is January 6th, 1971. Minimum streamflows associated with the Murphy Rights on Rock Creek are provided in the table below. A hydrograph is also provided comparing typical Rock Creek streamflows to the FWP Murphy water right for the reach from Ranch Creek to the mouth.

TABLE 3. MURPHY RIGHTS IN THE ROCK CREEK WATERSHED

Claim Number	Period of Use	Flow (cfs)	Volume (acre-ft)
Reach: Ranch Creek to Mouth			
76E 133209	July 16 - April 30	250	143,272
76E 133211	May 1 - May 15	454	13,504
76E 133213	May 16 - May 31	975	30,935
76E 133214	June 1 - June 15	926	27,544
76E 133212	June 16 - June 30	766	22,785

76E 133210	July 1 - July 15	382	11,363
Reach: Headwaters to Ranch Creek			
76E 133219	July 16 - April 30	150	85,963
76E 133216	May 1 - May 15	454	13,504
76E 133217	May 16 - May 31	975	30,935
76E 133215	June 1 - June 15	926	27,544
76E 133208	June 16 - June 30	766	22,785
76E 133218	July 1 - July 15	382	11,363

Downstream from the mouth of Rock Creek on the Clark Fork River, Avista Corporation owns a 50,000 cfs water right at the Noxon Rapids Dam. Though the dam is not very close in proximity to the Rock Creek watershed, its associated water right has implications for new appropriations and water rights changes.

The Rock Creek basin is legislatively closed to new water use permits; no new water rights have been issued since 1955. Exceptions to the closure include rights for stock water, surface water storage, and groundwater. Legal water availability is limited by the Noxon Dam hydropower water right and the Murphy Rights on Rock Creek. Applications to change the existing water use for any water right will require mitigation or aquifer recharge, if it will result in flow reductions when streamflow is less than either the Noxon Dam right or FWP's Murphy Rights (Kirk Engineering & Natural Resources, 2015).

3.431 East Fork Rock Creek Dam

In 1938, East Fork Rock Creek was dammed and a transfer pipeline (siphon) was constructed to move the impounded water to the Flint Creek drainage. The East Fork Rock Creek Dam is owned by DNRC and operated by the Flint Creek Water Users Association. It is an earthen embankment dam, 88 feet high and 1,083 feet long. The reservoir stores 16,040 acre-feet at normal pool covering 390 acres (Montana Department of Natural Resources and Conservation, 2012). The transfer pipeline diverts about one-quarter of a mile below the dam and follows a northwesterly direction to Trout Creek, which is used as a carrier for the diversion of water by other canals in the Flint Creek valley below (State Engineers Office, 1959). The canal has a maximum capacity of 200 cubic feet per second (cfs) (Norberg, M as cited in DEQ, 2013). On the basis of flow data collected by DNRC in 2010 and 2011, water is typically diverted into the canal from late May through September with flow rates in the range of 50 to 150 cfs. In 2010, the canal diverted between 34 and 98 percent (median 94 percent) of the flow discharged from East Fork Reservoir. A fish screen was installed downstream of the diversion structure in late 2013. Below the canal diversion, East Fork Rock Creek gains between 24 and 32 cfs by the time it reaches the mainstem of Rock Creek. Flows occasionally decrease or remain constant in this section due to multiple small irrigation withdrawals (Norberg, M., as cited in DEQ, 2013).

3.5 Fish

Rock Creek is a well-known coldwater fishery designated as a "blue-ribbon" trout stream as defined by Montana FWP. Rock Creek is a stronghold for native bull trout and westslope cutthroat trout. Other native species in the watershed include: mountain whitefish, longnose dace, redside shiner, slimy sculpin, northern pike minnow, largescale sucker, and longnose sucker. Non-native species present in the watershed include brook trout, rainbow trout, brown trout, and grayling. The sections that follow detail the status of both focal native species, in addition to species that are important to the sport fishery. Information is lacking on the abundance and life histories of mountain whitefish and other non-game native species. **Appendix D** present species distribution of native and non-native trout surveyed by FWP using electroshocking methods.

ILLUSTRATION OF BULL TROUT BY JOEL SARTORE WITH WADE FREDENBERG (NATIONAL GEOGRAPHIC STOCK, CITED IN USFWS, 2015).

3.51 Bull Trout

In November 1999, the U.S. Fish and Wildlife Service (USFWS) listed all populations of bull trout within the coterminous United States as a threatened species pursuant to the Endangered Species Act. FWP has also designated bull trout as a "species of concern". The Rock Creek drainage is a designated "core area" for bull trout in the USFWS Bull Trout Recovery Plan (USFWS, 2015). 75 miles of Rock Creek and its tributaries, in addition to the East Fork Rock Creek Reservoir, have been designated as critical bull trout habitat. Furthermore, local bull trout populations in the Rock Creek watershed appear to be the least vulnerable to climate change-related flow and temperature stressors relative to other areas in the Lolo National Forest (Wade et al., 2016).

Bull trout are currently found throughout the mainstem of Rock Creek and comprise a large meta-population of fluvial fish, with fish moving throughout the drainage for spawning, rearing, and foraging. This population also contributes bull trout to the Clark Fork River. The majority of the populations are considered migratory, but there is evidence that some tributary populations may be mostly resident fish (e.g. North Fork Rock Creek). Redd surveys indicate that a majority of larger bull trout spawning populations are located in tributaries in the upper end of the drainage, though spawning and rearing tributaries are found throughout the watershed. The East Fork Rock Creek Reservoir contains the largest bull trout population in the drainage. This adfluvial population uses East Fork Rock Creek for spawning and rearing, and juveniles eventually out-migrate to the reservoir, where they reside as sub-adults and adults. A large of amount of spawning occurs in the portion of the creek inundated by stored water from the reservoir, since East Fork Rock Creek is intermittent about a half mile above the reservoir (FWP, 2013 and Liermann, 2017).

The Rock Creek watershed was historically a major bull trout drainage in western Montana. USFS biologists estimate the Rock Creek Core Area may have supported as many as 400 to 800 fluvial bull trout redds prior to the 1850's. Significant human resource usage began in the early 1900's with impacts ranging from small scale ranching and stocking of non-native species to extensive timber harvests. In 1907, construction of the Milltown Dam severed the connection between Rock Creek and the lower Clark Fork River and interrupted migration and spawning (USFS and BLM, 1998). Despite changing trends and regulations surrounding land use and fisheries, bull trout numbers in Rock Creek continue to decline. The average number of redds over the past six years has been about 50, while a century ago those numbers were probably ten times higher (USFS 2013). Over the past 20 years, the number of bull trout redds has decreased in index reaches of Lower Rock Creek tributaries. The number of redds has also decreased in index reaches of Upper Rock Creek tributaries, though the degree of decline is less certain. Bull trout catch-per-unit effort in the Rock Creek mainstem has also dropped substantially over the past 45 years. Observed declines in bull trout abundance may be attributed to reduced streamflows and increased stream temperatures associated with climate change and/or the expansion of brown trout, but data is too limited to make definitive conclusions. Despite these observed population declines, the number of observed redds in both Upper and Lower Rock Creek appears to have stabilized since 2009. Redd counts in the East Fork Rock Creek index reach indicate a trend of increasing bull trout spawning over the past 15 years (Liermann, 2017).

3.52 Westslope Cutthroat Trout

Westslope cutthroat trout are also a state-designated "species of concern". Similar to bull trout, westslope cutthroat trout are a meta-population moving throughout the Rock Creek drainage and Clark Fork River to complete their life history. Westslope cutthroat trout spawning and rearing tributaries are found throughout the drainage. Fluvial westslope cutthroat trout are found throughout the mainstem Rock Creek and are most abundant in the upper portion of the watershed. Populations of weststlope cutthroat trout are relatively well connected, allowing for gene flow between populations, hybridization, and colonization by introduced species (FWP, 2013 and Liermann, 2017). However, environmental conditions in the higher elevation portions of Upper Willow Creek, West Fork, Ross Fork, Middle Fork, and East Fork subbasins will likely reduce hybridization potential relative to other parts of the watershed (Youngs et al., 2016).

3.53 Sport Fish

Brown trout provide a majority of the sport fishery in the Rock Creek drainage, although westslope cutthroat trout are abundant in the upper mainstem and provide an excellent fishery. Rainbow trout were historically abundant throughout the drainage until whirling disease was introduced into the drainage in the early 1990s. The disease is suspected to have caused widespread declines of rainbow trout in the late 1990's and early 2000's. Rainbow trout are still abundant in the lower portion of the drainage, but their densities are much lower than was observed before whirling disease. In contrast, brown trout have increased throughout the mainstem and replaced rainbow trout as the most abundant salmonid (FWP, 2013 and Liermann, 2017).

Public fishing access in the drainage is excellent, and Rock Creek supports some of the highest angling pressure in the state of Montana. Angling occurs year-round and is most popular in the spring, summer, and fall. Float fishing is only allowed on Rock Creek from December 1 through June 30. East Fork Rock Creek Reservoir has been stocked with westslope cutthroat trout since 2004, which has been successful in establishing a popular recreational fishery. Several other lakes in the drainage are stocked with fish (FWP, 2013).

3.6 Wetlands

According to a modern mapping effort completed by the Montana Natural Heritage Program in 2016, the Rock Creek watershed contains 17,359 acres of mapped wetlands, riparian areas, and deepwater habitat (**Appendix E**). The new classification system includes attributes that allow for the identification of wetland and riparian areas with a high capacity to improve water quality and/or water quantity. Specific wetland

and riparian area functions include flood abatement, sediment retention, nutrient attenuation, streamflow maintenance, bank stabilization, and stream temperature improvement (Carpenedo, 2013). Wetland types comprising more than 50 acres of the watershed are displayed below according to their water regime.

Wetlands with special modifications include 61 acres of palustrine wetlands with beaver influence, 248 acres of palustrine wetlands that are farmed, 442 acres of palustrine and lacustrine wetlands that are diked/impounded, and 38 acres of palustrine and riverine wetland areas that have been excavated.

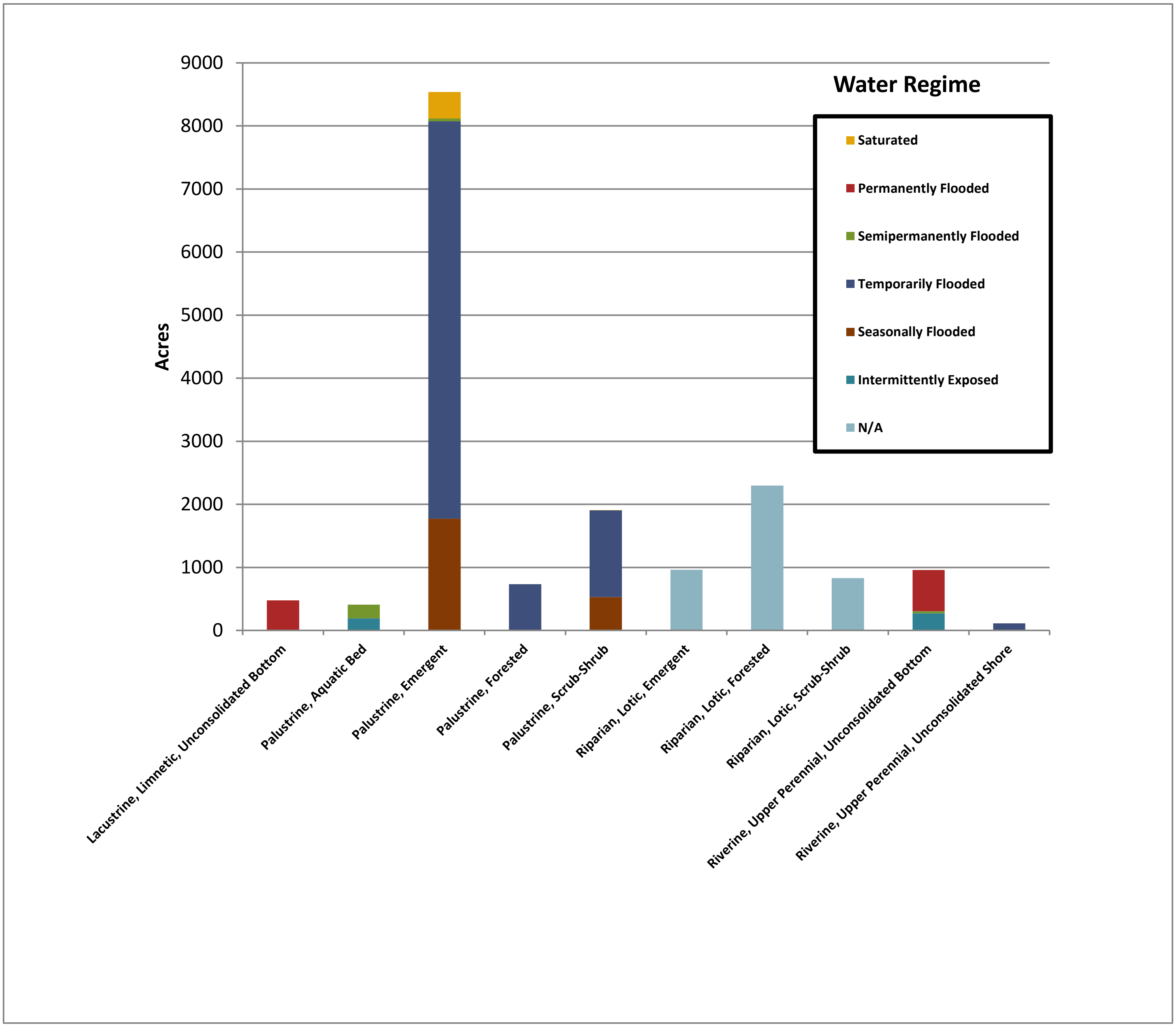


FIGURE 5 WETLAND TYPES IN THE ROCK CREEK WATERSHED

NWI Code			Wetland Type	Acres	Description
		Lacustrine (Lakes)			
	L1UB		Limnetic, Unconsolidated Bottom	475	Deep waterbodies with mud or silt covering at least 25% of the bottom
	L2AB		Littoral, Aquatic Bed	30	Shorelines with vegetation growing on or below the water surface for most of the growing season
	L2US		Littoral, Unconsolidated Shore	47	Shorelines where there is less than 75% areal cover of stones, boulders, or bedrock, and less than 30% vegetation cover. The area is also irregularly exposed due to seasonal or irregular flooding and subsequent drying.
		Palustrine			
	PAB		Aquatic Bed	410	Wetlands with vegetation growing on or below the water surface for most of the growing season.
	PUB		Unconsolidated Bottom	21	Wetlands where mud, silt or similar fine particles cover at least 25% of the bottom, and where vegetation cover is less than 30%.
	PUS		Unconsolidated Shore	11	Wetlands with less than 75% areal cover of stones, boulders, or bedrock, and with less than 30% vegetative cover. The wetland is exposed to seasonal or irregular flooding and subsequent drying.
	PEM		Emergent	8539	Wetlands with erect, rooted herbaceous vegetation present during most of the growing season.
	PSS		Scrub-Shrub	1906	Wetlands dominated by woody vegetation less than 6 meters (20 feet) tall. Woody vegetation includes tree saplings and trees that are stunted due to environmental conditions.
	PFO		Forested	735	Wetlands dominated by woody vegetation greater than 6 meters (20 feet) tall.
		Riparian			
	Rp2FO		Lentic, Forested	2	This riparian Class has woody vegetation that is greater than 6 meters (20 feet) tall
	Rp1SS		Lotic, Scrub-Shrub	829	This type of riparian area is dominated by woody vegetation that is less than 6 meters (20 feet tall). Woody vegetation includes tree saplings and trees that are stunted due to environmental conditions.

	Rp1FO		Lotic, Forested	2298	This riparian Class has woody vegetation that is greater than 6 meters (20 feet) tall.
	Rp1EM		Lotic, Emergent	963	Riparian areas that have erect, rooted herbaceous vegetation during most of the growing season.
		Riverine (Rivers)			
	R4SB		Intermittent, Streambed	24	Active channel that contains periodic water flow
	R2US		Lower Perennial, Unconsolidated Shore	1	Shorelines with vegetation growing on or below the water surface for most of the growing season
	R2UB		Upper Perennial, Unconsolidated Bottom	957	Stream channels where the substrate is at least 25% mud silt or other fine particles
	R3US		Upper Perennial, Unconsolidated Shore	112	Shorelines with less than 75% areal cover of stones, boulders, or bedrock and less thatn 30% vegetation cover. This area is also irregularly exposed to seasonal or irregular flooding and subsequent drying.

FIGURE 6 WETLAND WATER REGIMES IN THE ROCK CREEK WATERSHED

3.7 Terrestrial Habitat

The Rock Creek watershed provides habitat to hundreds of mammalian and avian species. Wetland habitat along the length of the Rock Creek headwaters and sagebrush grasslands in the adjoining foothills are home to sandhill cranes, mountain lions, mountain goats, black bear, Bighorn sheep, mule deer, whitetail deer, and elk. Riparian habitats in the Rock Creek headwaters provide critical nesting/foraging habitat for riparian birds, yearlong moose habitat, and water for many species. Prairie pothole wetlands, unique for the generally dry Upper Clark Fork watershed, are found at Potato Lakes (NRDP, 2012). The Rock Creek watershed is home to at least 7 mammalian, 20 avian, 2 reptilian, 1 amphibian, 9 invertebrate, and 20 plant species that the state of Montana has designated “species of concern”. This includes the Canada lynx, a federally listed threatened species, and the wolverine, which is a proposed federally threatened species. It also includes the whitebark pine, which USFWS has designated as a candidate species due to existing status and threats (MTNHP, 2017). Species of concern with common habitat comprising more than 0.05% of the watershed area are given in the table below.

Species Group	Common Name	Habitat	Distribution	% of Watershed Area that is Common Habitat
Amphibians	Western Toad	Wetlands, floodplain pools	Resident Year Round	0.1%

Birds	Long-billed Curlew	Grasslands	Migratory Summer Breeder	6.2%
	Brown Creeper	Moist conifer forests	Resident Year Round	6.1%
	Clark's Nutcracker	Conifer forest	Resident Year Round	6.1%
	Flammulated Owl	Dry conifer forest	Migratory Summer Breeder	6.1%
	Northern Goshawk	Mixed conifer forests	Resident Year Round	6.1%
	Pacific Wren	Moist conifer forests	Resident Year Round	6.1%
	Pileated Woodpecker	Moist conifer forests	Resident Year Round	6.1%
	Varied Thrush	Moist conifer forests	Migratory Summer Breeder	6.1%
	Harlequin Duck	Mountain streams	Migratory Summer Breeder	2.2%
	Cassin's Finch	Drier conifer forest	Resident Year Round	1.2%
	Great Gray Owl	Conifer forest near open meadows	Resident Year Round	1.2%
	Veery	Riparian forest	Migratory Summer Breeder	1.2%
	Black Rosy-Finch	Alpine	Resident Year Round	0.4%
	Golden Eagle	Grasslands	Resident Year Round	0.4%
	Peregrine Falcon	Cliffs / canyons	Resident Year Round	0.1%
Mammals	Canada Lynx	Subalpine conifer forest	Resident Year Round	6.1%
	Fisher	Mixed conifer forests	Resident Year Round	1.2%
	Hoary Bat	Riparian and forest	Migratory Summer Breeder	0.1%
	Little Brown Myotis	Generalist	Resident Year Round	0.1%
	Townsend's Big-eared Bat	Caves in forested habitats	Resident Year Round	0.1%
Reptiles	Northern Alligator Lizard	Talus slopes / rock outcrops	Resident Year Round	0.4%
	Western Skink	Open conifer forest and adjacent grasslands	Resident Year Round	0.4%

Vascular Plants	California False-hellebore	Wetland/Riparian	Present	8.7%
	Keeled Bladderpod	Grassland slopes (low-elevation)	Present	6.2%
	Hollyleaf Clover	Open areas (foothills and montane)	Present	6.1%
	Missoula Phlox	Slopes/ridges (Open, foothills to subalpine)	Present	0.5%
	Whitebark Pine	Subalpine forest, timberline	Present	0.5%
	Kruckeberg's Swordfern	Alpine	Present	0.4%
	Dense-leaved Pussytoes	Alpine	Present	0.2%
	Thick-leaf Whitlow-grass	Alpine	Present	0.2%
	Mountain Lousewort	Alpine	Present	0.2%
	Cascade Willow	Alpine	Present	0.2%
	English Sundew	Fens	Present	0.1%
	Pod Grass	Wetland/Riparian	Present	0.1%

FIGURE 7. SPECIES OF CONCERN IN THE ROCK CREEK WATERSHED(MNHP)

Portions of the Rock Creek watershed are included in the Philipsburg West priority area identified in a 2011 effort led by FWP and the Montana Natural Resource Damage Program (NRDP) to identify and rank terrestrial wildlife priority areas in the Upper Clark Fork River Basin. The Philipsburg West priority area spans portions of the Rock Creek and Flint Creek watersheds and contains 51,751 acres of Priority 1 areas and 44,828 acres of Priority 2 areas. Priority 1 areas in the Philipsburg West region consist of important riparian habitat, extensive high-quality native grasslands, and low level of landscape fragmentation (NRDP, 2012). These habitat areas contribute to wildlife occurrence and persistence across a much larger area than their own footprints.

The Rock Creek watershed also contains several areas identified as aquatic and terrestrial focal areas in Montana's State Wildlife Action Plan (SWAP) (FWP, 2015). Nearly half the watershed (276,354 acres) was designated as Priority Level 1 in a statewide assessment of crucial habitat; 36% of the watershed was designated as Priority Level 2. These prioritization efforts considered distributions of species of concern and species of economic or recreational importance, landscape connectivity, and the presence of large intact habitat blocks, among other factors.

4.0 Watershed Condition: Causes and Sources of Impairment

4.1 Sediment

4.11 Effects of Sediment on Beneficial Uses

Sediment is a naturally occurring component of healthy and stable aquatic ecosystems. Deposition of sediment by flood events builds floodplain soils and point bars, and prevents excess scour of the stream channel. Vegetation and natural instream barriers such as large woody debris and beaver dams help trap sediment and build channel and floodplain features. When these features are absent or when excessive sediment loading occurs, channel form and function may be altered and aquatic habitat may be degraded. Sediment can block light and cause a decline in primary production, interfere with fish and macroinvertebrate survival and reproduction, cause streams to appear murky and discolored, and increase filtration costs for water treatment facilities (DEQ, 2013).

4.12 Sediment Impairments, Sources, and TMDL

DEQ identified ten waterbody segments as impaired by sediment and three stream segments of concern (**Appendix F**). Sources of sediment in the Rock Creek watershed include:

- **Bank Erosion**: Streambank erosion occurs naturally, but is also caused by human disturbances and land use practices in the following categories: transportation, riparian grazing, cropland, mining, silviculture, instream energy shifts from irrigation, and historical human disturbances. The largest contribution of loads due to streambank erosion in the Rock Creek watershed comes from natural sources, however, current and historical riparian grazing is the greatest anthropogenic contributor of sediment loads for most assessed sites in the watershed. Transportation is the second largest anthropogenic contributor, especially where roads were confining the stream.
- **Hillslope Erosion:** Upland hillslope erosion also occurs naturally, but is influenced by land cover (e.g. historical fires and timber harvest), grazing, and riparian vegetation health.
- **Unpaved Roads:** Roads consisting of gravel or native material contribute sediment to waterbodies at road crossings, where contributing lengths were greater than 100 ft.
- **Culverts:** Undersized or improperly installed culverts may be a chronic source of sediment or an acute source in the case of failure. A yearly load estimate for culverts was not calculated or incorporated into the 2013 TMDL due to uncertainty of the timing of culvert failures and the lack of monitoring to track the occurrence of these failures. Within the Rock Creek watershed, 23 of 27 culverts assessed in the field are capable of passing a 2-year flood event, while only 9 of these culverts pass a 100-year flood event.

The Rock Creek TMDL (DEQ, 2013) describes the sediment loading and load allocations for waterbodies in the Rock Creek watershed. Load allocations are based on modeled implementation of Best Management Practice (BMP) scenarios, and are therefore indicative of potential sediment loading reductions that could be achieved with the implementation of this WRP.

4.2 Nutrients

4.21 Effects of Excess Nutrients on Beneficial Uses

Nitrogen and phosphorous are natural chemical elements required for healthy and stable aquatic ecosystems. However, human activities can increase the biologically available supply of nitrogen and phosphorous, which can lead to eutrophication. Eutrophication is the enrichment of a waterbody that leads to increased aquatic plant production, including nuisance algae. Respiration rates from nuisance algae can deplete oxygen available for other aquatic organisms and can shift the macroinvertebrate community structure. Nuisance algae also effects waterbody aesthetics and can pose health risks if ingested, both of which harm recreation uses. Excess nitrogen in the form of dissolved ammonia can be toxic to aquatic life, and excess nitrogen in the form of nitrates in drinking water can inhibit normal hemoglobin function in infants (DEQ, 2013).

4.22 Nutrient Impairments, Sources, and TMDL

In the Rock Creek watershed, 5 waterbody segments appeared on the 2016 Montana 303(d) list for nutrient impairments (**Appendix G**). East Fork Rock Creek is also listed for chlorophyll-a- or excess algal growth- which is correlated with high nutrient concentrations. Sources of nutrients in the Rock Creek watershed include:

- **Natural Background:** soils and local geology, natural vegetative decay, wet and dry airborne deposition, wild animal waste, natural biochemical processes
- **Agricultural Practices:** animal waste, loss of riparian and wetland vegetation along streambanks
- **Silvicultural Practices:** limited nutrient uptake due to loss of overstory
- **Historical Mining:** release of contaminants from mine waste material or acid mine drainage

DEQ determined that agricultural sources (primarily cattle grazing) are the most current and prominent sources of nutrients for every impaired stream segment. Nutrient TMDLs are calculated using the water quality target values detailed in Section 7.4 of the TMDL document and loads apply during the summer growing season. Nutrient TMDL allocations are composited into a single load allocation to all nonpoint sources, including natural background sources. The table below provides a summary of waterbodies in the Rock Creek watershed that have nutrient impairments. The table also provides nutrient sources, and example existing loads and allocations based on the median growing season flow for each stream. The examples provided below apply only to the median growing season flow (July1 – September 30) (DEQ, 2013). The example allocations are indicative of potential nutrient loading reductions that could be achieved with the implementation of this WRP.

TABLE 4 EXAMPLE NUTRIENT TMDLS IN THE ROCK CREEK WATERSHED BASED ON MEDIAN GROWING SEASON FLOW OF 34.1 CFS. FOR ACTUAL LOADS BY DISCHARGE, SEE LOAD CURVES IN THE TMDL DOCUMENTATION (DEQ 2013)

Stream Segment	Median Growing Season Flow	Nutrient Pollutant Listing	Source Category	Current Load (lbs/day)	TMDL (lbs/day)	% Reduction
East Fork Rock Creek (East Fork Reservoir to mouth)	34.1 cfs	Total Nitrogen	Natural Background	N/A*	15.6	N/A*
			Agriculture	N/A*	39.6	N/A*
		Total Phosphorous	Natural Background	1.0	1.0	0%
			Agicultural and Silvicultural Land Use	9.30	4.51	51.5%
South Fork Antelope Creek (Headwaters to mouth)	0.44 cfs	Total Nitrogen	Natural Background	0.20	0.20	0%
			Agicultural and Silvicultural Land Use	2.19	0.51	76.7%
		Total Phosphorous**	Natural Background	0.024	0.024	0%
			Agicultural and Silvicultural Land Use	0.111	0.047	57.7%
		Nitrate + Nitrite	Natural Background	0.047	0.047	0%
			Agicultural and Silvicultural Land Use	1.25	0.19	84.8%
Scotchman Gulch (Headwaters to mouth)	0.39 cfs	Total Nitrogen	Natural Background	0.18	0.18	0%
			Agriculture Land-Use	1.13	0.45	60.1%
		Total Phosphorous	Natural Background	0.013	0.013	0%
			Agriculture Land-Use	0.129	0.05	61.2%
Sluice Gulch (Headwaters to mouth)	1.27 cfs	Nitrate + Nitrite	Natural Background	0.14	0.14	0%
			Agricultural Land-Use and Historical Mining	3.06	0.54	82.4%
		Total Nitrogen	Natural Background	0.58	0.58	0.0%
			Agricultural Land-Use and Historical Mining	3.57	1.48	58.5%
Flat Gulch (Headwaters to mouth)	0.12 cfs	Total Phosphorous	Natural Background	0.06	0.06	0%
			Agricultural Land-Use and Historical Mining	0.59	0.13	77.9%
		Total Nitrogen	Natural Background	0.006	0.006	0%
			Agricultural Land-Use and Historical Mining	0.31	0.013	95.8%
*Measured instream TN concentrations are within natural background conditions and below target concentrations. However, high algal mass was observed and indicates that nutrients are being taken up by algal growth, suggesting that actual loads may be greater than measured instream.						
**Load reduction calculation based on the 94th percentile of the TP concentration data to account for exceedances during the summer growing season.						

4.3 Metals

4.31 Effects of Elevated Levels on Beneficial Uses

Elevated metals concentrations can have toxic, carcinogenic, or bioconcentration effects in humans, wildlife, aquatic organisms, plants, and livestock. Metals can therefore impair several beneficial uses of surface water including aquatic life support, drinking water, irrigation, and livestock water supplies.

4.32 Metals Impairments, Sources, and TMDLs

DEQ lists seven waterbody segments as impaired for metals on the 2016 303(d) list (**Appendix H**). Metals sources include:

- **Natural background**: mineralized bedrock surface erosion
- **Abandoned mines**: adit discharge or precipitation seepage through mine wastes.
  - Many inactive mines occur in the upper Ross Fork, Middle Fork, East Fork, Stony Creek, Williams Creek, Brewster Creek, and Williams Creek tributaries that have either not been assessed or are not currently listed as being impaired by metals.
  - DEQ's mine waste bureau classified seven inactive mine sites within the Rock Creek watershed as "priority" mines, or those that are a source of high public concern due to hazardous mine openings and/or heavy metal and mineral processing contamination of surface and ground water.
  - The MBMG abandoned mines inventory includes 133 abandoned mine sites dispersed within the watershed, 46 of which have been visited and/or assessed. MBMG completed an environmental survey of 35 mines in the watershed the mid-1990s, identifying 8 sites to have potential environmental problems (Metesh et al., 1995).
- **Active mines**: discharges from mining facilities operating under a Small Miners Exclusion Statement.
  - As of 2013, active mining activities included placer mining for sapphires in several ephemeral drainages in lower West Fork Rock Creek and placer mining for gold in Eureka Gulch. Alluvial deposits in Basin and Cornish Gulches had been excavated.
- **Sediment**: sediment-bound metals entering surface water from human-caused surface erosion

TMDLs for metals are a function of stream discharge and, in some cases, water hardness; calculation procedures for specific metals are detailed in Section 8.6 in the TMDL document. The tables below list impaired waterbodies and associated sources. The table also provides example metals loading estimates and example waste load allocations based on a given flow (DEQ 2013). Example A are indicative of potential metals loading reductions that could be achieved with the implementation of this WRP.

TABLE 5 METAL SOURCES IN TMDL IMPAIRED WATERBODIES IN THE ROCK CREEK WATERSHED

Stream Segment	Prominent Metals Sources
Basin Gulch (headwaters to mouth)	Inactive underground mine and breached tailings impoundment related to the former Blue Bell silver mine. Series of valley bottom check dams from historic placer mining. Surface disturbances resembling exploration trenches, drill pads, and roadways.
Eureka Gulch (confluence of Quartz Gulch and Basin Gulch to mouth)	Historic and recent placer mining operations.
Flat Gulch (headwaters to mouth)	There are no abandoned mines described in either the MBMG or DEQ abandoned mine databases. Metals impairments appear to relate to accelerated erosion from human land uses such as timber harvesting, livestock grazing, or historic placer mining, which can contribute sediment-bound aluminum and iron loads to surface waters. Additional potential sources include groundwater or an unidentified mine adit or shaft.
Quartz Gulch (headwaters to mouth)	Sediment-bound loading. The stream has been extensively placer mined; channel stabilization after reclamation varies from in the upper drainage to distinguishable channel near the mouth.
Scotchman Gulch (headwaters to mouth)	Sediment from past mining operations (two inactive placer mines), livestock grazing, and silvicultural practices.
Sluice Gulch (headwaters to mouth)	Abandoned mines and past mining activities, predominantly the Silver King and Lori No.13 mines.
West Fork Rock Creek (headwaters to month)	Inactive abandoned placer mine operations in the upper portion of the drainage and quarried placer deposits in the Anaconda and Sapphire Gulch drainages further downstream. Two lode mine developments in the Maukey Gulch tributary.

Table 6 Example Metals TMDLs for impaired waterbodies in the Rock Creek watershed. For actual loads by discharge, see load curves in the TMDL documentation (DEQ, 2013).

Stream Segment	Station	Metal	Flow Conditions	Discharge (cfs)	Hardness (mg/L)	Existing Metal Concentration (µg/L)	Target Concentration (µg/L)	Existing Load (lbs/day)	TMDL (lbs/day)	Natural Background Load Allocation (lbs/day)	Waste Load Allocation (lbs/day)	Needed Reduction (%)
Basin Gulch (headwaters to mouth)	C02BASNG10	Arsenic	High flow	0.4	NA	15	10	0.0324	0.0216	0.0032	0.0184	37%
			Low flow	0.1		15	10	0.0081	0.0054	0.0005	0.0049	36%
Eureka Gulch (confluence of Quartz Gulch and Basin Gulch to mouth)	C02EURKG10	Arsenic	High flow	0.67	NA	16	10	0.0578	0.0361	0.0054	0.0307	41%
			Low flow	0.3		16	10	0.0259	0.0162	0.0016	0.146	40%
		Mercury	High flow	0.67		0.5	0.05	0.0018	0.0002	0.000009	0.00019	89%
			Low flow	0.3		0.5	0.05	0.00081	0.0001	0.000004	0.00002	88%
Flat Gulch (headwaters to mouth)	C02FLATG04	Aluminum	High flow	0.07	NA	50	87	0.0188	0.0329	0.0329		0%
			Low flow	0.03		130	87	0.021	0.0141	0.0064	0.0076	47%
		Iron	High flow	0.07		170	1000	0.0641	0.3776	0.0775	0.3002	0%
			Low flow	0.03		1370	1000	0.2217	0.1618	0.0097	0.1553	28%
Quartz Gulch (headwaters to mouth)	C02QRTZG01	Aluminum	High flow	0.37	NA	460	87	0.9182	0.1737	0.1737		81%
			Low flow	0.06		15	87	0.0049	0.0282	0.013	0.0152	0%
		Lead	High flow	0.37	26	0.6	0.57	0.0012	0.0011	0.0005	0.0006	14%
			Low flow	0.06	57	0.25	1.56	0.0001	0.0005	0.0001	0.0004	0%
Scotchman Gulch (headwaters to mouth)	C02SCTMG03	Aluminum	High flow	0.52	NA	140	87	0.5966	0.2441	0.2441		59%
			Low flow	0.53		160	87	0.5092	0.2487	0.1273	0.1213	68%
Sluice Gulch (headwaters to mouth)	C02SLUCG01	Arsenic	High flow	1.4	NA	12	10	0.0906	0.0755	0.0113	0.0642	17%
			Low flow	1.2		11	10	0.0712	0.0647	0.0065	0.0582	9%
		Copper	High flow	1.4	143	4	12.66	0.0302	0.0956	0.0038	0.0918	0%
			Low flow	1.2	148	0.5	13.04	0.0032	0.0844	0.0032	0.0812	0%
West Fork Rock Creek (headwaters to mouth)	C02ROCWF05	Aluminum	High flow	940	NA	90	87	456	441	441		3%
			Low flow	33		15	87	2.7	15	7.1	1.9	0%

4.4 Temperature

4.41 Temperature and Aquatic Life

Warmer water temperatures can negatively affect aquatic life and fish that depend upon cool water for survival. The upper incipient lethal temperature (UILT, or the temperature considered to be survivable indefinitely by 50% of the population over a specified period of time) for Bull Trout is 68.5°F (20.3°C) (Selong et al., 2001). The temperature that will kill 10% of the population within a 24 hour period (LD10) for Bull Trout is 74°F (23.4° C). Bull trout have a maximum growth near 59.5°F (15.3° C) (McCullough and Spalding, 2002). For westslope cutthroat trout, the UILT is 67.5°F (20.0°C) (Bear et al, 2007), and the LD10 is 73.0°F (22.8°C) (Lines and Graham, 1988). Westslope Cutthroat Trout have an optimum growth range from 50.5°F to 62.6 °F (10.3-17.0 °C)

Rainbow trout have an optimum growth temperature range of 44.4 °F to 69.4 °F (6.8-20.8 °C), allowing for increased competition with cutthroat trout in warmer streams (Bear et al., 2007). Brown trout also tolerate warmer temperatures better than native trout, but high temperatures can still negatively affect the population. The 7-day UILT for brown trout is between 76.5 °F and 80.1 °F, and the upper lethal concentration for juvenile brown trout is 75.4 °F (Beschta et al., 1987).

4.42 Temperature Impairments, Sources, and TMDL

East Fork Rock Creek is the only waterbody segment in the Rock Creek watershed that is on the 2016 303(d) list of impaired waters for temperature impairment (**Appendix I**). South Fork Antelope Creek was on the list in 2012, but was removed in 2013 after the TMDL assessment. Modeling results indicate that current daily maximum temperatures are 0.6 to 3.6°F greater than a scenario in which all reasonable land, soil, and water conservation practices are implemented. Sources of thermal loading to East Fork Rock Creek include:

- **Reduced Streamflow**: due to irrigation diversions
- **Lack of riparian shading:** due to impacts from timber harvest, grazing, irrigated hay production, and limited recreational activity and residential activity.
- **Channel geometry:** increased width-to-depth ratios due to riparian canopy cover alterations resulting from timber harvest, grazing, and hay production.

Surrogate indicators are used for temperature TMDL allocations for East Fork Rock Creek, from the East Fork Reservoir to the mouth, and are shown in the table below. These allocations represent restoration targets for potential thermal loading reductions that could be achieved with the implementation of this WRP.

TABLE 7 TEMPERATURE TMDL ALLOCATIONS FOR EAST FORK ROCK CREEK

Source Type	Allocation
Land uses that reduce riparian health and shade provided by riparian vegetation	Minimum effective shade of 42% along reaches A through F; Minimum effective shade of 63% along reaches G through I (see Figure 6-5 in the TMDL document for reach break-outs)
Land uses and practices that result in overwidening of the stream channel	Average width-depth ratios of <23 on C channels and <12 on E channels
Streamflow diversions for irrigation water during summer months	15% water savings from improved irrigation delivery and application efficiencies, and allowing that water savings to flow down East Fork Rock Creek downstream from the point of the diversion of the East Fork Rock Creek canal (any voluntary water savings and subsequent in stream flow augmentation must be done in a way that protects water rights).

5.43 Stream Temperature and Climate Change

Stream temperatures are projected to increase with increasing air temperatures and decreased streamflows associated with climate change. The magnitude of these increases are variable and depend on several factors; for example, naturally occurring colder streams may warm less than warmer streams. Modeled August stream temperatures for 2040 and 2080, based on global climate model ensemble averages, are shown in the **Appendix J** below (Isaak et al., 2016).

4.5 Streamflow Depletion

4.51 Stream Segments of Concern

Extreme low flow conditions and dry channels resulting from local water use management are harmful to fish and aquatic life, and may have implications for future water supply.

In the 2016 Integrated Report, DEQ identified 3 stream segments impaired by low-flow alterations:

- **East Fork Rock Creek**: East Fork Reservoir to mouth (9.74 miles)
- **Upper Willow Creek,** headwaters to mouth (21.7 miles)
- **Brewster Creek,** East fork to mouth (4.57 miles)

FWP has identified 6 stream reaches in the watershed that support or contribute to important fisheries and are significantly dewatered by man-caused flow depletions:

- **North Fork Spring Creek**
- Lower 0.5 miles of **Brewster Creek**
- Lower mile of **Ranch Creek**
- Lower 5 miles of **South Fork Spring Creek**
- Lower 7.4 miles of **Upper Willow Creek**
- Lower 5 miles of **Ross Fork Rock Creek**

It is also worth noting that East Fork Rock Creek is intermittent above the reservoir, eliminating upstream passage during summer low flow periods.

4.52 Streamflow and Climate Change

Climate and streamflow models predict seasonal shifts in precipitation and increased temperature, which will likely result in lower summer flows and, in lower elevation streams, earlier and potentially higher and more frequent peak flows (Mantua et al. 2010; Wu et al. 2012). While future conditions are uncertain, these changes will almost inevitably augment the need to conserve water for both aquatic life and other beneficial uses.

4.6 Geomorphological changes

Stream channels may be straightened to accommodate roads, agricultural fields, or through placer mine operations. Channel straightening and human-influenced down-cutting results in reduced morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life.

DEQ lists “physical substrate habitat alterations” as a probable cause of impairment for **Upper Willow Creek** (headwaters to mouth).

4.7 Fish Passage and Entrainment

Native and non-native fluvial fish species are affected by infrastructure that forms instream passage barriers and water diversions that entrain upstream and downstream moving fish. Impoundments for water diversions and perched culverts at road crossings fragment fish habitat and can impede fish movement. Toxic barriers such as mine discharge also act as fish passage barriers. Both physical and chemical barriers isolate native species from non-native species, restrict access to preferred habitat and food resources, increase the chance of predation and disease, and reduce genetic flow between populations (DEQ, 2013). Furthermore, fish entrainment into irrigation ditches, pipelines, and agricultural fields causes mortality that can affect fish populations (Bahn, 2007).

4.71 Culverts

Within the Rock Creek watershed there are 691 road-stream crossings, according to the most updated versions of the high-resolution National Hydrography Database (NHD) and the Montana transportation network database. Of those crossings, 110 culverts are documented in the watershed.

The USFS surveyed culverts at potential fish-bearing stream and road crossings from 2002 to 2005. In the Lolo and Beaverhead-Deerlodge National Forests within the Rock Creek watershed, 84 culverts were surveyed, and 79 were identified as full or partial fish passage barriers. DEQ also performed 30 culvert surveys as part of the 2013 TMDL development for the watershed. 27 culverts were assessed and 26 were classified as fish passage barriers.

4.72 Irrigation Diversions

From 2007 to 2011, FWP surveyed and assessed 16 diversions in the Rock Creek watershed for fish passage and entrainment issues. 11 of these diversions were determined to be high priorities for mitigation because of the high probability of entraining bull trout and/or large numbers of westslope cutthroat trout. The other five ditches were classified as medium priority for mitigation, because of the probability that fewer native fish would be entrained in those ditches (Schreck et al., 2011).

In 2017, TU began a multi-phase process to inventory diversions in the Rock Creek watershed. 92 discrete diversions were identified with aerial imagery or by landowners in the watershed. During the 2017 field season, TU was granted access to survey 35 of those diversions for fish passage and entrainment. Information was recorded on the physical characteristics of the diversion and headgate structures as well as the stream. The information was used to assess whether the diversion was a barrier to fish passage and for the threat of entrainment to down-migrating fish. Data collected for the assessment of the diversion included:

- Passage barrier inventory form (based on NRCS fish passage evaluation criteria)
- GPS location, photo points, & site sketch
- Topographical laser survey for slope profiles of stream at point of diversion and ditch or pipeline
- Flow measurements or ditch cross sectional survey

Of the 35 diversions surveyed, five were inactive, two had existing fish screens, 24 were found to be partial barriers to fish passage, and four were identified as full fish passage barriers (**Appendix K**).

4.8 Vegetation

4.81 Riparian Vegetation Alteration

Alteration or removal of riparian vegetation can lead to destabilized banks, overwidened stream channel conditions, elevated sediment loading, and elevated stream temperatures. Streamside vegetation alteration may be the result of road or utility construction, streamside mine tailings or placer mining remnants, overgrazing by livestock, loss of beaver, and increases in big game (DEQ, 2013; USFS, 2000).

DEQ lists 7 waterbodies in the Rock Creek watershed for "alteration in streamside or littoral vegetative covers" (DEQ 2016):

- **Basin Gulch**, headwaters to mouth
- **East Fork Rock Creek,** East Fork Reservoir to mouth
- **Eureka Gulch,** confluence of Quartz Gulch and Basin Gulch to mouth
- **Quartz Gulch,** headwaters to mouth
- **Sluice Gulch,** headwaters to mouth
- **South Fork Antelope Creek,** headwaters to mouth
- **Upper Willow Creek,** headwaters to mouth

On some stream reaches, particularly at lower elevations, conifers are encroaching and overtopping riparian vegetation (USFS, 1998). Conifer encroachment is in part influenced by fire management and timber harvest practices, and is also occurring on former grasslands and shrublands (USFS, 1998). Encroachment of conifers may have significant impacts on stream hydrology, reduce forage for native ungulates, and threaten the viability of streamside vegetation, including cottonwood and willow stands.

4.82 Weeds

Weeds can out-compete and replace native vegetation with greatly reduced ground-cover and altered soil productivity. This can lead to high erosion rates and long-term losses in soil productivity.

In the process of collecting stakeholder input for this WRP, several landowners cited weeds as an issue in the watershed. Numerous exotic, non-native species, many of which are listed by the state of Montana as "noxious weeds", have been introduced into the Rock Creek watershed, especially in agricultural areas, along the Skalkaho Highway, Road #102 and other roads, the Bonneville Power utility corridor, and areas within the forest that have experienced disturbance from recreation, roads, and timber harvesting. Spotted knapweed is a major competitor in warm dry forests and in grasslands, and other weed species are also starting to gain a foothold in the watershed (USFS & BLM, 1998). Lower elevations and drier aspects are at the highest risk of invasion by noxious weeds (USFS, 2000).

During the 2011 sediment/habitat surveys, DEQ noted the presence of weeds along several streams, including Antelope Creek, Brewster Creek, Eureka Gulch, Flat Gulch, Miners Gulch, Sluice Gulch, South Fork Antelope Creek and West Fork Rock Creek. Weed species included knapweed, mullein, thistle, and dock-leafed smartweed, (DEQ, 2013).

4.9 Point Source Pollution

Nine National Pollution Discharge Elimination System (NPDES) permits were identified in the Rock Creek watershed. These were not active point sources when the TMDL was written in 2013, therefore their impacts on water quality should be evaluated.

Table 8 National Pollution Discharge Elimination System (NDPES) permits in the Rock Creek watershed

Stream	Date Created or Updated	Purpose
Rock Creek	8/9/2016	Excavation Work
Rock Creek	3/5/2013	Excavation Work
Rock Creek	8/18/2015	Gold Ores
East Fork Rock Creek	8/18/2015	Water, Sewer, Pipeline, and Communications and Power Line Construction
East Fork Rock Creek	12/19/2014	Water, Sewer, Pipeline, and Communications and Power Line Construction
Ross Fork Rock Creek	3/5/2013	Excavation Work
Rock Creek	8/18/2015	Heavy Construction
East Fork Rock Creek	12/29/2014	Bridge, Tunnel, and Elevated Highway Construction
Rock Creek	7/5/2016	Bridge, Tunnel, and Elevated Highway Construction, Heavy Construction

5.0 Information Gaps

The Rock Creek TMDL document identifies the need to strengthen pollutant source assessments and increase available data (DEQ, 2013). The restoration and protection of the Rock Creek watershed will depend on additional resources to refine water quality pollutants and sources on both the mainstem and its tributaries. Furthermore, there is a need to identify where opportunities exist to address these issues. Efforts to address information gaps should focus on the following:

- **Main sediment sources along the mainstem of Rock Creek and in sub-watersheds**. Project opportunities to address this data need, include but are not limited to BEHI assessments on eroding banks and an inventory of stream and road crossings.
- **Metal sources from abandoned mines in the watershed.** There is a need to update the database of priority abandoned mines. Data collection in the form of site visits and soil and water samples identify metal contamination from historical mining and opportunities for mine restoration projects.
- **Waterbody segments contributing to excessive temperature loads.** To address this data need, ground cover and land use models can be combined with ground-based knowledge of water use. This information will show where low seasonal flows and riparian coverage overlap, and identify opportunities to reduce temperature loading through riparian restoration and planting.
- **Water use on the mainstem and in subwatersheds**. Continue inventorying irrigation structures, withdrawals, and needs. Identify where withdrawal and instream flow depletions occur simultaneously, where fish passage barriers exist, and opportunities to improve irrigation efficiency.
- **Bull trout presence in the watershed.** Continued eDNA sampling throughout the watershed will detect bull trout presence, especially in tributaries. Improved knowledge of bull trout populations in the watershed will help guide fishery restoration priorities and make federal grants and other funding available.
- **Groundwater return.** There is a need for better data evaluating irrigation return flows (volume and timing) to prioritize irrigation efficiency project development.
- **Natural nutrient levels and sources in subwatersheds.** A better understanding of baseline nutrient levels and sources would help discern anthropogenic nutrient sources from background sources and identify projects to reduce anthropogenic nutrient loading.

6.0 Watershed Restoration: The Path to Improvement

6.1 Management Goals and Objectives

The Rock Creek TMDL provides management recommendations for the watershed. Several other entities have developed resource priorities as well. This WRP incorporates information from the following reports and assessments to identify watershed priorities:

- Rock Creek Subbasin Review (USFS, 1998)

- Section 7 Watershed Baseline (USFS, 2000)
- Conservation Strategy for Bull Trout on USFS lands in Western MT (May 2013)
- Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (USFWS, 2015)
- Statewide Fisheries Management Plan (FWP)
- Montana State Wildlife Action Plan- Aquatic and Terrestrial Focus Areas (GIS layers)
- Upper Clark Fork River Basin Terrestrial Wildlife Resource Prioritization (FWP & NRDP, 2011)
- Rock Creek Assessment (BLM, 2008)
- 2007-2009 Riparian Assessment Data (FWP, 2008 and 2009)
- Beaverhead Deerlodge National Forest Plan (BHDLNF, 2009)
- West Fork Rock Creek Watershed Assessment (BHDLNF, 2007)
- Lolo National Forest Climate Change Vulnerability Assessment (USDA, 2016)
- Additional Landowner/Stakeholder Input

The following table summarizes restoration goals for the Rock Creek Watershed.

TABLE 9 WATERSHED RESTORATION GOALS

Project category	Goals
Landowner outreach	• Form working relationships with watershed landowners and ranch managers • Assess potential projects and land management opportunities on private land • Identify mutually beneficial projects with long-lasting impacts to natural resources and agricultural improvement • Use demonstration projects to build trust and support throughout the watershed
Grazing management	• Control livestock access to stream through incentive programs or comprehensive grazing management plans • Allow for streambank recovery in locally degraded areas
Crop production	• Provide technical assistance for crop conversion to improve yield or drough resiliency • Increase vegetative ground cover to reduce soil erosion • Allow for vegetation to filter cropland runoff before it enters waterways
Streambank and aquatic habitat recovery	• Improve stream access to floodplain • Increase presence of native, deeply-rooted vegetation along stream banks • Reduce presence of invasive plant species in riparian zones • Reconstruct channel in areas where other options will likely be unsuccessful at achieving restoration goals • Improve complexity of within stream habitat to slow down water and provide fish habitat and reduce water temperature
Forestry	• Maintain upland forest to be resilient towards disturbances such as bark beetles and fire. • Limit ecological disturbance, especially in riparian areas, during and after timber harvest.

Transportation	• Reduce sediment transport from roads to streams • Maintain or improve suitable access areas for recreation • Ensure priority culverts can withstand 100-year events • Enhance upstream travel for fish populations
Irrigation and drought response	• Increase instream flow, especially in low-water months • Improve irrigation efficiency • Reduce fish entrainment in ditches and movement over dams • Provide technical assistance to irrigators to improve drought resiliency
Developed areas	• Mitigate stormwater run off • Ensure construction follows stormwater permitting regulations
Protection	• Maintain robust stream segments in their current state • Protect reaches with high potential to recover naturally • Consider land easements or acquisitions where feasible

During the spring of 2017, Trout Unlimited and the Granite Conservation District mailed a survey to all registered, private mailing addresses (approximately 500) within the Rock Creek watershed with the following questions:

1. What Natural Resource Management Issues are your biggest concern?

2. What water quality issues do you believe exist in Rock Creek?

3. Are there any projects you completed that have improved water quality, water quantity or other natural resources conservation on your property?

4. What Restoration or Conservation issues do you believe exist in Rock Creek?

Then, on June 26th, 2017 TU and Granite CD hosted a public meeting at the Stony Creek Campground to solicit input on key issues and restoration opportunities in the watershed. The results of the survey and follow-up conservations identified the following issues as natural resource priorities identified by landowners in the watershed:

TABLE 10 SURVEY RESULTS OF THE RELATIVE PRIORITY OF NATURAL RESOURCE ISSUES

Relative Priority of Natural Resource Issues		
High	**Medium**	**Low**
Forest Management	Riparian Restoration	Water Quality: Sediment
Water Quality: Nutrients	Stream Restoration	Fish Passage
Dewatering	Water Quality: Metals	Habitat Restoration
Fishing Pressure/Recreation	Development/Population Pressure	Stream Temperature

Additionally, in November of 2017, Trout Unlimited hosted a meeting with representatives from FWP, U.S. Fish and Wildlife Service (USFWS), Beaverhead-Deerlodge National Forest (BDNF), and Lolo National Forest (LNF). Through the course of the meeting, priority management needs and current projects in the watershed were discussed. Those projects and priorities are integrated in the following section.

These sources have contributed to the development of this WRP. The expertise from many of these entities will maintain a critical role in the implementation of the Rock Creek watershed restoration plan. Overarching goals for restoration of the Rock Creek watershed include the following:

- **Water Quality:** Restore and maintain the ability of Rock Creek's waters to support drinking water, agricultural and recreational uses.
- **Water Supply:** Manage water supply effectively to meet the needs and benefit multiple water supply needs, including the needs of water users and aquatic habitat.
- **Fish and Aquatic Life:** Restore and maintain the ability of Rock Creek to fully support healthy populations of fish and aquatic life, especially species that are considered threatened or endangered. Minimize the impacts of drought and angling on fish populations.
- **Wildlife Habitat:** Preserve and protect wildlife habitat, especially large intact blocks, critical travel corridors, and habitat for species that are considered threatened or endangered.
- **Forestry:** Implement practices that prevent catastrophic wildfires and minimize impacts to streams and fisheries
- **Outreach and Education:** Maintain working relationships among stakeholders in the watershed. Ensure availability of resources for land managers and the public to engage in watershed restoration and protection.

The following section identifies the geographies, stream or subwatershed, where specific restoration BMPs should be applied. Additional resources on BMPs for grazing, cropping, and timber harvest are available from the TMDL (DEQ, 2013), Montana's Nonpoint Source Management Plan (DEQ, 2012a), Montana State University Extension, the USDA, NRCS, and local USDA Agricultural Service Centers. Collectively, the implementation of these management actions will ultimately lead to the restoration and preservation of the Rock Creek watershed and its resources.

6.2 Management Actions and Restoration Opportunities

Implementation of management measures for reducing nonpoint source pollution will rely on voluntary participation by watershed stakeholders, including private landowners and actions by federal and state land managers through their management plans and collaborative processes. Activities recommended here will require the support of the people who live, work, and recreate in the watershed for long-term success. These management measures are designed to achieve TMDLs, work towards restoration goals, and help landowners make economical improvements to their land management practices. Many goals of restoration activities are to balance the needs of agriculture with the needs of other watershed uses, including drinking water, fish and wildlife habitat, and recreation.

A number of stream segments are listed for non-pollutant impairments, which are probable causes of impairment on these streams and may be closely linked to sediment and nutrient pollution. Restoration goals and management measures here address these non-pollutant issues in addition to sediment and nutrient reductions. In localized areas, historical mining has left a legacy of altered streambank morphology, often in addition to toxic waste. Abandoned mines projects should consider the potential for sediment reductions and channel restoration in conjunction with other reclamation work.

BMPs listed in the tables below are intended to give readers a sense of possible options for the watershed. Practices employed, however, should be considered based on site-specific needs, landowner involvement, and implementation feasibility. These suggested management practices are by no means an exhaustive list of ways to mitigate and control pollutants in the watershed, but may inform stakeholders about encouraged activities as a starting point for discussions.

6.21 Landowner outreach

Privately owned land encompasses a significant portion of the Rock Creek watershed and achievement of TMDLs will require voluntary participation by private landowners in restoration efforts. Outreach to these landowners is therefore a necessary component of the restoration plan. Efforts will involve working with landowners one-on-one as well as creating general community consciousness of water-related issues and ways to get involved with restoration efforts. Furthermore, landowners should be informed of available economic incentives for engaging in conservation practices and the other benefits that can arise from helping to reduce non-point source pollution. Trout Unlimited has initiated these activities (see sections 2.3 and 7.1) and will continue general and project-specific outreach in the basin.

Conservation projects can have significant benefits for private landowners – for example irrigation efficiency projects can increase arable land and reduce labor costs, while at the same time reducing surface water withdrawal and reducing fish entrainment. Similarly, managing stock access to stream banks can eliminate the need for landowners to deal with costly bank stabilization projects to prevent high flows from eroding pastureland.

6 .22 Grazing management

The goals of improving grazing management are not to limit agricultural operations, but rather to find practices that may mutually benefit agricultural operations and riparian zones. Modern grazing management in riparian zones involves changes in timing, duration and intensity of grazing activity, which has differential impacts on grass, shrub and tree growth and reproduction. Additionally, clean off-site watering sources can reduce impacts to stream banks while also improving cattle weight gain. It is very possible to have high functioning riparian systems with grazing presence, but the grazing must be managed so that it is sustainable over time and works within the ecosystem's tolerance.

Grazing management in the riparian zone should be tailored to the specific riparian area under consideration (DNRC, 1999). The *LBFTMDL* highlights the need for application of BMPs which minimize livestock disturbance of the streambank and channel, including creation of water gaps, fencing to restrict livestock access to a stream in heavily impacted areas, and creation of off-site watering sources. Creating grazing management plans, which may include establishing a rotational grazing system, will help landowners work sustainably on the land.

TABLE 11 EXAMPLES OF GRAZING MANAGEMENT BMPS (DEQ, 2012; DNRC, 1999)

BMP	Description
Grazing management plan	• Manage grazing frequency, duration, season of use, and intensity to promote desirable plant communities, maintain vegetative cover, and prevent soil erosion. • The plan should identify the stocking density, season, duration, and location of grazing activities field by field. • Set target grazing use levels in accordance with production limitations and plant sensitivities.
Livestock distribution	• Distribute livestock to promote dispersion and decomposition of manure to prevent delivery to water sources. • Periodically rotate winter feeding areas and feed placement within winter feeding area • Relocate corals and pens away from riparian zones .
Promote livestock travel away from riparian zones	• Provide off-stream water sources where adequate forage is available. • Place salt and supplemental feed in upland areas • Rest or defer riparian pastures when needed for recovery and plant growth. • Fence off riparian zones • Seed uplands with preferred forage species • Avoid grazing in riparian areas during rainy season. • Provide shelter structures to protect livestock from weather as an alternative to riparian vegetation

Stream crossings	• Create stabilized area or structure built across a stream to provide a travel way for livestock, people, vehicles and equipment.
Water gap	• Create a controlled access point from which livestock can obtain water from a stream; if possible should only permit one animal to access at a time.
Manure storage	• Keep manure piles ≥ 100 ft away from streams, cover them to prevent storm runoff
Filter strip	• A strip of permanent perennial vegetation placed on the down gradient edge of a field, pasture, barnyard, or animal confinement area.

6.23 Crop production

The main goals for BMPs related to crop production are to reduce the amount of erodible soil and to engage in practices which trap or attenuate pollutants before entering streams. A riparian buffer is a zone of vegetation along the banks of streams which is composed of native grasses and deeply rooted woody vegetation. This buffer can not only trap and filter sediment, nutrients, and pesticides but also provides bank stabilization, shade, and wildlife habitat, and slows flood waters (Helmers et al., 2008). These buffers should be maintained where existing and their creation should be considered in conjunction with other streambank restoration work. Vegetative filter strips can be planted downgradient and adjacent to croplands and pastures to filter runoff before the water is transported to waterways (Helmers et al., 2008). Additionally, careful consideration of fertilizer application and manure storage is important to prevent excess nutrient additions to streams.

If floodplains are cleared of native vegetation and converted to hayfields, famers should ensure that there is established woody vegetation to act as a riparian buffer to reduce haying impacts on water quality. Additionally, many of the riparian/floodplain hayfields are used for winter grazing and feeding, which can lead to a buildup of manure that can become washed into the stream during spring floods. Cattle should be wintered away from the floodplain if possible and manure should be properly stored to reduce its transport to the stream. Native vegetation should be reestablished in riparian and wetland areas that have been cleared in the past but are no longer in use, which may require active planting and seeding.

TABLE 12 BMPS ASSOCIATED WITH CROP GROWING PRACTICES.

BMP	Description
Riparian buffer	• Planted perennial vegetation located adjacent to and upgradient from a waterbody which can filter sediment and nutrients from upstream and upland sources. Buffer width, slope, species composition, and target pollutants must be considered in the design.
Filter strip	• A strip of permanent perennial vegetation placed on the downgradient edge of a field, pasture, barnyard, or animal

	confinement area. If the purpose of the strip is to take up nutrients, the vegetation must be periodically harvested in order to prevent nutrient buildup.
Fertilizer application	• Avoid near waterways
Cover crop	• Vegetation planted on what would otherwise be fallow ground. Designed to prevent mobilization and transport of pollutants by precipitation and runoff during periods when the primary agricultural crop is unable or unavailable to perform similar a function.
Conservation tillage	• May include, but are not limited to, reduced tillage or minimum till, no till, strip till, direct seeding, mulch till, or ridge till to prevent soil erosion and reduce surface or subsurface runoff potential.
Alley cropping	• Trees, shrubs, or tall, rigid, perennial herbaceous vegetation planted in sets of single or multiple rows with agronomic horticultural crops or forages produced in the alleys between the sets of woody plants to reduce soil erosion.
Waste management	• Store, transport and using agricultural wastes, such as manure, wastewater, and organic residues, in a manner that reduces nonpoint source pollution.
Erodible land conversion	• Converting highly erodible lands to permanent vegetative cover.

6.24 Streambank and aquatic habitat recovery

Streambank and aquatic habitat recovery projects will address bank stabilization, streamside revegetation, floodplain connectivity, and within-stream habitat. These projects can directly improve alterations in streamside or littoral vegetative covers and alterations to physical substrate habitat. Candidate reaches for recovery efforts should be prioritized based on potential for improvement and existing condition. In areas that are actively grazed, any streambank work should only be implemented in conjunction with riparian protection measures.

Streambank efforts should establish or help maintain vigorous streamside vegetation composed of diverse age classes of deeply rooted native woody species to stabilize streambanks and filter transported sediment and nutrients. In some areas, this may be dependent on eradication and control of invasive plants. Improvement of within-stream habitat may involve LWD placement, shade creation via streamside vegetation, or beaver habitat protection. The presence of beaver dams and/or beaver dam analogues can have significant positive impacts on stream function and morphology, by slowing flows, reducing stream bank erosion downstream, trapping and filtering sediments and pollutants, and improving water temperature (Błędzki et al., 2011; Pollock et al., 2015; Westbrook et al., 2006). Where possible on headwaters streams, improving beaver habitat and populations should be considered.

Passive restoration is desired over intensive streambank engineering to achieve bank stability due to high costs of bank reconstruction and disturbance caused by equipment. Examples of passive restoration options to achieve streambank stability include riparian fencing and access restrictions for people and/or livestock, allowing for natural ecological processes to resume. Active restoration options which are less intensive than channel reconstruction include LWD placement, beaver dam analogues, reseeding, and planting, which may accelerate natural processes and help achieve restoration goals over time.

Channel reconstruction may be needed in heavily impacted areas with little potential to return to historical conditions without intensive intervention, such as areas where the stream is significantly incised and has no access to its floodplain or where past mining operations have significantly altered streambank morphology. When streambank rebuilding is needed, bank building materials should be natural or bioengineered – riprap and other "hard" bank armoring approaches should be avoided unless required to protect existing infrastructure.

TABLE 13 SELECTED PROJECTS TO IMPROVE STREAMBANKS AND AQUATIC HABITAT

Options	Description
Aquatic habitat improvements	• LWD/ log jam placement • Pool creation/ riffle creation • Streamside shade establishment
Passive restoration	• Access/use restriction • Beaver damn analogues
Channel reconstruction	• Should only be considered in heavily impacted areas with little potential for natural recovery • Use natural/bioengineered building materials

6.25 Forestry

Maintaining healthy, resilient forestland is a key component of upland management in Montana watersheds. Increasing forest resilience to future disturbances, especially wildfire, has positive impacts on the streams which flow through these forests while also helping protect existing infrastructure, including homes, from destruction. Creation of diverse forest conditions, including varying species, age-classes, and density across the landscape, can attenuate future fire severity and extent as well as lessen the impacts of future insect outbreaks.

Landowners may choose to engage in timber harvesting on their own land. Any private timber harvesting should adhere to the Streamside Management Zone laws and BMPs for Montana (Logan, 2001) to reduce direct and indirect impacts to riparian systems (**Error! Reference source not found.**). Landowners are required to notify MT DNRC prior to any timber harvesting.

TABLE 14 SELECTED BMPS ASSOCIATED WITH TIMBER HARVESTING (LOGAN, 2001)

BMP	Description
Streamside Management Zone (SMZ)	• Designated area least 50 feet wide from each side of a stream, lake or other body of water, measured from the ordinary highwater mark in which management actions are limited • Refer to SMZ laws (see MT DNRC, 2006)
Harvest	• Avoid wet areas including moisture-laden or unstable toe slopes, seeps, wetlands, wet meadows and natural drainage channels. • Avoid operation of wheeled or tracked equipment within isolated wetlands, except when the ground is frozen. • Use directional felling or alternative skidding systems for harvest operation in isolated wetlands.
Road use	• Use existing roads where practical, unless use of such roads would cause or aggravate an erosion problem. • Locate roads to provide access to suitable (relatively flat and well-drained) log landing areas to reduce soil disturbance.

6.26 Transportation

There have been substantial assessments of existing road conditions, including number of stream crossings, parallel stream segments, and unpaved road density throughout the watershed in recent years. These efforts have helped prioritize projects and road work to improve sediment delivery and riparian habitat throughout the watershed. Additional investigation may be needed to develop management and road relocation or restoration opportunities for parts of the road network, especially along the mainstem of Rock Creek with the Granite County road system.

Future work that is not currently proposed should seek to improve ford stream crossings with hardened structures (ideally bridges), especially on high-risk roads, and reduce use of dispersed campsites in valuable fish habitat. Culverts should be prioritized for replacement and or removal. On fish bearing streams, any new culverts, in addition to those which replace failed culverts, should be designed for a 100-year flood event; on non-fish bearing streams, culverts should be designed to withstand at least a 25-year flood event. When considering fish passage around a barrier, both upstream and downstream fish populations should be evaluated to preserve genetics of native populations if isolated populations exist upstream. The highest priority fish passage projects are those where native fish production is moderate to strong and improvement could reconnect the tributary watershed to the mainstem of Rock Creek.

The management of these stream and road crossings on the Forest remains a priority for the National Forests and the Rock Creek TMDL identifies at least 25 culverts in the watershed that are inappropriately sized for high flow periods. The existing database of surveyed culverts will be used to identify data gaps and inform follow-up survey efforts of unassessed culverts on NF and private property. Documenting culverts will be achieved using aerial imagery and Forest Service field survey protocols. A comprehensive database will be used to determine priority removal projects.

Additionally, while the use of traction sand to reduce safety hazards during winter driving conditions cannot be eliminated, certain practices can help reduce the amount of sand that is transported from roads to streams, including improved training of sand appliers and sand recovery (Staples et al., 2004).

TABLE 15 SELECTED BMPS FOR TRANSPORTATION SYSTEMS. IN GENERAL, TRANSPORTATION PROJECTS SHOULD FOCUS ON REDUCING THE HYDROLOGIC CONNECTIVITY BETWEEN ROADS AND STREAMS AND REESTABLISHING A STREAMS ABILITY TO ACCESS ITS FLOODPLAIN. (CDM, 2004; LOGAN, 2001; STAPLES ET AL., 2004)

BMP	Description
Transportation planning	• Minimize the number of roads constructed and utilized in a watershed through comprehensive road planning. • Decommission/recontour closed roads to reduce sediment transport
Road design	• Roads should not be built in a manner that restricts a stream's access to its floodplain during high flow events. • Locate roads on stable geology, including well-drained soils and rock formations. • Route road drainage through adequate filtration zones or other sediment settling structures to ensure sediment doesn't reach surface water.
Drainage	• Provide energy dissipaters (rock piles, slash, log chunks, etc.) to reduce erosion at the outlet of drainage features. • Maintain erosion-control features through periodic inspection and maintenance, including cleaning dips and crossdrains, repairing ditches, marking culvert inlets to aid in location, and clearing debris from culverts.
Stream crossings	• Bridges should be installed whenever possible instead of culverts; ford crossings, especially unimproved ford crossing should be avoided. • Design stream crossings for adequate passage of fish, and at a minimum, the 25-year frequency runoff.

6.27 Irrigation and drought response

Irrigation and instream flow projects can directly address streams with low flow alterations. Improvements to irrigation systems can increase irrigation efficiency (which may allow for increased instream flow), reduce transportation of sediment and nutrients to waterways, and improve fish passage. Discussing these types of irrigation projects and their benefits with private landowners may be an effective way to gain traction for other types of stream restoration projects in the community. Further research about the existing irrigation network throughout the Rock Creek watershed and the impacts on groundwater storage and late season recharge will help in project development.

Reducing the amount of stream water diverted is important so that streams can attenuate pollutants and provide adequate aquatic habitat. Rights leasing and conversion helps ensure that water remains in the streams – additional water left in the stream by one user is not available for downstream water use. Reducing water usage in July and August when flow is already naturally low and temperatures are warm is of highest priority.

Promoting natural water storage can be another way to increase drought resiliency throughout the watershed. Some ways to increase the natural storage capacity of a stream system is by encouraging beavers to build damns (via beaver population management or habitat improvements) or by creating beaver dam analogues, which are structures that mimic or reinforce natural beaver dams (Pollock et al., 2015). Beaver impoundments and complexes increase water storage capacity within a stream system by slowing down surface flows and encouraging lateral water spreading. Thus, these dams create wetland areas, promote groundwater recharge, and elevate the water table (Pollock et al., 2015). Additionally, properly functioning floodplains slow runoff and promote groundwater recharge, which allows water to be slowly released back to the surface water system (DNRC, 2015). In low precipitation years or in the hottest, driest months of summer, this stored water can provide a buffer for base flows in streams.

TABLE 16 SELECTED BMP'S FOR IRRIGATION AND DROUGH RESPONSE

BMP	Description
Irrigation system conversion	• Converting flood irrigation system with a sprinkler system if conversion can result in a decreased pollutant transport to streams.
Canal conversion	• Replace irrigation canal with a pipe
Canal lining	• Line irrigation canal with and impermeable layer or improve existing lining
Irrigation structure improvements	• Allow for better control of timing and quantity of water withdrawals.

6.28 Protection and passive restoration

It is a high priority to conserve stream reaches that are well-functioning and sustainable. These reaches are characterized by having intact floodplains and limited channel incision, are not confined by roads or the railroad, are generally well vegetated, and often have nearby active beaver presence. Reaches which exhibit many of the same characteristics with some small impacts but a high potential to return to a functioning state with minimal intervention should also be protected.

Trout Unlimited has already started and will continue to identify, develop, and implement projects including, but not limited to following: mine reclamation, irrigation efficiency and diversion infrastructure improvements, development of BMPs in cooperation with landowners, habitat improvement and protection, and culvert and bridge replacement/removal. The general project categories and the criteria used to develop projects are described below. Projects in development phase are also included in this section.

6.3 Reach-specific conditions and recommendations

Appropriate management actions will be highly variable depending on reach conditions and landowner willingness to participate in restoration projects. Table 18 summarizes observations and conditions from the most recent assessments on key stream segments

TABLE 17 SUMMARY OF EXISTING CONDITIONS AND OBSERVATIONS FROM RECENT ASSESSMENTS ON KEY STREAMS THROUGHOUT THE ROCK CREEK WATERSHED

Waterbody	Land ownership	Major observations
Mainstem Rock Creek (Upper)	Primarily private; USFS/BLM land in headwaters with some private inholdings.	General decline in riparian habitat, moderate instream fish habitat and fish passage barriers, limited cottonwood recruitment, highly manipulated floodplain, overutilization of the riparian area by livestock, haying along streambanks, streambank erosion, sediment inputs from the road.
Mainstem Rock Creek (Lower)	USFS, with interspersed parcels of private land; primarily private in lower reaches near Highway 90	Riparian conditions highly variable throughout with some reaches exemplifying near-optimal conditions. Channelization by roads, road erosion, channel modifications, heavy recreational use.
Brewster Creek	Headwaters: USFS; lower section is privately owned	Lack of LWD and riparian shrub cover in places, channelization by roads and sub-development, disconnected floodplain, potential upstream fish barriers associated with irrigation
Stony Creek	Headwaters: USFS; lower section is privately owned	Excellent riparian vegetation in reaches, LWD accumulations, pool habitat, fish cover, minimal streambank erosion; Lower reaches LWD and riparian cover sparse, disturbance induced grasses along channel, lateral bank erosion, limited flow,
Upper Willow Creek	Primarily USFS and state land in headwaters. Valley bottom is privately owned	Channel disturbances associated with livestock and irrigation activity, limited riparian woody vegetation, bank trampling, over-widened and shallow channel,
Middle Fork Rock Creek	Headwaters: USFS; lower section is privately owned	Excellent riparian vegetation in reaches, LWD accumulations, pool habitat, fish cover, minimal streambank erosion; Moderate to good riparian condition, little active irrigation, variable grazing pressure. Fires in 2017 burned a large portion of the drainage in moderate to high severity
East Fork Rock Creek	Headwaters: USFS and some state land; lower section is privately owned below East Fork Reservoir	Headwaters have excellent riparian vegetation in reaches, LWD accumulations, pool habitat, fish cover, minimal streambank erosion; Lower reaches LWD and riparian cover sparse, problems with stream temperature
Ross Fork Rock Creek	Headwaters: USFS; lower section is privately owned	Headwaters in good condition; heavy grazing and agriculture in lower drainage; bank erosion evident; many diversions take large portion of the water; poor riparian habitat in some stream segments
West Fork Rock Creek	Headwaters: USFS, with private mining claims; lower section is privately owned	Moderate to good riparian condition, little active irrigation, variable grazing pressure, some active mine sites on the mainstem of the West Fork

Recommended activities are meant to have realistic goals, and as such are recommended in the context of existing constraints, such as presence of infrastructure and present land management. These activities are grouped into the following categories:

A. Identify and remove or replace undersized or deteriorating culverts, crossings, and bridges

Culverts and other stream crossings can contribute to sediment loading through lack of BMPs or after catastrophic failure. These crossing can also affect fish passage movement. Project partners have identified projects in the Brewster Creek and Middle Fork Rock Creek watersheds (Green Canyon Creek) to improve fish passage and decrease sediment loads. Further discussions, analysis and prioritization working with the USFS, BLM, MT DNRC and private landowners is warranted to develop future projects in the watershed.

B. Identify and address roads contributing to excessive sediment loads

A comprehensive inventory of road and river networks in the watershed would identify segments of roads that are contributing to sediment loads in stream channels and characterize riparian habitat quality issues. The inventory should include, but not be limited to the waterbodies identified in the TMDL as impaired by sediments. An inventory will highlight priority locations within the watershed, opportunities for road relocation or decommissioning, installation of BMPs, and identified. Criteria for prioritizing problem road segments would be the height and slope of the cut banks, the road proximity to stream, land ownership, geology and if the stream is listed as impaired by sediment on the 303(d) list. The USFS and Granite County have ongoing road maintenance obligations in the watershed and could benefit from an analysis and potential restructuring of the road network.

C. Complete irrigation inventory

Irrigation diversions typically consist of an in-stream structure that raises the water surface and an adjustable headgate that controls the flow of water into an open ditch, which delivers water to the place of use. A partial inventory of irrigation structures in the Rock Creek watershed was completed in 2017. Completing the inventory, especially in the priority watersheds of the Middle Fork Rock Creek and upper mainstem Rock Creek, would identify the number, type, and seasonal management of the diversions, along with impacts to fish passage, dewatering, potential costs and designs for replacement or improvement. A laser level should be used to survey the longitudinal profile of the stream and ditch at each diversion to estimate slope, water surface height difference, and physical characteristics of the diversion, spillway and plunge pool. Photopoints, velocity and discharge measurements should be taken in the stream above the diversion and in the ditch to allow for screening recommendations and potential water conservation measures.

D. Complete mine reclamation and reduce sediment/metal loads

Abandoned mines contribute to metal contamination in the watershed. Not all of the known mine locations are listed as priority abandoned mines by the State of Montana. Reclamation of the Silver King Mine on Sluice Gulch would restore 1,000 feet of stream channel and safely contain mining waste rock at an abandoned mine on BLM land. The current conditions, impacts and activity at abandoned or active mines in the impaired streams of Basin Gulch, Quartz Gulch, Flat Gulch, Eureka Gulch, and Scotchman Gulch should be investigated and projects developed depending on the potential cost-benefit to the watershed. Furthermore, an actively discharging adit in Williams Gulch should be investigated for its impact on water quality.

E. Develop and implement BMPs and habitat protection & planting projects,

Riparian buffers and other BMP's can reduce land-use impacts to streams. Because agriculture is the primary land-use downstream of the forest boundaries in the Rock Creek watershed, engaging with landowners to identify opportunities for riparian planting, grazing management and off-site water source development would be potential beneficial to reducing sediment loads, stream temperatures and impacts to stream/riparian health. Developing collaborative projects will occur over time, but potential opportunities with high cost-benefit exist in the Ross Fork Rock Creek, Middle Fork Rock Creek, mainstem Rock Creek, and East Fork Rock Creek.

F. Develop education and outreach tools

Several outreach and education tools are critical to the implementation of a WRP, including:

- Hosting tours of projects for partners and the public.
- Working with local watershed education groups to develop a volunteer monitoring program and engage local students and community members to participate.
- Keeping up to date with posting online resources on relevant websites.
- Providing technical assistance to landowners interested in participating in restoration projects, such as a BMP training workshop.
- One on one contact with private landowners.

Furthermore, the following opportunities have been identified for the collection of important natural resource data collection in the Rock Creek watershed, which would also serve to educate and inform local landowners and the general public about water supply, climatic variables and general watershed condition:

1. Install weather station
    - Provide information about soil water moisture and atmospheric temperatures to the public; improve weather database; improve accuracy of local weather pattern predictability; support agriculturalists with information about current conditions and enable water conservation through improved irrigation efficiency practices.

2. Install stream gage on mainstem Rock Creek
    - Engage multiple user groups in watershed protection. Encourage self-education for recreation when there are good river conditions, and encourage fishing & other recreational activities when fish are not being stressed by high temperatures.

6.4 Schedule of Interim Milestones and Evaluation Criteria

Milestones are individual steps towards achieving the ultimate restoration goals. Setting milestones is important because of the extremely wide scope of watershed-scale restoration. Bringing the focus towards smaller, measurable objectives helps involved parties stay on task while working towards achieving big picture changes throughout a watershed. A pathway to achieving water quality targets is laid out in the Figure below. Short-term milestones (green boxes) should be achievable on a yearly basis starting immediately, while long-term milestones (blue boxes) may take 10+ years to achieve (2025 and beyond). This framework is not linear, but rather a continual process, and requires regular evaluation to assess if projects are helping to achieve water quality and restoration goals. Strategies should be adapted based on new information, stakeholder involvement, and lessons learned through project implementation.

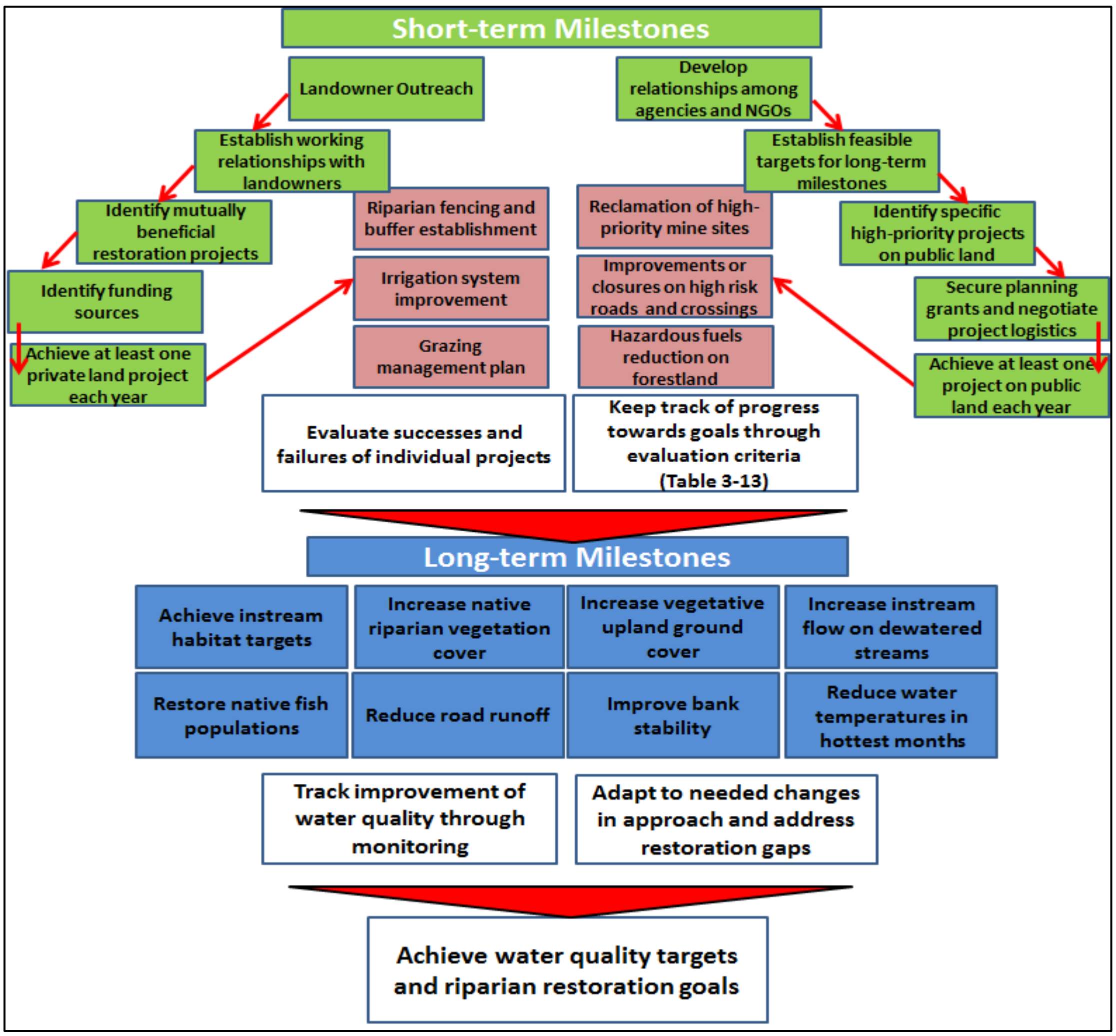


FIGURE 8 PATHWAY TO ACHIEVING RESTORATION AND WATER QUALITY GOALS. SHORT TERM MILESTONES (IN GREEN) SHOULD BE ACHIEVED ON A ROLLING BASIS EACH YEAR, WORKING TOWARDS TO THE LONG-TERM MILESTONES (IN BLUE). EXAMPLE HIGH-PRIORITY PRIORITY PROJECTS ARE IN PURPLE.

6.5 Partners and Outreach

Throughout this planning process, TU has engaged both public and private stakeholders for input regarding desired future conditions in the watershed and possible restoration projects to include in this plan. As this WRP is implemented, updated and adapted over time, this collaborative process will continue and other parties not currently involved are encouraged to join.

Education and involvement of the local community and partners will be important to garner support for project implementation on public lands and to establish willing partners to participate in best management practices on private land. Other outreach efforts will include:

- Attendance and presentations at the Granite Conservation District to communicate project updates and solicit input.
- Hosting tours of projects for partners and the public.
- Working with local watershed education groups to develop a volunteer monitoring program and engage local students and community members to participate.
- Distribute information regarding upcoming projects, workshops and volunteer days at community centers.
- Keeping up to date with posting online resources on relevant websites.
- Providing technical assistance to landowners interested in participating in restoration projects, such as a BMP training workshop.
- One on one contact with private landowners.

Specific stakeholders and agencies that will be vital to these restoration efforts include:

Governmental Agencies

- Granite Conservation District
- US Forest Service
- US Fish and Wildlife Service
- Natural Resource Conservation Service
- Montana Department of Natural Resource Conservation
- Montana Fish, Wildlife, and Parks
- US Environmental Protection Agency
- Montana Department of Environmental Quality
- US Bureau of Land Management
- Montana Bureau of Mines and Geology

Non-governmental organizations

- Trout Unlimited
- Rock Creek Protective Association
- Clark Fork Coalition
- Montana Aquatic Resources Services

- Montana Water Center
- University of Montana Watershed Health Clinic
- MSU Extension Water Quality Program

Technical Resources

- Private landowners
- US Forest Service
- US Bureau of Land Management
- State of Montana
- Five Valleys Land Trust

Land owners and managers

6.6 Sources of Technical and Financial Assistance

The Montana Non-Point Source Management Plan includes a non-exhaustive list of grant opportunities to target nonpoint source pollution, available to communities, homeowners' associations, conservation districts, governmental entities, and non-governmental organizations. The most up-to-date list of these funding opportunities can be downloaded as "Watershed Funding Opportunities" on their Wiki page: http://montananps319grants.pbworks.com/w/page/21640335/NPS%20Home.

Landowners are also encouraged to participate in voluntary environmental incentives programs, many of which are administered by the NRCS. For example, the **Environmental Quality Incentive Program (EQIP)** provides financial assistance to help plan and implement conservation practices that address natural resource concerns on agricultural land and non-industrial private forestland. Additionally, the **Conservation Stewardship Program (CSP)** provides money to farmers and ranchers who maintain a high level of conservation on their land. Interested parties can contact the Deer Lodge Valley Conservation District for more information and assistance in applying to these and other programs.

Further, **NRDP terrestrial restoration funds** are a potential funding source for projects in Rock Creek watershed. Currently, the Final Upper Clark Fork River Basin Aquatic and Terrestrial Resources Restoration Plan outlines priorities and funding opportunities in the Philipsburg West Priority Landscape, which includes the headwaters of Rock Creek. **NRDP terrestrial restoration funds** are available to riparian habitat projects on both priority and non-priority streams. In addition, NRDP terrestrial funds may be used for land acquisition for conservation easements. Collaboration between government agencies, private organizations, and local landowners will be required to leverage funds and accomplish projects.

7.0 Monitoring

As the implementation of this plan proceeds, monitoring efforts carried out by a variety of entities will provide information for ongoing evaluation of water quality status, instream flows, and aquatic habitat. Monitoring will include both baseline monitoring to evaluate current conditions, and effectiveness monitoring to evaluate the impact of project implementation. While some parameters can be characterized quantitatively, other monitoring efforts will use more qualitative measures (e.g. photopoint monitoring). All agencies and entities conducting monitoring should follow the latest standardized protocols so that results can be compared and progress towards goals tracked over time.

- **Sediment and Habitat**: Protocols for sediment and habitat monitoring are identified within *The Montana Department of Environmental Quality Western Montana Sediment Assessment Method* (Kusnierz et al., 2013) and the Field Methodology for Sediment and Habitat Source Assessment (DEQ, 2017). At a minimum, the following parameters should be collected: riffle cross section (Rosgen methodology), riffle pebble count (Wolman pebble count methodology), pool assessment (count and residual pool depth), and greenline assessment (NRCS methodology).
- **Temperature**: Data loggers should be deployed at the same locations through the years, and should at a minimum, record temperatures that represent the hottest part of the summer.
- **Nutrients**: Monitoring should follow DEQ's *Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels* (Suplee & Sada, 2016).
- **Metals**: Monitoring should include analysis of a suite of total recoverable metals, sediment samples, hardness, pH, discharge, and TSS for all pollutant waterbody combinations. Entities performing sampling should use current DEQ metals sampling methodologies (DEQ, 2012) and reporting limits for the standard metals suite.

The following table outlines existing methods for monitoring restoration in Rock Creek, and the entities involved therein.

Objective	Indicator	Monitoring Description	Entities that historically monitored	Entities Responsible for Future Monitoring
Reduce metals loading to waterbodies	• Metals concentrations in the water column and sediment	Water Quality Sampling	• DEQ, • MBMG	DEQ
Reduce nutrient loading to waterbodies.	• Concentrations of Nitrate, Total Nitrogen, and Total Phosphorous • Chlorophyll-a concentrations • Ash Free Dry Mass • Hilsenhoff's Biotic Index	• Water Quality Sampling • Macroinvertebrate assessments	• DEQ • FWP	DEQ
Increase streamflows, especially during summer months	Estimated annual volume of water conserved	• Gaging stations • Instantaneous discharge measurements	• USGS • DNRC • DEQ • FWP	• USGS • DNRC • TU
*Reduce sediment loading to waterbodies and improve **physical aquatic habitat features including riparian vegetation, channel form and stability, pools, and large woody debris.***	• Stream channel morphology measurements • Fine sediment measures • Stream habitat measures • Riparian vegetation measures • Streambank erosion measures • Fish populations • Bank erosion assessment • Roads assessment • Upland erosion assessment	• Sediment and habitat assessment • Fish population survey • BANCS model • WEPP model • USLE model • Photopoints	• DEQ • USFS (PIBO) • FWP	• DEQ • USFS (PIBO) • FWP
Reduce stream temperatures, during summer months	• Seasonal stream temperatures • Effective Shade • Channel Width-to-Depth Ratio • Instream Discharge	• Temperature logger • Instantaneous temperature measurements • Solar pathfinder data • Vegetation analysis (type, height, offset, density, overhang) • Photopoints •	• USGS • USFS • DNRC • FWP	• USGS • USFS • DNRC • FWP
Reconnect native fish habitat	• Miles of stream channel reconnected • Fish Populations	• Culvert and irrigation infrastructure aquatic organism passage surveys • Fish population surveys	• USFS • FWP	• FWP • TU
Mitigate the impacts of recreational activities and infrastructure.	• Fish populations • Stakeholder satisfaction	Fish population surveys	• FWP • USFS	• FWP • USFS
Prevent the introduction of aquatic invasive species into the watershed.	Presence/Absence of aquatic invasive species	• Watercraft Inspections • Aquatic plant and plankton sampling • Cross-polarized light microscopy • eDNA sampling or Polymerase Chain Reaction testing • Fish pathogen testing	FWP	FWP

Prevent the spread of existing noxious weeds and the introduction of new noxious weeds	Presence/Absence of weed populations	Qualitative or semi-quantitative monitoring of weed species abundance and distribution	USFS	USFS
• *Prevent the development of critical wildlife habitat blocks and corridors* • *Protect terrestrial habitat types for game and non-game species.*	• Spatial extent of large intact habitat blocks and migration corridor • Habitat type spatial distributions	Geospatial analysis	• NRDP • FWP • MTNHP	• FWP • MTNHP
Increase the availability of streamflow and temperature information	• Successful installation of a streamflow and temperature monitoring station • Successful development of data-sharing platform.	Qualitative Criteria	N/A	N/A
Establish effective avenues of communication among stakeholders	• Successful development of a drought plan • Opportunities for stakeholder involvement • Successful completion of watershed improvement projects requiring stakeholder collaboration	Qualitative Criteria	N/A	N/A

TABLE 18 METHODS AND ENTITIES MONITORING RESTORATION IMPACT

Evaluation criteria can help various partners track progress towards achieving long term milestones. At this point, establishing quantitative goals (e.g., 50 miles of riparian fencing installed by 2020) is not necessarily helpful given that watershed-wide restoration planning for the Rock Creek watershed is in its infancy and the great uncertainties regarding time requirements for project implementation. However, the evaluation criteria listed in Table 20 provide examples of how project effectiveness can be monitored and tracked in a watershed. In the future it will be possible to establish quantitative targets, given what we have learned through our work in the basin.

TABLE 19 CRITERIA FOR EVALUATING RESTORATION EFFECTIVENESS

Project category	Evaluation criteria
Grazing management	• Miles of riparian fencing installed • Number of landowners participating in grazing management strategies • Number of improved livestock crossings • Number of off-stream water sources installed
Crop production	• Acres of vegetative ground cover • Number of BMPs installed to filter pasture runoff
Streambank and aquatic habitat recovery	• Miles of improved floodplain functionality • Miles of reconstructed channel • Fish habitat scores throughout sample reaches • Water temperature throughout sample reaches • Composition and abundance of the riparian vegetative community
Forestry	• Acres of forestland treated for fuels reduction and insect management.

Transportation	• Miles of high-risk roads improved • Number of stream crossings improved or closed to motorized use • Number of culverts replaced or upgraded
Irrigation and drought response	• Discharge in streams during hottest months • Number of irrigation efficiency projects implemented • Number of diversions screened to reduce fish entrainment • Number of fish passage barriers removed • Number of consolidated diversions
Developed areas	• Adherence to stormwater permitting regulations • Number of BMPs installed to filter/reduce stormwater runoff
Protection	• Acres of land set aside in conservation easements or other forms of long-term protection

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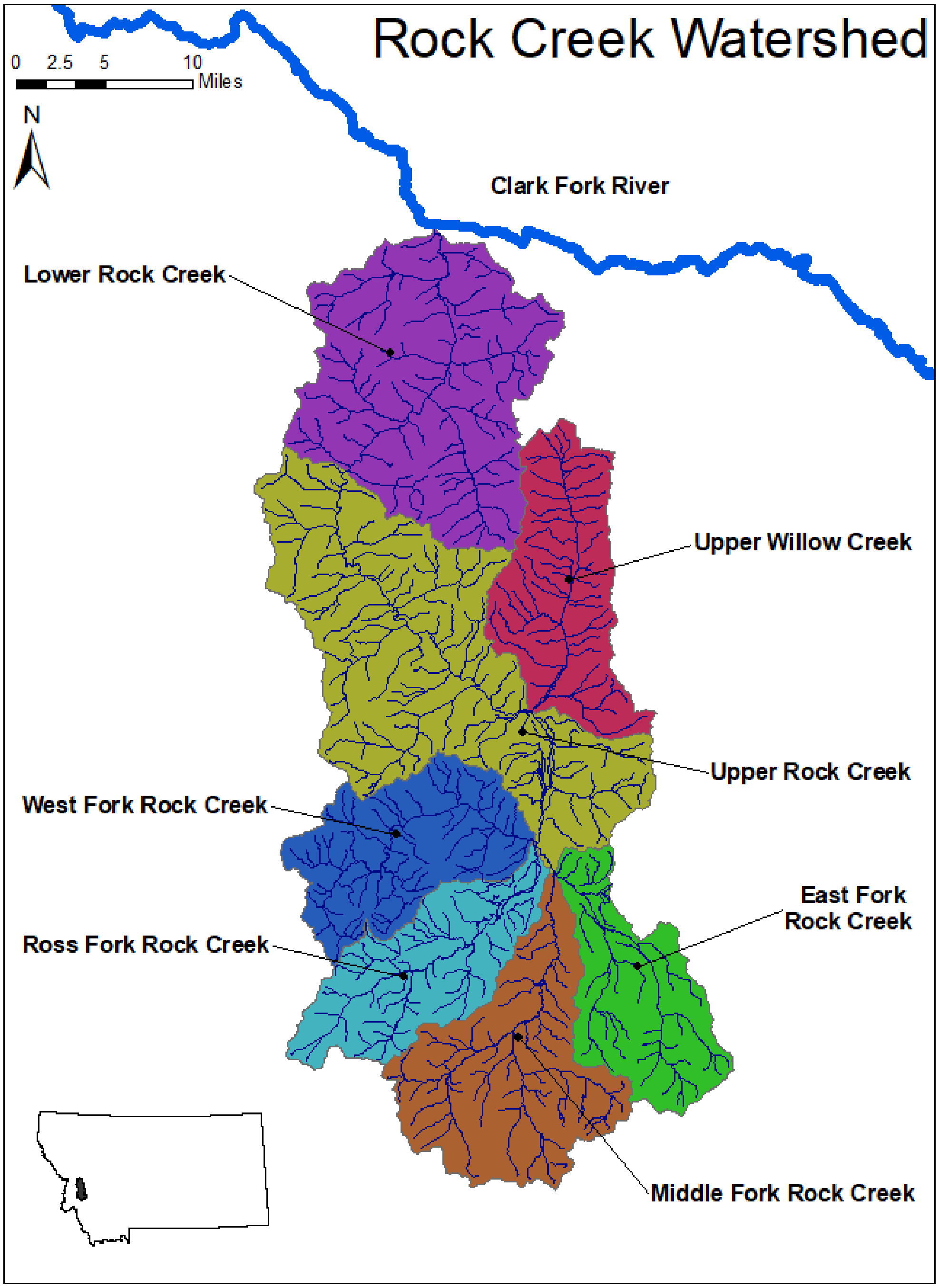
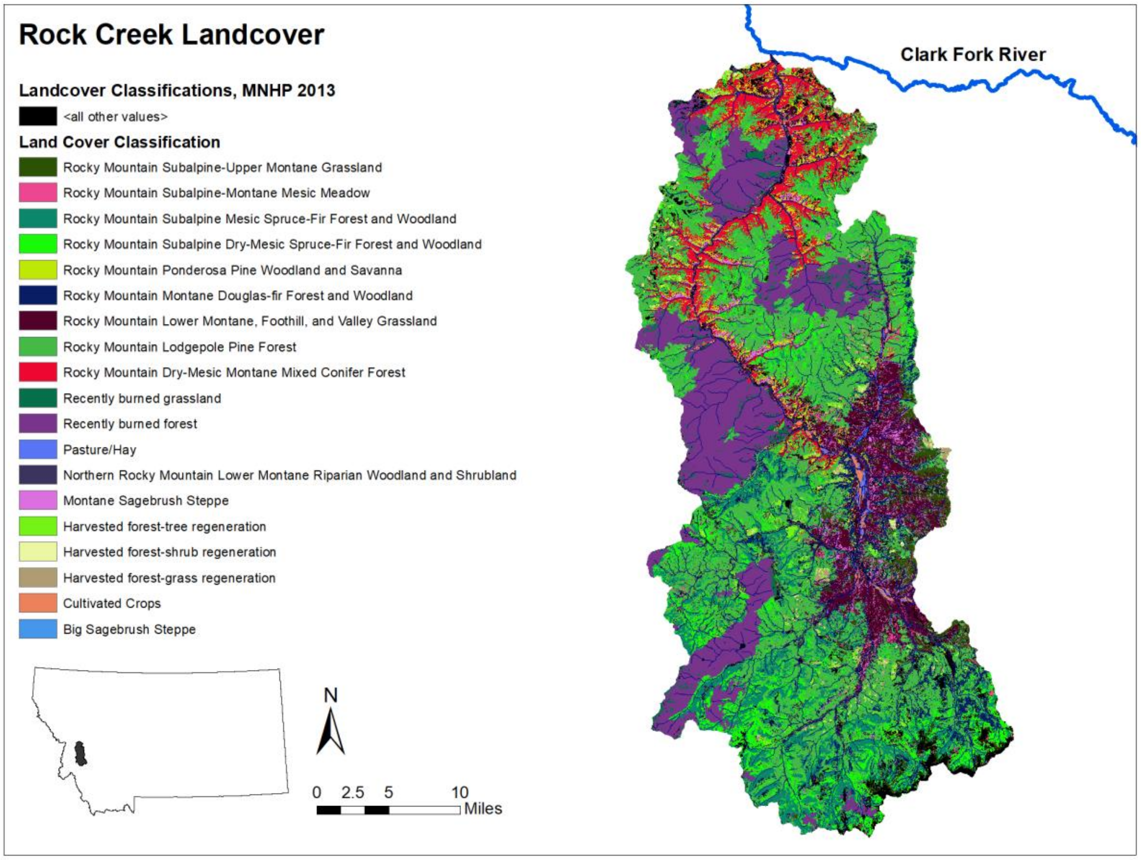
Appendix A.



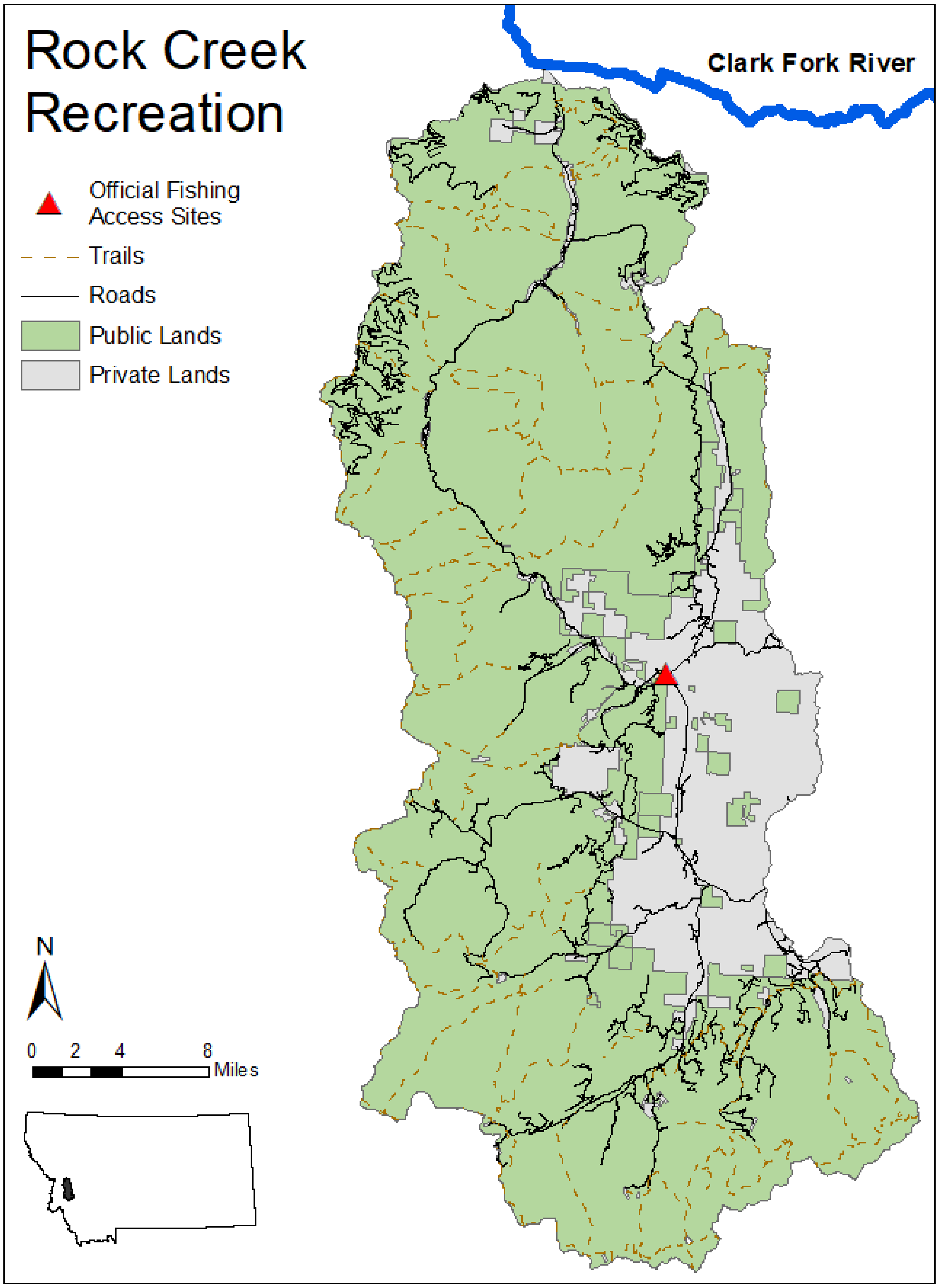
Data source: Montana Fish, Wildlife and Parks, USGS

Appendix B



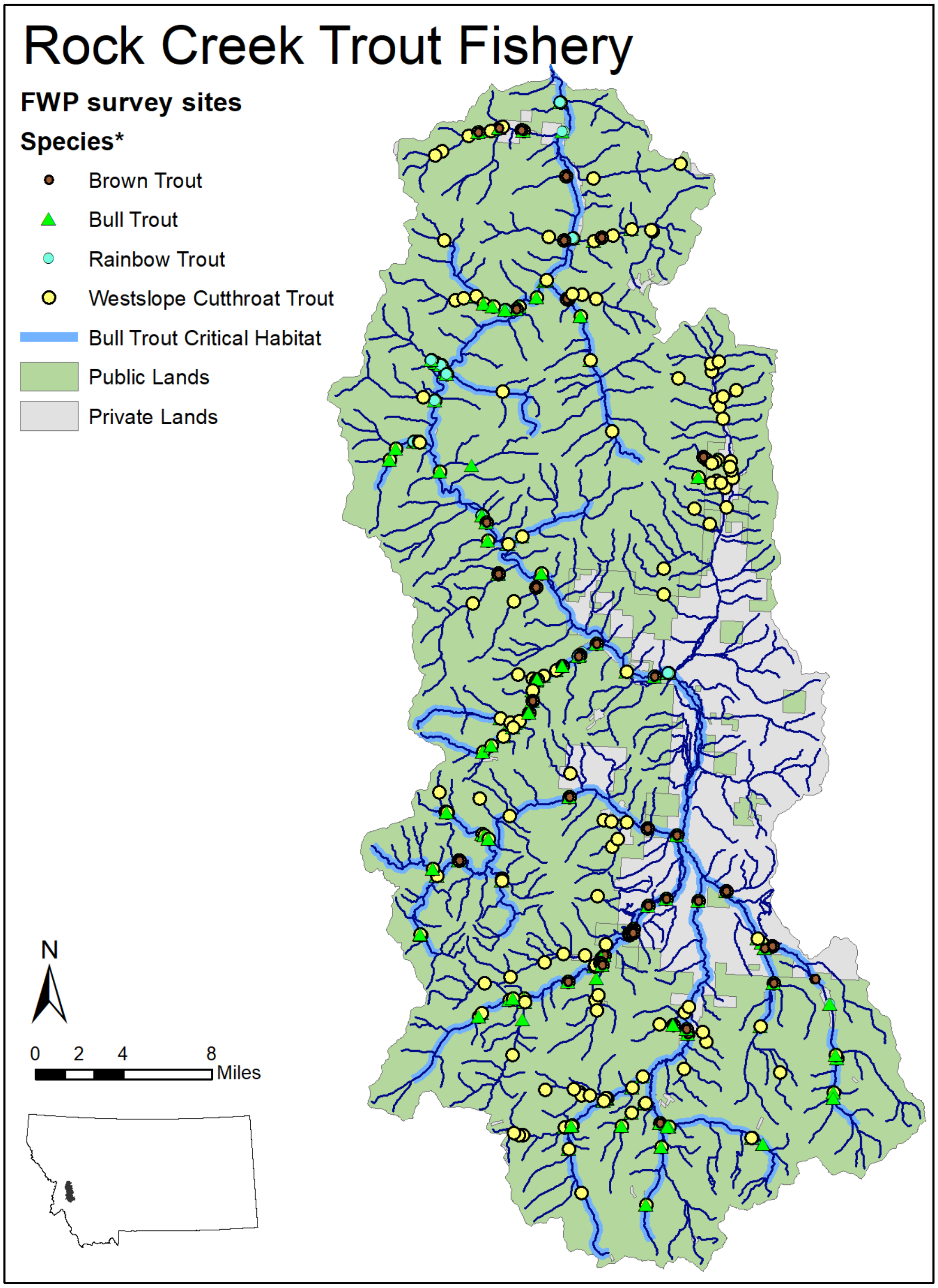
Data sources: Montana Fish, Wildlife and Parks, Montana Natural Heritage Program, 2013

Appendix C



Data Sources: Montana Fish, Wildlife and Parks, The Montana Transportation Framework, USDA Forest Service

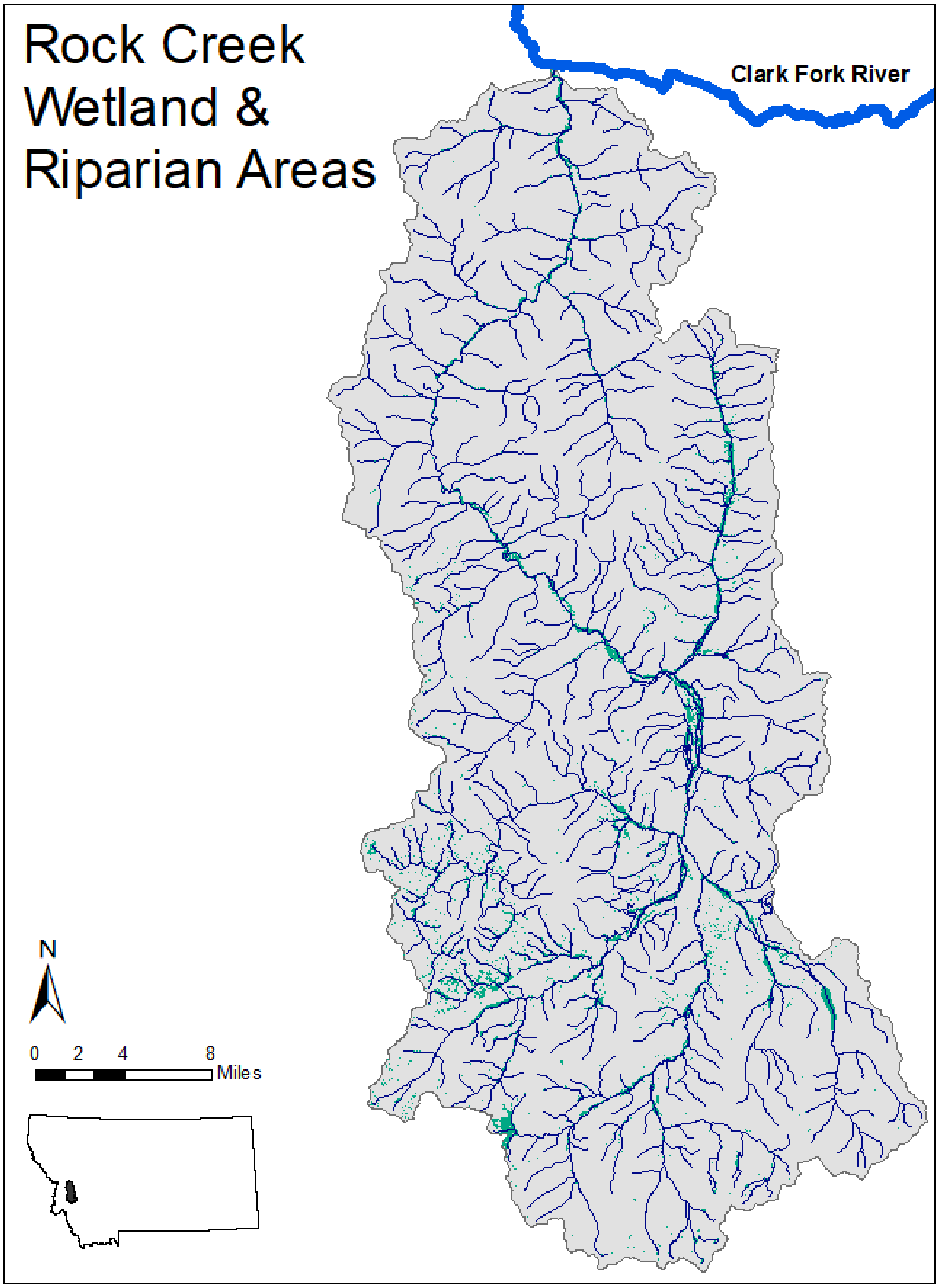
Appendix D



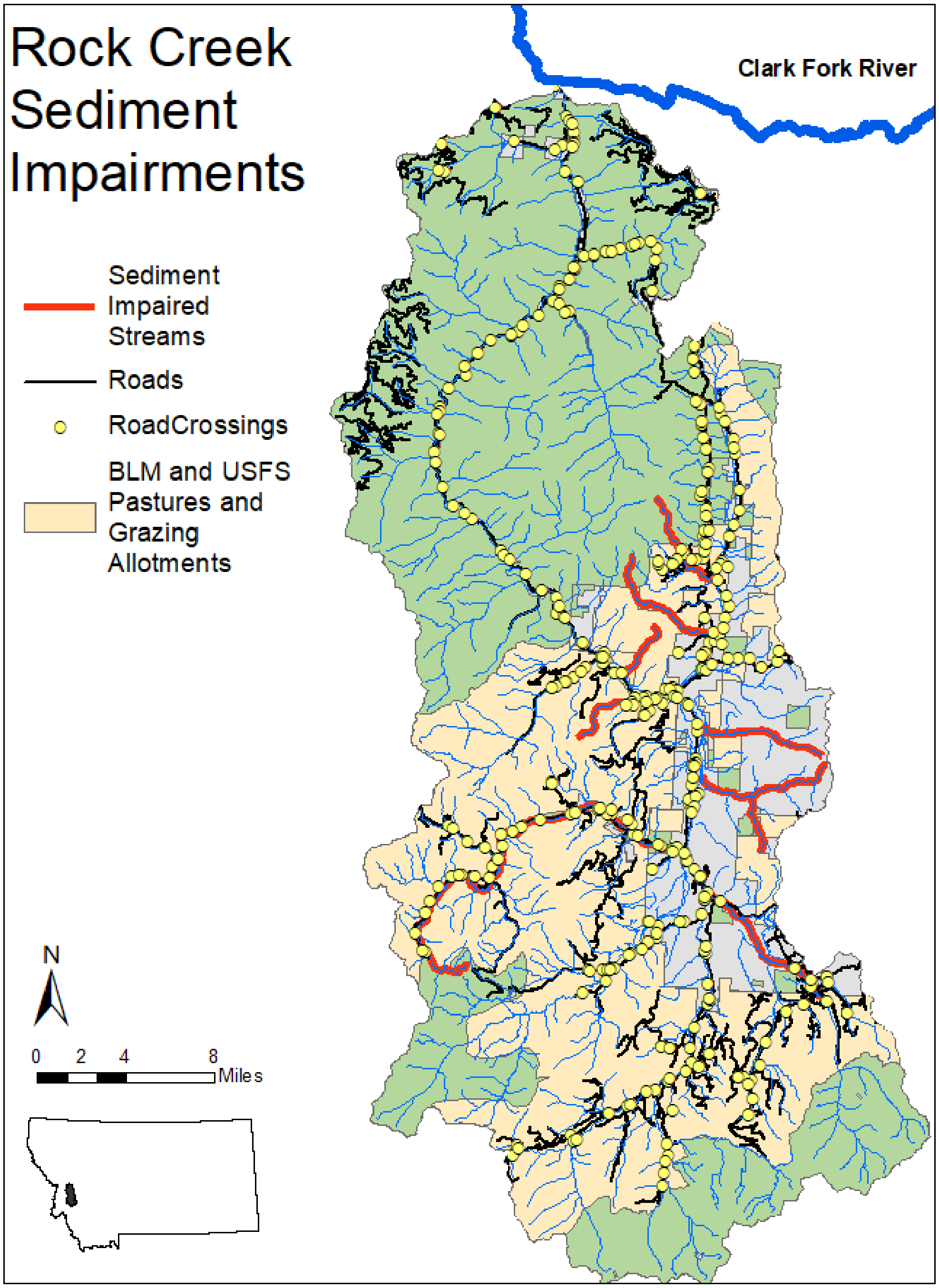
**Map does not include hybridized trout recorded as part of sampling*

Data Source: Montana Cadastral, Montana Fish, Wildlife and Parks, USDA Forest Service

Appendix E

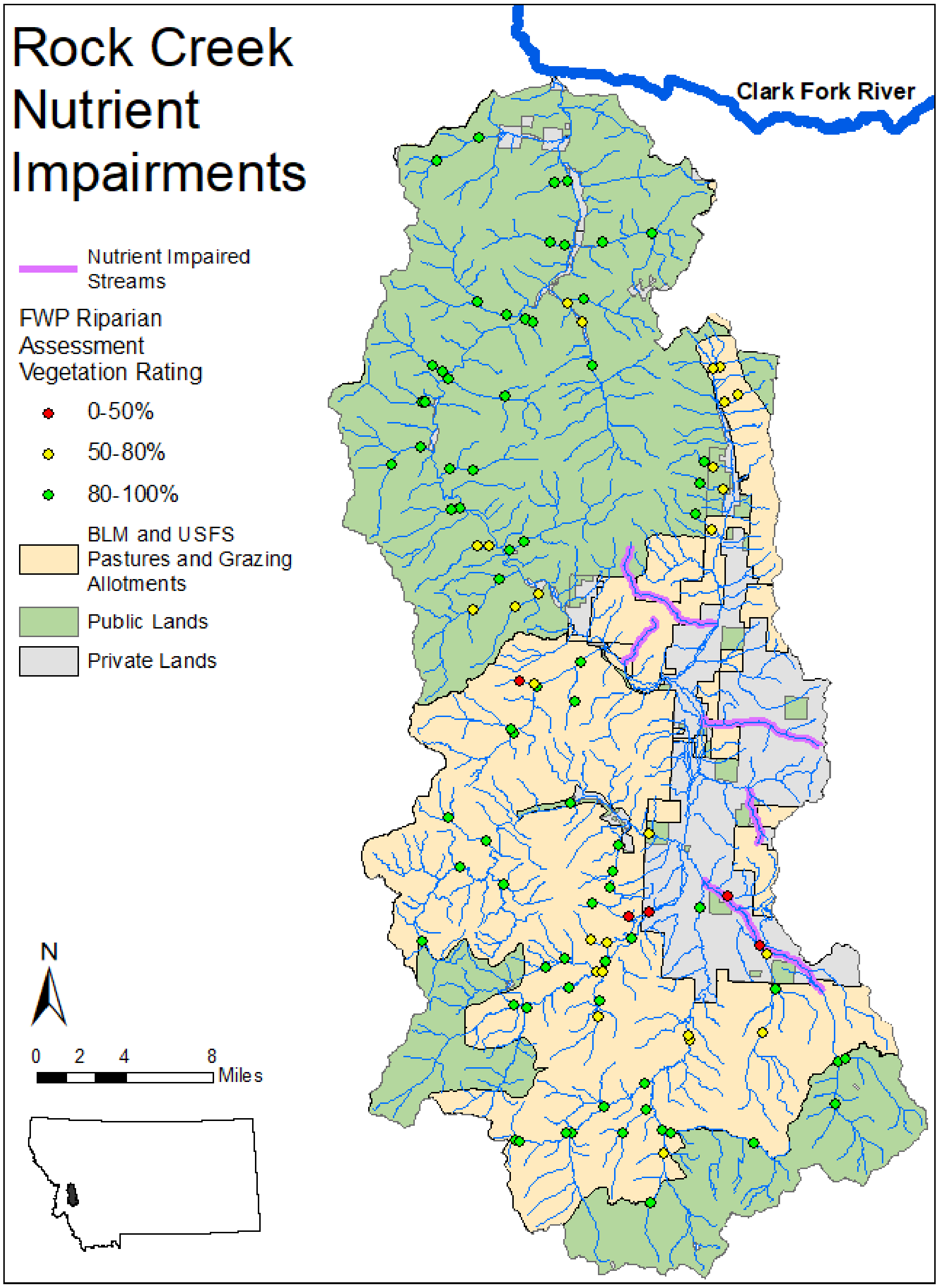


Data sources: The Montana Wetland and Riparian Framework, Montana Natural Heritage Program, Montana Fish, Wildlife and Parks

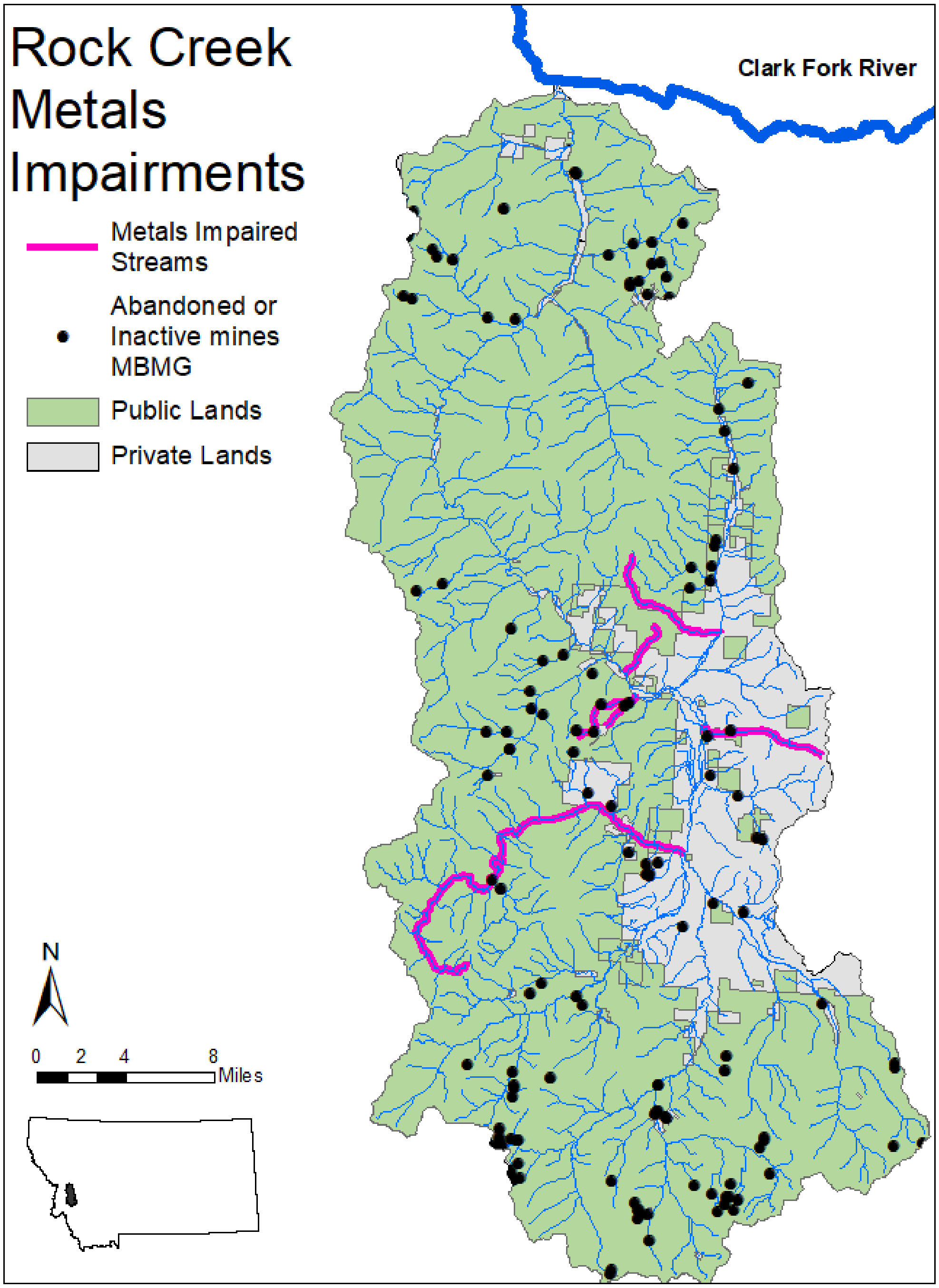


Data sources: BLM, Montana Cadastral, Montana DEQ, USDA Forest Service, The Montana Transportation Framework

Appendix G

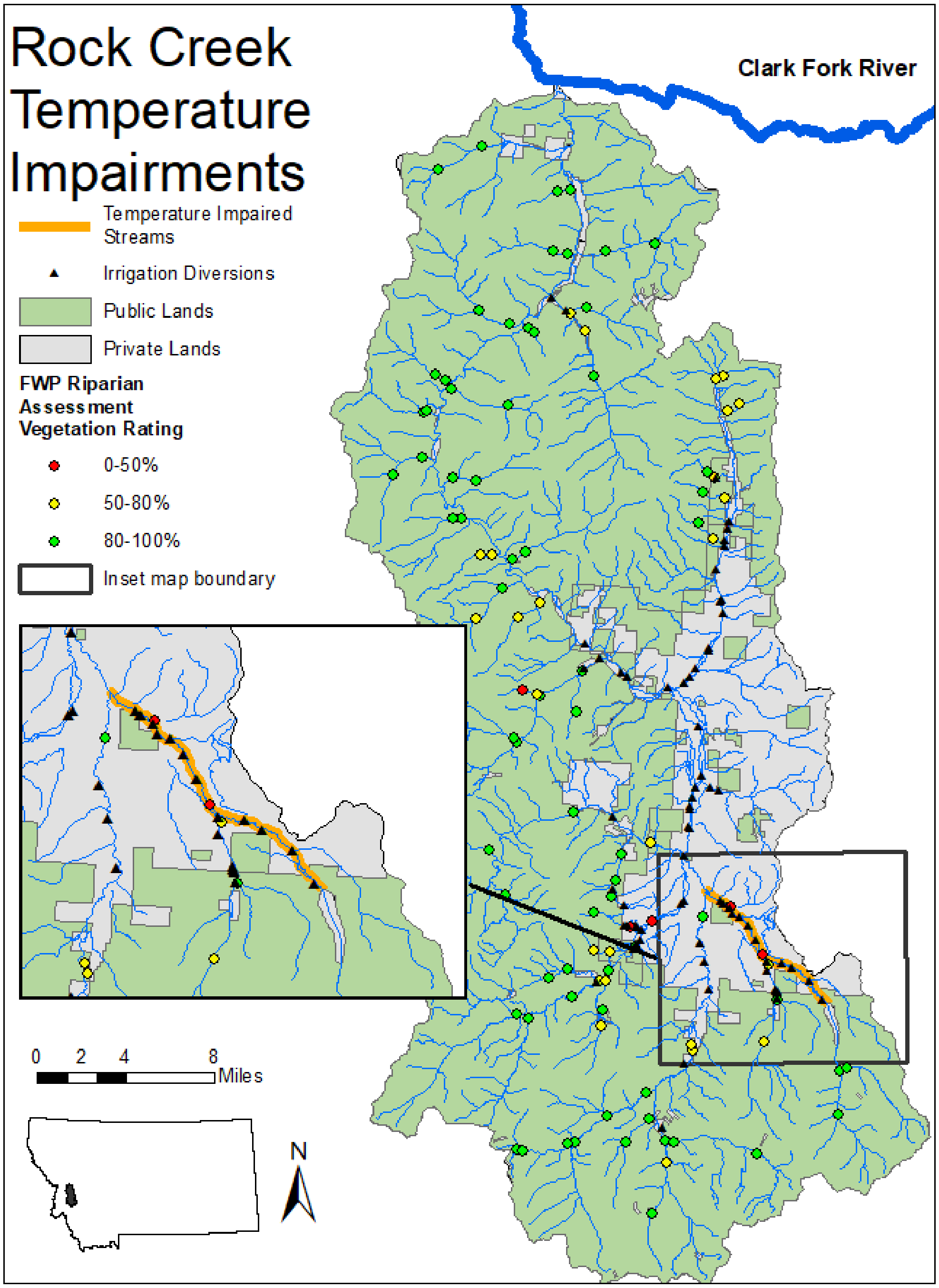


Data Sources: BLM, Montana Cadastral, Montana DEQ, Montana Fish, Wildlife and Parks, USDA Forest Service



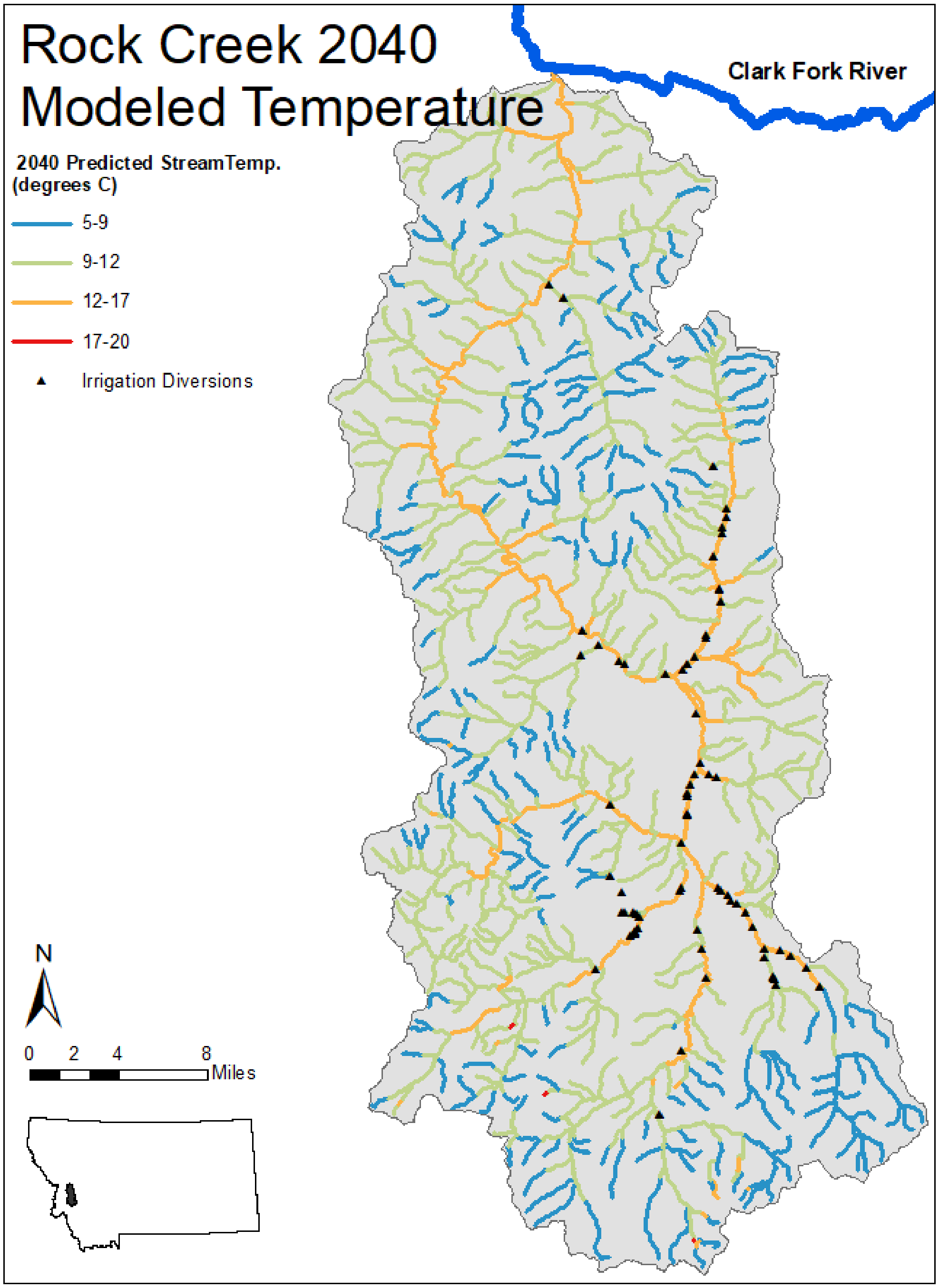
Data Sources: Montana Bureau of Mines and Geology, Montana Cadastral, Montana DEQ, Montana Fish, Wildlife and Parks, USDA Forest Service

Appendix I



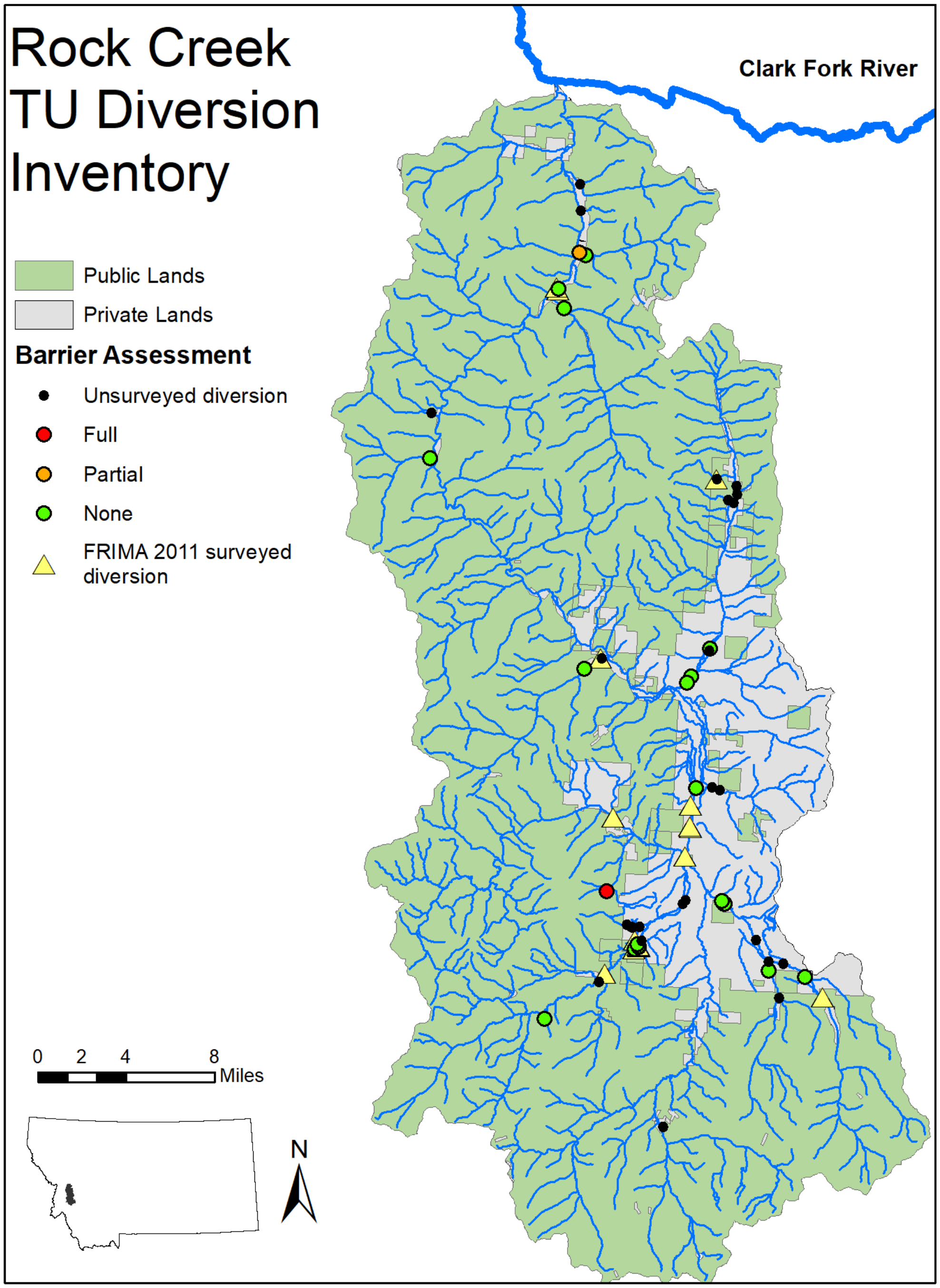
Data Sources: Montana Cadastral, Montana DEQ, Montana Fish, Wildlife and Parks, USDA Forest Service, Trout Unlimited

Appendix J



Data Source: USDA, NorWest (Isaac et al. 2017), Trout Unlimited

Appendix K



Data source: Trout Unlimited, 2017; FRIMA, 2011