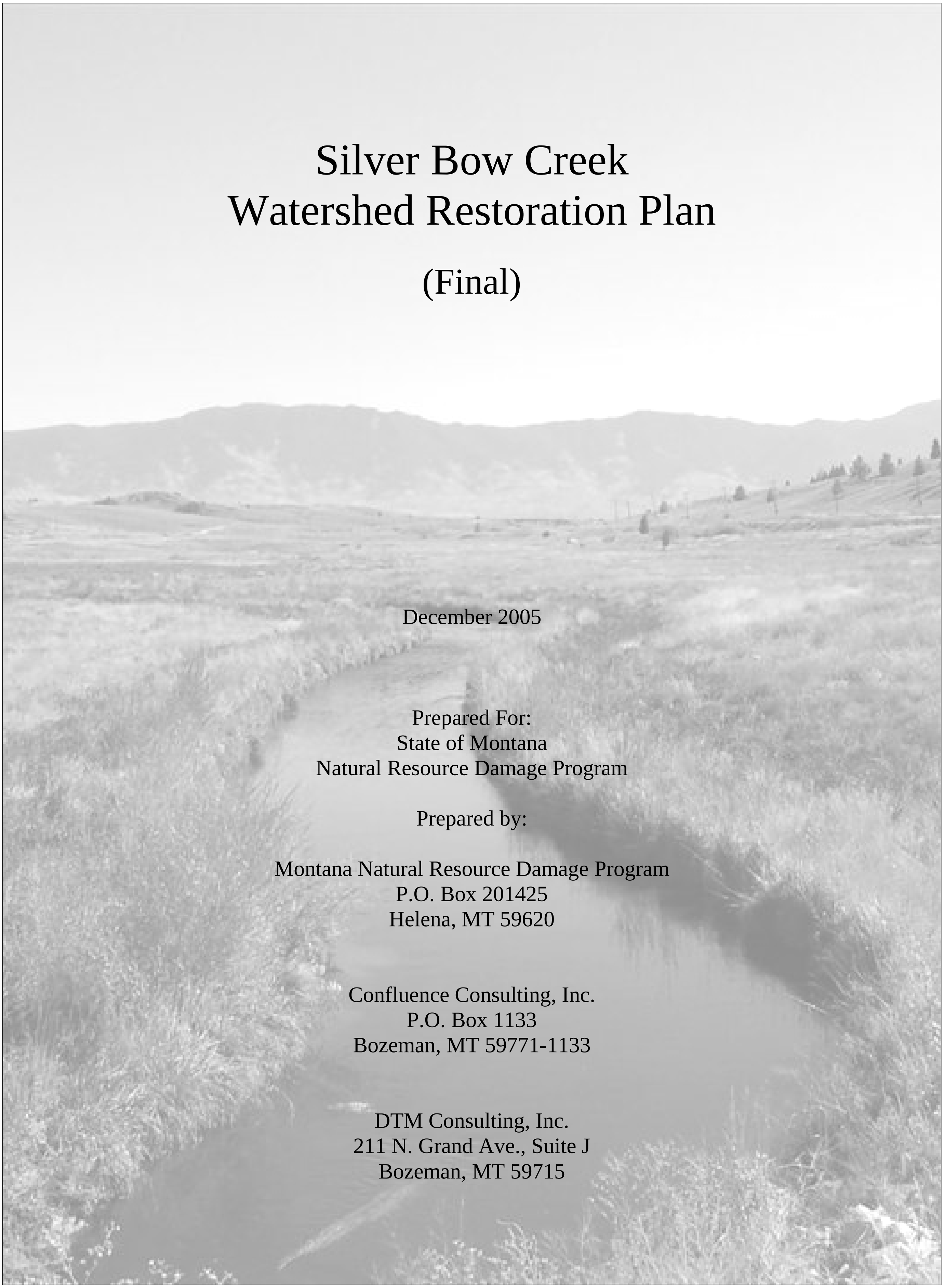


Silver Bow Creek Watershed Restoration Plan

(Final)

December 2005

Prepared For:
State of Montana
Natural Resource Damage Program

Prepared by:

Montana Natural Resource Damage Program
P.O. Box 201425
Helena, MT 59620

Confluence Consulting, Inc.
P.O. Box 1133
Bozeman, MT 59771-1133

DTM Consulting, Inc.
211 N. Grand Ave., Suite J
Bozeman, MT 59715

Table of Contents

List of Figures:

List of Tables

Abbreviation List

ARCO – The Atlantic Richfield Company

BPSOU – Butte Priority Soils Operable Unit

CECRA – The Comprehensive Environmental Cleanup and Responsibility Act

CERCLA – Comprehensive Environmental Compensation and Liability Act

CFS – cubic feet per second

DEQ – Department of Environmental Quality

DNRC – Department of Natural Resources and Conservation

EPA – Environmental Protection Agency

EQIP – Environmental Quality Incentives Program

FWP – Fish, Wildlife, & Parks

GAP – Gap Analysis Program

GIS – Geographic Information System

GWIC – Groundwater Information Center

GLO – Government Land Office

MBMG – Montana Bureau of Mines and Geology

MPDES – Montana Pollution Discharge Elimination System

Mg/L – milligram per liter

µg/L – microgram per liter

NLCD – USGS National Land Cover Database

NPL – National Priority List

NRD – Natural Resource Damage

NRDP – Natural Resource Damage Program

NRIS – Natural Resource Information System

NWI – National Wetlands Inventory

OHV – Off highway vehicle

OU – Operable Unit

PDG – Project Development Grant

PRP – Potentially Responsible Party

ROD – Record of Decision

RPPC – Restoration Plan Procedures and Criteria

SCD/BUD – Sufficient Credible Data/Beneficial Use Determination

SSTOU – Streamside Tailings Operable Unit

TMDL – Total Maximum Daily Load

UCFRB – Upper Clark Fork River Basin

USFS – United States Forest Service

USGS – United States Geological Survey

WCT – Westslope Cutthroat Trout

WMA – Wildlife Management Area

WWTP – Waste Water Treatment Plant

EXECUTIVE SUMMARY

The Silver Bow Creek watershed in southwest Montana encompasses approximately 474 square miles and forms a portion of the headwaters the Clark Fork River and ultimately, the Columbia River. The watershed encompasses parts of Silver Bow and Deer Lodge counties. The eastern boundary of the watershed corresponds to the boundary between Silver Bow and Jefferson counties. The watershed contains both upland forested areas and grass and shrub dominated valley bottoms. The city of Butte (population 33,892 – 2000 Census) is the largest population center and the city of Anaconda (population 9,417) is just outside of the watershed area. The dominant land use has historically been mining, with minor amounts of agriculture and tourism.

Decades of mining activities near Butte and Anaconda resulted in extensive environmental degradation and designation of portions of the watershed as federal Superfund sites. In 1983, the State of Montana filed a natural resource damage lawsuit against ARCO to recover damages for injuries to the water, soils, vegetation, fish and wildlife resources in the Upper Clark Fork River Basin, including along the Silver Bow Creek floodplain corridor. The lawsuit also sought damages for the public's lost use and enjoyment of these resources. As part of the 1999 settlement, the state received $215 million, including about $130 million in natural resource damages to restore or replace the injured resources.

In early 2000, the State finalized the criteria and procedures for spending the $130 million damage award. The State established a grant process whereby government agencies and private entities and individuals are eligible to apply for funds for projects that will restore or improve the injured natural resources and the recreation opportunities that accompany them, including hunting and fishing. The State developed the *Silver Bow Creek Watershed Restoration Plan* as a result of public input indicating the need for watershed-scale restoration planning that would serve as a guide to restoration work in the watershed. This plan provides guidance for prioritizing restoration activities to address injuries caused by mining and mineral processing activities and other issues, and to improve the overall watershed condition. Although disbursement of grant funds drove this watershed restoration plan development, not all restoration needs can be addressed with this funding. The plan identifies all known restoration needs for the watershed regardless of funding restrictions, and identifies potential alternative restoration funding sources.

This plan relies on many watershed restoration concepts and methods applied in other regions and on modern digital spatial technologies for analysis. Public involvement also played a major role in the development of this plan. Stakeholders provided valuable information on restoration issues, needs, and priorities. Most importantly, stakeholders contributed to the development of the following future vision statement that provided guidance throughout the development of this plan:

> *In the 21st century, the Silver Bow Creek Watershed is a vibrant place to live, work and recreate. The watershed is protected from adverse impacts of mining*

contamination. The restored watershed supports viable, self-sustaining communities of fish, wildlife and vegetation, and high-quality water resources. Native species are maintained and restored where practicable. The watershed's healthy ecosystem provides for quality education and balanced recreation, contributing to a diverse and sustainable economy, improved aesthetics, and community well-being. Stable and healthy local communities of informed citizens actively protect the watershed's resources.

Development of this plan required dividing the watershed into eight planning areas to create a manageable spatial framework (Figure ES-1). Seven of the eight planning areas coincide with major tributary sub-watersheds. The exception is the Silver Bow Creek corridor, which warranted a separate planning area. For each area, this plan summarizes information on the conditions of water, fisheries, vegetation, wildlife, and recreational resources and identifies the restoration needs.

This plan identifies 60 significant restoration needs within the eight planning areas. Restoration needs fall into six separate categories listed in order of importance to watershed restoration, with the first two equally important. These categories follow the public vision statement developed for the Silver Bow Creek watershed:

1. preserve and protect existing resources
2. mitigate pollution
3. improve water quantity
4. restore fisheries
5. restore vegetation and wildlife
6. enhance and develop recreational opportunities

A prioritization process that considered the watershed benefits, local (planning area) benefits, and costs to address each of the restoration needs, provided information to develop a ranking of the restoration needs. The importance of the restoration category for each restoration need and the primary and secondary goals provided in the vision statement also contributed to the ranking. Figure ES-2 illustrates the watershed restoration plan development process.

The tables below provide a condensed version of the priorities established through this process. Four of the 60 identified needs were not ranked because they will likely be addressed through ongoing or planned efforts. Of the remaining 56 prioritized needs, 11 ranked very high, 17 ranked high, 17 ranked moderate, and 11 ranked low in restoration importance. The restoration needs with a high or very high restoration importance will be favorable funding prospects for natural resource damage grant funds or other funding sources. Those of moderate importance are likely to derive sufficient benefits to warrant funding consideration for natural resource damage grant funds or other funding sources. Restoration needs with low restoration importance are likely to have insufficient benefit to warrant funding in the near future.

As part of its grants evaluation process established by the *UCFRB Restoration Plan Procedures and Criteria*, the State will consider the consistency of proposed projects in the Silver Bow Creek watershed with the priorities established with this plan. Therefore, prospective applicants for natural resource damage grant funds should utilize this plan to ensure that potential restoration projects address important, identified restoration needs. This plan does not affect the funding evaluation of proposed projects that are within the Upper Clark Fork River Basin but outside of the boundaries of the Silver Bow Creek watershed.

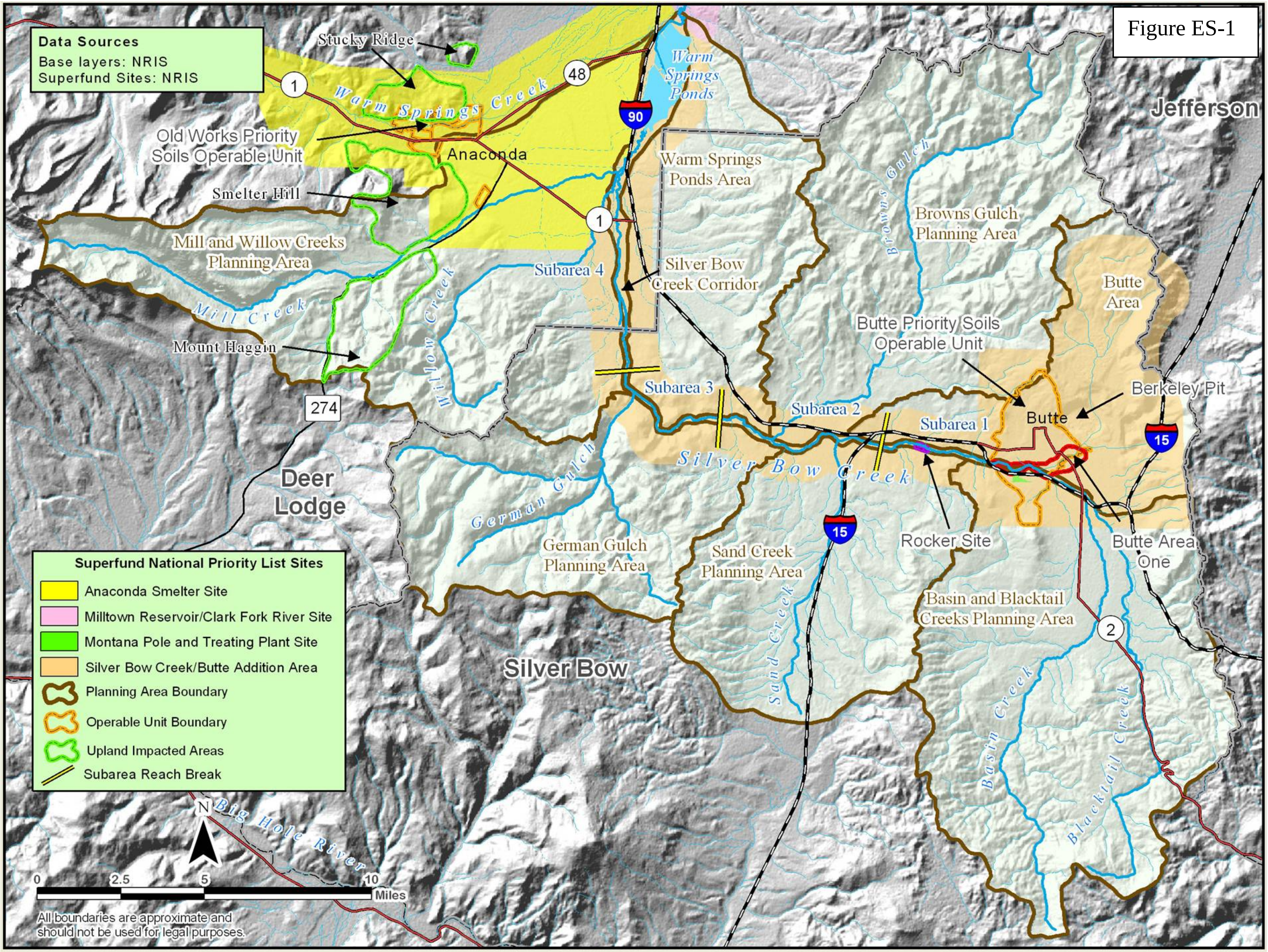
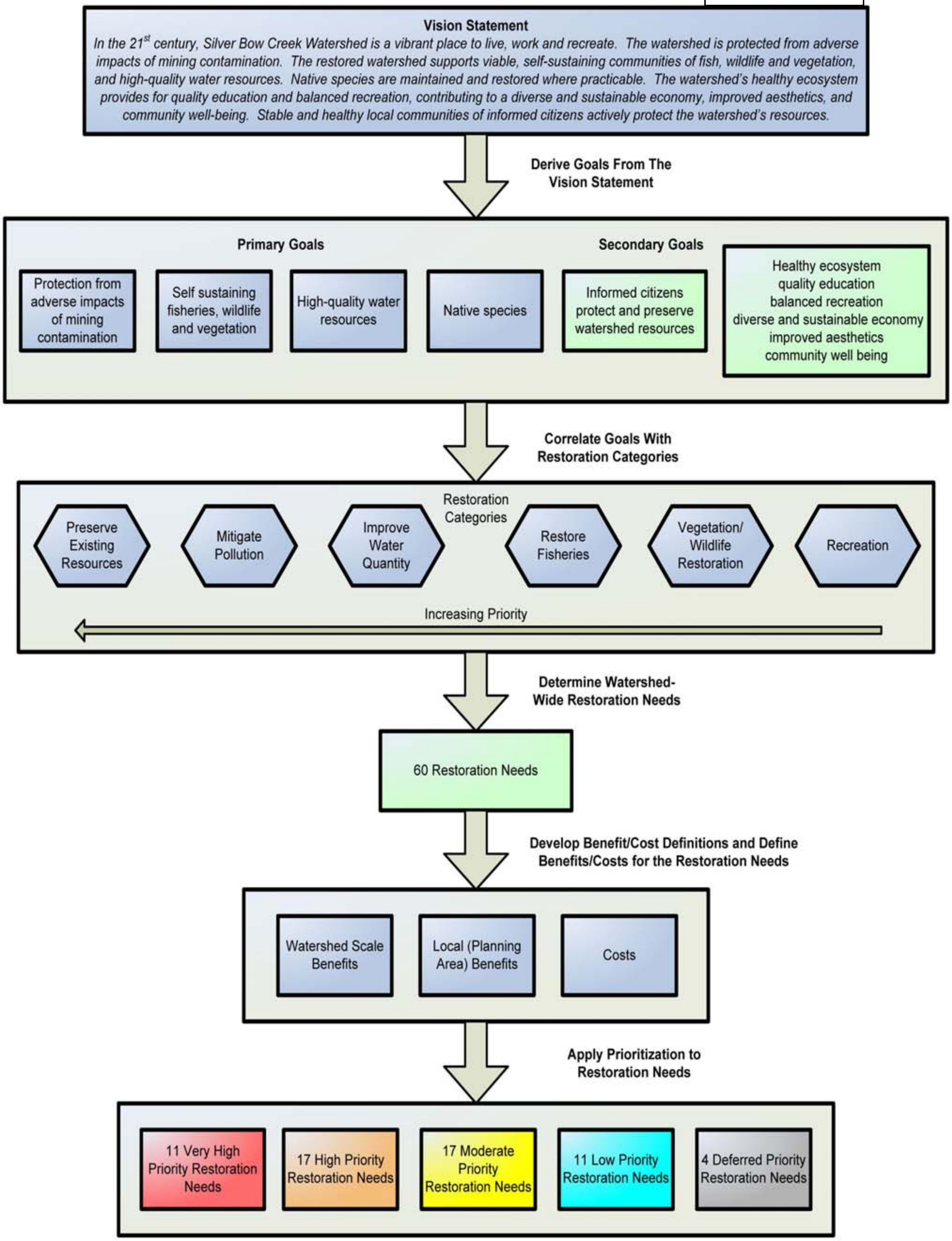


Figure ES-1
Data Sources
Base layers: NRIS
Superfund Sites: NRIS
Stucky Ridge
Warm Springs Creek
Old Works Priority
Soils Operable Unit
Anaconda
Smelter Hill
Mill and Willow Creeks
Planning Area
Mill Creek
Mount Haggin
Willow Creek
Warm Springs Ponds
Warm Springs
Ponds Area
Subarea 4
Silver Bow
Creek Corridor
Subarea 3
Subarea 2
Subarea 1
Browns Gulch
Browns Gulch
Planning Area
Jefferson
Butte
Area
Butte Priority Soils
Operable Unit
Berkeley Pit
Butte
Silver Bow Creek
Rocker Site
Butte Area
One
German Gulch
German Gulch
Planning Area
Sand Creek
Planning Area
Sand Creek
Basin and Blacktail
Creeks Planning Area
Basin Creek
Blacktail Creek
Deer
Lodge
Silver Bow
Big Hole River
1
48
90
274
15
2
Superfund National Priority List Sites
Anaconda Smelter Site
Milltown Reservoir/Clark Fork River Site
Montana Pole and Treating Plant Site
Silver Bow Creek/Butte Addition Area
Planning Area Boundary
Operable Unit Boundary
Upland Impacted Areas
Subarea Reach Break
N
0
2.5
5
10
Miles
All boundaries are approximate and
should not be used for legal purposes.

Figure ES-2



Vision Statement
In the 21st century, Silver Bow Creek Watershed is a vibrant place to live, work and recreate. The watershed is protected from adverse impacts of mining contamination. The restored watershed supports viable, self-sustaining communities of fish, wildlife and vegetation, and high-quality water resources. Native species are maintained and restored where practicable. The watershed's healthy ecosystem provides for quality education and balanced recreation, contributing to a diverse and sustainable economy, improved aesthetics, and community well-being. Stable and healthy local communities of informed citizens actively protect the watershed's resources.
Derive Goals From The Vision Statement
Primary Goals
Secondary Goals
Protection from adverse impacts of mining contamination
Self sustaining fisheries, wildlife and vegetation
High-quality water resources
Native species
Informed citizens protect and preserve watershed resources
Healthy ecosystem quality education balanced recreation diverse and sustainable economy improved aesthetics community well being
Correlate Goals With Restoration Categories
Restoration Categories
Preserve Existing Resources
Mitigate Pollution
Improve Water Quantity
Restore Fisheries
Vegetation/ Wildlife Restoration
Recreation
Increasing Priority
Determine Watershed-Wide Restoration Needs
60 Restoration Needs
Develop Benefit/Cost Definitions and Define Benefits/Costs for the Restoration Needs
Watershed Scale Benefits
Local (Planning Area) Benefits
Costs
Apply Prioritization to Restoration Needs
11 Very High Priority Restoration Needs
17 High Priority Restoration Needs
17 Moderate Priority Restoration Needs
11 Low Priority Restoration Needs
4 Deferred Priority Restoration Needs

Summary of prioritized restoration needs in the Silver Bow Creek watershed

Rank	*Restoration Importance*	*Planning Area and Issue/Problem*	*Restoration Needs*
1	Very High	**Basin and Blacktail creeks:** Limited drinking water sources for the city of Butte make **Basin Creek** a critical source of water.	Protect Basin Creek from potential pollution sources and activities that may threaten water quality. Mitigate risk of wildfire and potential sediment loading.
2	Very High	**Butte Area:** Limited drinking water supplies for the city of Butte make Moulton Reservoir a critical source of water.	Protect Yankee Doodle Creek from potential pollution sources and activities that may threaten water quality.
3	Very High	**Mill and Willow creeks and Silver Bow Creek corridor:** The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	Investigation should be conducted as to the ultimate fate and the implications of changing the configuration of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River prior to EPA's determination of a final remedy for the Ponds. See also deferred category #59.
4	Very High	**Basin and Blacktail creeks:** Genetically pure population of native westslope cutthroat trout exist in focal habitat in upper **Basin Creek** and need protection.	Activities to protect the upper Basin Creek water supply will help protect westslope cutthroat trout. Reservoirs form a fish passage barrier to prevent introgression of non-native species. Evaluate adjunct westslope cutthroat trout habitat in other parts of Basin Creek.
5	Very High	**Butte Area and Silver Bow Creek corridor:** Mining related contaminants continue to enter Silver Bow Creek and degrade water quality. Storm water from the Butte area and groundwater in Butte Area One are the primary sources.	Ongoing and future remediation and the outcome of current litigation may address some of these sources of contamination. Seek effective remediation of the Butte Priority Soils Operable Unit. Following the Record of Decision, update the State's restoration plan for Butte Area One. Eliminate or isolate remaining sources of water quality impairment.
6	Very High	**Silver Bow Creek corridor:** Remediation and restoration actions along the Silver Bow Creek floodplain on private lands need to be protected from potentially detrimental land management activities in the long term.	Acquire land or conservation easements along the Silver Bow Creek corridor to protect restored areas. Subarea 2 contains about 320 acres and Subarea 4 contains about 500 acres of private lands that should be considered for acquisition or easements.
7	Very High	**German Gulch:** A significant native westslope cutthroat trout population needs preservation and protection. Chronic competition from brook trout may jeopardize native westslope cutthroat trout populations.	Continue actions by Montana FWP and USFS to suppress brook trout. See deferred need #57 associated with Beal Mine.
8	Very High	**German Gulch:** Much of German Gulch is diverted for irrigation just before reaching Silver Bow Creek. This water could significantly help water quality problems in Silver Bow Creek, especially during low flows.	Explore the best alternative for obtaining adequate flows for connectivity with Silver Bow Creek. Alternatives include water conservation, water leasing, alternative irrigation source, or acquisition. In 2005 the State approved funding of a project to provide for fish passage and this connectivity.

Rank	*Restoration Importance*	*Planning Area and Issue/Problem*	*Restoration Needs*
9	Very High	**Browns Gulch:** Current conditions of fisheries are not well understood.	Conduct additional fisheries assessment in the upper and lower reaches of Browns Gulch and major tributaries. In 2004 the State approved funding for such assessment work.
10	Very High	**Silver Bow Creek corridor:** Recreational opportunities are minimal due to historic mining impacts.	Implement a greenway trail system along the entire length of Silver Bow Creek. Acquire/develop access for fishing and water recreation. Create a series of trails connecting to nearby communities (Anaconda and Butte). These needs reflected in the 1998 Silver Bow Creek Greenway design document. Public land managers believe this trail should be low impact where it bisects important wildlife habitat and should allow foot, bicycle, or horse access only.
11	Very High	**Butte Area:** Additional connecting trails between the Greenway and urban residential areas are desired.	Develop additional connecting trails.
12	High	**Mill and Willow creeks:** Critical wildlife winter range exists along the public land/private land boundary and could be developed.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.
13	High	**Mill and Willow creeks:** Dewatering for irrigation impairs fisheries and exacerbates water quality problems.	Increase instream flow during critical life stages of fish through water leasing, conservation and other measures.
14	High	**Browns Gulch:** Stream flow is inadequate for fisheries in the lower reaches of Browns Gulch. Lack of flow is the greatest limiting factor to fishery improvements.	Identify and implement means to augment stream flow. Water conservation and water leasing are possibilities. In 2004 the State approved funding for a project to conduct needed flow studies.
15	High	**Silver Bow Creek corridor:** Remedial actions will fall short of creating an optimal fishery.	Enhance fish habitat diversity and structural complexity; improve substrate in future reaches where appropriate. Approved Greenway funding will address this need in Reaches A - I. Coordinate with installation of migration barriers as needed to promote native fishery.
16	High	**Basin and Blacktail creeks:** Genetically pure westslope cutthroat are likely present in upper Blacktail Creek.	Evaluate focal and adjunct westslope cutthroat trout habitat in Blacktail Creek. Take appropriate measures to improve/protect these habitats.
17	High	**Butte Area:** The Westside Soils Operable Unit area currently has a high level of recreational use but has impacts from this use and hazards associated with historic mining activity, such as abandoned mine dumps.	EPA decisions on the needed remediation, if any, of the Westside Soils Operable Unit has been deferred until the Agency is funded to address this area. Restoration planning should be deferred until completion of a final remedy decision. ARCO owns the majority of lands and seeks a recreational land use scenario. Anticipated recreational needs are likely to be limited to trails for dispersed recreation.

Rank	*Restoration Importance*	*Planning Area and Issue/Problem*	*Restoration Needs*
18	High	**Butte Area:** The upper reaches of Silver Bow Creek were obliterated by historic mining activities. A replacement surface water feature is desired.	Create a surface water feature with adjacent parkland and trails along the upper reaches of Silver Bow Creek between Texas Ave and the Blacktail Creek confluence. Plans are under way to accomplish this using water from the Silver Lake water system. Treated Berkeley Pit water is also a possible future water source if this treated water is not needed for mining operations. Current mining operations consume all of the current output of the Horseshoe Bend treatment plant.
19	High	**Butte Area:** Butte area residents have not had access to a variety of recreational features as a result of mining activities and contamination.	Develop a variety of recreational features such as parks, open spaces, swimming areas and trails that are readily accessible for citizens of all ages. Benefits will vary based on number and magnitude of these features; cost assumes 3 of these features.
20	High	**Basin and Blacktail creeks:** Thompson Park recreation facilities are in need of upgrade or repair. A consistent funding source is needed to maintain these facilities.	Obtain funding for renovation and maintenance of facilities. Undertake renovation activities.
21	High	**Mill and Willow creeks:** Storm water runoff from smelter fallout contaminated hillslopes continues to deliver metals to Mill Creek and to a lesser extent, Willow Creek.	The outcome of pending remedial action/remedial design and litigation may address part of this issue. The State's restoration claim and plan cover the needed actions.
22	High	**German Gulch:** Private lands along lower German Gulch adjacent to the Fleecer Mountain and Mt. Haggin Wildlife Management Areas are at risk for potentially detrimental development. These lands are part of the elk and deer winter range in this area.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.
23	High	**Browns Gulch:** Establish focal habitat for westslope cutthroat trout.	Assess feasibility of and establish isolated westslope cutthroat trout habitat in headwater areas, particularly in Alaska Gulch, via fish passage barriers and limited habitat improvement.
24	High	**Silver Bow Creek corridor:** Remedial actions will fall short of restoring a healthy riparian vegetation zone along Silver Bow Creek and its floodplain. Wildlife populations are limited in the corridor.	Enhance riparian vegetation. Wetlands creation may be appropriate locally and will have a beneficial impact on water quality. Establishment of a healthy riparian zone along Silver Bow Creek will create the opportunity for wildlife to reoccupy this area. Approved Greenway funding will address Reaches A-I and P-R..
25	High	**Butte Area:** Contaminated soils and lack of fresh water supplies have prevented vegetation from surviving and thriving in the Butte area. Entryway corridors and open spaces are in need of "greening."	Identify limiting factors to vegetation survival and address these issues. Develop alternative water sources that will enable vegetation to survive. One option is to utilize water that flows from upper Silver Bow Creek and Yankee Doodle Creek into the Yankee Doodle tailings impoundment. Use of this water is limited by current mining operations. Plant metals-tolerant trees, shrubs, and grasses (preferably native species) along entryway corridors and open spaces.

Rank	***Restoration Importance***	***Planning Area and Issue/Problem***	***Restoration Needs***
26	High	**Mill and Willow creeks:** Smelter emissions have caused widespread contamination of soils with metals and arsenic in upland areas around Anaconda, degrading vegetation and wildlife habitat.	The outcome of current remediation and litigation is anticipated to address this problem. Restoration of the upland areas is addressed in the State's 2002 restoration plan.
27	High	**German Gulch:** Public input indicates a desire for trail access from Silver Bow Creek.	Examine feasibility and appropriateness of a trail from Silver Bow Creek to German Gulch. In 2005 the State approved funding for a footbridge and 2 mile trail in lower German Gulch.
28	High	**Butte Area:** Nearby recreational fishing opportunities are not available to local residents.	Develop recreational (stream and/or pond) fishing opportunities in the Butte area. One such opportunity in Butte is currently being considered.
29	Moderate	**Mill and Willow creeks:** The Yellow Ditch, the Blue Lagoon, and railroad and road crossings over streams are all sources of metals contamination to Mill and Willow creeks.	Ongoing remediation and the outcome of current litigation may address some of these sources of contamination. Identify, assess, and restore those not the subject of these efforts.
30	Moderate	**Browns Gulch:** Water quality (siltation, nutrients, temperature) may be impaired.	Address water quality impairments via improvement in land use practices.
31	Moderate	**Silver Bow Creek corridor:** Nutrients are discharged to Silver Bow Creek from the Butte and Rocker wastewater treatment facilities.	Improve/upgrade treatment of municipal effluent. Proportionately, the Butte wastewater treatment plant contributes far greater amounts of nutrient loading to Silver Bow Creek than the Rocker wastewater treatment plant. Butte-Silver Bow has obligations to further reduce its nutrient discharge by 2007 via the Clark Fork River voluntary nutrient reduction program.
32	Moderate	**Basin and Blacktail creeks:** Riparian degradation and channelization along **Blacktail Creek** were detected in the aerial photography assessment.	Improve aquatic habitat and riparian vegetation along Blacktail Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.
33	Moderate	**German Gulch:** Noxious weed infestations are present and associated with historic placer mining disturbance, grazing, modern mining, and roads.	Take actions to reduce spread of noxious weeds. (See #34 regarding grazing.)
34	Moderate	**German Gulch:** Livestock grazing has reportedly had a detrimental impact on stream habitat.	Examine grazing practices and implement appropriate grazing management strategies to minimize impacts.
35	Moderate	**Basin and Blacktail creeks:** High density of septic systems south of Butte may be contributing nutrients to ground and surface water.	Evaluate the impact of septic systems. Take appropriate actions such as expansion of Butte wastewater treatment facility to incorporate some residential areas currently on septic systems.
36	Moderate	**Browns Gulch:** Improve fisheries habitat in lower reaches of Browns Gulch. Connecting a lower Browns Gulch fishery to a future Silver Bow Creek fishery is desired.	Assess feasibility of adequately addressing limiting factors to fisheries of water quantity, water quality, and habitat issues. Subsequent to addressing the water quantity and quality problems that limit fisheries in Brown's Gulch, improve aquatic habitat to further improve fishery populations.

Rank	*Restoration Importance*	*Planning Area and Issue/Problem*	*Restoration Needs*
37	Moderate	**Mill and Willow creeks:** Livestock grazing degrades riparian vegetation and causes bank erosion.	Restore healthy riparian zones through better grazing management and re-vegetation. Stream restoration measures may be necessary locally. See also deferred restoration need #60.
38	Moderate	**German Gulch:** Off-highway vehicle use in the area has caused disturbances.	Examine restrictions on motorized access.
39	Moderate	**Basin and Blacktail creeks:** Recreational fisheries along the valley foothill portions of **Basin and Blacktail creeks** are marginal.	Subsequent to or concurrent with needed fishery improvements (#30), improve recreational fishing access opportunities via trail access and fishing access sites.
40	Moderate	**Browns Gulch:** Better public access is desired.	Identify and pursue public access opportunities in cooperation with current landowners.
41	Moderate	**German Gulch:** Riparian lands (old placer mining claims within the USFS land) along German Gulch are at risk for potentially detrimental development. Already, historic access to private lands in this area has been lost after change in ownership.	Acquire lands or conservation easements to protect these areas from potentially detrimental development. In 2005 the State approved funding for public acquisition of 82 acres of riparian corridor in lower German Gulch.
42	Moderate	**Basin and Blacktail creeks:** The historic Highland Mine may be a source of metals contamination in the headwaters of **Basin Creek**.	Additional water quality and site sampling is necessary; water quality sampling from the 1970s is suspect. Contamination problems, if any, are predicted to be minor given the site's location and small area of disturbance.
43	Moderate	**Basin and Blacktail creeks:** Limited 1970s water quality sampling on the valley foothill portion of **Basin Creek** (downstream of municipal source water area) indicates metals contamination.	Re-sample Basin Creek water quality. Evaluate railroad bed as a possible source. Mitigate pollution source(s) if water quality impairment is confirmed.
44	Moderate	**German Gulch:** Historic placer mining has disturbed both aquatic and riparian habitat.	Restore stream and riparian habitat where habitat has not recovered from placer mining. In 2005 the State approved funding of a stream restoration demonstration project in placer-impacted areas of lower German Gulch.
45	Moderate	**Mill and Willow creeks:** Public access is lacking.	Seek recreational access through easements, acquisitions, or access programs.
46	Low	**Mill and Willow creeks:** Mining related contaminants are present in groundwater underneath the Opportunity Ponds. These contaminants may eventually reach Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek.	Metal contamination from this source should be minimized to limit impact to these streams. Current amounts of contaminants (metals) from this source reaching Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek are believed to be low. Identified contaminant plumes of cadmium, lead, zinc, and arsenic are believed to be slow moving. Secondary contaminants iron, manganese, and sulfate are faster moving and at higher levels, but do not present significant environmental impacts.
47	Low	**Mill and Willow creeks:** Nuisance algae is observed in both Mill and Willow creeks. Sources and impacts to fisheries are unknown.	Investigate potential sources and impacts. Reduce nutrient loading as determined necessary from studies.

Rank	*Restoration Importance*	*Planning Area and Issue/Problem*	*Restoration Needs*
48	Low	**Mill and Willow creeks:** Excessive siltation is reported in both Mill and Willow creeks. Reduced vegetative cover resulting from smelter impacts exacerbates erosion. Other known sources are timber harvest in the upper reaches of Willow Creek, road and railroad crossings, and cattle grazing.	Via remediation and restoration activities in the Anaconda Uplands, vegetation cover will be increased (refer to restoration need #26). Address other known sources of siltation through implementing better timber harvest and grazing management and restoration measures where appropriate.
49	Low	**Sand Creek:** Fisheries data in the headwater tributaries is lacking. Small headwater tributaries in the southwest portion of the sub-watershed may host isolated populations of native fish.	Investigate the presence of fisheries and nature of these streams for stocking potential and protection/restoration needs.
50	Low	**Basin and Blacktail creeks:** Riparian degradation and channelization along **Basin Creek** was detected in the aerial photography assessment. Riparian vegetation along Basin Creek below the reservoirs is sparse and lacks diversity.	Improve aquatic habitat and riparian vegetation along Basin Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.
51	Low	**Sand Creek:** Land development is threatening open space and wildlife habitat in the higher elevation areas of the sub-watershed.	Acquire land or conservation easements along the private/public land boundary in the southwest portion of the watershed to protect wildlife winter ranges. This area is of lower priority to agency land managers than winter range in the Mill and Willow creeks and German Gulch sub-watersheds.
52	Low	**Sand Creek:** Private land in-holdings in USFS land are at risk for development.	Acquire land or conservation easements. (USFS considers these areas to be low priority).
53	Low	**Sand Creek:** Surface water quality data for Sand Creek is lacking. Mine waste in rail beds adjacent to Sand Creek may be a source of metals contamination to Sand Creek and Silver Bow Creek. Bank erosion and road and rail disturbances along Sand Creek may be producing excess fine sediment that is ultimately delivered to Silver Bow Creek.	Investigate the presence and impacts from these potential sources. Take appropriate actions. See also deferred action #58.
54	Low	**Warm Springs Ponds:** Noxious weeds restrict growth of native vegetation. Wildlife habitat is also reduced. Historic smelter fallout may have rendered soils slightly phytotoxic, restricting plant growth.	Work with county and conservation officials to develop appropriate weed management strategies that takes into consideration findings of the Butte-Silver Bow soils survey. Take appropriate actions to improve upland vegetation.
55	Low	**Sand Creek:** Noxious weeds restrict growth of native vegetation.	Work with county and conservation officials to develop and implement appropriate weed management strategies that take into consideration findings of the Butte Silver Bow soils survey.
56	Low	**Warm Springs Ponds:** Access is restricted to private lands.	Pursue easement or other access possibilities such as Montana FWP block management as appropriate.

Summary of deferred restoration needs in the Silver Bow Creek watershed

Rank	*Issue/Problem*	*Planning Area and Restoration Needs*
Deferred (57)	**German Gulch:** Seepage from a waste rock dump at the Beal Mine has caused releases of selenium and other metals. Selenium levels found in fish tissue exceed aquatic toxicity levels and in down gradient waters exceed aquatic life standards.	Wait for outcome of pending remedial actions by the USFS and Montana DEQ to evaluate need for additional actions to reduce impacts from the seepage and address the future needed treatment of the leachate from the leach pad.
Deferred (58)	**Sand Creek:** Detailed nature and potential impacts of Rhodia phosphate facility are not fully known. The site is currently undergoing investigations and cleanup under an EPA order.	Wait for outcome of current investigations and cleanup of this site, which is to cover the entire site and any off-site releases. Evaluate following cleanup.
Deferred (59)	**Silver Bow Creek corridor:** Groundwater is contaminated beneath and to the north of the Warm Springs Ponds.	Under remedy, metals contamination from this source is being collected and pumped back to Pond 2 for treatment. The groundwater flowing from the system is expected to improve to the point that inception, pumping and treating will no longer be necessary in a few years to decades.
Deferred (60)	**Mill and Willow creeks:** Tailings from the 1908 flood of Silver Bow Creek have been deposited in the floodplain of Willow Creek.	This area is currently the subject of joint restoration and remedy planning and likely to be adequately addressed via that process.

1.0 Introduction

The Silver Bow Creek watershed is approximately 474 square miles in size and located at the headwaters of the Clark Fork River in southwest Montana (Figure 1-1). Decades of mining activities near Butte and Anaconda, Montana resulted in extensive environmental degradation and designation of portions of the watershed as federal Superfund sites. This document (*the Silver Bow Creek Watershed Restoration Plan*) provides guidance for prioritizing restoration activities to address these and other issues and to improve overall watershed condition. This chapter describes the development of this document and introduces the goals and objectives of the planning process. This chapter also explains document organization and provides guidance on using this information to assist with planning restoration activities in the watershed.

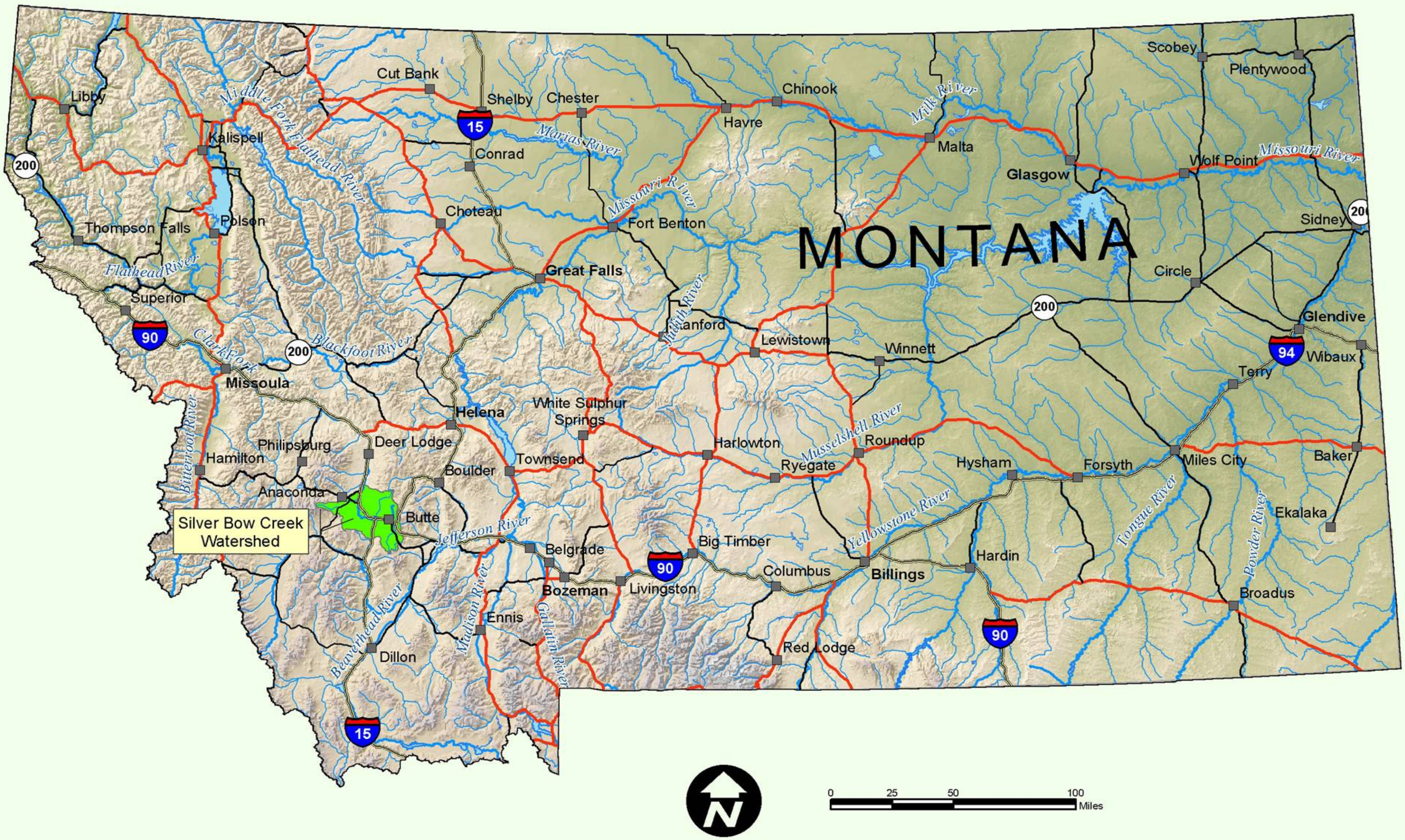
1.1 Basis for Developing the Watershed Restoration Plan

Mining and mineral processing operations in and around Butte and Anaconda released substantial quantities of hazardous substances into Silver Bow Creek beginning in the 1860s and continuing until the present day. These hazardous substances extensively injured the area's natural resources. In 1983, the State of Montana filed a natural resource damage lawsuit against the Atlantic Richfield Co. (ARCO) to obtain compensation for injuries to natural resources in the Upper Clark Fork River Basin (UCFRB). The lawsuit included compensation for the lost use and enjoyment of those resources injured by release of hazardous substances from the mining and mineral processing activities of ARCO and its predecessors. The lawsuit covered injuries to aquatic, terrestrial, and groundwater resources in the UCFRB, including injuries to the water, soil, vegetation, fish, and wildlife resources of the Silver Bow Creek floodplain corridor.

ARCO and the State partially settled the lawsuit in 1999. As a result, ARCO paid the State $86 million to remediate (clean up) the Silver Bow Creek area as called for by the Streamside Tailings Operable Unit Remediation Plan (Montana DEQ and US EPA, 1995). ARCO also paid the State about $130 million in natural resource damages (NRD) to restore the UCFRB's public natural resources, and $15 million for legal costs. Restoration funds primarily target improving fish, wildlife, vegetation, groundwater, and rivers and streams and the public's use and enjoyment of these natural resources.

In early 2000, the State finalized the *UCFRB Restoration Plan Procedures and Criteria* (*RPPC*), which provides the framework for spending the $130 million in settlement funds. The State elected to establish a grant process, administered by the Montana Natural Resource Damage Program (NRDP). Government agencies, private entities, and individuals are all eligible to apply for funding based on procedures and criteria outlined in the *RPPC*. Through 2005, the State has completed six grant cycles and awarded about $38 million of grant funds for 50 projects. The State updated the *RPPC* in 2002 (NRDP, 2002a). A new update will be issued in January 2006 that will address how the *Silver Bow Creek Watershed Restoration Plan* will be considered in grant funding decisions, as further explained in Chapter 9.0.

Figure 1-1: Location of the Silver Bow Creek watershed.



All boundaries are approximate and should not be used for legal purposes.
Data Source: NRIS

Public comments on the *RPPC* and annual work plans suggested that the State develop a comprehensive restoration plan to set forth a watershed vision and broad-based, watershed-scale restoration needs and goals that would serve to guide project selection and restoration work in the UCFRB. Based on this public input and with the concurrence of the UCFRB Restoration and Remediation Education Advisory Council and the Trustee Restoration Council, in 2002 the NRDP initiated the watershed planning effort for Silver Bow Creek presented in this plan.

1.2 Goals of the Watershed Restoration Plan

The goal of the *Silver Bow Creek Watershed Restoration Plan* is to provide guidance for identifying and prioritizing restoration activities in the Silver Bow Creek watershed. This includes guidance for those who submit grant applications to the NRDP as well as guidance for the NRDP when evaluating grant proposals. The focus of this guidance is on restoration activities that meet the legal requirements for NRDP restoration funding. However, given the broad watershed approach to this planning effort, the plan also includes restoration activities that may be ineligible or partially eligible for NRDP grant funds.

1.3 Objectives of the Watershed Restoration Plan

Objectives to reach the goal of the *Silver Bow Creek Watershed Restoration Plan* Project are to:

- summarize background information on the environmental history of the Silver Bow Creek watershed;
- undertake a public participation process to obtain public input and feedback regarding experiences, needs, concerns, ideas, and the current and desired future conditions of the Silver Bow Creek watershed;
- develop a public vision for the restored watershed that is used as a basis for establishing goals and objectives for restoration;
- describe the current conditions of the Silver Bow Creek watershed using existing information;
- review, analyze, and model existing information to identify restoration needs;
- prioritize restoration needs based on benefits to the watershed as a whole, benefits to local sub-watersheds, and relative costs where possible;
- describe the NRDP grant funding process and provide guidance and recommendations for prospective applicants;
- identify other funding opportunities for projects outside the scope or priorities of the NRDP; and
- summarize all of the above information into a coherent user-friendly report.

1.4 Document Organization

Chapter 1.0 describes the reasons the plan was developed, and introduces the goals and objectives of the planning process. The introduction section also explains document organization and provides guidance on using this document when planning restoration activities in the watershed.

Chapter 2.0 provides background information on the environmental history of the Silver Bow Creek watershed. This includes a brief narrative history of mining activities in the area and of the Superfund regulatory actions pursued by the State of Montana and U.S. Environmental Protection Agency (EPA). Also included is a summary of completed or planned remedial and restoration activities in the UCFRB.

Chapter 3.0 provides a synthesis of watershed restoration planning principles used in other areas. Since no two watersheds are the same, this section identifies and describes concepts relevant to the Silver Bow Creek watershed applied in subsequent portions of this document.

Chapter 4.0 describes the methods used to develop this plan. This includes the public participation process, data compilation and review, data analysis and modeling, identification of restoration needs, and determination of restoration priorities.

Chapter 5.0 summarizes the process used to conceive a consensus vision statement for the future of the Silver Bow Creek watershed and the results of this process.

Chapter 6.0 summarizes physical characteristics of the Silver Bow Creek watershed. This includes climate, hydrology, geology, soils, vegetation, land ownership, land use, sources of environmental impairments, and major gaps in the knowledge base.

Chapter 7.0 describes the known watershed condition and restoration needs of each of eight major study areas defined for the Silver Bow Creek watershed. The resources addressed in this chapter are primarily water, fisheries, vegetation, wildlife, and recreation.

Chapter 8.0 contains results and discussion of the determination of restoration priorities for the Silver Bow Creek watershed. This includes a comprehensive list of restoration needs for the watershed and prioritization of these restoration needs based on benefits to the entire Silver Bow Creek watershed, benefits to the local sub-watershed, and relative cost. This section also presents the rationale behind the priority ranking.

Chapter 9.0 contains two sections. The first details how prospective applicants for restoration funds should use the *RPPC* and the information presented in this plan to guide their restoration project planning and proposals. The second portion of this chapter identifies additional funding opportunities for projects that are outside the scope or priorities of NRDP grant funding. These additional funding sources can diversify the participation of granting agencies, as most grant programs give preference to proposals that cost share through in-kind donations or participation by other funding sources.

Several appendices follow the main chapters of this document. These include additional information on the public involvement process, available data, water quality information, aerial photo interpretation results and wildlife population data.

1.5 Using this Document

This document serves as a planning tool for organizations or individuals interested in initiating watershed restoration projects in the Silver Bow Creek watershed. The steps involved in using this plan should include:

- develop goals for the proposed restoration project
- review Chapter 7.0 to determine which restoration needs may be addressed by the proposed project
- develop objectives (how you will meet the goals) for the proposed project
- use information contained in Chapter 8.0 to determine how well goals and objectives of the proposed project meet the restoration priorities identified in this plan, and
- consult Chapter 9.0 of this document to verify if project goals and objectives meet the *RPPC* grant process criteria and to identify additional funding sources that may be used.

For proposed projects within the Silver Bow Creek Watershed, the NRDP grant procedures give preference to the projects that both meet the criteria of the *RPPC* and restoration priorities identified of the *Silver Bow Creek Watershed Restoration Plan*. If a proposed restoration project is inconsistent with this plan, it may not necessarily be disqualified from consideration. However, the applicant must be able to justify why the project funding is justified. For more information on proposal development, see Chapter 9.0 and the *RPPC*.

2.0 Background Information

The Silver Bow Creek watershed includes all of the area that drains into Silver Bow Creek upstream of its confluence with Warm Springs Creek. In order to distill the vast amount of information available, we subdivided the watershed into eight planning areas based primarily on sub-watershed boundaries. These eight areas are the Silver Bow Creek corridor, the Mill and Willow creeks sub-watershed, the German Gulch sub-watershed, the Sand Creek sub-watershed, the Blacktail and Basin creeks sub-watershed, the Butte area sub-watershed, the Browns Gulch sub-watershed, and the Warm Springs Ponds area sub-watershed (Figure 2-3). The Silver Bow Creek corridor is the only planning area not defined by a watershed boundary.

This chapter provides background information on the environmental history of the Silver Bow Creek watershed. This includes both a brief narrative history of mining activities in the area, history of the legal actions pursued by the State of Montana and EPA, completed or planned remedial activities, and restoration activities that have been initiated through the NRDP.

2.1 Environmental History of Silver Bow Creek Watershed

2.1.1 Historic Watershed Conditions

Descriptions of pre-settlement conditions of streams in the Silver Bow Creek watershed are rare. In 1864, a party of prospectors from Virginia City sought riches along Silver Bow Creek. They described their chosen destination as follows (Freeman, 1900):

> "…upon a bend of the stream, which forms a perfect figure of a gracefully curved Indian bow, and from the mountain peaks which surround the valley, the glistening waters of the 'silver bow' etched in a shimmering sheen upon a dark ground of furzy grass form a striking feature of the landscape."

This description of the physical beauty of Silver Bow Creek may have inspired the name for the area and stream. Early settler accounts give additional insight of conditions in the upper portions of the watershed (NRDP, 1995a). These accounts indicate that the Silver Bow Creek watershed supported abundant game. Deer, elk, mountain goats, and mountain lions provided an important food source for early settlers and the Native Americans before them. Thick stands of conifers, aspen, and mixed grasslands full of "knee deep bunch grasses" provided the physical habitat and forage to support thriving populations of wildlife.

2.1.2 Post-settlement Environmental Changes

The earliest recorded gold discoveries in Montana date from the 1850s. The first significant gold discovery was on Grasshopper Creek in the Headwaters of the Beaverhead River in 1862. The town of Bannack arose from this boom and the population there supplied numerous prospecting expeditions throughout the region. In 1864, prospectors discovered placer gold in Silver Bow Creek and German Gulch. Small settlements immediately sprang up in German Gulch, Silver Bow, and "Town Gulch" (adjacent to present day Butte, later renamed Dublin Gulch). The gold boom peaked in the area in 1866-1867 with a local population estimated at 5000. Silver Bow City, seven miles west of Butte, was the center of most activity. Reports from this period indicate that the stretch of Silver Bow Creek from Butte to Silver Bow had been completely worked by placer miners by 1866 (Malone, 1981).

By 1868, the Butte area placer workings were playing out and in decline, and severe drought in 1869 exacerbated the the decline of placer mining. By 1870, the Montana gold boom collapsed. A nationwide depression in 1873 and the Black Hills gold rush of 1875-1876 further depleted the area of population (Malone, 1981).

Some of the early travelers to the Butte area recognized unusual rock formations described as “black quartz reefs” as hosting some combination of precious and base metals. Early efforts in the late 1860s to mill and smelt these ores proved unsuccessful. In the early 1870s, Andrew J. Davis and William A. Clark came to the Butte area and purchased many of the existing lode claims in the area. More importantly, they brought with them investment capital and business management skills that would be key to the development of hard rock mining in Butte (Malone, 1981). Clark financed the Dexter Mill to refine the silver bearing ores of the Travona Mine in 1874. The success of this operation led to the development of several additional mines and mills by 1876. By 1881, rail service had reached Butte, allowing Butte to become a large mining center.

In 1883, Marcus Daly recognized the huge copper potential of the Butte area. With backing from a San Francisco partnership called the Anaconda syndicate, Daly began construction of a huge copper smelter (the Old Works) at present day Anaconda. Although silver production provided much of the early economic benefit to the area, by the late 1880s, copper would surpass silver as the commodity of most importance. By this time, several more mills and smelters were operating along Silver Bow Creek, the most significant of which were the Colorado Smelter, the Butte Reduction Works facility, the Parrot Smelter, the Montana Ore and Purchasing Company Smelter, and the Butte and Boston Smelter (Montana DEQ and US EPA, 1995). These facilities disposed of large volumes of waste directly into Silver Bow Creek. The smelters along Silver Bow Creek in Butte operated until approximately 1910.

Figure 2-1: Silver Bow Creek flowing through slag wall canyon in Butte.

After this time, most ore traveled by rail to the Anaconda Mining Company's Washoe Smelter in Anaconda.

The rapid pace of early mining-releated development had significant environmental consequences. These included altered stream morphology from placer mining; extensive logging to provide mine timbers and building materials; and disposal of mine, mill, and smelter wastes directly into Silver Bow Creek and its tributaries in and around the city of Butte. The construction of smelters, although an improvement from early open roasting practices, released large amounts of sulphur dioxide, arsenic, and other contaminants to the air. Fallout of these contaminants resulted in significant degradation of soils and vegetation, most notably in the Mount Haggin, Stucky Ridge, and Smelter Hill Injured Areas (see Section 2.2.2 below).

Underground mining continued as the primary method of extracting ore until 1955 when the Anaconda Mining Company began surface mining low-grade ore in the Berkeley Pit. Anaconda constructed the Weed Concentrator in 1963 to process the ore (Montana DEQ and US EPA, 1995). These operations also contributed to contamination of Silver Bow Creek. In 1977, ARCO purchased the Anaconda Mining Company. ARCO closed all underground mines in 1980 and continued mining in the Berkeley Pit until 1982. The Washoe Smelter shut down in 1980.

In 1986, Montana Resources resumed open pit copper mining in the Continental Pit, east of the Berkeley Pit. Operations continued until 2000 when rapidly rising electrical power costs forced a shut down of the mine. Montana Resources resumed mining again in December 2003, after power costs decreased.

2.2 History of Silver Bow Creek Watershed Cleanup Efforts

2.2.1 Remediation and Restoration under Superfund

Investigation and cleanup of mining wastes in the Silver Bow Creek watershed have taken place since the early 1980s under the provisions of the federal Comprehensive Environmental Compensation and Liability Act CERCLA[1], also known as the federal Superfund law. This law mandates the Superfund program, which is the federal program aimed at cleaning up the nation's uncontrolled hazardous waste sites. CERCLA and its Montana counterpart, CECRA,[2] provide a two-pronged approach for dealing with areas contaminated by hazardous substances:

- remediation (also commonly called "remedy" or "cleanup") involves cleaning up hazardous substances so that the public and environment are protected against further harm; and
- restoration entails returning the injured resources to their uncontaminated or "baseline" condition (baseline in this case refers to the condition the resource would have been in had the hazardous substance not been released.)

[1] 42 USC ξξ 9601, *et seq*.
[2] The Comprehensive Environmental Cleanup and Responsibility Act, ξ 75-10-701, *et seq*.

Remediation must follow the remedy selection provisions of the Superfund law. Remediation actions address the contamination in a manner that eliminates the most direct threats to human health and the environment. Remedies occur in accordance with specific legal requirements that set "cleanup levels," such as water quality standards, or require that actions be conducted in a certain manner, such as in accordance with mine reclamation laws. In Montana, both the U.S. Environmental Protection Agency (EPA) and the Montana Department of Environmental Quality (Montana DEQ) implement the remediation provisions of the federal Superfund law and the Montana DEQ implements the remediation provisions of the state Superfund law.

Restoration actions occur under the natural resource damages provisions of the Superfund law. Designated natural resource trustees, including the State, can obtain damages from a party responsible for the contamination to return the resource to its uncontaminated condition and to compensate for the public's loss of use of the resource. Damages are monetary compensation for the injury or loss of natural resources due to hazardous substance contamination. Damages are typically based on the residual injury to the resources after the anticipated effect of remedy is considered, since remedies often do not return the area to its completely uncontaminated or "baseline" condition. In Montana, the NRDP implements the restoration provisions of the federal and state Superfund laws on behalf of the State.

2.2.2 Remediation in the Silver Bow Creek Watershed

In recognition of the public health risks and environmental harm resulting from the widespread contamination of the UCFRB, the EPA designated the entire Silver Bow Creek/Clark Fork River corridor from Butte to Milltown and certain adjacent areas as federal Superfund National Priorities List (NPL) sites. EPA defined four sites: the Silver Bow Creek/Butte Addition site, the Montana Pole and Treating Plant site, the Anaconda Smelter site, and the Milltown Reservoir/Clark Fork River site (Figure 2-3). Together these four sites comprise the largest contiguous set of Superfund sites in the country. The sites are further divided into "operable units" (OUs) for management and administrative purposes. The following sections provide an overview of the federal operable units and related sites in the Silver Bow Creek watershed.

Silver Bow Creek/Butte Area

In 1983, EPA listed the Silver Bow Creek/Butte area as one of multiple Superfund sites in the UCFRB. The agency later designated approximately 23 stream miles of Silver Bow Creek as the Streamside Tailings Operable Unit (SSTOU) within this overall Superfund site. The Silver Bow Creek SSTOU extends from the lower end of the Colorado Tailings to Warm Springs Ponds. The SSTOU has become one of the areas of focus for Superfund cleanup in the Butte area and was divided into divided four reaches reflecting the geomorphology of Silver Bow Creek (Figure 2-3):

- Subarea 1 – a 5.2-mile reach originating at the Colorado Tailings and continuing downstream from Butte to the town of Nissler,
- Subarea 2 – a 5.6-mile reach from Nissler to the upper end of Durant Canyon,
- Subarea 3 – a 5.0-mile reach within Durant Canyon, and

- Subarea 4 – a 6.8-mile reach from the lower end of Durant Canyon and continuing to the Warm Springs Ponds.

From the late 1800s until the 1980s, tailings and other mining wastes containing hazardous substances discharged to Silver Bow Creek. As a result, hazardous substances including arsenic, cadmium, copper, lead, and zinc are pervasive throughout the Silver Bow Creek ecosystem, including its waters, the floodplain, and streambed. The resulting injuries to the aquatic and riparian resources of Silver Bow Creek ecosystem include:

- surface water contains concentrations of hazardous substances that exceed water quality standards established for the protection of aquatic life and thresholds that have been demonstrated to cause injury to fish,
- streambed sediments with significantly higher concentrations of hazardous substances than would exist under baseline conditions,
- the number of aquatic insects is significantly reduced relative to baseline conditions,
- the elimination of trout populations from Silver Bow Creek,
- hundreds of acres of Silver Bow Creek's floodplain contain phytotoxic concentrations of hazardous substances resulting in virtually no vegetation,
- populations of otter, mink and raccoons that rely on fish or benthic macroinvertebrates in their diets were virtually eliminated from the Silver Bow Creek ecosystem, and
- populations of birds, mammals, and other wildlife that would otherwise be abundant in the Silver Bow Creek riparian zone, are substantially reduced due to habitat elimination.

Prior to the start of remediation activities in 1999, an estimated 4.5 million cubic yards of tailings and contaminated soils ranging in thickness from a few inches to as much as six feet covered approximately 1,300 acres of the original Silver Bow Creek floodplain surface. Upstream and downstream of Durant Canyon, where the floodplain is relatively broad, the contamination extends across 500 acres and 700 acres, respectively. In the canyon, where the floodplain is confined, contamination extends across 92 acres. Infiltration of precipitation through these materials leaches hazardous substances to underlying floodplain soils and groundwater.

Figure 2-2: Floodplain tailings contamination in Subarea 4.

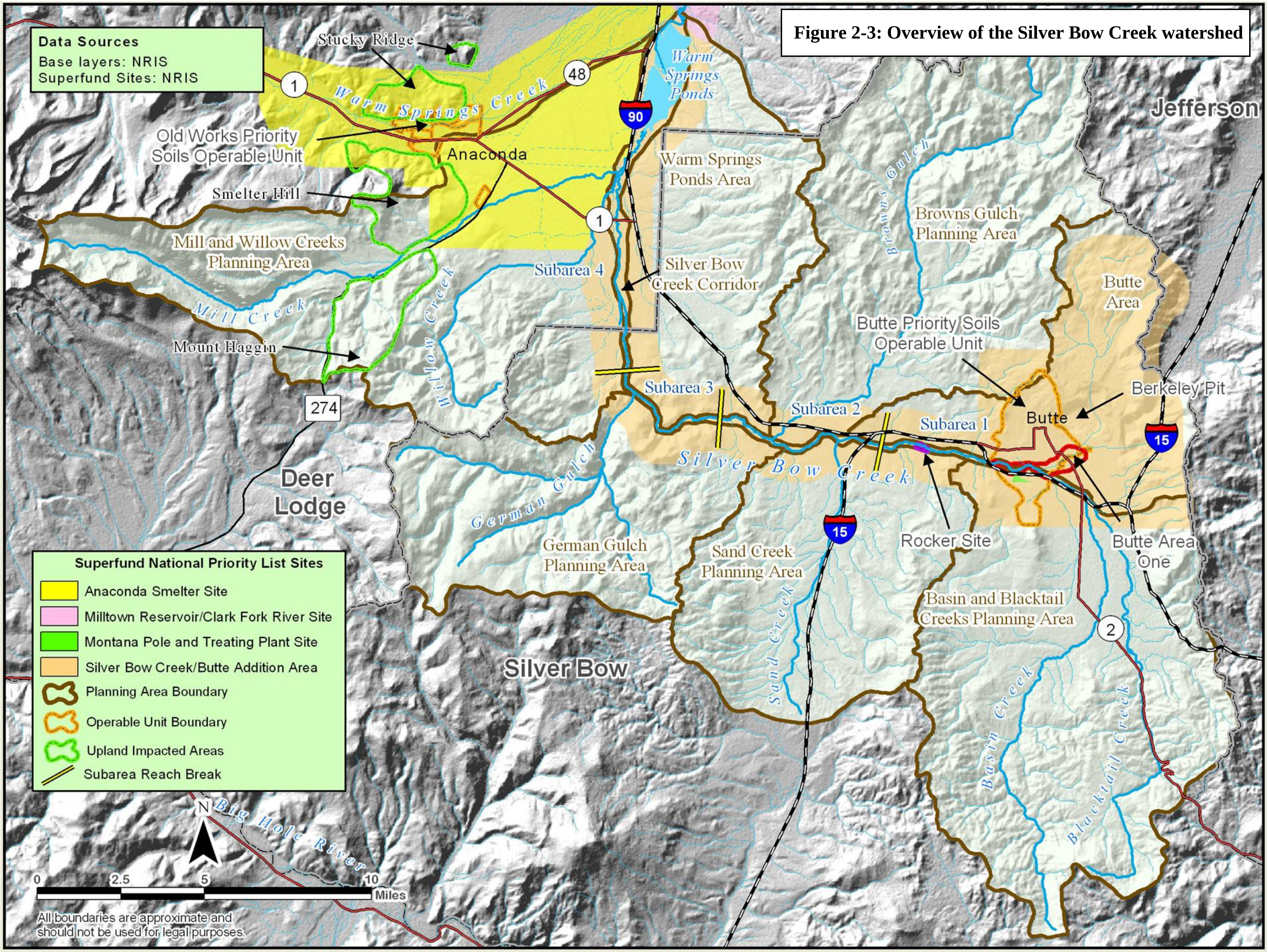


Figure 2-3: Overview of the Silver Bow Creek watershed
Data Sources
Base layers: NRIS
Superfund Sites: NRIS
Stucky Ridge
Warm Springs Creek
Warm Springs Ponds
Old Works Priority Soils Operable Unit
Anaconda
Smelter Hill
Jefferson
Warm Springs Ponds Area
Browns Gulch
Browns Gulch Planning Area
Mill and Willow Creeks Planning Area
Subarea 4
Silver Bow Creek Corridor
Butte Area
Mill Creek
Willow Creek
Butte Priority Soils Operable Unit
Mount Haggin
Subarea 3
Berkeley Pit
Subarea 2
Butte
Subarea 1
Silver Bow Creek
Deer Lodge
German Gulch
Rocker Site
German Gulch Planning Area
Sand Creek Planning Area
Butte Area One
Basin and Blacktail Creeks Planning Area
Sand Creek
Silver Bow
Basin Creek
Blacktail Creek
Big Hole River
Superfund National Priority List Sites
Anaconda Smelter Site
Milltown Reservoir/Clark Fork River Site
Montana Pole and Treating Plant Site
Silver Bow Creek/Butte Addition Area
Planning Area Boundary
Operable Unit Boundary
Upland Impacted Areas
Subarea Reach Break
N
0
2.5
5
10
Miles
All boundaries are approximate and should not be used for legal purposes.

EPA and Montana DEQ jointly issued a Record of Decision (ROD) for Silver Bow Creek in November 1995 and supplemented it with an "Explanation of Significant Differences" in August 1998 that details remediation activities for the Silver Bow Creek/Butte area NPL sites (Montana DEQ and EPA, 1995 and 1998). The remedy involves excavation of tailings and related impacted soils from the floodplain of Silver Bow Creek and reconstruction of the stream channel and floodplain. The major remediation components are:

- removal of some 4.5 million cubic yards of tailings from the floodplain to repositories outside of the floodplain or to Opportunity Ponds,
- backfilling of excavated areas,
- reconstruction of stream banks and streambed, and revegetation with native species, and
- remediation (excavation or capping) of contaminated railroad bed materials that impact the stream or floodplain and present threats to human health.

The Montana DEQ, in consultation with EPA, began clean up of Silver Bow Creek in 1999, with completion expected by 2012. The major remedial accomplishments through 2005 are:

- reconstruction of the first seven miles of Silver Bow Creek and remediation design for the next two miles,
- removal of tailings in approximately 400 acres of tailings impacted area,
- removal of about two million cubic yards of tailings from the floodplain, which amounts to almost one-half of the tailings volume present in the entire site, and
- revegetation of stream banks and floodplain in the first six miles of Silver Bow Creek.

Butte Hill Groundwater Resources

The Berkeley Pit, the adjoining underground mine workings, and the bedrock and alluvial aquifers on Butte Hill constitute one of the most contaminated bodies of water in the world, currently containing over 60 billion gallons of contaminated water. Mining in Butte began before the turn of the century and ultimately resulted in an extensive network of interconnected subsurface workings including an estimated 10,000 miles of tunnels, shafts, stopes, and drifts. Because the workings were below the level of the water table, groundwater accumulated in them. In order to mine, it was necessary to pump this water from the mine workings.

Figure 2-4: Berkeley Pit in Butte.

Open pit mining began at the Berkeley Pit in 1955. When mining ceased in 1982, the bottom of the pit was 4,265 feet above mean sea level. The total depth of Berkeley Pit, from the bottom to the highest point on the rim is 1,780 feet. The surface extent of the pit is approximately 700 acres. Dewatering the mine workings kept the Berkeley Pit dry. Dewatering, however, ended with the cessation of mining. Consequently, since 1982, groundwater has risen toward pre-mining levels and the pit and mine workings have been filling with contaminated groundwater. The water level in the pit in October 2005 was 5,255 feet above mean sea level, resulting in a water depth of approximately 990 feet (PitWatch, 2005). While water level in the pit and associated bedrock aquifer remains at or below an elevation of 5,410 feet, referred to as the "critical water level," the pit and the connected underground workings will serve as a hydraulic depression into which Butte Hill's contaminated groundwater will continue to flow. If the water exceeds the critical level, studies indicate that contaminated groundwater will flow away from the pit, causing further injury to the Butte ground and surface water systems (NRDP, 2002a).

Injury at this site manifests as concentrations of metals and other chemicals that greatly exceed drinking water standards. Mining-related processes have resulted in the release of hazardous substances, such as arsenic, beryllium, cadmium, copper, lead, mercury, zinc, sulfuric acid, and sulfides of copper, arsenic, zinc and lead to the groundwater. Estimates of the total volume of injured groundwater in the bedrock aquifer (including the underground workings) are 119,000 acre-feet. In addition, the Berkeley Pit contains some 74,000 acre-feet of contaminated water. Estimates of the total volume of injured groundwater in the Butte Hill alluvial aquifer are 4,860 acre-feet (NRDP, 2002a). The extent of the injured groundwater in the bedrock aquifer is about 4,133 acres (6.5 square miles) and in the alluvial aquifer, about 505 acres. When Berkeley Pit water reaches the critical level, the volume of contaminated water in the pit will be 196,000 acre-feet. At that time, the volume of contaminated groundwater in the bedrock aquifer will have increased to about 131,000 acre-feet.

Groundwater contamination in the bedrock aquifer occurs primarily through leaching of mineralized material, including sulfide minerals and efflorescent salts remaining in underground workings, which generates acid mine drainage. When circulated in the underground workings and bedrock aquifer, acid mine drainage dissolves metal sulfides and releases sulfates and metals to the groundwater.

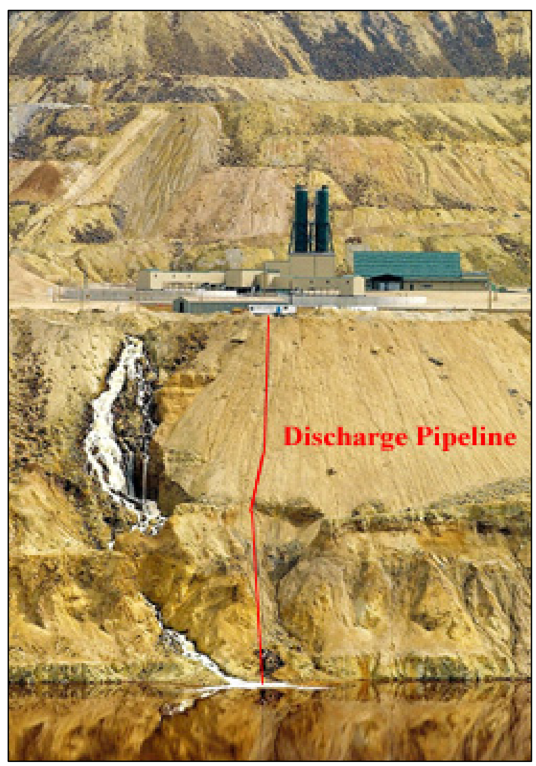


Figure 2-5:Sludge discharge pipeline, Horsehoe Bend Water Treatment Plant (www.pitwatch.org).

Other sources of contamination for both the bedrock and alluvial aquifers are waste rock, mill tailings, leach pads, leaching solution (with added sulfuric acid), and mill process solutions. The leaching of exposed ore and mine waste (both by circulating groundwater and added sulfuric acid) also causes injury to groundwater. The remedy for the Butte Hill Mine Flooding OU seeks primarily to maintain the groundwater in the bedrock system at or below the 5,410-foot critical elevation to preclude the further release of contaminants into the alluvial aquifer and Silver Bow Creek. The major components of the 1994 Record of Decision (ROD) are:

- permanently controlling and treating 2.4 million gallons of surface water flowing each day from the Horseshoe Bend area towards the pit (the Horseshoe Bend Treatment Plant began treating Horseshoe Bend water in December 2003 and treatment of Berkeley Pit water will begin once it approaches the critical water level of 5,410 feet);
- construction of a pipeline to transport treated water to the approved discharge point on Silver Bow Creek at its confluence with Blacktail Creek following the Silver Lake Water system pipeline and the historic Silver Bow Creek channel through the central part of Butte;
- establishing a bedrock groundwater control area to restrict installation of bedrock wells;
- establishing a comprehensive ground and surface water monitoring program; and
- continuing the treatment of water from the Travona shaft, located less than a mile northeast of Butte’s waste water treatment plant, to maintain groundwater levels in that area.

Keeping the water level below the 5,410-foot level will prevent water from entering and contaminating the area’s alluvial aquifer. EPA estimates that without preventative action, groundwater may reach this level by the year 2018. Pumping and treating water will not address the continued infiltration of contamination from existing mine tunnels and other surface and subsurface sources. Consequently, groundwater in both the alluvial and bedrock aquifers in the Butte Hill area and in the pit itself may remain contaminated above drinking water standards for thousands to tens of thousands of years.

Butte Priority Soils Operable Unit

The Butte Priority Soils Operable Unit (BPSOU) is part of the Silver Bow Creek NPL site administered by EPA. BPSOU covers an area of approximately five square miles and includes the part of Butte north of Silver Bow Creek, west of the Berkeley Pit, and east of Montana Tech; the town of Walkerville; and the area south of Silver Bow Creek to Timber Butte (Figure 2-3).

Mining operations created numerous waste rock dumps and tailings deposits along Silver Bow Creek, Metro Storm Drain, and throughout the City of Butte. In 1987, EPA added BPSOU to the Silver Bow Creek NPL site and began investigations to determine the nature and extent of contamination. The Phase II Remedial Investigation Report, finalized in 2002, identifies three areas of contamination:

- solid media, which includes contaminated soils, solid media in residential living spaces, waste rock and tailings;

- groundwater, which includes the alluvial aquifer and bedrock water associated with Butte Area One and saturated mine wastes that are sources of metals contamination to groundwater; and
- surface water in Silver Bow Creek and storm water runoff.

Numerous interim remedial actions and other reclamation activities have been conducted at BPSOU since 1987 to address the contamination problems that presented the greatest risk to public health. EPA estimates that the potential responsible parties have spent over $50 million dollars on these remedy actions within BPSOU to date. In all, more than 175 mine dumps covering more than 400 acres have been partially removed and capped, more than 180 residential yards have been cleaned up (lead soil removals), and over 1.4 million cubic yards of wastes have been removed. The caps generally consist of 18 inches of clean soil materials with organic amendments placed over the wastes and planted with native vegetation to hold the soil in place and minimize erosion. To complement the caps, a system of storm-water collection facilities (new drainage ditches and retention ponds) collects water that may still contain heavy metals and prevent those contaminants from reaching Silver Bow Creek. Major projects include: the Alice Pit/Dump (1998); several areas in Walkerville (1988, 1994, 2002); the Missoula Gulch, Buffalo Gulch and Kelley ditches and retention ponds (1997-99); railroad corridors (2001-03); and Lower Area One, including the reconstructed Silver Bow Creek, the Colorado Tailings removal, and the Clark Tailings project (1993-2000).

Figure 2-6: Colorado Tailings liming facility.

The major cleanups still ahead include the Parrot Tailings near the Butte Civic Center and the Metro Storm Drain corridor, which once was the historic Silver Bow Creek channel, and a large area north of the Kelley Mine, surrounding the Mountain Con mine yard and the Granite Mountain Memorial. In addition to cleanups, other issues include deciding what type of water treatment system is necessary to ensure groundwater, surface water, or storm water leaving the area will not pollute Silver Bow Creek. Another important decision is to determine whether the interim remedial action projects already completed will provide permanent protection or whether additional work is necessary.

The Potentially Responsible Party (PRP) group consisting of ARCO, three railroad companies, and Butte-Silver Bow County completed a final feasibility study in April 2004. The EPA issued a Proposed Plan in December 2004 and expects to issue a Record of Decision for this site in 2006. Based on the proposed plan, The following response action likely be implemented at BPSOU:

- Collection of contaminated groundwater at the east end of Lower Area One.
- Treatment of 750 gallons per minute of contaminated groundwater at a lime treatment facility at Lower Area One.
- Development of a Best Management Program to address contaminated storm water runoff. This Program could include source controls on mine wastes areas, sediment controls, routing of storm flows, lime treatment of contaminated storm water or placement into the Berkeley Pit.
- Continuation of the on-going Lead Abatement Program that involves sampling and clean up of residential yards.
- Reclamation and enhancement of the Granite Mountain Memorial Area and monitoring of previously reclaimed areas on Butte Hill.
- Monitoring of surface water and site-wide vegetation.

Montana Pole Site

The former site of the Montana Pole and Treating Plant is located in the southwest portion of Butte and is bounded on the north by Silver Bow Creek, on the east by a railroad right-of-way, on the south by Greenwood Avenue, and on the west by the former location of the Colorado Smelter. An elevated portion of Interstate 15/90 cuts across the site in an east-west direction. During the lifetime of the facility, treatment of lumber for use as mine timbers released hazardous substances, primarily in the form of pentachlorophenol, directly to the ground surface. These substances then infiltrated to the underlying groundwater. An estimated 1.1 million pounds of pentachlorophenol contaminated the site. Other contaminants released from the plant and detected on site include polynuclear aromatic hydrocarbons, benzene, toluene, ethyl benzene, total xylenes, dioxins, and furans.

EPA and Montana DEQ jointly issued a ROD for the Montana Pole Site in 1993. Montana DEQ, in consultation with EPA, is conducting the remediation with monies from a 1996 settlement with the PRP group for this site for $35 million. To date, accomplishments include an addition to the water treatment plant and the placement of tens of thousands of cubic yards of contaminated soils on a nine-acre, above ground biological land treatment unit. Further remedial actions will remove or treat contaminated soils beneath Interstate 15/90 and continue groundwater treatment.

Rocker Site

The site of the former Rocker Timber Framing and Treating Plant is adjacent to Silver Bow Creek approximately seven miles west of Butte. The plant milled and treated timbers for the mining industry from the late 1880s to 1957 using a process that required the application of dissolved arsenic and creosote. Organic compounds, metals, and metalloids released from wood treatment processes moved through soils to the water table and contaminated the groundwater system beneath and next to the site. While arsenic is the contaminant of most concern, contaminants in the groundwater also include cadmium, copper, lead, zinc, iron, manganese, and sulfate and polynuclear aromatic hydrocarbons.

EPA and Montana DEQ jointly issued a ROD in 1995 and ARCO began remediation in 1996. The remedy used an innovative technique that entailed the excavation of some of the source material and the injection of an iron compound into the soil to fix arsenic in-place. Groundwater exposed during excavation of source materials was also treated to remove arsenic and ARCO developed an alternative water supply for Rocker residents. While groundwater concentrations of arsenic and other contaminants decreased since the remedy was implemented, the newness of the remediation technology prevents a fully informed assessment of residual injury. ARCO remains liable for additional remedial work, if necessary, to prevent plume migration in the adjoining groundwater.

Smelter Hill Area Uplands

From the early 1900s to 1980, hazardous emissions from the Anaconda (Washoe) Smelter injured nearly 17.8 square miles of land in the "Smelter Hill Area Uplands," commonly referred to as the "Anaconda Uplands." These uplands include portions of Smelter Hill, Stucky Ridge, and the Mount Haggin Game Management Area. One half of the Smelter Hill area and the entire Mount Haggin area are in the Silver Bow Creek watershed. Enormous volumes of hazardous substances released into the air by smelter operations subsequently deposited onto the land, resulting in almost complete loss of vegetation. The lack of vegetation, in turn, resulted in widespread erosion and topsoil loss.

Soils in this area have elevated concentrations of hazardous substances including arsenic, cadmium, copper, lead, and zinc. Consistent with visual observation, laboratory tests confirmed that these soils are toxic to plants. Metal concentrations are highest in the upper two inches of soil. Elevated metal concentrations on the soil surface prevent seed germination, precluding natural recovery. There has been a shift in plant community types from predominantly forest with open grassland to predominantly sparse grassland or bare ground. The elimination of vegetation communities in the injured area resulted in a severe reduction in the quantity of wildlife habitat.

Figure 2-7: View of Anaconda uplands from Mount Haggin WMA.

A 1998 ROD established criteria and a process for determining what reclamation actions would take place across the Anaconda Uplands. The ROD specifies reclamation efforts to plant trees, shrubs, and grasses across parts of the Stucky Ridge, Smelter Hill and Mount Haggin injured areas. Remediation on areas of Stucky Ridge and Smelter Hill may reduce natural resource injuries. In those areas of Smelter Hill, Stucky Ridge and Mount Haggin that will not be subject to remediation, significant residual injury will remain for centuries.

Anaconda and Opportunity Ponds and other Anaconda Area Resources

Disposal, releases, and spills of solid mining wastes, milling debris, smelting by-products, and process fluids occurred over the last 110 years in the Anaconda area. Mining and processing wastes containing hazardous substances caused injury to groundwater, riparian vegetation, and wildlife resources. There are five areas of injury: Old Works, Smelter Hill, Anaconda Ponds, Opportunity Ponds, and Warm Springs Ponds. While the Old Works site and half of the Smelter Hill site are outside the boundaries of the Silver Bow Creek watershed, they are described below because groundwater contamination from the Smelter Hill site and soil contamination caused by aerial emissions from both sites extend into the watershed. Estimates of the total volume of injured groundwater in the Anaconda area are 440,000 acre-feet extending over 40 square miles.

Old Works

The Old Works facility along Warm Springs Creek processed copper ore mined in Butte from 1883 until shortly after the turn of the century. These processing activities deposited approximately one million cubic yards of wastes containing high concentrations of arsenic, cadmium, copper, lead, and zinc at and around the facility. These wastes injured the alluvial groundwater system around Old Works, and are a source of surface water contamination to Warm Springs Creek.

Smelter Hill

In 1902, the Washoe Works (Anaconda Smelter) began operations on Smelter Hill. By the 1930s, the facility processed thousands of tons of ore on a daily basis. Infrastructure to support the smelting operations included waste piles and lagoons, leach pads, and numerous facilities extending across approximately 600 acres of Smelter Hill. Operations discharged, disposed of, or otherwise released to the environment large volumes of hazardous substances. Both historical and current releases of hazardous substances injured groundwater in the bedrock aquifer of Smelter Hill, with arsenic, cadmium, iron, manganese, zinc, fluoride, and sulfate at concentrations exceeding drinking water standards. Surface soil contamination is most severe at the location of the former smelter complex. As precipitation infiltrates through contaminated soils and the unsaturated portion of the bedrock aquifer, hazardous substances dissolve and migrate to groundwater. Similarly, groundwater flowing through the contaminated fractured bedrock aquifer dissolves hazardous substances adhering to aquifer materials. Groundwater contamination in the bedrock aquifer extends to a depth of at least 200 feet below the land surface.

The Anaconda and Opportunity Ponds

The Washoe operation deposited tailings in the 600-acre Anaconda Ponds and the 3,400-acre Opportunity Ponds, resulting in significant groundwater contamination (NRDP, 1995c). Groundwater at some locations under Opportunity Ponds has elevated concentrations of contaminants to depths of 70 feet below the ground surface. Contaminant plumes of arsenic, cadmium, and zinc are smaller than plumes of iron, manganese and sulfate. The former set of plumes are found beneath the ponds only, while the latter set of plumes are found beneath and extend down gradient of the ponds to the Mill-Willow Bypass and Warm Springs Creek. The volume of waste materials in Anaconda Ponds is approximately 100 million cubic yards and in Opportunity Ponds is about 150 million cubic yards. In addition to the groundwater injury, the tailings at Opportunity Ponds are phytotoxic and the absence of vegetation has resulted in the elimination of wildlife across the 3,400 acre Opportunity Ponds.

Warm Springs Ponds

In 1918, Silver Bow Creek was dammed to create Warm Springs Ponds one and two; Pond three was built in the 1950s. In total, the Ponds cover an area of approximately four square miles. These settling ponds contain mining and smelting wastes from upstream sources. Seepage from the Warm Springs Ponds has injured groundwater below and north of the ponds to at least 40 feet below the ground surface as evidenced by concentrations of arsenic, cadmium, fluoride, iron, manganese, and sulfate that exceed drinking water standards. The ponds contain about 19 million cubic yards of tailings, contaminated sediments, and sludges.

Remediation at Waste Ponds and Other Areas

There have been six Records of Decision for these areas to date. The Old Works site was remediated through the removal of contaminated material and capping of the area. ARCO subsequently redeveloped the site into a golf course. The tailings and other wastes in Warm Springs Ponds remain in place. However, berms were constructed at Warm Springs Ponds to prevent the release of wastes from the ponds to the Clark Fork River, which could occur from earthquakes or floods. In addition, a groundwater collection system was installed at the ponds. The Warm Springs Ponds RODs also required improvements in the treatment capabilities of the pond system through lime addition and water retention control, and required the removal of tailings in and along the Mill-Willow Bypass.

Actions pursuant to the September 1998 ROD issued for the Anaconda Regional Wastes, Water and Soils Operable Unit will reclaim much of the area over the next decade or so. Remedial actions revegetated the Anaconda Ponds. The Opportunity Ponds will be revegetated by in-situ reclamation or by soil capping. Other areas planned for remediation are those near Silver Bow Creek but outside the SSTOU boundary, the old Mill Creek townsite, and in areas immediately north of the Silver Bow Creek watershed boundary. Reclamation should reduce the amounts of contaminant migration to the groundwater. However, wastes in the areas will remain in place and continue to contaminate the groundwater.

2.2.3 Unresolved Natural Resource Damage Litigation

The 1999 partial settlement of the State's natural resource damage lawsuit did not cover the State's restoration damage claims for three sites: Smelter Hill Upland Resources, Upper Clark Fork River Aquatic and Riparian Resources, and Butte Area One Ground and Surface Water Resources. The remaining claim for these sites totals approximately $200 million. A consent decree outlining the terms of the partial settlement provides a framework for negotiating or litigating these remaining claims. Following the issuance of a ROD for each site, the State and ARCO will have 60 days to negotiate a settlement. If a settlement is not reached, litigation on that site will resume. A ROD has been issued for the Smelter Hill Uplands site. Negotiations were unsuccessful and the NRDP is pursuing litigation of this injury claim. Negotiations for the Clark Fork River began when the ROD was completed in May 2004 and are ongoing. Negotiation of the Butte Area One claim will begin once the ROD for BPSOU is completed. Following is a more detailed description of the two areas within the Silver Bow Creek watershed that are still the subject of litigation.

Butte Area One Ground and Surface Water Resources Claim

The NRD Butte Area One groundwater and surface water injury area is a small part of the BPSOU. Butte Area One extends from the upper end of the Metro Storm Drain in Butte west to the downstream end of the former location of the Colorado Tailings along Silver Bow Creek (Figure 2-3). The NRD injury assessment determined that the extent of alluvial groundwater injury is approximately 560 acres, which will continue to receive contaminants for thousands to tens of thousands of years absent removal of sources or implementation of effective remediation (NRDP, 1995d). In addition, contaminated groundwater and surface water entering Silver Bow Creek throughout Lower Area One injure surface water resources of the stream. Contaminated groundwater enters Silver Bow Creek from the alluvial aquifer. Contaminated surface water enters Silver Bow Creek from storm water runoff flowing across mine dumps and soils located within BPSOU. This untreated ground and storm water adversely affects water quality and aquatic life in Silver Bow Creek. The NRDP will update its 1995 restoration plan and claim for Butte Area One following the completion of the ROD, scheduled for 2006. This plan will address any storm water runoff or other contaminant sources that will affect natural resources, mainly Silver Bow Creek and area groundwater.

Anaconda Uplands Claim

In March 2002 the State released three Restoration Plan Reports for the Anaconda Uplands. These reports are: 1) *Summary Report- Restoration Plan for the Mount Haggin, Stucky Ridge, and Smelter Hill Injured Areas* (NRDP, 2002b); 2) *Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Areas* (NRDP, 2002c); *and* 3) *Ecological Restoration Plan for the Mount Haggin Injured Area* (NRDP, 2002d). These reports outline the basis for the State's $47.4 million claim for restoration of the Anaconda Uplands areas. Approximately 60%, or 10 square miles of the injured upland areas are in the Silver Bow Creek watershed (Figure 2-3). These areas cover about half the Smelter Hill injured area and all of the Mount Haggin injured area.

The State's restoration plan targets restoring plant communities to start recovery toward vegetation conditions characteristic of baseline. Remedial actions planned for the upland areas will not accomplish this goal. All remedial actions will consider the State's Restoration Plan and fully coordinate with all proposed restoration actions.

The Mount Haggin restoration plan considered different alternatives that ranged from no action to $28 million in restoration expenditures. The chosen alternative involves restoration of the most severely impacted areas (representing approximately half the Mount Haggin injured area) for a cost of $19.8 million. The plan includes restoration treatments such as tree and shrub plantings, erosion control measures, lime incorporation, fertilizers, seeding, and weed control efforts; and would take five years to implement. Implementation of restoration actions will result in substantial recovery of natural resources toward baseline conditions within a few decades and will produce noticeable improvements in wildlife habitat in the short-term. Without implementation of restoration actions, however, it is likely baseline soil and vegetation conditions will not return to the Mount Haggin injured area for several hundred years or longer.

The Smelter Hill and Stucky Ridge restoration plan also considered different alternatives, ranging from no action to intensive restoration for $72 million. The chosen alternative costs $27.6 million and includes restoration treatments such as tree and shrub plantings, lime incorporation, fertilizers, and weed control. Implementation may take 10 years and will significantly shorten the timeline for recovery to baseline conditions to between 50 and 100 years. Substantial recovery should occur within a few decades. A failure to implement these restoration actions could result in further erosion, noxious weed invasion, additional time for recovery of natural resources to baseline conditions, and a potential steady state consisting of only those vegetation species utilized in remedial actions. Moreover, baseline vegetation conditions would not return to the Smelter Hill and Stucky Ridge injured areas for about 500 years and it could take even longer for soil conditions to return to baseline.

2.2.4 Restoration in the Silver Bow Creek Watershed

The Superfund laws require that any natural resource damages recovered in the lawsuit be used for actions in three categories: restoration, replacement, or acquisition of the equivalent of the injured resources. As noted previously, restoration refers to actions taken, in addition to remediation, to return the injured resources and services to their baseline condition. For example, planting additional grasses, shrubs and trees in the Silver Bow Creek floodplain in addition to those planted under remediation would help restore the area. Replacement refers to actions that create or improve resources and services that are the same as or substantially similar to the ones that have been injured or lost, but away from the immediate site of injury. An example of replacement would be improvement of stream bank conditions and aquatic habitat in a tributary of Silver Bow Creek. While this type of project addresses an injury related to natural resource damages, it does not directly address Silver Bow Creek, the immediate site of injury. Acquiring equivalent resources involves obtaining unimpaired resources comparable to those that are injured. For example, acquiring land along an uncontaminated tributary stream constitutes acquiring an equivalent resource. Such properties would be available for recreational use for Montanans to replace lost uses in injured areas.

The State initiated its annual restoration grant cycle process in February 2000 and has completed six grant cycles as of the publication of this plan. Through 2005, the State has awarded about $38.2 million to 50 projects that will improve the Basin's fish and wildlife habitat and populations, public recreation opportunities, and public drinking water supplies. Table 2-1 lists all the projects approved for funding through 2005. The following paragraphs discuss restoration projects funded in the Silver Bow Creek watershed.

Table 2-1: Funded Restoration Grant Projects and Amounts.

Project	*Pilot Year 2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Greenway	$1,772,758	$1,206,755	$4,955,273			1,845,500
Bighorn	$ 110,800					
Bridger Plant	$141,439				$253,926	
Lost Creek	$518,382					
Watershed Land Acquistion	$3,764,231	$2,067,673				
Z-4 Easement	$10,000					
Manley Ranch Easement	$608,048					
Uof M database	$9,550					
Opportunity		$309,269				
Douglas Creek		$10,000			$25,000	
Butte Waterline		$1,165,795	$1,168,842	$1,188,900	$1,197,971	$1,539,269
Rocker WWT (withdrawn)		$719,566				
Antelope Creek		$10,000				
East Deer Lodge		$135,941		$408,810		
Upper Willow Creek			25,000	$282,758		
Basin Dams				$503,006		
German Gulch			$24,550		$25,000	$876,162
Little Blackfoot			$25,000	$25,000		
Anaconda Waterline			$749,942	$995,000	$1,223,374	$1,738,700
Stuart Mill Bay			$2,000,000			
Meyers Dam			$11,710			
Twin Lakes			$11,056			
Big Butte Acquisition					$20,200	$667,642
Clark Fork Watershed Educaton Program				$25,000	$673,801	
Ramsay School					$16,151	
Duhame Acquisition				$24,748		$1,643,809
High Service Tank					$1,192,802	

Project	*Pilot Year 2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Brown Gulch Assessment					$143,404	
Butte Master Plan						$174,634
Total	**$6,935,208**	**$5,624,999**	**$8,971,373**	**$3,453,222**	**$4,771,629**	**8,485,716**

Shading indicates the project is in the Silver Bow Creek watershed.

NRD Restoration along Silver Bow Creek

Establishment of the NRD Program in 2000 triggered funding requests to restore areas along the Silver Bow Creek corridor. Through 2005, the State has funded five restoration projects totaling $10.5 million that coordinate with the Montana DEQ remediation work along the first 10 stream miles of Silver Bow Creek from Butte to Durant Canyon and along miles 16-18 near Opportunity. Four grants were awarded to the Greenway Service District and one to Bighorn Environmental. Table 2-1 highlights the projects, which fall into four categories: trail construction, floodplain revegetation enhancements, tailings removal, and aquatic habitat enhancement.

The State awarded grant funds to the Greenway Service District for a trail along Silver Bow Creek. Construction of trails near Butte replaces lost hiking opportunities, increases the quality of life for residents and visitors to the area, and provides recreation for a large cross-section of the Butte community. The plan for this trail is to pave the first five miles and surface miles six and seven with gravel. Other improvements associated with trail construction include installation of rest areas, improvements to railroad bridges to provide trail access, and construction of stream crossings. Cost estimates for these community access features, which will replace lost recreational services in a way that will protect natural resources and cleanup, are approximately $2.2 million for the first 8 miles of the Greenway. Cost estimates for land acquisition/easement for the first ten miles of the Greenway are about $600,000.

Figure 2-8: Successful vegetation restoration, Silver Bow Creek floodplain, Subarea 1.

The State awarded restoration funds to Bighorn Environmental and the Greenway Service District to enhance riparian floodplain vegetation along the stream miles 1 –10 and 16-18 of Silver Bow Creek. Floodplain revegetation enhancement restores ecological values following remediation of threats to human health and the environment. Funded activities include placement of organic matter on the floodplain, construction of wetlands, and planting of trees and shrubs throughout the floodplain. Estimated costs for these efforts are $4.5 million. These floodplain revegetation efforts will enhance completed remedial efforts and will help to restore severely injured wildlife habitat along the corridor.

Figure 2-9: Tailings removal and reconstruction of Silver Bow Creek in Subarea 2.

The State also funded removal of tailings on approximately 100 additional acres along Ramsay Flats to augment remediation of tailings as identified under Superfund in the Silver Bow Creek ROD. This will result in removal of all tailings in this area and will allow development of a naturally functioning stream and floodplain system. Tailings removal in this area will be completed in spring 2006 and will cost approximately $1.7 million, $1 million less than originally estimated and approved for funding.

Enhancement of aquatic habitat along remediated sections of Silver Bow Creek will aid in the restoration of injury to aquatic habitat following removal of contaminated tailings. Constructing a stream that exhibits a higher channel sinuosity, installing a series of pools, varying stream widths, and placing logs at key locations in the stream will enhance aquatic habitat. The objective of this project is to enhance the recovery of aquatic resources to a near pre-disturbance condition. Cost estimates for these aquatic habitat enhancements about $700,000.

In total, about $10 million has been approved for funding ecological enhancements, land acquisitions, and recreational trail development along miles 1-10 and 16-18 of Silver Bow Creek via the Greenway project. Using costs incurred for restoration work in Subarea 1, and adjusting for the varying conditions further downstream, the NRDP estimates the cost for the needed ecological enhancements in the remaining 11 miles will range from $4 to $5 million. Based on estimates for the entire Greenway project provided in the first year's application (GSD, 2000), the NRDP estimates the associated land acquisition and access features for the Greenway project in the remaining 11 miles will range between $3 and $4 million.

Butte water projects

Butte-Silver Bow has plans to apply for NRD funds to replace leaking water distribution lines in the City of Butte over a 15 year period. Five years of work replacing 85,000 feet has been funded for a total of $5,919,479. In 2004, the State funded Butte-Silver Bow for $1,192,802 to replace the dilapidated 2.5 million gallon High Service drinking-water storage tank, with a new pre-stressed concrete tank. In 2005, Butte-Silver Bow was awarded $174,634 to prepare a water master plan to identify and prioritize future water system needs.

Basin Dams

In December 2003, Butte-Silver Bow was awarded $503,006 to rehabilitate the Basin Creek Reservoir system, which is located about seven miles south of Butte and provides 35% of Butte's annual water supply. Currently, no water treatment or filtration of this supply is required because of high water quality in the reservoirs. The funded improvements will help to maintain the filtration waiver and supply the citizens of Butte with an economical, reliable, and safe drinking water supply.

Figure 2-10: Silver Bow Creek in Durant Canyon.

Duhame Property Acquisition

In 2003, the Greenway Service District was awarded $24,748 to develop a Restoration Grant proposal for purchase of the 1800-acre Duhame property along Silver Bow Creek in Durant Canyon. In 2005, the Governor approved acquisition of this property for $1,643,809. The property, which has prime upland game winter forage areas, partly borders four miles of the Silver Bow Creek corridor and is adjacent to the Mt. Haggin and Fleecer Mountain state wildlife management areas.

Education Projects

The Department of Technical Outreach at Montana Tech, in partnership with five other entities, developed and implemented a pilot Clark Fork Watershed Education Program in 2003. In the pilot program, 6th grade and high school students from Butte used Blacktail and Silver Bow Creeks as large-scale outdoor laboratories to apply age appropriate math and science principles. In 2005, the State funded Montana Tech for $673,801 to implement this program over three years for primary and secondary school children and teachers in 29 schools from Butte to Bonner. Each phase of the program includes student and teacher training in the classroom and the field. The long-term goal of this project is to create a sustainable field science program that is widely available to school age children.

In 2004, the State funded $16,151 to the Montana Bureau of Mines and Geology to develop and implement an education project that teaches primary school students about the watershed and the ecosystem in the Ramsay area. Students will use the nearby Silver Bow Creek as a outdoor classroom to learn about mining impacts before and after remediation/restoration activities are conducted.

Big Butte Property Acquisition

In 2004, Butte-Silver Bow was awarded $20,200 in NRD funds to develop a restoration grant proposal for purchase of approximately 300-acre Big Butte property adjacent to Butte's urban corridor. In 2005, the Governor approved acquisition of this property for

$667,642. This acquisition provides public access to lands that provide an array of recreational opportunities close to the Butte urban area and protects the property's natural resource and scenic values from potentially detrimental development.

German Gulch

Using $49,500 total in NRD funds via a 2002 Phase 1 and a 2004 Phase 2 project development grant, the George Grant Chapter of Trout Unlimited developed a restoration proposal for the lower five miles of the German Gulch Watershed. In 2005, Trout Unlimited was awarded $876,162 to conduct various restoration activities that involve: improving westslope cutthroat habitat by conducting a stream restoration demonstration project on a 1,450 foot reach of German Gulch; removing 7,200 cubic yards of mine tailings, revegetating the disturbed areas and conducting weed control and planting in upland areas; constructing a 2.5-mile passive recreational trail and replacing a bridge; installing a fish barrier and a fish screen; rebuilding a headgate and securing a 30-year lease for 2 cfs of water from an irrigator; acquiring private mining claims for public ownership; conducting a cultural resource inventory; and installing interpretive signage.

Browns Gulch

In 2004, the State awarded funding to the Watershed Restoration Coalition of the Upper Clark Fork and Mile High Conservation District to assess natural resources in the Browns Gulch watershed. The studies will help establish baseline conditions and prioritize habitat, water quality and stream flow restoration needs. This assessment work will occur over two years and result in an implementation guideline plan for improving water, fish and wildlife resources.

3.0 Watershed Planning and Restoration Concepts

This chapter presents general concepts regarding watershed health, watershed planning, and restoration principles that are relevant to the Silver Bow Creek watershed.

3.1 Characteristics and Benefits of a Healthy Watershed

A healthy watershed is defined in terms of its fish, wildlife, vegetation, and human inhabitants. With respect to wildlife and vegetation, a healthy watershed provides diverse habitat that supports adaptive plant and animal communities, especially native species. Particularly important are riparian areas, which can provide critical habitat, dissipate flood energy, reduce nutrient and sediment inputs, store surface waters, recharge groundwater, moderate water temperature, and maintain channel integrity. Healthy watersheds also maintain long-term soil productivity in upland and riparian areas with adequate vegetative cover to reduce overall soil and nutrient losses and mitigate processes such as hill slope erosion.

A central component of healthy watersheds is a high degree of connectivity from headwaters to downstream reaches. Connectivity enables fish and wildlife populations to move throughout the watershed, increasing their viability and ability to withstand stress. In the terrestrial environment, riparian areas provide this connectivity, and serve as the critical connections between the upland and riverine environments. In the aquatic environment, adequate water quality and quantity, an absence of migration barriers (e.g. dams, diversions), and suitable habitat for aquatic life provide connectivity. Through connectivity, surviving populations from unaffected parts of a watershed can reestablish populations stressed or eliminated by disturbance in other portions of a watershed. Other important components of healthy watersheds include diverse habitats, productivity, and adaptive communities of native plants and animals. Combined with connectivity, these conditions promote biotic resilience. Watersheds with biotic resilience recover rapidly from natural and human disturbances, their ecosystems are stable and sustainable, and they are more resistant to the establishment of exotic species (Williams, et al, 1997).

The human components of healthy watersheds include an aware population that values and protects the health of the watershed. This includes a community awareness of watershed condition, an understanding of the cause and effect relationship between human activities and the condition of the watershed, and the political will and economic wherewithal to modify behaviors or activities that are detrimental to watershed and community health. Many communities do not possess these socioeconomic components. Therefore, communities must actively promote these components through public awareness, communication, and education of watershed issues, developing common ground and cooperation among diverse interest groups, and linking the health of the local economy and community to watershed health. This requires the integration of social and natural sciences in planning and policy-making (Thorud, et al., 2000).

The benefits provided by healthy watersheds are numerous and include:

- maintaining high quality, dependable water supplies
- moderating flooding or drought effects

- recharging surface and groundwater aquifers
- maintaining diverse and productive riparian plant communities that trap silt and moderate stream temperature by providing shade
- promoting diverse and healthy populations of native fish and wildlife
- improved aesthetics
- providing recreational opportunities and associated economic and health benefits
- overall improvement in human health and community well-being
- citizens become engaged in actively protecting the watershed's resources

3.2 Watershed Planning

The watershed planning process facilitates restoration and maintenance of healthy watersheds. Table 3-1 presents the general steps in the watershed planning process adapted from Angermeier (1997), Zeimer (1997) and practices commonly applied to development of Total Maximum Daily Loads (TMDLs). The process of developing TMDLs for watersheds includes many steps that are directly applicable to the Silver Bow Creek Watershed. For example, compliance with section 303(d) of the Clean Water Act has forced states to develop lists of impaired streams that do not support designated beneficial uses, develop numeric TMDLs that describe the pollutant carrying capacity of the streams, and develop restoration and monitoring plans to address these impairments. Silver Bow Creek, Mill Creek, Willow Creek, the Mill-Willow Bypass, and German Gulch are on Montana's 303(d) list of impaired streams, scheduled for completion in 2007. Development of TMDLs for these streams will further characterize water quality and habitat conditions, set targets for improvements, and further the watershed restoration process. Section 6.11.2 provides additional information on 303(d) listings.

Table 3-1: Watershed restoration planning steps.

	Watershed Planning Steps	***Examples***
1.	Assemble a group of representatives from relevant stakeholder groups and establish a formal organization to develop and implement the watershed plan. Hold regular meetings throughout the planning process to solicit input on major issues associated with the watershed plan and to resolve potential conflicts among the stakeholders.	Most watershed groups organize as 501(3)c nonprofit corporation. Stakeholders may include landowners, outdoor recreation groups, federal and state resource management agencies, municipal and county governments, industry, concerned citizens, and other interested parties.
2.	Develop a series of clearly definable goals or desired conditions for the watershed. Goals may be established in terms of water quality, biological parameters, and socioeconomic factors.	Goals might include improving water quality and habitat to restore a native fishery comparable to a nearby, healthy watershed.
3.	Establish criteria and standards that quantitatively define the desired conditions in the watershed. These standards are used in later steps to evaluate the health of the watershed.	State and federal standards are useful for water chemistry parameters such as metals or nutrients. Additional criteria (e.g. vegetation diversity, fish and wildlife habitat, etc.) may be developed by examining nearby, relatively undisturbed watersheds to establish reference conditions.

	Watershed Planning Steps	*Examples*
4.	Conduct a watershed assessment to evaluate the present condition of the watershed and compare it to the criteria and standards established in Step 3 to identify any potential impairment. This requires gathering sufficient information to describe and quantify the present condition of the watershed. Recognize the system's inherent limitations such as climatic, biologic, and physiographic, limitations.	The assessment may include gathering and evaluating existing information about the watershed, then developing a sampling strategy to gather additional information (e.g. water chemistry, biota, channel stability, land use, etc.) to identify and quantify sources of impairment. Data should be compared to criteria and standards to assess water
5.	Link any identified impairments to specific causal factors. Distinguish between human-related and natural causal factors and valuate the relative contributions of each to watershed health.	Poor fish populations might be linked to heavy metals from streambed sediments and storm water runoff. Similarly, reduced health of riparian and floodplain vegetation communities may be linked to metals contaminated tailings in stream banks and floodplain soils.
6.	Establish thresholds or targets for each human-related causal factor below which impairments may be considered non-existent or insignificant compared to background or natural conditions.	Targets for metals are potentially based on state water quality standards. Targets for sediment might be based on percent fines in spawning areas found in nearby reference watersheds.
7.	Develop and implement a watershed restoration plan to address or reduce each source of impairment. Integrate watershed protection, including adjustment or cessation of management practices that are responsible for degraded habitat.	The plan might include implementing best management practices, treating sources of contamination, stabilizing eroding banks, or other mitigative measures.
8.	Monitor ecological conditions in the watershed to determine whether the plan is meeting the established targets. Monitor conditions at several scales such as reach, stream, sub-watershed, watershed, and multiple taxa that have varying sensitivities to human impact. Recognize the appropriate time frame for evaluating each response variable.	Progress may be measured in biotic terms, focusing on species diversity and richness as measures of restoration success. Progress may also be measured in terms of human parameters such as recreational use or angling and hunting surveys.

3.3 Watershed Restoration Strategies

Once a watershed restoration plan is completed, more specific restoration strategies are necessary to address specific impairments within the watershed. The Silver Bow Creek Watershed Restoration Plan serves as a good starting point for developing more specific restoration strategies for specific impairments. These strategies are also useful for restoration project planning (Table 3-2).

Table 3-2: Watershed restoration strategies for the Silver Bow Creek watershed.

	Watershed Restoration Strategies	*Examples*
1.	Generally, begin implementing the restoration strategy in headwaters areas and proceed downstream through the watershed. This prevents upstream areas of impairment from affecting restoration efforts in downstream reaches.	Restoration in Silver Bow Creek should ideally begin at the contaminant source areas such as the Butte Hill and progress downstream to Warm Springs. The order of settlement of claims may require modification of this sequence.

	Watershed Restoration Strategies	*Examples*
2.	Eliminate the causes of problems rather than just treating the symptoms.	The cause of bank erosion may be heavy metals contamination that has eliminated riparian vegetation. Simply stabilizing the banks would treat the symptom, but eliminating contamination and revegetating stream banks would treat the cause.
3.	Whenever possible, restore or enhance natural recovery processes that are self-sustaining and require minimal maintenance or operation once completed.	Restoration based on designs that emulate natural channels promotes self-sustaining processes such as sediment transport, channel migration, riparian vegetation regeneration. In contrast, stabilizing a stream by constructing a trapezoidal, riprap-lined channel ignores natural recovery processes and sustainability.
4.	Conduct a limiting factors analysis to determine the extent to which various factors limit watershed health. Consider the potential for natural recovery and focus restoration efforts on those limiting factors that are likely to take the longest time to recover naturally.	The most significant factor limiting fisheries in Silver Bow Creek is metals contamination. Natural attenuation of metals is not likely to occur any time soon, so restoration efforts should focus first on ensuring metals are no longer a limiting factor before pursuing other limitations such as nutrients or habitat.
5.	Implement each restoration activity at a scale that is appropriate for the problem. Watershed restoration plans may be implemented at various scales, from stream reaches, to individual streams, sub-watersheds, or entire watersheds.	Treatment of metals contamination sources on the Butte Hill may occur at the reach scale while benefits may extend downstream to include all of Silver Bow Creek. In contrast, treatment of weeds at discreet locations may be ineffective if weeds exist throughout the watershed.
6.	Take into consideration the costs/benefits of reducing recovery time, which may be significantly shortened by more active forms of restoration.	In Silver Bow Creek, contaminated floodplain soils prevent the re-establishment of native riparian plant communities. Removal of these tailings could accelerate recovery time by hundreds of years.
7.	Evaluate restoration success and use the findings to improve subsequent restoration efforts (adaptive approach).	Lessons learned from remediation completed in Subarea 1 of Silver Bow Creek are valuable and are being incorporated into the designs for subsequent reaches of the stream.

3.3.1 Restoring Habitat for Fish, Wildlife, and Vegetation

The general principals described above apply to all aspects of watershed restoration. Specific factors should be considered when restoring habitat for fish, wildlife, and plant communities. Doppelt et al. (1993) and Frissell (1997) address some of these factors by identifying various categories of habitat for fish and other biota based on functional significance, location in the basin, and existing condition. Table 3-3 below summarizes habitat categories as described by La Marr (2003b):

Table 3-3: Habitat categories for fish and wildlife habitat restoration.

Habitat Category	***Examples***
Focal Habitat. A focal habitat is least impaired by human landscape alteration or non-native species introductions. These critical areas support a mosaic of high quality, intact habitat that provides the needs of all life stages of the target species. Since these areas are relatively intact, protection and restoration costs are low relative to more impaired portions of the watershed.	For westslope cutthroat trout, focal habitat would include German Gulch and tributaries, and the headwaters of Basin Creek. For big game animals, focal habitat is present within the Mt. Haggin Wildlife Management Area (WMA).
Nodal Habitat. These areas are spatially dissociated from focal habitat but serve critical life history functions for biota that originate from other habitat throughout the basin. Nodal habitat may be partially impaired but retains components that are vital for certain life history stages.	Nodal habitat for trout would include relatively unimpaired stream segments that connect isolated patches of focal habitat. Some of the tributaries to German Gulch most likely are nodal habitat. For wildlife, nodal habitat might include winter feeding areas in Durant Canyon.
Adjunct Habitat. These areas are typically adjacent to focal habitat or nodal habitat. They are impaired by human or natural disturbances and often do not presently support abundant native species. They can be a relatively high priority for restoration because of their proximity to focal areas.	German Gulch downstream of the Forest Road 83 bridge provides an example of adjunct habitat. This section of stream is impaired by historic mining and grazing activities but is a high priority for restoration due to proximity to focal habitat areas. Adjunct big game habitat might include the degraded riparian corridor of German Gulch.
Critical Contributing Areas. These are portions of watersheds that do not directly support habitat for the species of interest, but are important sources of high-quality water and stable watershed conditions for downstream focal or nodal habitat. They can also serve as critical municipal water supplies.	Critical contributing areas within the watershed include undisturbed uplands and the upstream reaches of headwaters streams where flows are insufficient to support fish. Other examples might include cold-water springs that help maintain relatively low summer water temperatures of main stem channels.
Grubstake Habitat. Restoration of grubstake habitat may require extensive planning and experimental work, and in many cases, the cost will be high. The potential long-term payoff of restoration work may be high but rapid biotic response is unlikely because these areas take a long time to recover from past impacts and they may lack a ready source of colonists to re-inhabit them once they do recover.	These areas tend to be low-elevation, heavily disturbed portions of watersheds and are often associated with lowland floodplain rivers. Silver Bow Creek and its contaminated floodplain are prime examples of grubstake habitat in the Silver Bow Creek watershed. Other grubstake areas would include areas disturbed by industry such as the Yankee Doodle tailings area, the Berkeley Pit, and the Rhodia phosphate plant area.

With these habitat categories in mind, the following general strategy applies to restoring communities of fish, wildlife, and vegetation:

1. When possible, focus on restoring communities of historical or native species. Native species are generally better adapted to local conditions and help to preserve the natural heritage of watersheds.
2. Preserve and protect existing critical habitat in unimpaired or minimally impaired areas to provide a network of refugia for the target species. This will help to ensure that target species populations survive in the watershed and will be available to expand into restored areas in the future.

3. Restore minimally to moderately impaired habitat adjacent to refugia to expand the habitat available to the target species. This will improve target species survival in each of the refugia.
4. Establish or reconnect severed linkages and migration corridors between unconnected habitat refugia (e.g. stream channel with floodplain, upstream to downstream, etc.). This will allow for gene flow and will provide a means for individual refugia to repopulate following disturbances or local extinctions.
5. Restore other, more heavily impaired areas of the watershed.

3.4 Watershed Planning and Restoration Concepts for Silver Bow Creek

The preceding sections of Chapter 1.0 serve as guidance for watershed planning and formulating restoration projects to address specific aspects of watershed impairment. Subsequent sections of this Plan incorporate these concepts.

This *Silver Bow Creek Watershed Restoration Plan* takes the watershed planning process to an advanced stage of completion. However, the restoration plan is incomplete primarily due to additional data needs (such as the ROD for the BPSOU) that may change restoration priorities in the future (Chapter 7.0). Therefore, this restoration plan is a work in progress that will need revision and upgrading when additional information becomes available. Nevertheless, it provides a starting point for any stakeholder group interested in pursuing restoration within the watershed.

To continue with the planning efforts initiated in the *Silver Bow Creek Watershed Restoration Plan*, we recommend that interested persons form a broad-based watershed organization. Although there are many groups actively involved in the Silver Bow Creek watershed, currently there is no watershed group to represent the interests of diverse stakeholders across the entire watershed. Members of the watershed group may include representatives from each of the stakeholder groups that participated in the focus groups as part of the public involvement process (Appendix A). The watershed organization would be responsible for implementing and updating this plan and helping stakeholders obtain funding to implement specific projects. The watershed group would also help stakeholders leverage funding from other sources to fund projects outside the scope or priorities of NRDP. This would maximize the value and utility of the settlement funds obtained by NRDP. In addition, formation of a Silver Bow Creek watershed group would help increase political interest in the watershed and could serve as the basis for long-term stewardship of the basin’s natural and human resources. Finally, a watershed group could serve as the entity to coordinate development of a plan that would meet upcoming TMDL requirements. Chapter 9.0 presents information about using this restoration plan and the *RPPC* to develop restoration proposals for funding consideration.

4.0 Methods

This chapter provides a description of the methods employed in the development of this plan. This includes the public participation process, data compilation and review, data analysis, and determination of restoration priorities.

Methods used to develop the *Silver Bow Creek Watershed Restoration Plan* needed to be similar to proven approaches applied in other watersheds, yet specific enough to account for the uniqueness of this area. As a result, the methods proposed for this effort changed as public input was gathered and our knowledge of the watershed's natural resources, limiting factors, and social concerns grew.

4.1 Public Involvement Plan

At the outset of this project, we developed a public involvement plan through which we solicited local knowledge, restoration ideas, public concerns, and public priorities. The goals of the public involvement plan were to:

- gather information from local citizens, resource users, resource managers, and interest groups regarding their experiences, concerns, needs, and ideas for restoration of the Silver Bow Creek watershed,
- work with stakeholders to develop a vision for a restored Silver Bow Creek watershed,
- share project progress and obtain local review and advice from key individuals, groups and interested citizens as the project advances, and
- report project findings and recommendations to stakeholder groups and the general public and receive input as the Silver Bow Creek Watershed Restoration Plan nears completion.

The public involvement process consisted of focus group meetings, general public meetings, Ad Hoc Committee meetings, a visioning process, a project web site, periodic project updates, and a public comment period and hearing on this draft plan. Chapter 5.0 summarizes results of the visioning process.

4.1.1 Focus Groups

Stakeholders representing more than twenty-five different interests participated in a series of focus group meeting between June 2002 and March 2003. The purpose of the meetings was to create an informal, non-threatening opportunity for stakeholders, natural resource managers, and interested persons to share their knowledge, concerns, experiences, and recommendations. Appendix A lists the stakeholder groups and individual participants.

An advisory subcommittee of the UCFRB Remediation and Restoration Education Advisory Council and NRDP staff identified focus group participants from a list of prospective stakeholders. Prospective participants helped expand the list by providing names of additional participants and groups that might want to be involved. The expanded list was critical in identifying key individuals, groups, and agencies representing a broad number of watershed stakeholders invited to participate in a focus group session. We grouped related interests together to insure that each meeting was non-confrontational and conducive to open dialogue.

At each meeting, focus group participants described their concerns about resource conditions, uses and needs, and recommended future restoration priorities. Maps of the key tributary watersheds to Silver Bow Creek provided a medium for participants to record site-specific information, including restoration goals, resource uses and other information helpful to priority setting. The general outcomes of the focus groups were acquisition and compilation of stakeholder input, including broad restoration goals arising from some groups' desired future conditions. Specifically, public information on key tributary watersheds highlighted restoration opportunities and priorities shared by several different focus groups. The focus group sessions also provided a forum for determining concerns of the various groups (see Appendix A).

In sum, the public information collected through the focus group process was one important set of data considered in developing the *Silver Bow Creek Watershed Restoration Plan.* Other important data, such as historic conditions and scientific information, provided additional information, as described in subsequent sections of this Plan.

4.1.2 Public Meeting

A second public involvement opportunity was a public meeting held in Butte on October 8, 2002. The purposes of the meeting were to describe the Silver Bow Creek restoration planning project to the general public, share information obtained at the focus group meetings, and obtain additional public information and comment. The public conveyed what they value about the Silver Bow Creek watershed and shared their visions of Silver Bow Creek in the year 2032. These comments later served as a starting point for the Ad Hoc Committee visioning process.

4.1.3 Web Site

During the development of the restoration plan, the NRDP maintained a project-specific website. The website included background information on the NRDP litigation and restoration activities, the Silver Bow Creek watershed restoration planning process; schedules of meetings and events; project updates; maps and photos; frequently asked questions; information on pending litigation; related documents and links to other relevant information. The site also allowed for public feedback. Upon finalization of this plan, the NRDP discontinued this website and added information specific to this restoration plan to the NRDP's website (www.doj.mt.gov/lands/naturalresource).

4.1.4 Project Updates

A December 2002 Project Update provided an overview and status report of the Silver Bow Creek restoration planning project. The newsletter was distributed to the UCFRB Remediation and Restoration Education Advisory Council, the Ad Hoc Silver Bow Creek Watershed Restoration Plan Subcommittee, and was posted on the project web site. The update described the restoration planning project's outcomes and goals, introduced the professional contract team, and provided a summary overview of the focus group and prioritization processes.

4.1.5 Public Hearing and Comment Period

The State held a 60-day public comment period on the *December 2004 Draft Silver Bow Creek Watershed Restoration Plan* from January 7 through March 11, 2005. The State also held a public hearing in Butte on February 1, 2005 on the plan. A total of five individuals, including representatives of three entities, submitted official comments during the public comment period. The *State of Montana's Response to Public Comments on the Decembe 2004 Draft Silver Bow Creek Watershed Restoration Plan*, dated December 2005, provides copies of the public comments received and the NRDP's responses to these comments, which indicate what changes were made to the draft restoration plan as a result of public comment. The response document is available from the NRDP website (www.doj.mt.gov/lands/naturalresource) or upon request from the NRDP.

4.1.6 Silver Bow Creek Watershed Restoration Ad Hoc Committee

One important outcome of the focus group meetings was identification of individuals and groups interested in serving on an Ad Hoc Silver Bow Creek Watershed Restoration Plan Committee. Representing eighteen stakeholder groups, the 19 members who volunteered provided continuing public input throughout the project. The group's role was essential for development of a shared vision for Silver Bow Creek Watershed Restoration, described in Chapter 5.0. The Ad Hoc committee met on two occasions, one on January 29, 2003, and a second meeting on October 29, 2003. At the first meeting, we presented findings of the focus groups, some examples of wildlife data compiled into the project GIS, and discussion of methods employed in the data analysis process. In addition, a first draft of the vision statement provided a feedback opportunity. At the second meeting, we presented preliminary methods and results employed in the prioritization process. Although this process was not complete at the time, the feedback obtained from the Ad Hoc Committee was invaluable and led to a restructuring of this process. Finally, the NRDP received input from the Ad-Hoc Committeee on an October 2004 version of this document at a November 16, 2004 meeting. The NRDP incorporated most of this input into the December 2004 draft plan.

4.2 Data Compilation and Review

The primary goal of the data compilation and review portion of this plan was to assess the condition of aquatic, riparian, terrestrial, and human influenced features in the Silver Bow Creek watershed, and describe these conditions and any known processes and interactions. Data compilation and review, in conjunction with data analysis described below, together formed the basis of a thorough watershed analysis using the best available information. Tasks undertaken for the data compilation task included:

- creation of a searchable reference library database,
- compilation available spatial data in a GIS database,
- review of data for relevance and quality,
- documentation of this data review in Chapters 6.0 and 7.0 of this document, and
- identification of data gaps.

The reference library database developed for this project provides a convenient, user-friendly means of cataloging the vast amount of information available for the study area. The database includes fields for author, title, subject, key words, and an abstract, and allows queries to locate desired information. It is available upon request from the NRDP. Compiling all information in a project GIS creates a spatial framework for organizing and analyzing relevant information. This provided the basis for analysis described below in Section 4.3. Chapter 6.0 of this report serves as the watershed characterization and summarizes the known natural and human influenced conditions of the Silver Bow Creek watershed. Chapter 7.0 further describes the features and resources of the eight planning areas within the Silver Bow Creek watershed. This includes water quality, water quantity, fisheries, vegetation, wildlife, recreation, public input, restoration needs, and data gaps.

4.3 Data Analysis

The goal of the analysis component of the *Silver Bow Creek Watershed Restoration Plan* was to provide sufficient information to prioritize areas within the watershed based on perceived benefits of addressing restoration needs. Chapter 7.0, summarizes much of the information gathered and analyzed for this plan.

4.3.1 Analysis of GIS Data

Numerous GIS data layers are available for the Silver Bow Creek watershed. Spatial analysis of these data provides valuable information on the distribution of natural resources and man made features across the landscape. Through analysis within the project GIS, the data sets listed in Appendix B yielded important information that are summarized below in Chapters 6.0, 7.0, and 8.0.

4.3.2 Water Quantity

Two data sources in this report contain information on water quantity. The hydrology section (section 6.3) of Chapter 6.0 provides information on discharge from active and historic stream gages in the Silver Bow Creek watershed. Section 6.3 also provides information on peak flows, flood frequency, flow durations, minimum flows and potential flow alterations. The sub-watershed sections in Chapter 7.0 each contain summary information on water rights compiled from the Montana DNRC water rights database. These sections provide information on the number and type of permitted water rights in the sub-watersheds, as well as the total maximum acreage and flow rate associated with these water rights. As with many river systems in Montana, the permitted water rights may exceed the amount of water available. Therefore, the DNRC water rights database provides only relative water rights information for comparison among the sub-watersheds.

4.3.3 Water Quality

Quantifying the magnitude of water quality impairments was an important component of developing this plan. A thorough review of available water quality information helped define relative levels of impairment from various sources for Silver Bow Creek and major tributaries.

Definition of Impairment

The definition of water quality impairment varies from stream to stream as specified by the stream classification system designated in the Administrative Rules of Montana (ARM 17.30.606-629). This classification system establishes water quality standards for streams based on the beneficial uses that each stream class should support. Most waters in the Silver Bow Creek watershed classify as B-1, which requires water quality to be suitable for the following beneficial uses: drinking, culinary and food processing, contact recreation; growth and propagation of salmonid fishes and associated aquatic life; waterfowl and furbearers; and agricultural and industrial water supply (ARM 17.30.623). Water quality in B-1 streams is impaired if any of these beneficial uses is compromised or not fully supported.

In contrast, Silver Bow Creek classifies as "I", which means an impaired stream. According to ARM 17.30.628, the goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. These beneficial uses are supported when the concentrations of toxic, carcinogenic, or harmful parameters in these waters do not exceed the applicable standards specified in department Circular WQB-7 when stream flows equal or exceed the stream flows specified in ARM 16.20.631 (4). These flows are the 10-year 7-day low flow (i.e., minimum consecutive 7-day average flow which may be expected to occur on the average of once in 10 years). Alternatively, site-specific criteria may be developed using the procedures given in the *Water Quality Standards Handbook*, if other routes of exposure to toxic parameters by aquatic life are addressed.

To allow a gradual attainment of these requirements in "I" class streams, the "I" classification allows point source discharges to be permitted at the higher concentration of (1) the applicable standards specified in department Circular WQB-7, (2) the site-specific standards, or (3) one-half of the mean instream concentrations immediately upstream of the discharge point. This effectively requires eventual attainment of the Circular WQB-7 levels in the stream, while allowing consideration of the current, impacted stream quality (a graduated reduction of point source discharge concentrations based on the mean instream concentration where the stream is substantially degraded). As the quality of the stream improves due to control of other sources, including cleanup of non-point source areas, point source dischargers such as the Butte and Rocker wastewater treatment plants must improve the quality of their discharges down to the instream standards (either WQB-7 or, for aquatic life only, site specific standards).

Traditionally, physical and chemical parameters were the standard means to express water quality. However, the high level of water quality required for uses such as recreation, salmonid fisheries, aquatic life, and drinking water is a function of more than simply water chemistry. For this reason, the operational definition of water quality includes the physical, chemical, and biological characteristics of a body of water necessary to sustain desired uses. Using this operational definition of water quality, we employed several types of information to describe water quality in the Silver Bow Creek watershed. This included the traditional chemical measures such as concentrations of metals and other constituents in the water column. In addition, we examined biological indicators of water quality such as macroinvertebrate and periphyton assemblages. These provide a direct measure of a designated beneficial use, associated aquatic life. Finally, concentrations of metals in benthic sediments provided an indirect measure of water quality.

Water Quality Standards

The Administrative Rules of Montana (ARM 17.30.601 through 17.30.670) designate either numeric or narrative standards for water quality parameters for surface waters in the state. Numeric standards provide quantitative thresholds for pollutants based on known toxicity or other deleterious effect. In contrast, narrative standards apply to concentrations that are elevated above natural or are at harmful concentrations.

Metals and ammonia are the primary pollutants in the Silver Bow Creek watershed with designated numeric standards. Applicable standards address acute and chronic toxicity to fish and aquatic life and concentrations that pose a risk to human health (Table 4-1). Toxicity of these constituents varies with the physical and chemical setting necessitating calculations to determine the standard. For instance, toxicity of most metals changes as a function of hardness or the buffering capacity of the water. Similarly, toxicity of ammonia relates to both temperature and pH of the water.

Currently, metals standards apply to concentrations present in the water column with no standards available to assess metals associated with benthic sediments. Nevertheless, metals-contaminated sediments present a limitation on macroinvertebrate and algae communities and provide a route of bioaccumulation of metals up the food chain. In the absence of standards, we compared concentrations of metals in benthic sediments against levels of observed toxicity compiled by CDM (1994).

In addition to presenting toxicity risks to fish and aquatic life, metals in surface water can also result in chemical barriers to movement of fish throughout a basin by creating fish avoidance zones. Fish have a keen sense of olfaction and actively avoid waters contaminated with a variety of pollutants, including many metals. Recovery of fish populations in the Silver Bow Creek basin depends largely on recruitment from tributaries; therefore, fish avoidance zones may present a constraint to re-establishment of fish populations in the Silver Bow Creek watershed. Idaho DEQ (2000) has developed metals avoidance thresholds for salmonids for their evaluation of mixing zone metals concentrations (Table 4-2).

Nutrients are the major category of pollutant in the Silver Bow Creek watershed assigned narrative standards. Nutrients consist primarily of compounds containing the elements nitrogen or phosphorus. These elements are essential to aquatic life; however, an excess of nutrients may have deleterious effects on fisheries, aquatic life, and recreational uses of a stream. The narrative standards for nutrients address the influence of nutrient concentrations on aquatic life. Specifically:

> "State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will…create conditions which produce undesirable aquatic life" (ARM 17.30.637[e]).

There are several possible manifestations of "undesirable aquatic life." Nuisance algal blooms that limit recreational uses and aesthetics present one type. Others include proliferation of macroinvertebrates or algae that are tolerant of nutrient pollution to the detriment of more sensitive taxa. In other words, waters where excess loading of nutrients from human-related sources results in the prevalence of nuisance or pollution tolerant organisms while inhibiting those that tolerate only lower concentrations of nutrients meet the criteria as impaired under this narrative standard.

A number of tools and strategies are available to assist evaluating compliance with narrative standards for nutrients. Comparison of biological, physical, and chemical conditions with ranges for an ecoregion is a common approach. For example, generation of distributional statistics for nutrient parameters in the STORET database provides a screening tool to identify streams with comparatively high levels of nutrients (Richards and Miller, 2000; Tables 4-3 and 4-4). Similarly, numeric standards developed for the Clark Fork River are a potential screening tool to evaluate nutrient loading. Other ecoregion measures include comparison to metric batteries developed for macroinvertebrates and periphyton (Bahls, 1993; Bollman, 1998). Additional options include the use of internal references or "least-disturbed" streams.

Table 4-1: Numeric standards for some parameters of concern (Montana DEQ, 2002a)

Parameter	***Acute Aquatic life***	***Chronic Aquatic Life***	***Human Health***
Ammonia	Calculated based on pH and temperature	Calculated based on pH and temperature	--
Arsenic	340 µg/L	150 µg/L	18 µg/L
Cadmium	1.05 µg/L @ 50 mg/l hardness	0.16 @ 50 mg/l hardness	5 µg/L
Copper	7.3 µg/L @ 50 mg/l hardness	5.2 µg/L @ 50 mg/l hardness	1300 µg/L
Lead	82 µg/L @ 100 mg/l hardness	3.2 µg/L@ 100 mg/l hardness	15 µg/L
Selenium	20 µg/L	5 µg/L	50 µg/L
Zinc	67 µg/L @ 50 mg/l hardness	67 µg/L @ 50 mg/l hardness	2000 µg/L
Nitrate (NO_3)	Narrative	narrative	10,000 µg/L
Nitrite (NO_2)	Narrative	narrative	1000 µg/L

Table 4-2: Salmonid metals avoidance thresholds for mixing zone evaluation (Idaho DEQ, 2000).

Selected Avoidance Thresholds	***Cadmium (µg/L)***	***Copper (µg/L)***	***Chromium (µg/L)***	***Nickel (µg/L)***	***Lead (µg/L)***	***Mercury (µg/L)***	***Zinc (µg/L)***
Lab	8	3	10	24	14	0.2	14
Field	16	3	20	48	28	0.4	28
1. The lab avoidance thresholds from studies reviewed by Idaho DEQ (2000) were multiplied by 2, which was the lowest lab-to-field response ratio to obtain field avoidance thresholds, except for copper.							
2. Because of the ambiguity with the threshold response of juvenile Chinook salmon to copper, the recommended avoidance threshold is 3 µg/L, without multiplication by the field response ratio.							

Table 4-3: Distribution statistics for key water quality parameters sampled in Ecoregion 16: Mountain Valley and Foothill Prairies (Richards and Miller, 2000).

Parameter	Min	25th Percentile	50th Percentile	75th Percentile	90th Percentile	95th Percentile	Max	N
Total Phosphorus (mg/L)	<QL1	0.02	0.05	0.11	0.42	0.75	107	5711
Total Ortho-phosphorus (mg/L)	<QL	0.000	0.010	.0250	1.02	102	108	73
Total Kjeldahl Nitrogen (mg/L)	ND[2]	0.20	0.30	0.60	1.60	2.90	181	3828
Total Ammonia (mg/L)	ND	<QL	0.02	0.07	0.53	1.50	33	2802
Total Nitrate + Nitrite (mg/L)	ND	0.02	0.12	0.57	1.44	2.01	25.5	2968
Nitrate (mg/L)	< QL	0.0030	0.10	0.50	1.95	2.88	106	1692

[1]Below quantification limit, [2]Below detection limit

Table 4-4:Distribution statistics for key water quality parameters sampled in Ecoregion 17: Middle Rockies (Richards and Miller, 2000).

Parameter	Min	25th Percentile	50th Percentile	75th Percentile	90th Percentile	95th Percentile	Max	N
Total Phosphorus (mg/L)	ND	<QL	0.01	0.04	0.09	0.13	0.30	532
Total Kjeldahl Nitrogen (mg/L)	ND	ND	0.00	0.20	0.31	0.40	2.80	544
Total Ammonia (mg/L)	<QL	<QL	0.01	0.04	0.07	0.11	9.00	145
Total Nitrate + Nitrite (mg/L)	ND	0.020	0.040	0.08	0.14	0.32	0.60	345
Dissolved Nitrate + nitrite	ND	ND	0.05	0.14	0.26	0.32	0.54	406
Nitrate (mg/L)	<QL	0.100	0.10	0.10	0.16	0.54	2.5	380

Sources of Data and Sufficient Credible Data Review

From the 1970s to the present, water chemistry sampling occurred sporadically throughout the Silver Bow Creek watershed. Water chemistry data are available in three different databases: the STORET database (1974-present), the Legacy STORET database (pre-1974), and the Tri-State Water Quality Council database (1986-present). The STORET and legacy STORET databases managed by the EPA contain data collected by various state and federal agencies. Monitoring data collected by the Montana DEQ comprised the bulk of the STORET database. Monitoring associated with phase I remedial activities in the SSTOU provide physicochemical water and sediment chemistry data for Silver Bow Creek (Multitech, 1986, reported in CDM, 1994). Finally, the Tri-

State Water Quality Council maintains a database of water chemistry for several locations on Silver Bow Creek and on the Mill-Willow Bypass.

These databases contain water quality sampling data from more than 40 sites in the basin. The number, type of parameter, and timing of sampling vary considerably among these stations. To focus effort on the most useful data, we applied sufficient, credible data (SCD) criteria developed by the Montana DEQ in determining which stations provide the best information (Table 4-5). These criteria include evaluation of data quality, data currency, detection limits, spatial coverage, and temporal coverage. To rate as sufficient, a dataset for a given stream should score two or greater for each of the four components.

Using data in the STORET and Legacy STORET databases, several streams in the Silver Bow Creek watershed had sufficient data for definitive evaluation of metals contamination in surface water (Table 4-6). For other streams where sufficient data was not available, data evaluated still provided insight into the conditions of impairment. Verification of results for these areas often requires further sampling before restoration is undertaken. Silver Bow Creek had the most comprehensive dataset with good spatial and temporal coverage. German Gulch also had sufficient data to evaluate metals contamination. Data for Basin Creek and Blacktail Creek were of relatively low quality due to data currency and low spatial coverage; however, some inference was possible using these data. While metals concentrations exist for other streams in the basin, factors such as few sampling events or high detection limit inference from these data.

The Tri-State Water Quality Council database provides another important source of water quality data for Silver Bow Creek but does not include any tributary streams. Applying SCD criteria to Tri-State Water Quality Council monitoring data indicates these data score relatively high in terms of data currency and spatial coverage. Metals sampled in this effort included cadmium, copper, and zinc in addition to nutrients.

Biological Indicators

Analyses of macroinvertebrate and periphyton community composition describe the biological integrity of streams. This type of information exists for four sites on Silver Bow Creek and one site on Blacktail Creek (McGuire, 2001; Weber, 2001; Table 4-7). In addition, sampling occurred intermittently on a site on the Mill-Willow Bypass from 1996 to 2000. Monitoring at these sites has been ongoing since 1986 as part of the Clark Fork Basin Project, a water quality assessment project of the Montana DEQ. Other monitoring sites include streams in the Browns and German Gulch sub-watersheds (McGuire and Weber, 1997; McGuire and Weber, 2000). Analyses of bioaccumulation of metals in macroinvertebrate tissues are another type of biological data describing water quality impairments in the Silver Bow Creek watershed.

Benthic Sediments

Metals and other toxic constituents in benthic sediments present another water quality concern in the Silver Bow Creek watershed. Due to their close association with benthic sediments, macroinvertebrates and periphyton readily incorporate these contaminants in their tissues. This presents a toxicity risk to these organisms and introduces the metals into the food chain where they may bioaccumulate and lead to ecological and human health risks. CDM (1994) assessed in detail the risks posed by metals in benthic sediments for Silver Bow Creek (see Section 7.1.1) using data collected by PTI (1989) and Canonie (1992). The Montana Bureau of Mines and Geology evaluated metals concentrations in benthic sediments in June 2002 and January 2003. Additional investigations occurred in the German Gulch sub-watershed during 2002 (Section 7.3.1).

Table 4-5: Criteria to evaluate whether water chemistry data are sufficient to make a beneficial use support determination (Montana DEQ, 2002b).

Score	*Technical Components*	*Spatial/Temporal Coverage*	*Data Quality*	*Data Currency*
1	-Best professional judgment based on land use data or source locations -Chemical parameters analyzed are limited and do not provide sufficient information concerning probable causes of impairment.	-Low spatial and temporal coverage-limited data at critical periods -Limited period of record (e.g. one day)	-Data precision and sensitivity is very low or unknown and data appear to be an outlier (suspect). -High detection limits make the data difficult or impossible to interpret. QC protocols indicate contamination, etc. QA/QC protocols were not followed.	-Data do not reflect current conditions.
2	-Usually grab or composite water quality samples -Synthesis of historical information on fish contamination levels -Screening models based on loading data (not calibrated or verified) -Sediment contamination data (e.g. metal scans) -Limited chemical parameters; however probable impairment causes are targeted and probable sources of impairment documented. -Reference condition can be approximated by a professional. -Acute or Chronic WET; Acute ambient; or acute sediment tests	-Moderate spatial and/or temporal coverage. -Data collected at critical periods (e.g. spring, summer, spawning season) -Short period of record but good spatial coverage -Quarterly sampling	-Data quality and sensitivity are low to moderate. -Data were collected following appropriate protocols but individuals had limited training. -Low detection limits. -QC indicates there was no contamination, etc. -Low replication used for toxicity tests.	-Data are substantially older than ideal, but appear to be a reasonable indicator of current conditions.
3	-Series of grab or composite samples (diurnal coverage as appropriate) -Calibrated models -Width/depth integrated sampling -Combination of two or more analyses of the following: water column, sediment, chlorophyll; toxicity testing; bioaccumulation data (e.g. fish consumption advisory data). -Reference condition can be determined with a reasonable degree of confidence and used as a basis for assessment. -2-3 Acute or Chronic Ambient; or Acute sediment; or Acute and Chronic WET tests for effluent dominated system	-Broad spatial and temporal coverage of site with sufficient frequency and coverage to capture acute events. -Typically monthly sampling during key periods. -Lengthy period of record (sampled over a period of months for >2 years)	-Data have moderate precision and sensitivity. -Professional scientist provides training; the individual collecting the samples is well trained. -Qualified professional collects samples; Data are analyzed in a competent laboratory that uses methods with low detection limits -QC documents where there are no sampling or analytical errors. -Moderate replication used for toxicity tests	-Data are older than ideal, but there are no indications that conditions have changed significantly.
4	-Combination of three or more of the following: water column chemistry, sediment chemistry, chlorophyll or bioaccumulation data; or toxicity testing. ->3 acute and chronic ambient tests; or acute or chronic sediment tests	-Broad spatial and temporal coverage (monthly sampling during key periods for >3 years) with sufficient frequency and parameter coverage to capture acute events, chronic conditions and all other potential impacts.	-High precision and sensitivity -Data collected and analyzed by qualified professionals following details QA/QC protocols. -High replication used for toxicity tests	-Data are current, generally less than 5 years old, and/or there is high certainty that conditions have not changed.

Table 4-6: Application of sufficient, credible data criteria for chemical analyses of streams in the Silver Bow Creek watershed.

Stream	*Number of Samples*	*Number of Stations*	*Date Range*	*Technical Components Score*	*Spatial/ Temporal Coverage Score*	*Data Quality*	*Data Currency*	*Overall Score*
Blacktail Creek	26	2	1974-1983	2	1	2	1	Insufficient
Browns Gulch	4	1	1976-1983	1	1	1	1	Insufficient
Edwards Creek	1	1	1995	1	1	2	2	Insufficient
German Gulch	428	6	1976-1992	2	2	2	2	Sufficient
Greenland Gulch	1	1	1995	2	1	2	2	Insufficient
Gregson Creek	11	1	1976-1977	1	2	1	1	Insufficient
Magnus Creek	1	1	1979	1	1	1	1	Insufficient
Mill Creek	4	1	1978	1	1	1	1	Insufficient
Mill Willow Bypass	3	2	1987-1990	2	1	1	2	Insufficient
Silver Bow Creek	2378	28	1973-2002	3	3	3	3	Sufficient
Willow Creek	4	1	1978	1	2	1	1	Insufficient

Table 4-7: Biological monitoring sites (McGuire, 2000 and Weber, 2000).

Station	*Name*	*Period of Record*
SF-1	Blacktail Creek above Grove Gulch	1993-2000
SF-00	Silver Bow Creek above Butte WWTP	1987-2000
SF-01	Silver Bow Creek at Rocker	1986-2000
SF-02	Silver Bow Creek near Ramsay	1986-2000
SF-2.5	Silver Bow Creek at Opportunity	1993-2000
SF-03	Silver Bow Creek above Warm Springs Ponds	1986-2000

Nutrients

Although not typically related to mining activities in the Silver Bow Creek watershed, nutrient enrichment may influence the potential for restoration of water quality and beneficial uses in streams. Narrative standards exist for most nutrients and are intended to prevent the occurrence of nuisance algal blooms and maintain healthy macroinvertebrate and periphyton communities. The exception is ammonia, which has numeric standards based on acute and chronic toxicity to fish and aquatic life. Nutrient data from the STORET database and Tri-State Water Quality Council database were sufficient to evaluate nutrient pollution on Silver Bow Creek and to draw limited inference on Blacktail Creek.

4.3.4 Aerial Photography Assessment

Air photos or satellite imagery often provide a means of identifying environmental impairments not otherwise identified in the literature. Digital Orthophoto Quarter Quadrangle black and white aerial photography collected in 1995 is the most extensive available imagery for the Silver Bow Creek watershed. Except for the Silver Bow Creek corridor, where remedial actions are under way, this imagery is still representative of current conditions. Limited, more recent aerial photography is available for portions of the Silver Bow Creek corridor but was not utilized for this analysis.

Air photo analysis included classification of major tributaries by general stream type (montane, valley foothill, or mainstem), Rosgen (1996) channel type, land use, and geology in order to define reach breaks. For each reach, impairments were identified where possible, as well as restoration needs, other opportunities (such as trails, land acquisition, etc.), associated benefits and limitations of this restoration, potential reference reach information, and general comments. Appendix D lists the results of the aerial assessment by reach and provides a description of channel types as described by Rosgen (1996). In addition, Chapter 7.0 contains sub-watershed maps illustrating results of the aerial assessment.

4.4 Determination of Restoration Priorities

4.4.1 Watershed Restoration and Prioritization Model

A challenging part of developing this plan was to determine the relative ecological value of watershed restoration activities. One of the methods employed was the development of a GIS-based spatial model. The model helped to assess, on a sub-watershed scale, the theoretical restoration potential of fisheries and vegetation in and along Silver Bow Creek and major tributary streams. When compared to current conditions, the difference between potential and current conditions would identify restoration needs.

The model became problematic when applied to the entire Silver Bow Creek watershed. Data gaps and lack of a method for spatial representation of public input information exacerbated the problems. Final model output had numerous exceptions that required manual modification of model inputs. The model output therefore only provided limited insight toward defining priorities of identified restoration needs.

4.4.2 Prioritization Ranking

Due to difficulties with the spatial model, we developed an alternative approach to prioritize restoration of the Silver Bow Creek watershed. This alternative approach began by utilizing the list of restoration needs identified through the data compilation and analysis and public input portions of this project. Chapter 7.0 presents these restoration needs as well as a summary of available scientific information, and identifies restoration needs for each of the eight planning areas. Focusing on these identified restoration needs rather than the entire watershed as described by the spatial model greatly simplified the prioritization process.

In identifying and prioritizing restoration needs, our starting point was the predicted condition of injured natural resources following completion of remediation. Injured resources subject to remediation occur mainly within the boundaries of the Silver Bow Creek corridor, the Butte area, and the Mill and Willow creeks planning areas. Remediation along the Silver Bow Creek corridor should be complete by 2012. Refer to Chapter 2.2 for more background on the completed, on going, and projected future remediation in the watershed.

Next, we developed a series of six broad restoration categories and considered the relative importance of each category. Development of these restoration categories required synthesizing watershed planning and restoration concepts presented in Chapter 1.0. The restoration categories correlate well with the goals outlined in the vision statement (see Chapter 5.0). Each of the restoration needs of the Silver Bow Creek watershed fall into one of the six categories.

Table 4-8 lists the restoration categories and presents the rationale for the relative importance of each, with the first two categories considered equally important. As summarized in Chapter 3.0, a general restoration strategy is to first preserve and protect existing critical fish and wildlife habitat that is in an unimpaired or minimally impaired condition before restoring other, more heavily impacted areas of the watershed. However, there are factors specific to the conditions in the Silver Bow Creek watershed that prompted us to consider pollution mitigation as equally important as protection/preservation of existing resources.Those factors are:

- the extensive injuries to natural resources caused by hazardous substance releases from historic mining and mineral processing operations in the Silver Bow Creek watershed;
- the substantial public input we received as to the importance of pollution mitigation; which is also reflected in the consensus-derived vision statement provided in Chapter 5.0 that envisions a watershed “protected from adverse impacts of mining contamination”; and
- the priorty given to restoration of injured resources in the NRDP’s funding framework document, the *UCFRB Restoration Plan Procedures and Criteria* (NRDP, 2002a).

Table 4-8: Categories of restoration needs for the Silver Bow Creek watershed.

Category	***Explanation***
Preservation/Protection of Existing Resources	Due to widespread habitat degradation in the watershed, protection of remaining critical fish and wildlife habitat is essential for effective long-term recovery efforts. If existing high quality resources face threats from current or future land uses, preservation and protection of these resources would provide significant ecological benefit. Preservation costs are typically lower than restoration costs.
Pollution Mitigation	Concurrent with efforts to secure protection for high quality resources, restoration efforts should focus on improving water quality by mitigating pollution. Pollution sources that degrade water quality and soils will pose limitations to restoring fisheries, vegetation, and wildlife. Consequently, the pollution sources that impose these limitations should be addressed before undertaking other types of restoration measures such as fishery, vegetation, or wildlife restoration. Similarly, it is recommended that pollution mitigation be given greater priority than recreation development.
Water Quantity Improvement	Water quantity closely ties to water quality and is essential for developing fish, vegetation, wildlife, and recreational opportunities. Opportunities to increase instream flow will be critical to the restoration of the Silver Bow Creek watershed. Increased instream flow can mitigate the negative impacts of contaminants (metals, nutrients, thermal), which in turn can mitigate pollution impacts to fisheries and vegetation. Increased instream flow can also be critical to maintaining and enhancing fish populations where habitat is degraded. Wildlife populations can also benefit from increased vegetation as the result of increased flow. Finally, improved fisheries, vegetation, and wildlife resulting from increased instream flow will enhance recreational opportunities.
Fishery Restoration	A fishery arguably is the natural resource that is most responsive to watershed conditions. Since fisheries respond to factors influencing the health of the entire watershed, fisheries serve as a bellwether for the condition of the watershed. Consequently, fishery health should be used as an important measure of watershed restoration success, but fishery restoration per se should receive a lower priority than pollution mitigation or water quantity improvement. Connectivity/migration corridors are important to fishery restoration.
Vegetation/Wildlife Restoration	Wildlife will respond primarily to vegetation because wildlife populations are tied to plant communities for browse and cover habitat. Consequently, wildlife populations will most directly benefit from projects that protect quality habitat, which falls under preserve and protect existing resources, and vegetation restoration. Healthy riparian vegetation also benefits water quality and improves cover and shade for fish. Critical habitat includes a mosaic of montane meadows, coniferous forest, and riparian and wetland areas distributed across a range of elevations, and provide both winter and summer range. Migration corridors provide important connections between each of these habitat types.
Recreation Development	Although important, the development of natural resource-based recreation opportunities such as trails, access, or facilities is most successful if the natural resources are in good condition. Consequently, development of recreation opportunities may occur concurrently with, but should not occur in place of the restoration of natural resources.

In many cases, addressing a restoration need in one of the six categories will improve conditions related to another restoration need in a different category. For example, improving instream flow (water quantity) in a tributary stream can also benefit fisheries and vegetation. The results of categorizing restoration needs are listed by sub-watershed in Chapter 7.0 and for the entire Silver Bow Creek watershed in Table 8-1 and Table 8-2.

Next, we considered all available information in light of the relative importance of each restoration category (Table 4-8), as well as estimated costs, to qualitatively rank the probable watershed-scale and local-scale (planning area) benefits realized by addressing the restoration needs. Each ranking uses four classifications; low, moderate, high, and very high and varies slightly for each category of restoration need. The low through very high classifications correspond to a one through four (1-4) numerical ranking (Table 4-9) with higher scores desirable. Note that lower costs have a higher cost ranking.

Table 4-9: Numerical scores corresponding to qualitative benefit and cost rankings.

Rank	***Watershed Benefits***	***Local Benefits***	***Cost***
Low	1	1	4
Moderate	2	2	3
High	3	3	2
Very High	4	4	1

The distinction between watershed scale and local scale benefits is important. For example, a tributary stream to Silver Bow Creek may have water quantity and fisheries restoration needs. If addressing the water quantity need only benefits the tributary stream and has little benefit to Silver Bow Creek, then local scale benefits of addressing this need are high, and watershed scale benefits of addressing this need are low. The highest priority projects will therefore have significant benefits to both the local area and the Silver Bow Creek watershed.

For ranking the watershed and local benefits of addressing restoration needs, it was necessary to develop definitions of low, moderate, high, and very high benefits for each of the restoration categories (Table 4-11). Benefit definitions are similar for pollution mitigation and water quantity improvement and are combined. Benefit definitions are also similar for fish, wildlife, and vegetation restoration needs. Benefit definitions for cost correspond to specific cost ranges. We relied on the information compiled and analyzed through this planning effort and best professional judgment in ranking these benefits.

Three methods of combining the numerical ranking for watershed benefits, local benefits, and costs yielded differing results (Table 4-10). The first method simply involved adding the three scores together to yield a total score. This method produced results that did not identify high cost, pollution mitigation restoration needs as high priority. Since these needs pose limiting factors to basin wide recovery, we tried a second method that gave more weight to benefits than to costs. This second method resulted in projects with high local benefits having higher priority than projects with high watershed scale benefits. This was also unsatisfactory given the intended focus of this planning effort to prioritize at a watershed scale.

Table 4-10: Numeric ranking combinations.

Combination	*Watershed Benefit Weighting*	*Local Benefit Weighting*	*Cost Weighting*	*Outcome*
1	1.0	1.0	1.0	Cost has too much weight. Critical pollution mitigation projects with high costs ranked low.
2	2.0	2.0	1.0	Projects with high local benefits ranked too high.
3	2.0	1.0	1.0	Ranking identified projects with watershed scale importance.

The third method of combining the numerical rankings provided the best results. This required doubling the numerical score for watershed benefits before adding to the local benefits and costs scores. The result is a list of restoration needs that when addressed, have a large benefit to the watershed as a whole, but also have local benefits and are cost effective.

Finally, because many needs have the same score using this methodology, we applied two secondary sorting methods. The first method applies when two or more restoration needs have the same combined score. In this case, we used the prioritization scheme for the restoration categories to sort them. For example, if two projects have a high ranking (3) for both watershed and local benefits, and have a moderate cost (3), both projects have a total score of nine (12). If addressing one restoration need protects existing resources and the other restores fisheries, the project protecting existing resources ranks higher. The second additional sorting criteria elevated restoration needs associated with Silver Bow Creek area historic mining in the case of a tie total score. Chapter 8.0 and Table 8-1 present the results of this prioritization process.

Restoration needs that are likely to be adequately addressed through existing or planned efforts have a deferred priority and are not ranked. If these efforts do not adequately address these needs as anticipated, they will be reevaluated and ranked.

Table 4-11: Restoration benefit definitions.

Rank	*Restoration Category*	*Watershed-scale Benefits*	*Local Benefits (Planning Area/Sub-watershed scale)*	*Level of Effort (Cost)*
		Addressing these restoration needs will:	**Addressing these restoration needs will:**	
Low	Protect/Preserve Existing Resources	• protect a resource considered not important to human or fish/wildlife populations	• protect a local resource considered not important to human or fish/wildlife populations	<$250,000
	Pollution mitigation or water quantity improvement	• mitigate a condition that has no influence on watershed conditions	• mitigate a condition that has no influence on local conditions	
	Fish, wildlife, or vegetation	• facilitate recovery of either minor fish or wildlife populations, or vegetation	• facilitate recovery of either minor fish or wildlife populations, or vegetation	
	Recreation	• provide a recreational resource that will be rarely utilized by the watershed community	• provide a recreational resource that will be rarely utilized by the local community	
Moderate	Protect/Preserve Existing Resources	• protect a watershed resource desired, but not critical to human or fish/wildlife populations	• protect a local resource desired, but not critical to human or fish/wildlife populations	$250,000-500,000
	Pollution mitigation or water quantity improvement	• mitigate a limiting factor that has limited influence on watershed conditions	• mitigates a limiting factor that has limited influence on local conditions	
	Fish, wildlife, or vegetation	• facilitate recovery of either minor fish or wildlife populations, or vegetation	• facilitate recovery of either minor local fish or wildlife populations, or vegetation	
	Recreation	• provide a recreational resource that will be occasionally utilized by the watershed community	• provide a recreational resource that will be occasionally utilized by the local community	
High	Protect Existing Resources	• protect a resource valuable to human or fish/wildlife populations	• protect a resource valuable to human or fish/wildlife populations	$500,000-$1,000,000
	Pollution mitigation or water quantity improvement	• mitigate a limiting factor that has some influence on watershed conditions	• mitigate a limiting factor that has some influence on local conditions	
	Fish, wildlife, or vegetation	• facilitate recovery of either significant fish or wildlife populations, or vegetation	• facilitate recovery of either significant fish or wildlife populations, or vegetation	
	Recreation	• provide a recreational resource that is desired and will be moderately utilized by the watershed community	• provide a recreational resource that is desired and will be moderately utilized by the local community	
Very High	Protect Existing Resources	• protect a watershed resource essential to human or fish/wildlife populations	• Protect a local resource essential to human or fish/wildlife populations	>$1,000,000
	Pollution mitigation or water quantity improvement	• eliminate a limiting factor that prevents healthy systems from developing in the watershed	• eliminate a limiting factor that prevents healthy systems from developing locally	
	Fish, wildlife, or vegetation	• facilitate recovery of significant watershed wide fish, wildlife, or vegetation resources	• facilitate recovery of combinations of significant local fish, wildlife, or vegetation resources	
	Recreation	• provide a recreational resource that is highly desired and will be heavily utilized by the watershed community	• provide a recreational resource that is highly desired and will be heavily utilized by the local community	

Note: Local refers to planning area or sub-watershed, such as German Gulch, Browns Gulch, etc.

5.0 Vision for Silver Bow Creek

Chapter 5.0 presents the process we followed to develop a consensus vision statement for a restored Silver Bow Creek watershed and the results of that process.

5.1 Visioning Process

The process of developing a shared vision for Silver Bow Creek restoration resulted from community conversations conducted at three public meetings over a period of six months. Through this process, we considered and addressed numerous suggestions conveyed to NRDP by telephone and e-mail from diverse individuals and groups. The process began with a simple brainstorming exercise at the first public meeting held in Butte on October 8, 2002. It continued at an Ad Hoc Committee meeting on January 29, 2003, when participants reviewed and revised a preliminary draft vision formulated after the October meeting. Those in attendance at this second meeting included representatives of interested groups who participated in the focus group process and sought a closer level of involvement with this project. The visioning process concluded with a consensus decision on the vision statement reached at the final meeting of the Ad Hoc Committee on March 7, 2003. Additional details follow.

Acquisition of public meeting participants' visions of the Silver Bow Creek watershed thirty years in the future was one important outcome of the first public meeting conducted on October 8, 2002. Thirty-five participants contributed their visions for the watershed. After the meeting, we compiled these visions and drafted a composite vision statement as a starting point for a more focused and intensive visioning process. We first isolated key concepts from the 35 visions collected at the public meeting. Second, we grouped the visions into five categories: recreation, ecology, pollution clean up, community building, and maintenance and preservation. Third, the numbers of responses within each category helped develop a general understanding of their comparative importance. From these results, we prepared two draft vision statements for consideration by the Ad Hoc Committee at their first meeting on January 29, 2003.

The visioning process continued on January 29, 2003 when the Ad Hoc Committee met in Butte. The group reviewed what a vision statement is and why it is necessary and then considered two draft vision statements. To discern how those present felt about the drafts, participants defined their level of agreement on a conceptual scale. This process identified considerable agreement on one of the draft vision statements. Working from this draft, those present further clarified what they did and did not like. This discussion was fruitful for isolating the components participants considered essential. Due to time limitations, a small visioning subcommittee formed to further refine and finalize the vision statement.

Between January 29 and March 6, 2003, NRDP, project staff, and members of the visioning subcommittee shared a number of iterations of the vision statement. Successive refinements indicated that a final meeting would be the best way to finalize a consensus vision statement. As a result, interested persons reconvened in Butte on March 6 to finalize the vision statement and try to reach group consensus. The group was instructed that if consensus was not achieved by the end of the meeting, Carol Fox, Restoration Program Chief of the NRDP, would make the final decision based on majority agreement. After considerable discussion and debate, the group reached an acceptable level of consensus.

Clearly, underlying public requests for development of a shared vision for watershed restoration requires a cogent image and focus for NRDP grant-making activities. In response, a deliberate, systematic process integrated the diverse ideas of many individuals and groups. In the end, it was not possible for every suggestion or recommendation to be included. However, the final vision was one that all participants found acceptable.

5.2 Vision Statement

The final vision statement for the Silver Bow Creek watershed, agreed upon by consensus at the March 7, 2003 meeting is:

> *In the 21st century, Silver Bow Creek Watershed is a vibrant place to live, work and recreate. The watershed is protected from adverse impacts of mining contamination. The restored watershed supports viable, self-sustaining communities of fish, wildlife and vegetation, and high-quality water resources. Native species are maintained and restored where practicable. The watershed's healthy ecosystem provides for quality education and balanced recreation, contributing to a diverse and sustainable economy, improved aesthetics, and community well-being. Stable and healthy local communities of informed citizens actively protect the watershed's resources.*

For local residents and stakeholders, the Silver Bow Creek Watershed Restoration Vision creates a conceptual bridge between the present, degraded state of natural resources and the future, restored watershed resources that residents' desire: *"In the 21st century, Silver Bow Creek watershed is a vibrant place to live, work and recreate. The watershed is protected from adverse impacts of mining contamination…"* The vision highlights shared values and present activities that merit continued attention: "*viable, self-sustaining communities of fish, wildlife and vegetation, and high-quality water resources. Native species are maintained and restored where practicable."* The vision serves establishes a *"healthy ecosystem"* as a focal point for local residents and stakeholders, and the NRDP. In addition, the vision identifies larger community goals once restoration is complete. *"… quality education and balanced recreation, a diverse and sustainable economy, improved aesthetics and community well-being."* The vision describes desired ends in local terms that speak to those who have the greatest stake in and role to play in the future of the Silver Bow Creek watershed: *"Stable and healthy local communities of informed citizens…"* who "*actively protect the watershed's resources."*

The vision statement leads to a series of goals for restoring the Silver Bow Creek watershed. These goals guide the development and implementation of restoration activities within the watershed. Primary goals from the vision statement are:

- protection from adverse impacts of mining contamination,
- self sustaining fisheries, wildlife and vegetation,
- high-quality water resources, and
- native species.

Secondary goals include:

- a healthy ecosystem that provides for quality education and balanced recreation, and contributes to a diverse and sustainable economy, improved aesthetics, and community well being, and
- informed citizens actively protect and preserve the watershed's resources.

In broader terms, creation of a vision for Silver Bow Creek watershed restoration helps to eliminate confusion regarding the purpose of restoration, by establishing a positive conceptual image for all those who need to understand where restoration intends to go. Furthermore, the fact that NRDP embraced the challenge of developing a shared community vision for watershed restoration demonstrates that those responsible for restoring Silver Bow Creek are serious about taking local needs, concerns, and goals into account as they plan future grant-making activities. Finally, the successful outcome of the visioning process affirms the importance of integrating local visions into the watershed planning process, for it has fostered good will and a positive working relationship among key stakeholders, Silver Bow Creek watershed communities, and the Montana State officials who share responsibility for long-term restoration efforts.

6.0 Watershed Overview

This chapter provides a summary of the physical characteristics of the Silver Bow Creek watershed. This includes climate, hydrology, geology, soils, vegetation, land ownership and use, sources of environmental impairments, and major gaps in the knowledge base.

6.1 General Characteristics

The Silver Bow Creek watershed covers approximately 474 square miles, located at the headwaters of the Clark Fork River in southwest Montana (Figure 1-1). The watershed encompasses parts of Silver Bow and Deer Lodge counties. The eastern boundary of the watershed corresponds to the boundary between Silver Bow and Jefferson counties. The watershed contains both upland forested areas and grass and shrub dominated valley bottoms. The city of Butte (population 33,892 – 2000 Census) is the largest population center and the city of Anaconda (population 9417) is just outside of the watershed area. The dominant land use has historically been mining, with minor amounts of agriculture and tourism. For this study, the Silver Bow Creek watershed was divided into eight planning areas defined by sub-watersheds or distinct geographic features (Figure 2-3). Table 6-1 below lists some of the characteristics of the planning areas.

Table 6-1: Silver Bow Creek watershed planning area characteristics.

Planning Area (Sub-watershed)	*Acres*	*Square Miles*	*Average Annual Precipitation, in/yr (PRISM)*	*Mean Elevation (ft)*
Blacktail and Basin Creeks	59,924	93.6	16.70	6207
Browns Gulch	54,380	85.0	16.84	6242
Butte Area	24,558	38.4	16.46	6187
German Gulch	32,528	50.8	20.67	6666
Mill and Willow creeks	63,554	99.3	19.20	6270
Sand Creek	34,609	54.1	14.56	5827
Warm Springs Ponds Area	30,314	47.4	13.84	5539
Silver Bow Creek Corridor	6561	10.3	12.51	5025
Entire Silver Bow Creek Watershed	316,193	474.4	17.00	6131

6.2 Climate

Long cold winters and short, moderately hot and dry summers characterize the climate of the Silver Bow Creek watershed. Average monthly minimum temperatures and maximum temperatures range from 7.3 to 79.7 degrees F in January and July, respectively (Figure 6-1 and Figure 6-2, Desert Research Institute (DRI, 2003). The valley portions of the watershed are semiarid with average annual precipitation of approximately 12 inches/year. Headwater portions of the watershed receive considerably more precipitation, reaching up to 45 inches/year in the headwaters of Mill Creek (Figure 6-3).

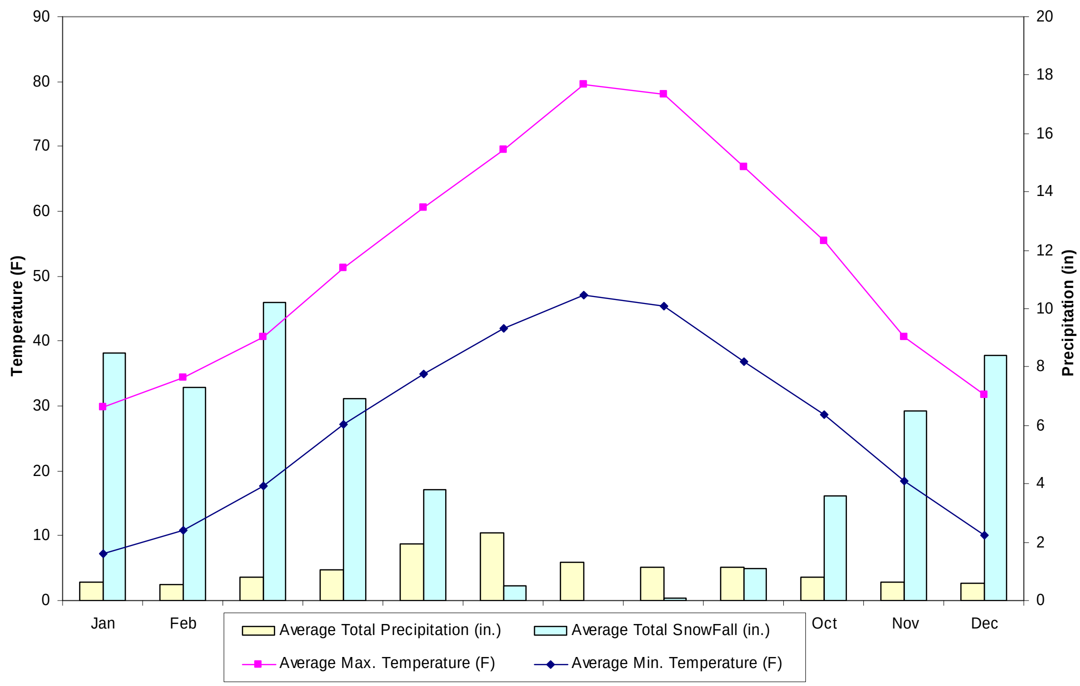


Figure 6-1: 30 year average climate statistics, Butte airport weather station.

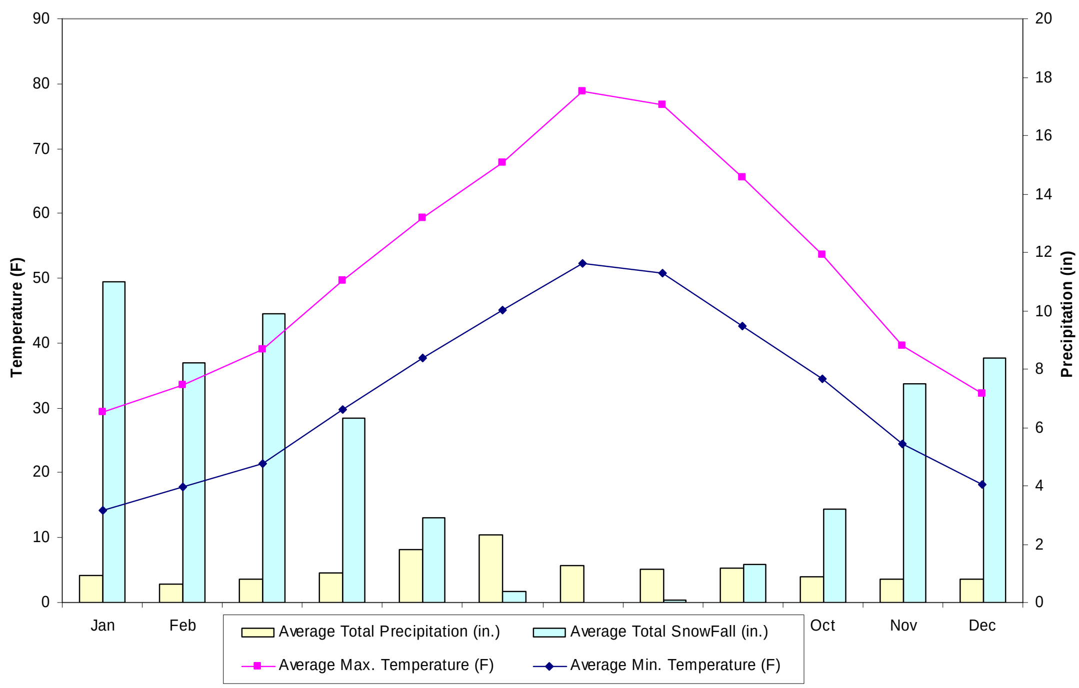


Figure 6-2: 30 year average climate statistics, East Anaconda weather station.

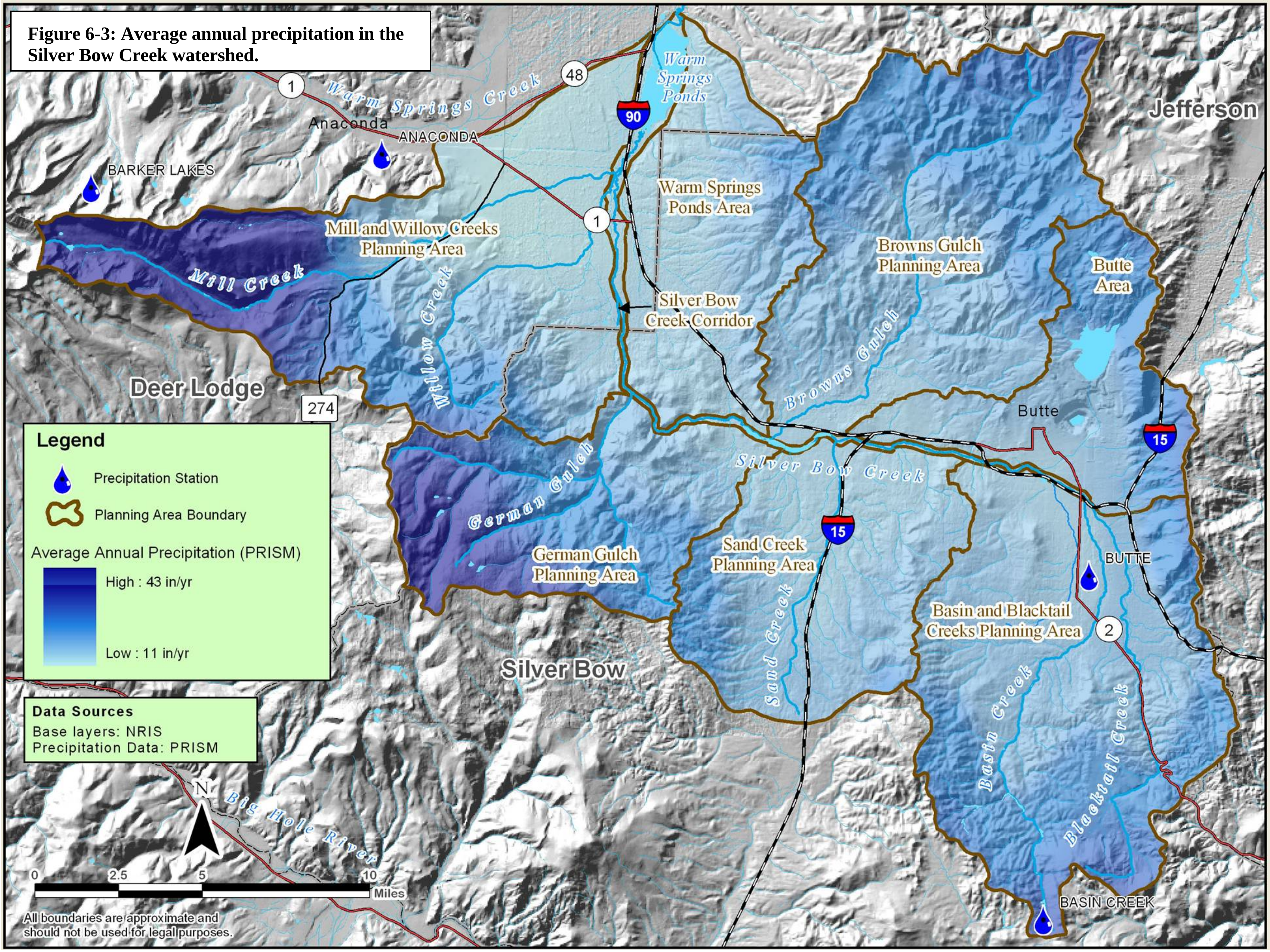


Figure 6-3: Average annual precipitation in the Silver Bow Creek watershed.
Warm Springs Creek
Anaconda
ANACONDA
BARKER LAKES
Warm Springs Ponds
Jefferson
Warm Springs Ponds Area
Mill and Willow Creeks Planning Area
Mill Creek
Willow Creek
Browns Gulch Planning Area
Butte Area
Silver Bow Creek Corridor
Browns Gulch
Deer Lodge
Butte
Legend
Precipitation Station
Planning Area Boundary
Average Annual Precipitation (PRISM)
High : 43 in/yr
Low : 11 in/yr
German Gulch
Silver Bow Creek
German Gulch Planning Area
Sand Creek Planning Area
Sand Creek
BUTTE
Basin and Blacktail Creeks Planning Area
Silver Bow
Data Sources
Base layers: NRIS
Precipitation Data: PRISM
Big Hole River
Basin Creek
Blacktail Creek
BASIN CREEK
0 2.5 5 10 Miles
All boundaries are approximate and should not be used for legal purposes.

6.3 Hydrology

The USGS has intermittently operated eight stream gages in the Silver Bow Creek watershed since the late 1950s (Figure 6-4, Table 6-2). The periods of record for these gages range from four to 28 years in duration. Mean daily flow data retrieved from these gage station records describe the typical magnitudes and patterns of watershed runoff within Silver Bow Creek and several of its major tributaries.

Table 6-2: USGS Gaging Stations located in the Silver Bow Creek watershed.

Site Name	*USGS Reference*	*Period of Record*
Silver Bow Cr above Blacktail Cr near Butte	12323170	10/1/83-9/30/94
Blacktail Cr near Butte	12323200	10/1/83- 9/30/88
Blacktail Cr at Butte (Basin Creek)	12323240	10/1/88-9/30/02
Silver Bow Cr. below Blacktail Cr at Butte	12323250	10/1/83-9/30/02
German Gulch	12323500	4/1/55-9/30/69
Silver Bow Cr. at Opportunity	12323600	7/1/88-9/30/02
Silver Bow Creek at Warm Springs	12323750	3/13/72-9/30/79 4/1/93-9/30/02
Clark Fork near Galen	12323800	7/1/88-9/30/02

6.3.1 Mean Annual Hydrographs

Recorded mean daily flows can be utilized to compute average monthly discharge for the period of record at each gage location. For the available periods of record, mean monthly discharges did not exceed 30 cfs (cubic feet per second) near, and upstream of Butte (Figure 6-4). In this area of the upper watershed, stream flows typically reach their maximum in May and June reflecting a dominance of spring runoff in overall sub-watershed hydrology. However, the mean monthly hydrographs of the upper watershed are relatively broad in shape, indicating that the rise in spring runoff volume is typically a relatively gradual event, and of relatively low magnitude. For example, on Silver Bow Creek below Blacktail Creek, the mean monthly spring runoff flows are approximately 50% higher than the low flow months of December and July. In contrast, further to the west, the contributing sub-watershed of German Gulch displays a more significant hydrologic influence with respect to spring runoff. Mean monthly discharges on lower German Gulch (Period of Record: 1956-1968) during May and June were approximately twelve times higher than in January, and the markedly steeper ascending and descending hydrograph limbs reflect rapid changes in flow volume between April and July.

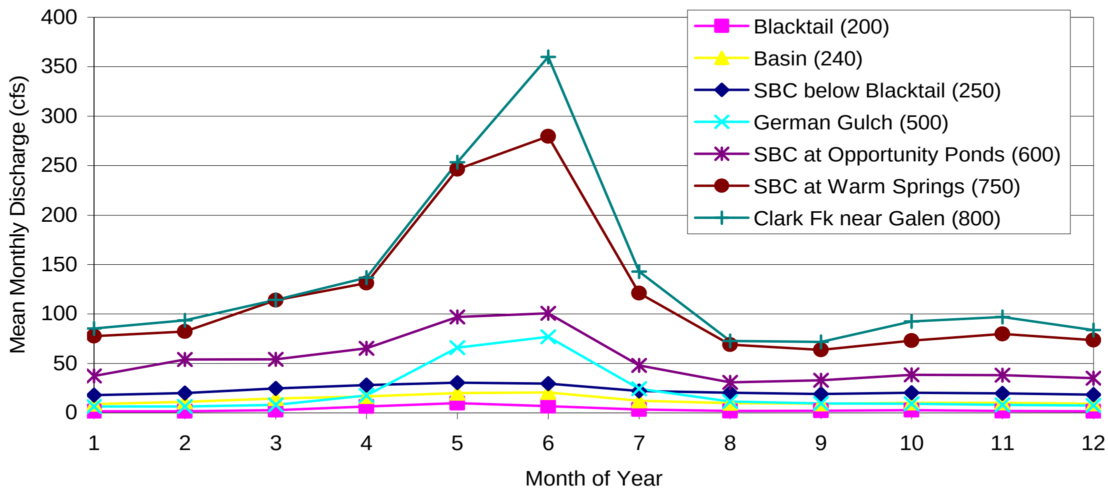


Figure 6-4: Discharge from stream gages in the Silver Bow Creek watershed.

Throughout the Silver Bow Creek watershed, annual peak water yields occur during the months of May and June due to a combination of precipitation and snowmelt runoff (Figure 6-4). Whereas the upper watershed tributaries of Basin and Blacktail creeks do not typically contribute a large influx of spring runoff, the downstream tributaries of German Gulch, Mill Creek, and Willow Creek do provide sustained increased flows during May and June. These average discharges decrease at all gages by July, reaching low flow conditions during August and September.

6.3.2 Recorded Peak Flows

Stream flow gages operated on Silver Bow Creek for a relatively short time. Consequently, Silver Bow Creek does not have a sufficient record of daily flows that accurately describe the basin's long-term flood history. Other historic records show that in June of 1908, the largest flood in recorded history in the Silver Bow Creek basin occurred, contributing to the extent of floodplain tailings found today. Heavy rains (8.12 inches) fell in late May and early June of 1908, melting the snow pack and causing extensive flooding (CH2M Hill, 1989). Floodwaters transported tailings from mining and smelting facilities in Butte and along Silver Bow Creek and deposited them downstream as floodwaters receded. Flood flows and fluvial deposits were physically constrained by railroad grades constructed parallel to Silver Bow Creek, limiting the extent of flood deposited tailings.

Other recorded significant storm events occurred in 1892, 1894, 1938, 1948, 1975, and 1980 (CH2M Hill, 1989). All of these events occurred during the spring and early summer when precipitation and melting snow combined to produce large runoffs. These events also contributed to the movement of mine wastes from their sources into the Silver Bow Creek floodplain.

Recent stream gage data show that over the past 15 years, the largest annual peak flow discharges recorded occurred sequentially during 1995, 1996, and 1997, when discharges peaked above 800 cfs on the Clark Fork at Galen (Figure 6-5). Prior to those events, gage data indicate a major flow event in excess of 1200 cfs occurred at the Silver Bow Creek at Warm Springs gage in 1975.

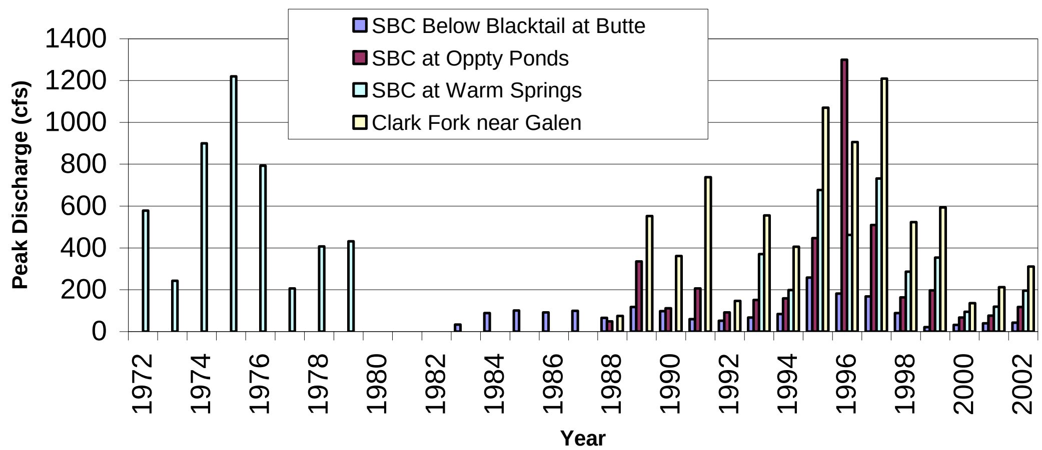


Figure 6-5: Measured annual peak discharges, Silver Bow Creek watershed.

6.3.3 Flood Frequency

The relatively short periods of record for stream gages in the Silver Bow Creek watershed have created challenges in the estimation of flood frequency in the system. The flood hydrology of Silver Bow Creek was quantified in several previous studies, and the results of those investigations vary with respect to the magnitudes and durations of specific flow events. Significant effort was expended determining design flows for reconstructed sections of Silver Bow Creek in Subarea 1 near Butte (CH2MHill, 1989; CCH, 1997, MEI, 1997). The hydrology developed by CH2M Hill in 1989 was based on results of a HEC-1 model (US Army Corps of Engineers), which estimates surface runoff for a given precipitation event. Clear Creek Hydrology (CCH) developed a continuous simulation hydrologic model (HSPF) to develop a synthetic flow record 96 years in length. From these modeling results, they estimated flood-frequencies. Mussetter Engineering, Inc. (MEI, 1997) performed a hydrologic analysis of mean daily flow data from the Silver Bow Creek below the Blacktail Creek stream gage (USGS Gage No. 12323250).

Table 6-3 shows the flood frequency analysis results from the three hydrologic evaluations performed on Silver Bow Creek (MEI, 1997). In general, the results indicate that the relatively frequent two-year discharge estimation is consistent regardless of method of computation, ranging from 200 cfs to 238 cfs, whereas the 100-year event estimations range from 422 cfs to 2330 cfs. The larger flows show a greater discrepancy due to the increased extrapolation required on the 14 years of available gage data. Instantaneous flow hydrographs utilized in the estimation of the two-year event (MEI, 1977), recorded three individual runoff events that ranged in peak magnitude from 237 to

274 cfs, and occurred over timeframes of one to approximately 10 hours. The estimated duration of a 230 cfs event at this gage, based on mean daily flow data, is approximately 0.02% of the time, or less than 2 hours per year.

Table 6-3: Peak flow estimates for Silver Bow Creek at Gage 12323250 (MEI, 1997).

	Peak Flow Estimate (cfs)			
Study	*2-Year*	*10-Year*	*50-Year*	*100-Year*
1979 FIS	---	683	997	1158
1989 CH2M Hill (HEC-1)	---	1270	---	2330
14 Years Gage Record, Bulletin 17b (MEI)	229	325	395	422
CCH HSPF Simulation	200	550	1250	1750
USGS Regional Regression Equations	238	610	1042	1282

6.3.4 Flow Duration and Minimum Flows

Mean daily stream flow data are useful for describing the timing, magnitude, and duration of minimum flow conditions at a given location. One way to assess typical low flow conditions is through an analysis of flow duration for a given stream gage record. Flow duration refers to the percent time that a given flow value is equaled or exceeded. A 100 percent duration flow reflects the flow equaled or exceeded 100% of the time, or the minimum flow value recorded at the gage. The 90% exceedence flows are those discharges that are equaled or exceeded, on average, 90% of the time, or 329 days per year. Typically, baseflows within Silver Bow Creek range from 14 cfs near Butte, to approximately 37 cfs at Warm Springs (Table 6-4). Baseflow refers to the average low flow volume of a given stream.

Flow duration values from multiple gage stations can be utilized to describe spatial variability in low flow conditions throughout a watershed. However, as the stream gage records for the Silver Bow Creek watershed do not necessarily overlap, the magnitude of the trends observed must be considered approximate. For example, flow duration analysis results indicate that downstream increases in Silver Bow Creek low flows do not increase commensurately with increasing drainage area. For example, between Butte and Opportunity Ponds, the contributing drainage area for Silver Bow Creek increases by almost 200%. Recorded mean daily flows that are equaled or exceeded 99% of the time increased only 8% over that channel distance, indicating that the relative contribution of base flows from contributing watershed areas of Sand Creek, Browns Gulch, and German Gulch is minor relative to headwater areas above Butte.

Table 6-4: Calculated flow duration discharges, Silver Bow Creek watershed.

*Gage**		*Percent of time discharge equaled or exceeded*						
		4%	*25%*	*50%*	*75%*	*90%*	*97%*	*99%*
		Discharge (cfs)						
12323170	Silver Bow Creek above Blacktail Cr at Butte	0.2	0	0	0	0	0	0
12323200	Blacktail Creek near Butte	14	4	2	1	1	0.3	0.1
12323240	Blacktail Cr at Butte (Basin Cr)	31	13	10	8	7	6	5
12323250	Silver Bow Creek below Blacktail	45	24	20	17	16	14	13
12323500	German Gulch near Ramsay	96	19	10	7	6	5	4
12323600	Silver Bow Creek at Opportunity Ponds	136	57	41	29	23	17	14
12323750	Silver Bow Creek at Warm Springs	374	136	82	56	37	25	20
12323800	Clark Fork near Galen	429	145	92	64	40	22	14

The recorded minimum 7-day flow for each gaging station shows that over a 7-day period, minimum flows range from approximately 5 cfs on Basin Creek to 25 cfs at Opportunity Ponds (Table 6-4). The minimum 7 day average flow on German Gulch during the 1956-1968 period of record was 6.5 cfs. The relatively small increase in minimum 7-day flows between Silver Bow Creek near Butte (Below Blacktail) and Opportunity Ponds further exhibits the lack of relative flow contribution from Browns Gulch and Sand Creek during dry periods.

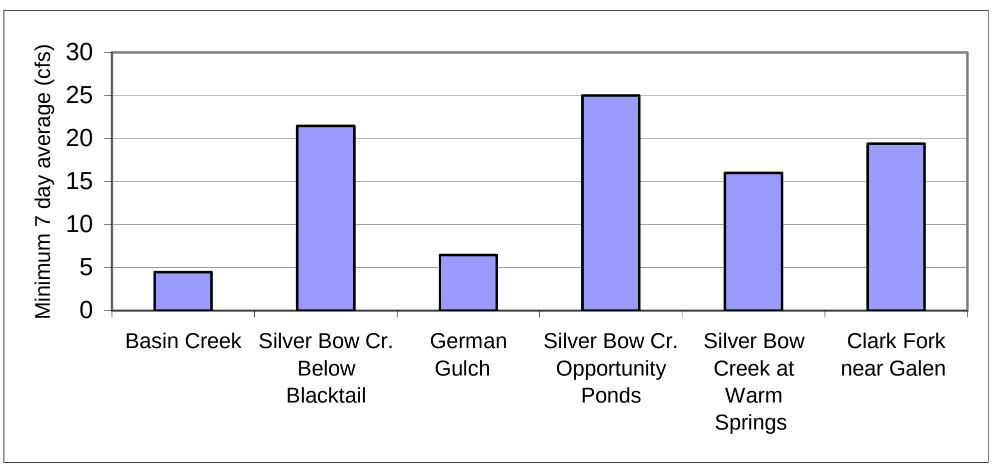


Figure 6-6 Minimum recorded 7-day average flows, Silver Bow Creek watershed.

6.3.5 Potential Flow Alterations

Several factors may affect the future hydrology of Silver Bow Creek. For example, the Horseshoe Bend Water Treatment Plant will treat water from Horseshoe Bend and the

Berkeley pit and may eventually discharge 10.85 cfs of treated water to Silver Bow Creek (Bertram and Chavez, 2002). Similarly, the PRPs for BPSOU may eventually augment flow in Silver Bow Creek flows to meet surface water quality standards. The amount of water used in flow augmentation is uncertain until the final ROD is issued for BPSOU. Another potential source of additional flow could come from increased wastewater treatment plant discharge because of growth of the City of Butte. The combined additional flows from BPSOU flow augmentation and City of Butte sewage discharges probably will not exceed the 52.7 cfs of water available in the Silver Lake pipeline. Consequently, the maximum potential flow increase could be as high as 63.55 cfs, although the actual amount is likely to be much less and may not occur for decades (Bertram and Chavez, 2002).

Presumably, the additional flows described above would be discharged somewhere near the City of Butte. This additional flow will have relatively little affect on the flood hydrology of Silver Bow Creek but will significantly increase base flows and more frequent flow events such as the 2-year bankfull flow. Presently, base flow in Silver Bow Creek near Butte is approximatley 14 cfs. If the maximum additional flow of 63.55 cfs is added to current base flows, the resulting baseflow could be 77.55 cfs, an increase of approximately 450%. This increase may profoundly affect the transport of fine sediment and coarse sands and may result in a coarsening of bed material. Depending on the composition of floodplain materials, this may also result in changes in channel geometry such as bank erosion and stream bed degradation (incision).

Increased base flow could greatly improve the ability of Silver Bow Creek to support trout populations by diluting contaminants, increasing residual pool volumes, creating greater depth of flow throughout the channel, removing or transporting fine sediment, and increasing bedload sorting to create spawining habitat. Increased base flows may also raise the water table and lead to transition toward more wetland vegetation in the floodplain.

Similarly, the potential maximum flow base flow addition would increase the frequency and duration of bankfull flows, currently estimated to be approximately 200 to 230 cfs. This change would cause the stream to scour its bed and banks more frequently and for longer periods. It is reasonsable to assume that a significant increase in bankfull flow frequency and duration would lead to enlarging the channel cross-section area, increase the capacity to transport fine sediments, and potentially result in lengthening of the stream through bendway (meander) migration.

It is important to note that these outcomes are based on theoretical maximum increases in base flow and that actual increases are likely to be significantly less. Nevertheless, this points to the importance of designing the restored Silver Bow Creek channel and floodplain using flexible, natural channel design concepts (as opposed to more rigid, traditional designs) that allow the system to adjust to changes in hydrology over time. The rate of channel change and the ability of the stream to adjust to these changes will largely depend on the magnitude of flow increases and the rate at which these increases occur. Rapid increases in flow may create unstable channel conditions. Consequently, any flow increases should be gradual to avoid exceeding the response time of the Silver Bow Creek channel and thereby maintain channel stability.

6.4 Geology

The geology of the Silver Bow Creek watershed is dominated by Cretaceous (70 million year old) granitic intrusive rocks of the Boulder batholith. These rocks make up approximately 36% of the watershed area and are the host to the rich ore deposits of the Butte area. Younger Tertiary (50 million year old) volcanic rocks are also abundant, making up almost 27% of the area and are found primarily in the Browns Gulch and Mill-Willow Creek sub-watershed. Tertiary sedimentary rocks of the Bozeman Formation are also abundant, mostly in the Sand Creek sub-watershed, and comprise about 13% of Silver Bow Creek watershed. Cretaceous, Paleozoic, and Proterozoic sedimentary rocks are all present in small amounts throughout the watershed. Quaternary (less than 1.6 million year old) alluvium, fan deposits, and glacial till cover approximately 16% of the watershed (Figure 6-7 and Figure 6-8).

The abundance of granitic rocks in the watershed is significant with respect to fisheries. Stream substrate formed from granitic rocks is typically fine grained (sand and silt) and does not contain a large proportion of gravel. This suggests that much of Silver Bow Creek prior to human disturbance may have been a passage reach to upstream or tributary spawning areas. The Sand Creek sub-watershed consists almost entirely of Teriary Bozeman Formation sedimentary rock. This formation forms well-drained soils that typically do not support much plant growth. Surface water in the Sand Creek sub-watershed quickly infiltrates into the subsurface, leaving Sand Creek as an intermittent stream. The Browns Gulch sub-watershed consists almost entirely of Cretaceous and Tertiary volcanic rocks. Based on limited flow information, Browns Gulch is also likely to lose surface flows to groundwater due to this geology.

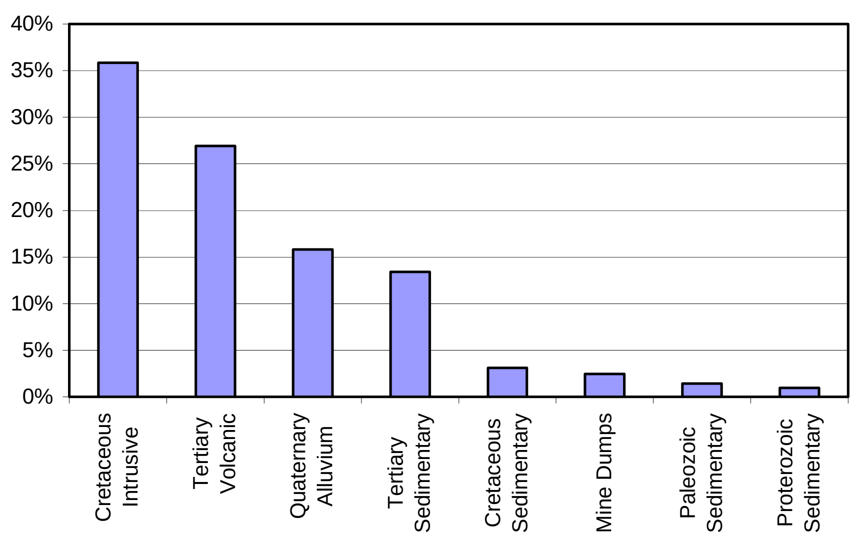
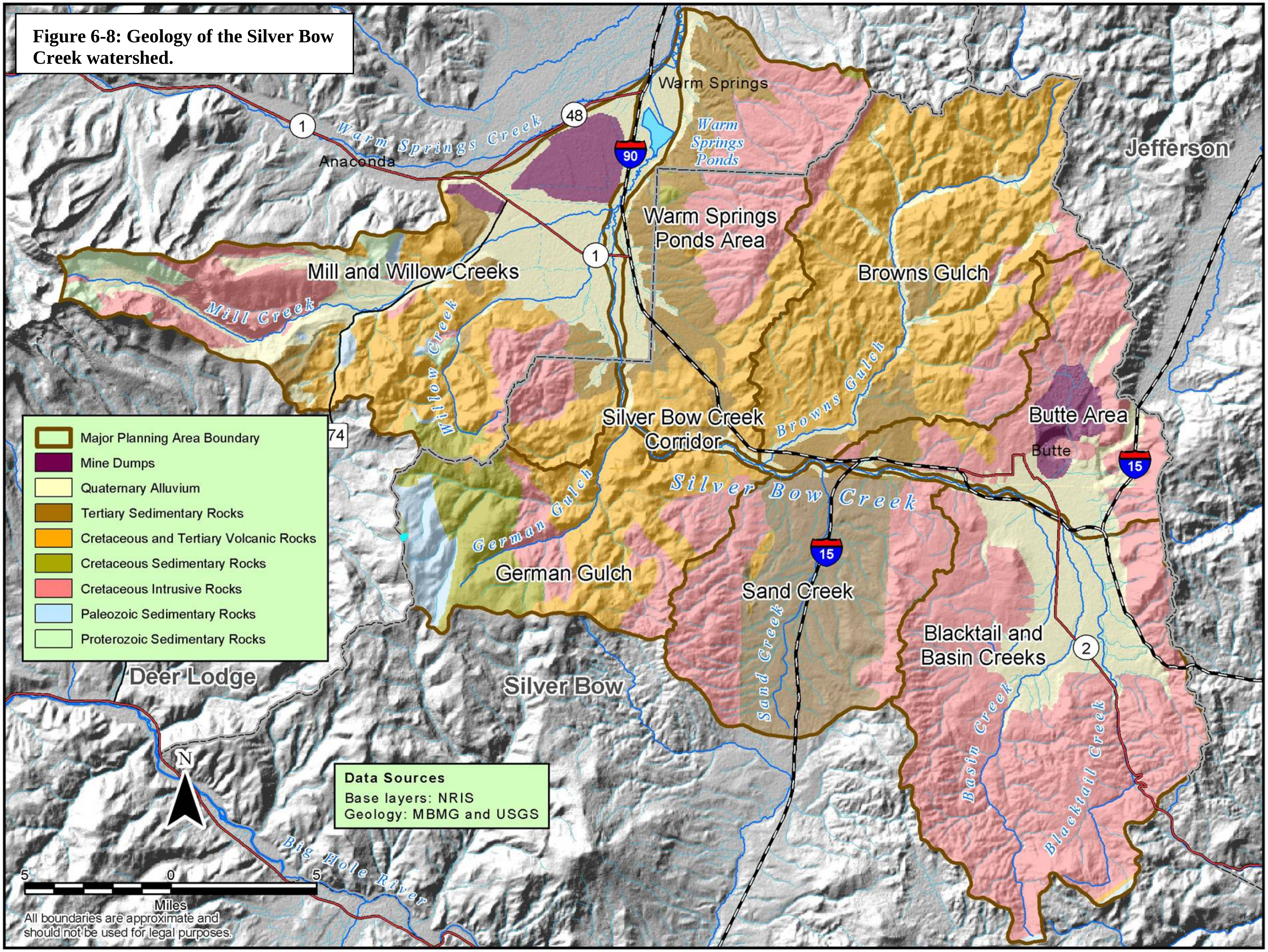


Figure 6-7: Distribution of rock types in the Silver Bow Creek watershed.

Figure 6-8: Geology of the Silver Bow Creek watershed.



6.5 Soils

An important factor influencing the productivity and potential of any ecosystem is the nature of its soils. For the Silver Bow Creek watershed, there are significant data gaps in current and baseline soil conditions prior to mining impacts. For example, the Natural Resource Conservation Service (NRCS) is typically a major source of soils information; however, NRCS soil survey information is not available for Silver Bow County. NRCS indicates these data may be available in 2005. In addition, pre-injury historical data regarding baseline soil conditions in the Silver Bow Creek do not exist.

The available soils information for the Silver Bow Creek watershed includes assessments of soils contaminated by tailings disposal and smelter fallout that record threats to human health and the environment in the Silver Bow Creek watershed. This section details available information on existing soil condition within the watershed, including impacted areas and areas selected for baseline comparisons. Specifically, we describe impacts to soil resources in alluvial locations within the floodplain of Silver Bow Creek, and the Mount Haggin, Stucky Ridge, and Smelter Hill upland locations (Figure 2-3).

6.5.1 Pre-Mining Soil Conditions

Mine tailings profoundly affect conditions of floodplain soils along the entire length of Silver Bow Creek. Since the release of hazardous substances began in late 19th century, before soils data were commonly collected, information describing baseline soil conditions is lacking. Nevertheless, several investigations attempted to predict soil characteristics prior to placement of tailings on the floodplain. Investigations in the Silver Bow Creek floodplain indicate that soils within the Silver Bow Creek floodplain originally developed on upland slopes under coniferous forest, or in valley-fill sediments under grasslands (CH2MHill, 1989). Using an external reference approach, NRDP (1995b) predicted baseline soil conditions based on soils along southwestern Montana streams with geomorphology and hydrology similar to Silver Bow Creek. These streams included Divide Creek, the Little Blackfoot River, and Flint Creek. Elevated concentrations of metals, however, eliminated Flint Creek as an appropriate reference. Mean metals concentrations of six composite samples from both Divide Creek and the Little Blackfoot River helped infer pre-settlement metals concentrations in Silver Bow Creek floodplain soils.

6.5.2 Phytotoxic Floodplain Soils

A principal effect of metals contamination of soils is phytotoxicity, which limits plant growth. Controlled laboratory tests have demonstrated the phytotoxicity of these soils, and the floodplain itself is almost entirely devoid of vegetation (NRDP, 1995b). The uppermost layer of sediment in the floodplain of Silver Bow Creek overlies the natural (pre-mining) floodplain. The natural floodplain contains dead vegetation partially buried by deposited tailings and tailings-contaminated alluvial material, evidencing relatively recent deposition of the upper sediment layer.

Composite soil samples from these barren “slicken” areas in the floodplain of Silver Bow Creek showed significantly higher concentrations of arsenic, zinc, copper, lead, and cadmium than baseline conditions (NRDP, 1995b). In addition, mill wastes deposited within the floodplain of Silver Bow Creek contain residual minerals often associated with metal oxides or pyrites. Specific bacteria found within waste tailings catalyze pyrite oxidation reactions, resulting in sulfuric acid generation and reductions in soil pH. During rain events, this leads to acidic runoff to surface waters and subsequent elevated pH and toxic dissolved metals concentration in Silver Bow Creek (NRDP, 1995b). In addition, due to weathering and other processes much of the tailings material exists as metal oxide complexes. Microbial reduction of these oxides may contribute to leaching of metals into groundwater.

6.5.3 Upland Soils Baseline Area

Due to the lack of information on pre-injury baseline conditions, NRDP defined soils in the German Gulch area, approximately six to ten miles south of the Anaconda smelter, as baseline conditions for comparison to injured upland areas (NRDP, 1995b). NRDP selected German Gulch as a baseline area for uplands conditions, based on proximity to impacted areas and similar elevation and aspect. Analysis of surface soils for total arsenic, cadmium, copper, lead, and zinc revealed average concentrations of these elements in excess of nationwide mean values. This indicates that aerial deposition of emissions from the Anaconda smelter affected soils in the German Gulch area, but not to a degree sufficient to meet the definitions for injured status. The Deer Lodge County soil survey mapped these areas as lightly impacted (NRCS, 2003). The relatively high concentration of metals in the German Gulch samples provides for conservative baseline values for other upland areas.

6.5.4 Injured Upland Soils

The NRDP documented areas of injured upland soils in both Deer Lodge and Silver Bow counties in locations near the Anaconda Smelter (Figure 6-9). These areas include the eastern portion of Stucky Ridge and the hills on the north side of Lost Creek Road (2,408 acres), portions of the Mount Haggin Wildlife Management Area east of the Mill Creek Highway (4,299 acres), and areas to the west and south of Smelter Hill (4,649 acres) (NRDP, 1995b). The NRDP defined injury for their assessment as:

- concentrations in the soil for hazardous substances sufficient to cause a phytotoxic response such as retardation of plant growth, or
- concentrations of hazardous substances sufficient to have caused injury as defined to surface water, groundwater, air or biological resources when exposed to the substances.

The primary source of hazardous substances to upland areas is emissions released from the Anaconda Smelter Stack. One type of evidence implicating smelter emissions is the location of metals contamination within the soil profile. Soils in the injured areas have elevated concentrations of arsenic, cadmium, copper, zinc, and lead, with highest concentrations in the upper two inches of the profile (NRDP, 1995b). This indicates that the source of hazardous materials is surficial rather than attributable to parent material. In addition, concentrations of all five hazardous substances decline exponentially with distance from the stack (NRDP, 1995b), a pattern indicative of point source contamination. Comparison of baseline soils and soils from injured areas revealed the following statistically significant differences:

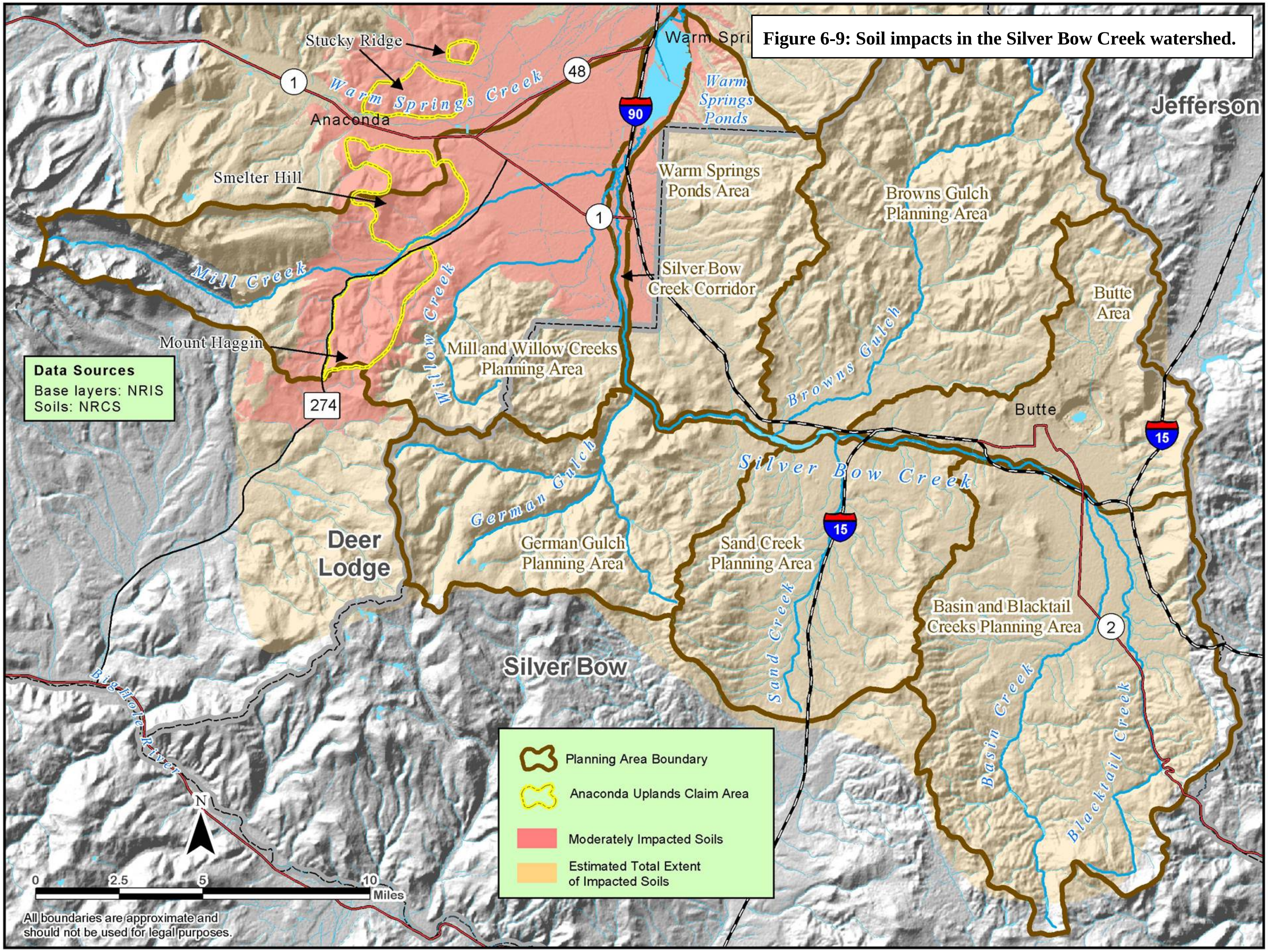


Figure 6-9: Soil impacts in the Silver Bow Creek watershed.
Stucky Ridge
Warm Springs Creek
Anaconda
Smelter Hill
Mill Creek
Mount Haggin
Willow Creek
Warm Springs
Warm Springs Ponds
Warm Springs Ponds Area
Silver Bow Creek Corridor
Mill and Willow Creeks Planning Area
Browns Gulch Planning Area
Browns Gulch
Butte Area
Butte
Jefferson
Silver Bow Creek
German Gulch
German Gulch Planning Area
Sand Creek Planning Area
Sand Creek
Basin and Blacktail Creeks Planning Area
Basin Creek
Blacktail Creek
Deer Lodge
Silver Bow
Big Hole River
Data Sources
Base layers: NRIS
Soils: NRCS
Planning Area Boundary
Anaconda Uplands Claim Area
Moderately Impacted Soils
Estimated Total Extent of Impacted Soils
0 2.5 5 10 Miles
All boundaries are approximate and should not be used for legal purposes.

- higher concentrations of arsenic, cadmium, copper, lead, and zinc occur in all upland impact area soils than in baseline (German Gulch) soils,
- higher concentrations of arsenic, copper, and zinc occur in Stucky Ridge area soils than in paired baseline soils,
- higher concentrations of arsenic, cadmium, copper, lead, and zinc occur in Smelter Hill area soils than in paired baseline soils,
- higher concentrations of arsenic, cadmium, copper, and lead occur in Mount Haggin area soils than in paired baseline soils, and
- higher percentage of organic matter occurring in control soils than in all upland impacted soils.

Other soil characteristics not likely influenced by smelter fall out (e.g. cation exchange capacity, concentrations of major nutrients, or particle size distribution) were similar between impacted soils and baseline conditions.

The extent of metals contamination of soils is considerable. Elevated metals concentrations are present on approximately 11,635 acres of land (NRDP, 1995b). Within this 18 square mile area, mean concentrations of hazardous materials are ten times background concentrations. In addition, the total area of exposed and contaminated soils is in the neighborhood 1,260 square miles. All these areas of contaminated soils serve as sources for recurring releases of hazardous substances through wind erosion and re-dxeposition in terrestrial locations, and through transport in surface runoff to aquatic resources.

In addition to NRDP information, the soil survey of Deer Lodge County (NRCS, 2003) mapped large areas in and around the Deer Lodge Valley impacted by past mining and smelting activities. The NRCS classified areas as severe, moderate, or slightly impacted based on the degree of impact from smelter emissions, land denudation, soil erosion, and metals deposition associated with past and present mining and smelting activities. In addition, observable plant community differences including percent bare ground and total canopy coverage of live vegetation helped determine the severity of impacts.

Lands mapped as severely impacted (NRCS, 2003) occur in both upland and alluvial settings. The resulting extensive erosion in many of these areas has led to the frequent loss of several layers of pre-impact soil horizons, often leaving only relic remains. Extreme soil loss has occasionally resulted in the loss of the entire soil horizon. Barren ground surfaces are common, as is substantial gully formation. Soils generally contain high levels of metal contaminants, though in severely eroded areas metals often transported to down slope locations. Accordingly, the entire native plant community is lost in many impacted areas with only relic portions remaining in isolated patches.

Areas mapped as moderately impacted (NRCS, 2003) have good ground cover with 50 to 100% canopy coverage of species generally palatable to livestock. Soil erosion has occurred in many locations, but the soil horizons are largely intact. High metal concentrations are present in upper layers of the horizon leading to decreased productivity. However, moderately impacted sites are in markedly better condition than severely degraded sites.

Slightly impacted soils generally support native assemblages of plants expected for the soil parent material, aspect and elevation conditions (NRCS, 2003). However, portions of the profile may possess significantly elevated concentrations of contaminants. Regional physiographic boundaries helped delineate areas of slight impact, as they likely acted as barriers to smelter emissions.

6.6 Fisheries

6.6.1 Species Composition

Fish communities in the Silver Bow Creek watershed include an assortment of native and introduced fishes typical of streams in western Montana (MFISH, 2003). Several members of the salmonid family (trout, char, whitefish, and salmon) reside in the basin. These include the native westslope cutthroat trout (*Oncorhynchus clarki lewisii*) and mountain whitefish (*Prosopium williamsoni*), and several species of introduced salmonids including rainbow trout (*O. mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*). Bull trout (*S. confluentus*), a federally threatened species, has probably been extirpated from the basin although there have been unsubstantiated reports of bull trout in the Willow Creek drainage. Other species found in the watershed include slimy sculpin (*Cottus cognatus*), longnose sucker (*Catostomus catostomus*), longnose dace (*Rhinichthys cataractae*), and the introduced central mudminnow (*Umbra limi)*.

The health of the fisheries in sub-watersheds varies across the basin. Toxic conditions have precluded fish from living in Silver Bow Creek for decades, although recent sampling found longnose sucker and slimy sculpin in reaches subjected to remediation (Spoon, 2004a). The tributaries support fisheries of variable biological integrity. Historic mining activities combined with other disturbances such as timber harvest, grazing, and road construction have also been a limiting factor on the basin’s fish populations. Nevertheless, many tributaries support valuable fisheries in terms of both recreation and native species conservation.

Persistence and conservation of native fishes, particularly westslope cutthroat trout, is of considerable concern in the Silver Bow Creek watershed. Native fish conservation is an identified management priority for Montana FWP and several stakeholder groups. Westslope cutthroat trout, a Montana species of special concern, occur in tributary streams throughout the watershed. For example, populations of westslope cutthroat trout (WCT) are present in the Basin and Blacktail creeks, German Gulch, Browns Gulch, and Mill and Willow creeks sub-watersheds (La Marr, 2003b). Agency fish biologists also suspect WCT inhabit the upper reaches of Willow Creek and possibly Mill Creek (Montana FWP, 2003). Genetic testing indicates variable purity between streams. Because WCT are sensitive to a variety of altered watershed conditions, the health of westslope cutthroat trout populations may serve as indicators of successful restoration to historical conditions. Consequently, recovery of WCT throughout the watershed may be considered an indication of successful, holistic restoration of the entire watershed.

The Warm Springs Ponds dam and the liming facility above the ponds, combined with poor water quality in Silver Bow Creek, currently protect the native fisheries by preventing brown and rainbow trout from migrating into upstream reaches of the watershed. The effectiveness of this liming facility as a migration barrier is questionable and may become entirely inadequate as water quality improves in Silver Bow Creek (Hadley, 2004). Consequently, a permanent fish barrier may need to be designed for Silver Bow Creek to prevent non-native trout in Warm Springs Ponds from becoming established in the watershed upstream of the barrier. Refer to Section 7.1.9 for more information pertinent to native trout restoration in the Silver Bow Creek watershed.

6.6.2 Metapopulation Dynamics

The presence of fragmented populations with connecting corridors suggests that a metapopulation dynamics approach is appropriate for restoration planning in the Silver Bow Creek watershed. A metapopulation is essentially a regional population consisting of semi-isolated local populations (Levins, 1969). These subpopulations are established by colonists, persist for a finite period, and eventually go extinct (Bengsston and Torbjorn, 1992). Extinct subpopulations are re-populated by surviving subpopulations in other parts of the watershed. Identification of existing populations, suitable habitat for various life history stages, and connectivity among subpopulations is important for westslope cutthroat trout conservation in the Silver Bow Creek watershed.

Toxic conditions in Silver Bow Creek have prevented migration and genetic mixing of fish populations between tributary sub-watersheds for decades. Even non-lethal concentrations of metals cause trout to exhibit avoidance behaviors, thereby preventing mixing of populations. For example, concentrations of zinc in Silver Bow Creek are high enough to cause trout to avoid these waters (Section 7.1.3). Successful restoration of fish populations in the Silver Bow Creek watershed will require reduced pollutant levels that not only prevent lethality, but also minimize avoidance behaviors in trout. This will allow migration and genetic exchange between fragmented populations of fish.

Due to the high level of impairment in the Silver Bow Creek watershed, a metapopulation conservation approach may also be appropriate for managing non-native fish species such as rainbow trout, brown trout, and brook trout in the Silver Bow Creek watershed. Non-native fish are similarly present in isolated tributary populations throughout the watershed and have a relatively high probability of local extinction due in part to the lack of connectivity, potential for toxic conditions, and natural environmental variables. Improving connectivity between these isolated populations will help ensure long-term survival of non-native fish populations. Note that some level of population isolation through construction of fish passage barriers is necessary to preserve native fish.

6.6.3 Habitat Suitability

Habitat Suitability

The Silver Bow Creek watershed contains all five categories of fish habitat described in Section 3.3.1 (La Marr, 2003b). The headwaters of German Gulch, and Basin Creek, and to a lesser extent Blacktail Creek, Browns Gulch, Willow Creek, and Mill Creek contain focal habitat for WCT. The precise locations of nodal and adjunct fish habitat in the Silver Bow Creek watershed are unknown. Critical contributing areas exist in the headwaters of all streams with known or potential nodal habitat and warrant protection from potentially detrimental land use impacts such as logging, mining, agriculture, or development. Finally, Silver Bow Creek, parts of Willow Creek and Mill Creek, and possibly local reaches of Basin Creek, Blacktail Creek, and Browns Gulch contain grubstake habitat.

Since the ultimate goal of the remedial and restoration actions is to improve Silver Bow Creek over time to a condition that supports a self-reproducing fishery for trout species, propagation of salmonids is important in the watershed. Substrate composition, another component of fluvial geomorphology, also influences achieving this goal. In order to provide spawning habitat, substrate particles must be small enough to be movable by female salmonids but not so small that they result in smothering or entombment of eggs or alevins. Salmonids can typically move particles up to 10% of their body length (Kondolf, 2000); therefore, the median particle size distribution should lie within 10% of the lengths of spawning females. Assuming a population of female salmonids ranging from 8 to 15 inches (200 mm to 381 mm), median particle sizes in pool tails should range between 20 mm and 38 mm in diameter.

Historical suitability of Silver Bow Creek for trout spawning is unknown. The granitic geology of the basin contributes significant amounts of relatively fine material, especially sand, to Silver Bow Creek. In time, it is likely that recruitment of native materials will result in a streambed dominated by fine-grained materials. This may make Silver Bow Creek unsuitable for trout spawning, especially bull trout, which are very sensitive to fine sediment. Presumably, most trout spawning will occur in tributaries of Silver Bow Creek where suitable-sized stream bed particles are more likely to exist. Consequently, recovery of fish populations in the Silver Bow Creek watershed will depend largely on recruitment of fish from tributary streams. This highlights the importance of streams such as German Gulch, Basin Creek, Blacktail Creek, Mill Creek, Willow Creek, and Browns Gulch as sources of trout for repopulation of Silver Bow Creek. The Silver Bow Creek corridor would provide rearing habitat for juvenile trout and holding water for adult fish, as well as providing connectivity between tributary streams. The importance of these tributary streams to the ability of Silver Bow Creek to support viable fish populations emphasizes the importance of a watershed level approach to planning.

6.7 Vegetation

Vegetation communities in the Silver Bow Creek watershed are important indicators of soil and geomorphic conditions and the riparian disturbance regime. The following data sources provided information on vegetation in the Silver Bow Creek watershed: historical accounts, USGS GAP data (Gap Analysis Program), USGS National Land Cover Database (NLCD), Montana Natural Heritage Program data, and NRDP injury assessment reports. GAP and NLCD data provided a coarse-scale vegetation overview, Natural Heritage Program data provided information on plant species of concern in the area, past reports provided information of soil conditions and detailed vegetation descriptions for certain areas, and historical accounts provide some limited information on pre-mining vegetation communities.

Vegetation communities respond to a number of ecological factors including, precipitation levels, elevation, aspect, and soil texture, depth, and composition. Smelter fallout or mine waste have made soils locally phytotoxic, and plant growth is either inhibited or prevented in these areas (see Section 6.5). In other areas, plants contain elevated levels of arsenic, cadmium, copper, lead, and zinc. Although copper and zinc are essential to plant growth in low concentrations and toxic at higher concentrations, arsenic, cadmium, and lead do not play a role in plant growth, and accumulation is toxic. The phytotoxic response of plant species varies according to metabolic processes, growth strategies, and chemical and enzymatic reactions. Some species can tolerate toxic metals concentrations by excluding or excreting hazardous substances, while others either die from the toxic concentrations, or are out-competed by more tolerant or resistant species. Phytotoxic symptoms can manifest as stunted growth, yellowing or discoloration of the leaves, tissue necrosis, withering, stunted root growth, and browning or death of the root meristem. Direct effects of phytotoxicity will occur almost immediately after exposure, while indirect effects disrupt biotic processes, such as growth and reproduction, which can manifest over a prolonged time (i.e. months or years). Upland and riparian vegetation can also be a source of contamination to wildlife because of their ability to uptake metals.

6.7.1 Upland Vegetation

The USGS GAP analysis indicates overall vegetation conditions in the Silver Bow Creek watershed are dominated by coniferous and deciduous forest, low to moderate cover grasslands, and sagebrush covering 42, 21, and 16 percent of the area, respectively. and Figure 6-11 illustrate the distribution of top 10 vegetation types (cover more than 1% of the study area) by sub-watershed.

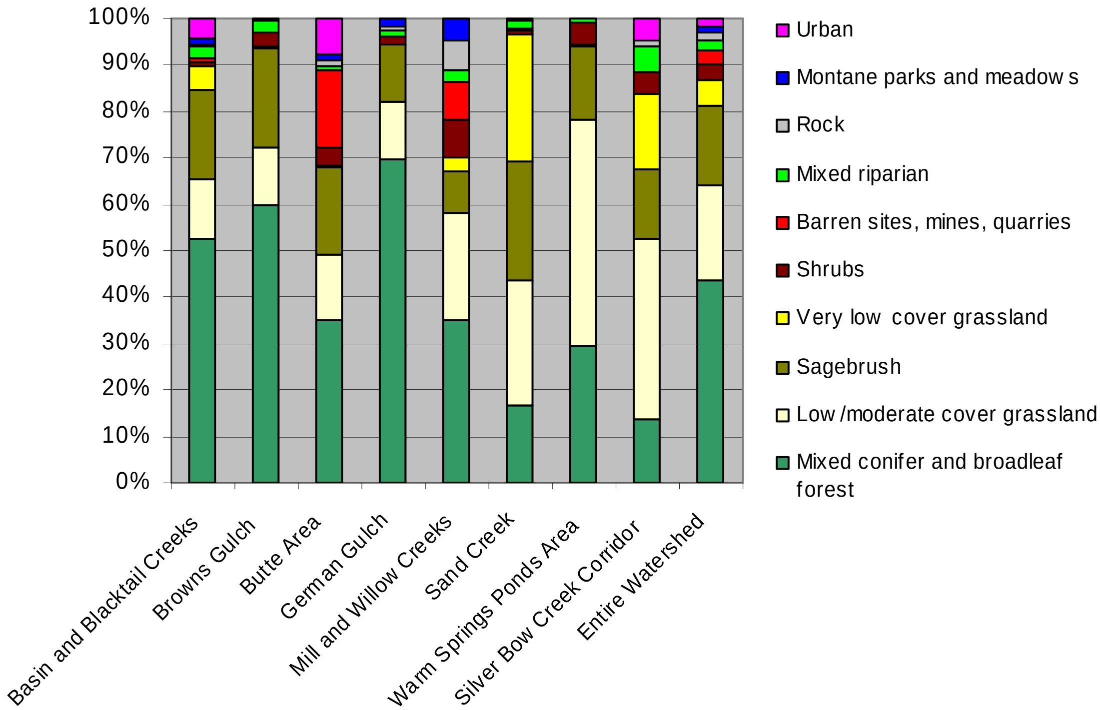


Figure 6-10: Distribution of major vegetation types (USGS GAP data).

The Sand Creek sub-watershed has the highest proportion of very low and low/moderate cover grasslands (55%), followed by the Warm Springs Ponds area sub-watershed (50%) and the Silver Bow Creek corridor (50%). In contrast, German Gulch, Browns Gulch, and Blacktail/Basin sub-watersheds are the most highly forested (69%, 60%, and 53%, respectively). In each of the sub-watersheds, riparian areas comprised relatively small components of the overall vegetation (between 0.6% and 1.9%). Xeric and mesic shrubs make up a relatively small component of the overall vegetation composition (3.3%), while sagebrush has a much greater presence, comprising approximately 16.5% of the Silver Bow Creek watershed area.

6.7.2 Riparian Vegetation

Riparian vegetation conditions are highly dependant upon the underlying soil composition (described in more detail in Section 6.5). Mine wastes released into Silver Bow Creek have rendered floodplain soils phytotoxic (NRDP, 1995b). This causes a virtual lack of riparian vegetation along Silver Bow Creek compared to reference streams. Riparian vegetation in southwest Montana is generally comprised of cottonwoods, willows, sedges, and rushes, species adapted to frequent disturbances and hydric or semi-hydric conditions. Although riparian areas are typically a small portion of the landscape, they support a diversity of wildlife. For example, 89% or terrestrial birds species in Montana use riparian areas during breeding season and 36% breed only in riparian areas (NRDP, 1995b). Analysis of the GAP vegetation data indicates that approximately 2.2% of the watershed is a combination of shrub, mixed, conifer, mixed broadleaf and conifer, broadleaf, and graminoid/forb riparian vegetation. Note that both the USGS GAP and NLCD vegetation data tend to underestimate small linear features such as streamside riparian vegetation.

6.7.3 Sensitive Plant Species

Montana Natural Heritage Program data indicate that Silver Bow and Deer Lodge Counties support 27 vascular plant species of concern. These species are at-risk or potentially at-risk due to rarity, restricted distribution, habitat loss, and/or other factors. Seven of these species are included as Bureau of Land Management Special Status and Watch species, and eight are included as U.S. Forest Service Sensitive and Watch species. None of these species are listed under the Endangered Species List; therefore, their presence does not require specific regulatory action. Table 6-5 lists the plant species of special concern, along with their status and habitat preference. The status column denotes global (range-wide) and state status rank ranging from one (critically imperiled) to five (demonstrably secure), reflecting the relative degree to which they are "at-risk." A number of factors are considered in assigning these ranks including the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat.

6.7.4 Wetlands

The U.S. Fish and Wildlife Service maintains a database of wetlands called the National Wetlands Inventory (NWI). At present, this inventory does not cover much of southwest Montana, including the Silver Bow Creek watershed. The best alternate data source concerning wetlands in the study area is the USGS National Land Cover Database (NLCD). This spatial database is a consistent coverage of general land cover types interpreted from 1992 Landsat satellite imagery and is similar to the USGS GAP vegetation analysis described previously. Analysis of the NLCD database indicates the presence of two wetland types, woody wetlands and emergent herbaceous wetlands, covering 0.72% of the watershed area (3.6 square miles). The woody wetlands occur along montane streams whereas emergent herbaceous wetlands occur near the valley bottoms, dominantly in and around Opportunity Ponds and the Mill/Willow Bypass. Note that both the USGS GAP and NLCD databases are derived from satellite imagery with coarse resolution (30 meters) and significantly underestimate small linear features such as wetlands and riparian vegetation.

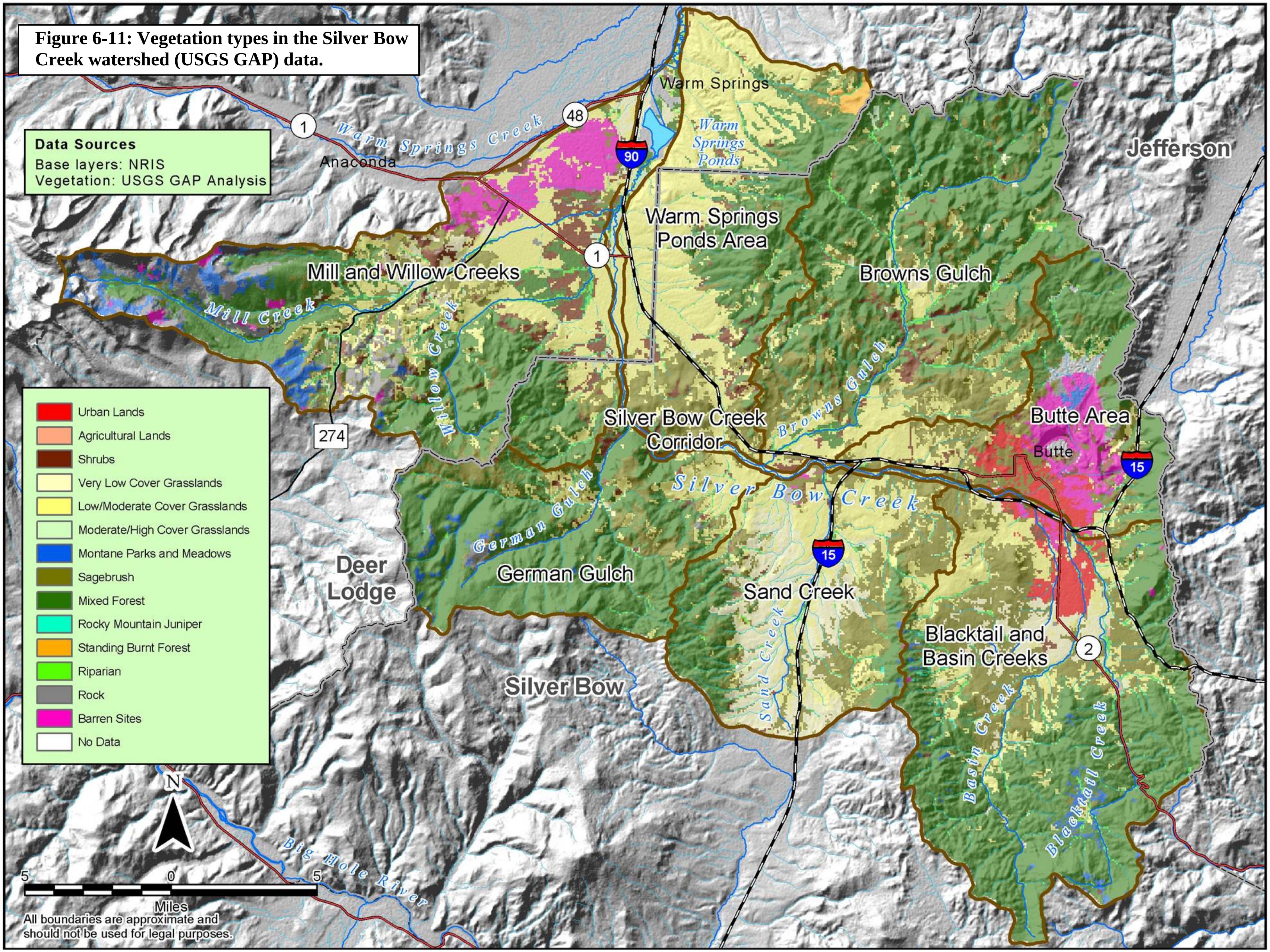


Figure 6-11: Vegetation types in the Silver Bow Creek watershed (USGS GAP) data.
Data Sources
Base layers: NRIS
Vegetation: USGS GAP Analysis
Urban Lands
Agricultural Lands
Shrubs
Very Low Cover Grasslands
Low/Moderate Cover Grasslands
Moderate/High Cover Grasslands
Montane Parks and Meadows
Sagebrush
Mixed Forest
Rocky Mountain Juniper
Standing Burnt Forest
Riparian
Rock
Barren Sites
No Data
Warm Springs
Warm Springs Creek
Anaconda
Warm Springs Ponds
Warm Springs Ponds Area
Mill and Willow Creeks
Mill Creek
Willow Creek
Browns Gulch
Jefferson
Butte Area
Butte
Silver Bow Creek Corridor
Silver Bow Creek
German Gulch
Deer Lodge
Sand Creek
Blacktail and Basin Creeks
Basin Creek
Blacktail Creek
Silver Bow
Big Hole River
N
5
0
5
Miles
All boundaries are approximate and should not be used for legal purposes.

Table 6-5: Sensitive plant species, Silver Bow and Deer Lodge Counties (MT Nat. Heritage Program).

Scientific Name	***Common Name***	***Status***	***Habitat***
Arabis fecunda	Sapphire rockcress	G2S2	Open, rocky slopes, foothills to montane, igneous substrate
Atriplex truncata	Wedge-leaved saltbush	G5S1	Alkaline soils, valley riparian areas
Botrychium hesperium	Western moonwart	G3S2	Lightly disturbed soils, grasslands, meadows
Botrychium paradoxum	Peculiar moonwart	G2S2	Mesic meadows, logdgepole and spruce forests, montane and subalpine
Carex idahoa	Idaho sedge	G2S2	Moist meadows, seeps, ponds, riparian areas, foothills to montane
Carex incurviformis var incurviformis	Maritime sedge	G4S1	Wet rock, alpine and moist tundra
Carex norvegica ssp stevenii	Steven's Scandinavian sedge	G5S1	Montane grasslands
Castilleja exilis	Annual Indian paintbrush	G5S2	Moist alkaline meadows, valleys
Draba densifolia	Dense-leaved draba	G5S2	Gravelly, rocky slopes, montane to subalpine
Draba fladnizensis var fladnizensis	White Arctic draba	G4S1	Alpine, rocky soil
Erigeron formosissimus var viscidus	Beautiful fleabane	G5S1	Meadows, open forest, montane to subalpine
Erigeron linearis	Linear-leaf fleabane	G5S1	Dry, rocky soil, sagebrush, grasslands, valleys to lower montane
Haplopappus pygmaeus	Pygmy goldenweed	G4SH	Alpine slopes, meadows
Juncus acuminatus	Tapered rush	G5S1	Wetland obligate, margins of ponds and marshes
Juncus hallii	Hall's rush	G4S2	Moist to dry meadows, valley to montane
Lewisia pygmaea var nevadensis	Nevada bitterroot	G4S1	Moist meadows, open forest, montane to subalpine
Penstemon lemhiensis	Lemhi beardtongue	G3S2	Sagebrush and woodland slopes, foothills to lower montane
Polystichum kruckebergii	Kruckeberg's sword fern	G4S1	Cliffs, talus slopes, montane to alpine
Primula incana	Mealy primrose	G4S2	Alkaline meadows, valleys, foothills
Ranunculus hyperboreus	High-arctic buttercup	G5S1	Wetland obligate, ponds and riparian areas, montane
Ranunculus verecundus	Timberline buttercup	G5S2	Gravelly meadows and ridges, alpine
Ribes triste	Swamp red currant	G5S1	Wetland obligate, montane to subalpine
Saxifraga tempestiva	Storm saxifrage	G2S2	Moist meadows, rock ledges, subalpine to alpine
Selaginella selaginoides	Low spike-moss	G5S2	Wet, mossy soil, montane/subalpine
Stellaria crassifolia	Fleshy stitchwort	G5S1	Moist to wet meadows, riparian, foothills to alpine
Thalictrum alpinum	Alpine meadowrue	G5S2	Moist alkaline meadows, valley to montane
Thalspi parviflorum	Small-flowered pennycress	G3S2	Moist to dry meadows, montane to subalpine

6.7.5 Noxious Weeds

Noxious weeds have been identified as a significant problem in the Silver Bow Creek watershed. During the public involvement process numerous groups and individuals expressed concern with respect to noxious weeds within the watershed. Important observations and comments included:

- numerous areas were identified as having noxious weed infestations,
- weed management needs to be an integral part of restoration,
- smelter fallout in the Deer Lodge valley is believed to have exacerbated weed infestations,
- increased access (trails) has the potential to spread weeds,
- weed spraying has only had a temporary effect,
- some private lands have responded well to aggressive weed management combined with managed livestock grazing,
- subdivisions contribute to the weed problems, and
- current institutional weed management programs are inadequate.

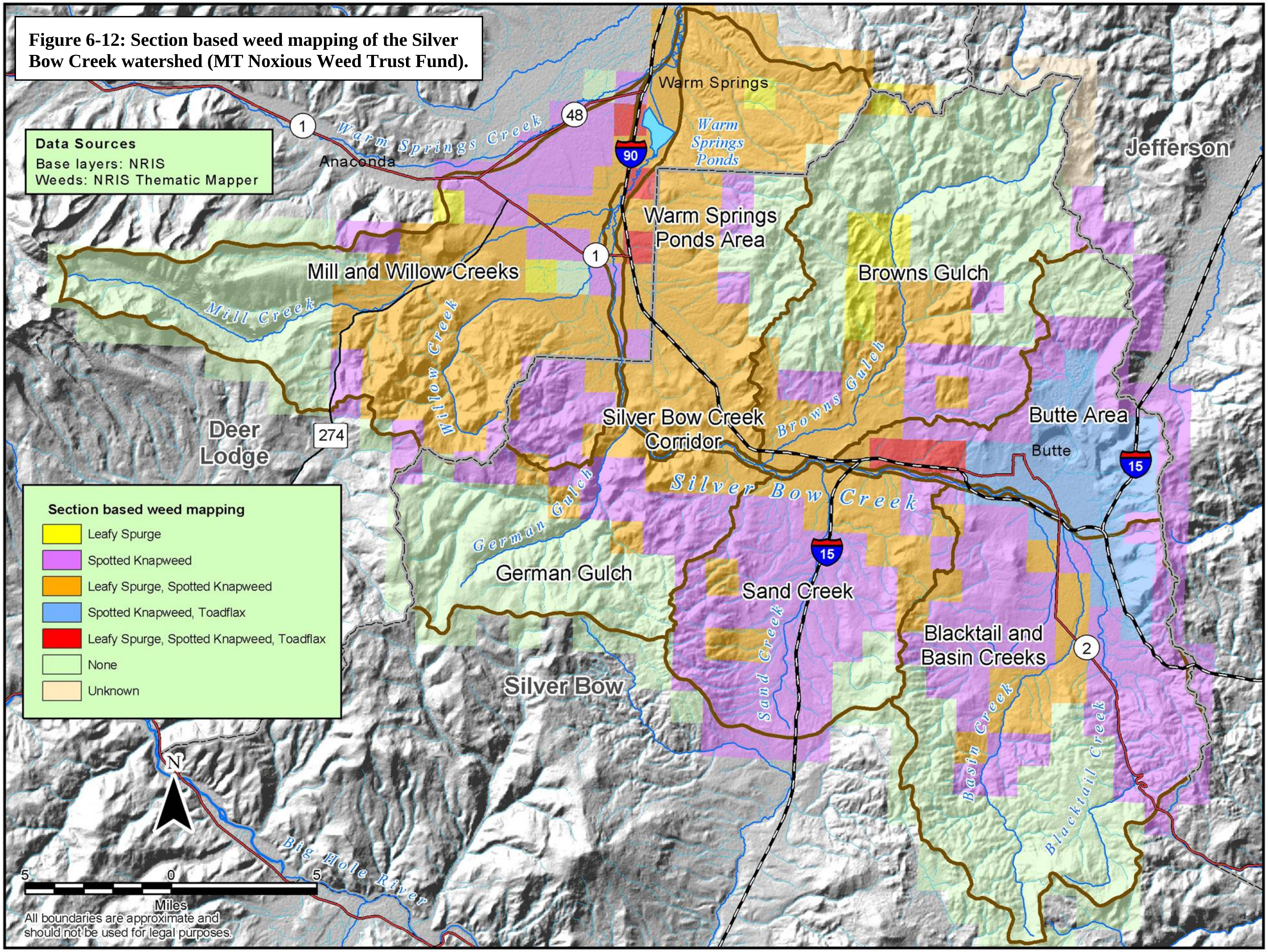
In 1997, the Montana Noxious Weed Trust Fund undertook a statewide inventory of five noxious weed varieties, leafy spurge, spotted knapweed, Russian knapweed, dalmatian toadflax, and sulfur cinquefoil. This resulted in the development of a section (1 square mile) based database of weed presence, absence, or status unknown. This dataset is only suitable for identifying general areas of weed infestation (Figure 6-12). Table 6-6 summarizes the section-based data by percent area of the various weeds and weed combinations. Note that this data set is simply a presence or absence rating and does not record weed density. In addition, weed mapping conducted by the Beaverhead-Deerlodge National Forest (described below) identified weed infestations in some areas listed as absent of weeds in the section based mapping.

Table 6-6: Weed infestation summary for the Silver Bow Creek watershed (MT Noxious Weed Trust Fund Data).

Weed(s)	*Percent of Sections with Weed Presence*
Leafy Spurge	1.8
Spotted Knapweed	29.5
Leafy Spurge and Spotted Knapweed	28.4
Spotted Knapweed and Dalmatian Toadflax	4.8
Leafy Spurge, Spotted Knapweed, and Dalmatian Toadflax	1.1
None	33.3
Unknown	1.1

The Butte-Silver Bow County weed district also conducted local detailed weed mapping and the Butte-Silver Bow GIS department provided GIS coverages of these data for analysis. These data indicate the presence of significant spotted knapweed infestations in the Warm Spring Ponds area and Sand Creek sub-watersheds as well as along the lower reaches of Basin Creek and an area just east of the junction of I-15 and I-90. Smaller leafy spurge infestations are recorded in the Warm Springs Ponds area sub-watershed and the lower reaches of Basin Creek. Houndstongue was mapped in the Sand Creek sub-watershed and numerous small infestations of leafy spurge and spotted knapweed were mapped throughout the Silver Bow Creek watershed.

Figure 6-12: Section based weed mapping of the Silver Bow Creek watershed (MT Noxious Weed Trust Fund).



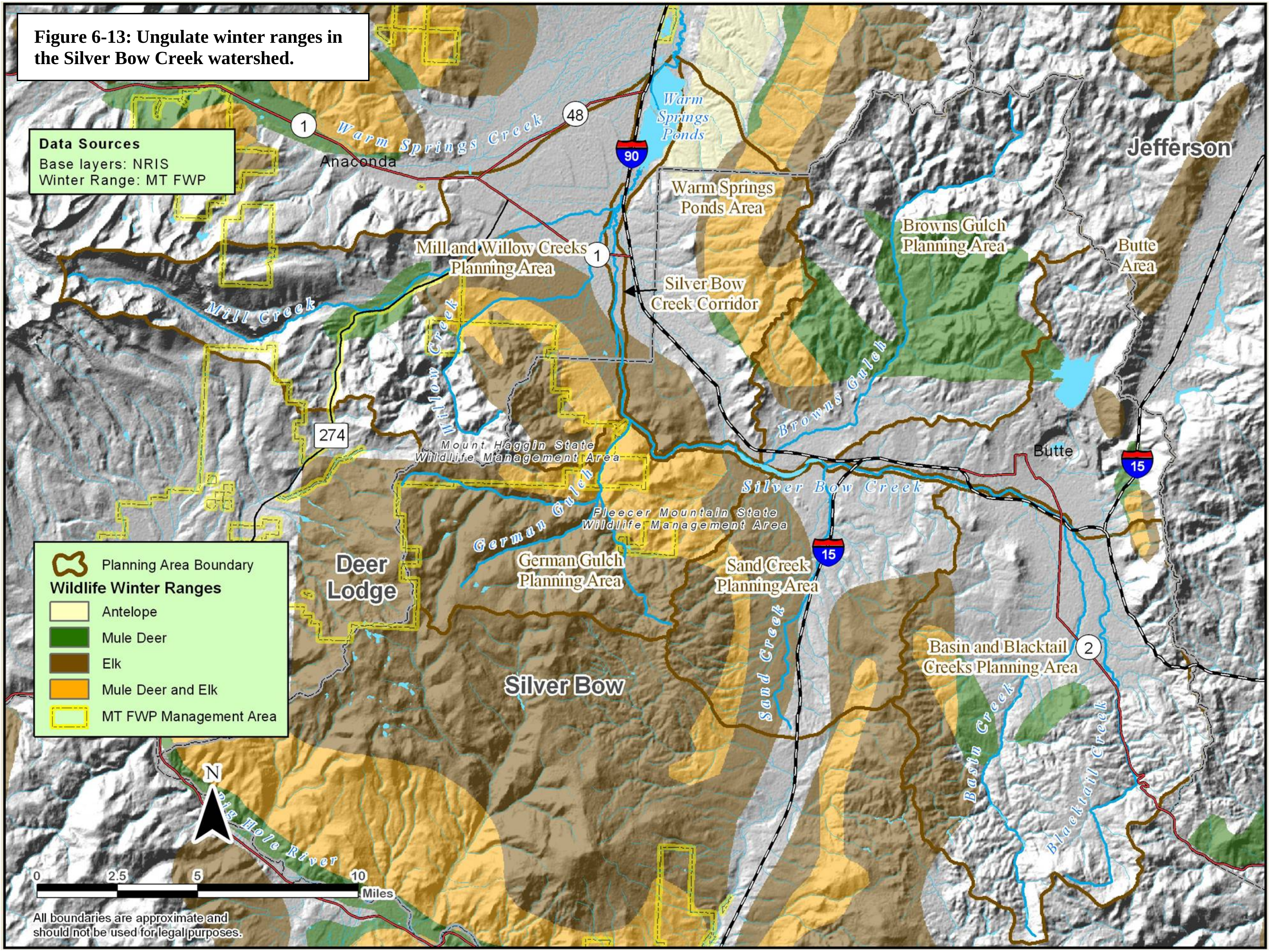
The Beaverhead-Deerlodge National Forest mapped weed infestations over a large area including parts of the Silver Bow Creek watershed. Although not comprehensive, this inventory identifies significant spotted knapweed infestations in the Browns Gulch, Blacktail and Basin Creeks, German Gulch, Sand Creek, Warm Springs Ponds Area, and Butte Area sub-watersheds in decreasing order of severity. The inventory mapped leafy spurge infestations in the Browns Gulch, Warm Springs Ponds Area, German Gulch, Sand Creek, and Basin and Blacktail creeks sub-watersheds, also in decreasing order of severity. Ground or aerial spraying, biologic actions, or mechanical means helped deter weeds in these areas. The Beaverhead-Deerlodge National Forest recently released a proposed action for a Forest Plan Revision (Beaverhead-Deerlodge National Forest, 2003a) as a preliminary part of the EIS required for a comprehensive revision of their forest plan. This document identifies the need for a vegetation management program that integrates noxious weed management rather than addressing weeds as part of a range program. Objectives listed to meet this need include managing weeds and other pests by an integrated pest management approach. This includes prevention, early detection, diagnosis, and treatment of pest organisms in cooperation with other agencies and organizations to control or eradicate invasive species. For additional information, refer to Beaverhead-Deerlodge National Forest, 2003a.

6.8 Wildlife

The Silver Bow Creek watershed contains areas with degraded wildlife habitat and reduced populations, particularly in the Anaconda upland and Silver Bow Creek floodplain corridor areas. However, other areas of the watershed are rich in quality wildlife habitat and support good populations of big game and other wildlife species. The watershed includes the Mount Haggin and Fleecer Mountain Wildlife Management Areas (WMA), managed by Montana FWP. The Mount Haggin WMA is the largest state administered area of this type. Statewide Montana FWP ungulate (antelope, deer, elk) distribution data show the general distribution of ungulate winter range in the Silver Bow Creek watershed (Figure 6-13). Data from Montana FWP winter aerial surveys also indicates a strong presence of ungulates in the same general areas as those depicted by the statewide data (Montana FWP, 2004 and Appendix E). Montana FWP statewide wildlife distribution data also show significant habitat present for moose, mountain goat, several species of grouse, Hungarian partridge, and turkey in the Silver Bow Creek watershed.

Nevertheless, hazardous substance injury, especially in more contaminated areas such as the Silver Bow Creek corridor, Butte Hill, and uplands affected by significant smelter fallout, has reduced wildlife populations. For example, disruption in stands of riparian vegetation along Silver Bow Creek reduces nesting and foraging habitat available to riparian obligate songbirds such as the yellow warbler, northern waterthrush, and American redstart. Other wildlife affected by release of hazardous substances include big game species such as whitetail and mule deer and moose; semi-aquatic furbearers such as otter, mink, and raccoon; waterfowl, and non-game species such as raptors, reptiles, and amphibians. In addition to hazardous substances impacts, critical elk and deer winter ranges along public/private land boundaries are at risk from development pressures.

Figure 6-13: Ungulate winter ranges in the Silver Bow Creek watershed.



As these areas develop, wintering wildlife become urban concerns, and pose additional problems for agency resource managers.

6.9 Land Ownership

Land in the Silver Bow Creek watershed is primarily privately owned (62%), followed by the USFS (28%), Montana Fish Wildlife and Parks (8%), and other state lands (1.8%). State ownership will likely increase slightly in the near future as the state purchases land in the SSTOU. Figure 6-14 summarizes land ownership by sub-watershed and Figure 6-15 illustrates the distribution of ownership throughout the basin.

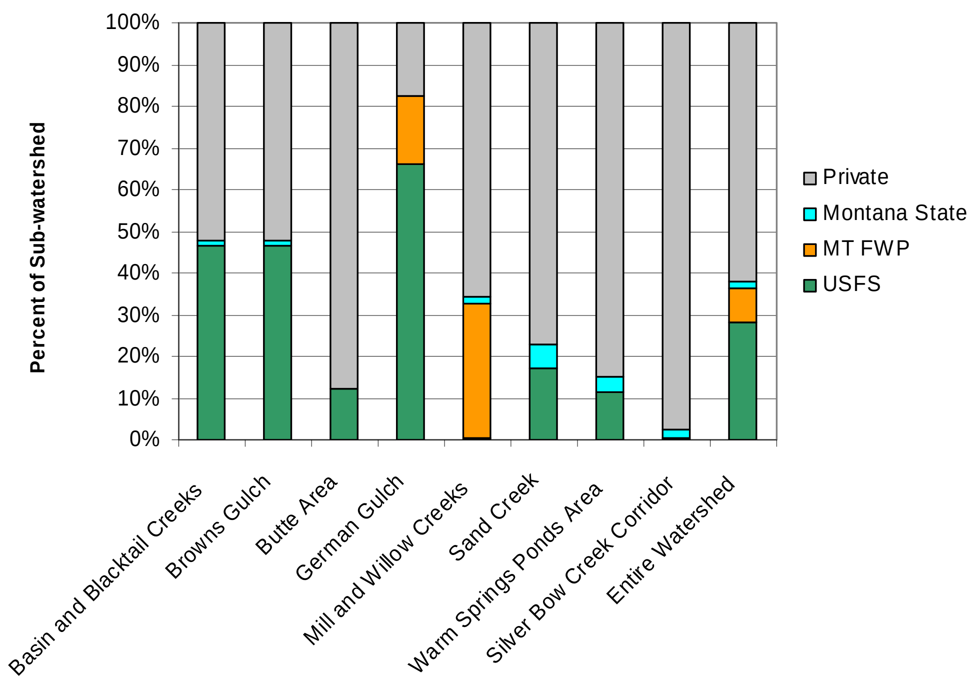


Figure 6-14: Land ownership by sub-watershed.

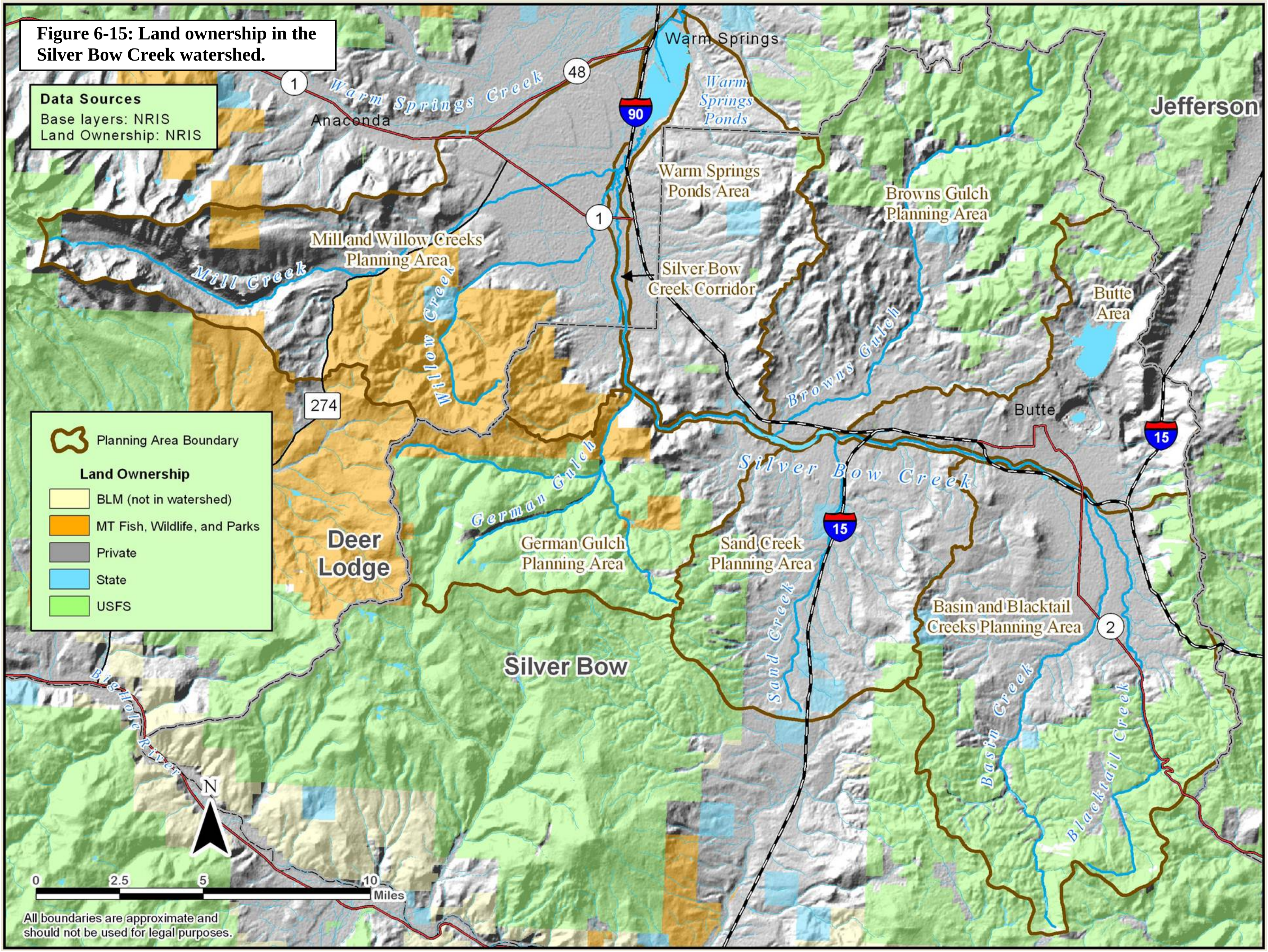
6.10 Land Use

The Silver Bow Creek watershed supports a variety of land uses including mining, agriculture, timber harvest, recreation, and municipal and industrial development.

A good available data source for evaluating the spatial distribution of land use is the USGS National Land Cover Dataset (NLCD, Figure 6-16). The NLCD illustrates several cover types that represent particular land uses. Table 6-7 lists the major cover types, associated land uses, and percent of watershed area consisting of these land cover types.

The majority of land cover in the watershed is grasslands (40%) followed by forest (38.7%) and shrubland (14%). Mining and related activities disturbed approximately 2.5% of the watershed area (7928 acres) whereas all other human disturbances such as transportation infrastructure and residential areas cover 1.8% of the watershed area (5370 acres).

Figure 6-15: Land ownership in the Silver Bow Creek watershed.



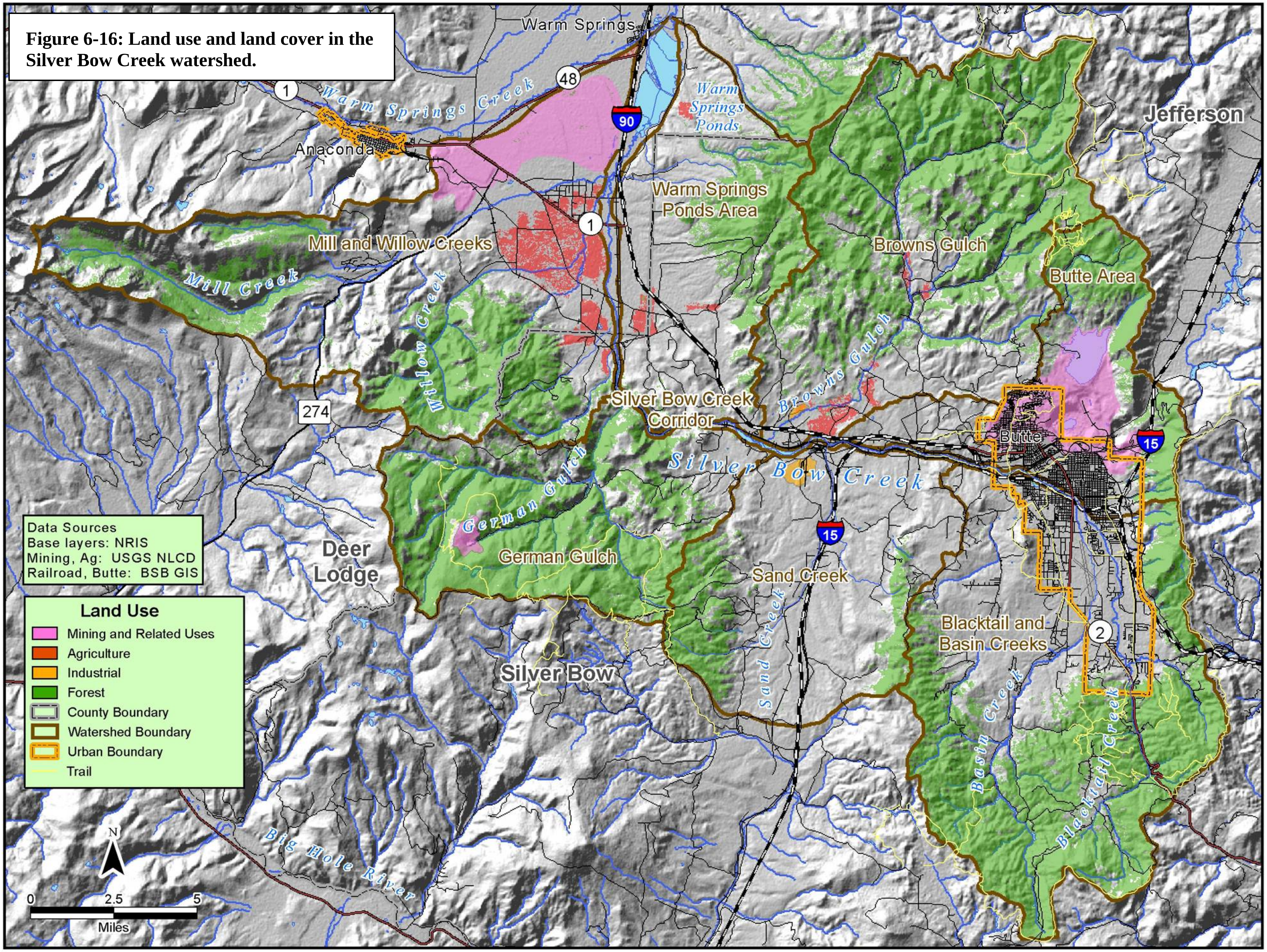


Figure 6-16: Land use and land cover in the Silver Bow Creek watershed.

Table 6-7: Cover types that correlate with land use in the Silver Bow Creek watershed.

NLCD Cover Type	*Land Use*	*Percent of Watershed*
Urban/Commercial/Transportation	Urban	1.3
Mines/Quarries	Mining	2.5
Forest	Undetermined	38.7
Shrubland	Undetermined	14.0
Grassland	Undetermined	40.1
Pasture/Hay	Agriculture	1.5
Crops	Agriculture	0.2
Recreational Grasses	Suburban	0.2
Wetlands	Undetermined	0.7

6.11 Water Quality

Water quality is severely impaired in the Silver Bow Creek watershed where mining related disturbances are significant. Other water quality impairments include nutrients from wastewater treatment plants and residential septic systems, and locally, siltation and thermal impairments. Chapter 7.0 describes the extent and nature of these impairments in each planning area.

6.11.1 Sources of Water Quality Impairment

Several sources of water quality impairment exist in the Silver Bow Creek watershed and include both point source and non-point source pollutants. Abundant water quality data exist for Silver Bow Creek due to inclusion on the Superfund National Priority List. Most of this information pertains to metals contamination resulting from decades of mining related activities. Water quality data on tributary streams is lacking however, perhaps due to the perception that mining impacts have irreparably damaged the Silver Bow Creek watershed, lowering the priority of this area for land managers and citizens. Subsections of Chapter 7.0 contain detailed information on water quality for each of the eight planning areas.

Point Sources

While non-point sources of metals pollution are the focus of remediation and restoration activities in the Silver Bow Creek watershed, there are several point sources of pollution that also have the potential to limit water quality. Point sources differ from non-point sources in that pollution originates from a discrete location as opposed to diffuse sources. The Administrative Rules of Montana (17.30.1304[14]) defines point sources as “any discernable, confined, or discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft, from which pollutants are or may be discharged.” The Montana DEQ regulates point sources, which require a Montana Pollution Discharge Elimination System (MPDES) permit. The goal of the MPDES program is to control point source discharges of wastewater so that water quality in the receiving streams meets water quality standards.

Currently, there are six facilities in the Silver Bow Creek watershed with MPDES permits pending or waiting for renewal (Table 6-8). These include municipal wastewater treatment plants for the cities of Butte and Rocker and several industrial discharges. These facilities discharge directly into Silver Bow Creek with the exception of the proposed Continental Energy Service, Inc. facility that will have three outfalls, one directly to Silver Bow Creek, one indirectly to Silver Bow Creek through Sheep Gulch, and one outfall to groundwater. In addition to discharge to surface waters, the permit issued to the Butte-Silver Bow wastewater treatment plant allows for land application of produced sludge. The Montana DEQ has a MPDES permit for three discharges and associated mixing zones related to contamination problems and associated reclamation activities at the Beal Mine.

For outfalls to surface or groundwater, MPDES permits designate a mixing zone. A mixing zone is a limited area of surface water or aquifer where initial dilution of a discharge occurs. Within the designated mixing zone, water quality conditions may not meet state standards, although conditions resulting in acute toxicity are not permitted. Most of the permits in the Silver Bow Creek watershed require an instantaneous mixing zone. This is the standard mixing zone and by definition, instantaneous mixing occurs within two stream widths downstream of the discharge location (ARM 17.30.502[7]). The prescribed mixing zone for the Rocker Water and Sewer District is the exception to the standard mixing zone. This permit allows a one-mile mixing zone from the outfall. Accordingly, water quality in Silver Bow Creek does not have to meet state standards from this discharge point to one mile downstream from where Interstate 15 crosses Silver Bow Creek.

The classification of Silver Bow Creek as an “I” or impaired water influences MPDES permitting requirements. According to the Administrative Rules of Montana, waters classified as “I” do not currently support any beneficial uses and non-degradation requirements are not applicable to Silver Bow Creek (see Section 4.3.3 for more information). Still, the goal of the State of Montana is to have these waters fully supporting beneficial uses. When the classification of Silver Bow Creek is upgraded from an “I” classification, permit effluent limits will need to be modified to meet the applicable water quality standards. Through the TMDL planning efforts to be completed by 2007 (see Section 6.11.2), it is likely that classification of Silver Bow Creek will require modification.

Table 6-8: Significant permitted point source discharges in the Silver Bow Creek watershed.

Point Source	***Expiration Date***	***Length of Mixing Zone***	***Type of Facility***	***Parameters with Wastewater Effluent Limitations***
Rocker Water and Sewer District (Silver Bow Creek corridor)	3/31/2000	1 mile	Domestic wastewater treatment	BOD_5[3] TSS Total phosphorus as P Total nitrogen as N Fecal coliform bacteria
Butte WWTP (Silver Bow Creek corridor)	10/31/2000	Instantaneous	Domestic wastewater treatment	BOD_5 Total suspended solids (TSS) Total phosphorus as P Total nitrogen as N Fecal coliform bacteria
Advanced Silicon Materials, Inc. (Silver Bow Creek corridor and Sand Creek)	8/31/2002	Instantaneous	Polycrystalline silicon purification	BOD_5 Diesel Range Organics – Total Extractable Hydrocarbons Fluoride Nitrate +Nitrite as N Oil & Grease Total Recoverable Metals (As, Cd, Cu, Fe, Pb, Zn) Total Residual Oxidant as Chlorine Total suspended solids
Continental Energy Services, Inc. (Silver Bow Creek corridor and Sand Creek)	Pending issuance	Instantaneous	Natural gas fired electric generating station	Total recoverable metals (all) TSS Oil & grease Total residual chlorine Free available chlorine Temperature
Montana Resources (Butte Area)	10/2002	Instantaneous	1,200 acre tailings impound-ment	TSS Total recoverable metals (As, Cd, Cu, Fe, Pb, Hg, Ag, Zn)
Motana DEQ	11/30/07	3.5 miles	3 discharge points: from drains , springs, and land application areas at the Beal Mine facility	Nitrate +Nitrite as N Ammonia (as N) Total Recoverable Metals (Cu, Se, Zn) Total cyanide Arsenic, dissolved

Non-Point Sources

There are a number of types of non-point source pollution in the Silver Bow Creek watershed. According to the Administrative Rules of Montana (ARM 17.30.602[18]), non-point source pollution is defined as a "source of pollution which originates from diffuse runoff, seepage, drainage, or infiltration." Probable pollutants contributed from non-point sources in the Silver Bow Creek basin include nutrients, sediment, and metals. Nutrients are contributed from a variety of non-point sources such as agricultural runoff,

[3] BOD_5 is the five-day measure of the pollutant parameter biochemical oxygen demand.

septic systems, lawns, and a golf course. There are several potential non-point sources of sediment pollution in the Silver Bow Creek watershed such as roads, bank erosion, and hill slope erosion related to phytotoxic soils, timber harvest, and other land clearing. Non-point sources of metals pollution include tailings, erosion from contaminated uplands, and wind deposition of contaminated soils.

Physical Impairments

Assessment of aerial photos provided a means to identify and assess potential sources of water quality and habitat impairment where other data was not available. Tabulated results of the aerial assessment are found in Appendix D. Reaches listed in this table correspond to those labeled on maps in Chapter 7.0. Physical impairments visible on aerial photography include placer mining, channelization, riparian vegetation degradation, flow alteration, and siltation. Chapter 7.0 describes the physical impairments known for each planning area.

6.11.2 303(d) List

Section 303(d) of the federal Clean Water Act requires states to assess the condition of their waters to determine where water quality is impaired or threatened. Impaired streams exceed water quality standards or do not meet beneficial uses. Threatened streams are those considered likely to become impaired in the near future. The result of this review is the Montana 303(d) list, submitted to the EPA by Montana DEQ every other year. Section 303(d) also requires states to prioritize and target water bodies on their lists for development of water quality improvement strategies referred to as TMDLs. This often involves the development of a watershed scale water quality and habitat restoration plan.

Six streams in the Silver Bow Creek watershed are on the Montana 2002 303(d) list; German Gulch, Mill Creek, Mill-Willow Bypass, Silver Bow Creek, and Willow Creek. Currently, these TMDLs are scheduled for completion by 2007. The development of TMDLs for these sub-watersheds will require more detailed water quality and land use information than presented in this document. However, the information on these 303(d) listed streams presented in Sections 7.1.1, 7.2.1, and 7.3.1 will be very useful in the TMDL planning process. Likewise, the results of TMDL development may aid in conceiving specific restoration projects aimed at improving water quality, instream habitat, and riparian condition. We therefore strongly recommended close coordination between restoration activities considered under this plan and those that may be prescribed through the TMDL process.

7.0 Sub-Watershed Conditions and Restoration Needs

This chapter describes our current understanding of watershed conditions, public interest, and restoration needs and potential of each of the eight sub-watershed areas in the Silver Bow Creek watershed (see Figure 2-3). Watershed conditions addressed in this chapter include water quality, fisheries, vegetation, wildlife, and recreation. Another component of this chapter is identification of data gaps that limit the ability to evaluate the status of natural and recreational resources. Chapter 8.0 (Restoration Prioritization) evaluates and prioritizes this information for watershed-wide restoration planning.

7.1 Silver Bow Creek Corridor

The Silver Bow Creek corridor in this study combines several geographic features including the Silver Bow Creek floodplain area, the extent of streamside tailings, and a 100-foot buffer zone generated on either side of the centerline of Silver Bow Creek. The boundary is determined by whichever is the greatest of the above three areas. The intent in creating the Silver Bow Creek corridor as a separate planning area for this project was to delineate tributary sub-watersheds such that their measured or analyzed attributes were distinct from Silver Bow Creek corridor features. In addition, the Silver Bow Creek corridor has unique contaminant issues and restoration needs that should be examined separately from other areas. This planning area extends from the confluence of Basin Creek and Blacktail Creek near Butte (and includes a portion of Blacktail Creek) to just downstream from and including Warm Springs Ponds (Figure 2-3 and Map1).

7.1.1 Water Quality

Figure 7-1: Tailings contamination of Silver Bow Creek and floodplain, Subarea 2.

Decades of disposal of mining and smelting wastes directly to Silver Bow Creek extensively injured surface water resources in the Silver Bow Creek corridor. Although mine wastes are no longer disposed of in this fashion, Silver Bow Creek continues to receive storm water contaminated by mine wastes in the Butte area, and groundwater contaminated through contact with hazardous substances (NRDP, 1995a). The sources of these types of contamination are still the subject of pending remediation and litigation actions (see Section 2.2). Hazardous substances (tailings) remaining in the streambed and stream banks of Silver Bow Creek provide another avenue for contamination of water in Silver Bow Creek. Remedial actions (Section 2.2) are currently addressing this contaminant source.

In addition to metals contamination, Silver Bow Creek receives direct discharge of nutrient-rich effluent from wastewater treatment plants (WWTP) serving Butte and Rocker. Silver Bow Creek may also receive nutrients from groundwater contaminated by non-point sources such as residential septic systems and nutrients from animal feedlots, although insufficient data exist to confirm or refute this. Another potential contaminant source is the 860-acre Rhodia Phosphate processing facility located in the Sand Creek sub-watershed close to Silver Bow Creek (see Section 7.4).

Metals and Arsenic Sampling

The State of Montana has acute and chronic water quality standards for aquatic life (Montana DEQ, 2002a). The acute standards are concentrations that water quality should not exceed at any point in time. Chronic standards are concentrations that water quality should not exceed on average over a four-day (96 hour) or longer period. For most of the data evaluated in this planning effort, inadequate sampling frequency precludes statistical determination of averages over a 96-hour period. Even though there is a lack of information regarding metals, arsenic and nutrient concentrations for any 96-hour or longer period in the Silver Bow Creek watershed, we used the chronic criteria to evaluate impairments. The application of the chronic criteria in this case assumes that any sampling event is representative of the previous 48 hours and the following 48 hours. Arsenic is included in this section even though it is a metalloid rather than a metal since its presence is generally associated with metals in this setting.

Monitoring of metals in Silver Bow Creek from the early 1970s to the present indicates concentrations frequently exceed state acute and chronic standards. Still, there are numerous signs of improving trends. To begin with, it is instructive to compare water quality parameters before and after passage of the Clean Water Act in 1972 and following cessation of major mining activities in the basin. The extent to which metals concentrations exceeded standards was considerable in the early 1970s. Data housed in the legacy STORET database indicate Silver Bow Creek had extraordinarily high concentrations of metals near Ramsey and east of Opportunity in 1970 and 1971. Copper and zinc were the most elevated with concentrations usually exceeding 20,000 µg/L and ranging as high as 1.2 million µg/L (Appendix C, Figure 7-2 and Map 1). These concentrations were up to 570 times greater than acute toxicity standards for aquatic life and 20 times greater than human health standards. Other metals that exceeded standards include arsenic, cadmium, lead, and selenium (Appendix C). While these metals frequently exceeded both acute aquatic life toxicity and human health standards, it was not by the orders of magnitude seen with copper and zinc.

Arsenic

Arsenic was not detected at most STORET sampling sites from the 1970s through 1990s with the exception of a station near the mouth of Silver Bow Creek (Appendix C, Figure 7-2 and Map 1). Arsenic concentrations at this lower site regularly exceeded the standard to protect human health (18 µg/L). In contrast, analysis of arsenic concentrations from the mid-1970s through the 1990s indicates considerable improvement from the early 1970s. Nevertheless, concentrations of arsenic still exceed acute toxicity standards for aquatic life. Appendix C describes trends in water quality over time for arsenic.

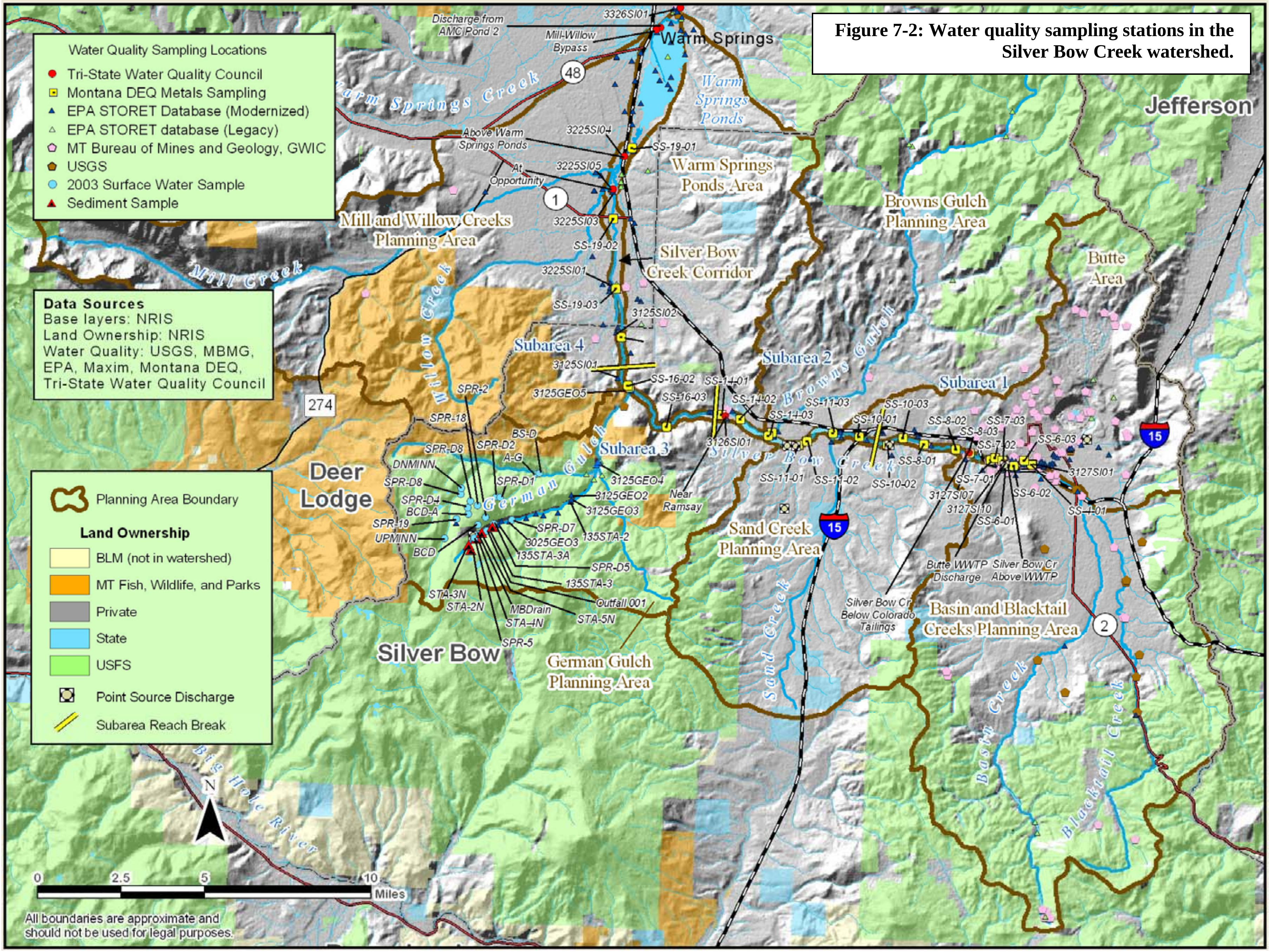


Figure 7-2: Water quality sampling stations in the Silver Bow Creek watershed.

Cadmium

Cadmium concentrations at STORET stations with more than four sampling events from the 1970s through the 1990s showed a slight trend towards increasing concentrations proceeding downstream (Appendix C, Figure 7-2 and Map 1). At the upper stations, concentrations occasionally reached 10 µg/L, although, cadmium was below detection limits in most samples. At the lowermost station, cadmium frequently exceeded chronic toxicity standards (0.16 µg/L at 50 mg/L hardness). Still, these concentrations are an enormous improvement from the early 1970s. Cadmium concentrations reported in the Tri-State Water Quality Council database (1999 through 2002) were below detection limits in all samples (Appendix C, Figure 7-2).

Copper

Copper concentrations for Silver Bow Creek from the STORET databases showed no clear spatial trend from the upper sampling stations to the lower from the 1970s through the 1990s (Appendix C, Figure 7-2 and Map 1). However, copper concentrations did decrease temporally compared to concentrations measured in 1970 and 1971. Copper concentrations frequently exceeded standards for acute and chronic toxicity at most stations on Silver Bow Creek. These concentrations were often over twice the levels known to result in acute toxicity to aquatic life. These results suggest sporadic influxes of copper may present a considerable constraint on fish and aquatic life.

Copper concentrations from the Tri-State Water Quality Council database varied along the length of Silver Bow Creek with the highest concentrations measured at the Opportunity sampling station (Appendix C, Figure 7-2 and Map 1). These sampling efforts occurred between 1999 and 2002. Copper concentrations at this station frequently exceeded both chronic and acute aquatic life standards. Water samples from above and below this site contained lower copper concentrations, and did not present a significant constraint to aquatic life.

Lead

Lead concentrations at all sampling stations on Silver Bow Creek were below detectable levels (Appendix C) for samples measured from the STORET database collected from 1974 to 1992. However, lead concentrations exceeding state water quality standards were found in surface water samples from other sampling events from 1970 through 1994 (NRDP, 1995a). The low solubility of this metal probably contributes to relatively low concentrations found in surface water.

Zinc

Zinc measured in STORET surface water samples on Silver Bow Creek showed a trend towards increasing concentrations from upstream to downstream in samples collected from the mid-1970s through the 1990s (Appendix C, Figure 7-2 and Map 1). While zinc remains a cause of impairment in Silver Bow Creek, it has diminished markedly from the early 1970s. Still, zinc concentrations occasionally exceeded acute aquatic life standards.

Zinc concentrations from the Tri-State Water Quality Council data showed a similar pattern as copper at Silver Bow Creek sampling stations in samples collected from 1999 through 2002. Zinc was highest at the Opportunity sampling station with concentrations greater than 800 µg/L. These concentrations substantially exceed acute aquatic life standards. The other sampling site with significantly elevated zinc was the site above the Butte WWTP. Water quality exceeded aquatic life standards much less frequently at this station (Figure 7-2). In addition, zinc pollution likely inhibits fish movement in Silver Bow creek, with concentrations substantially exceeding the Idaho DEQ (2000) avoidance level of 28 µg/L. These chemical barriers prevent fish migration between tributary streams to Silver Bow Creek.

Warm Springs Ponds

Water chemistry data available for Warm Springs Ponds from the STORET and Legacy STORET databases are limited to several sampling events in 1985 and 1987. Sample collection occurred at several locations in each of the three ponds. Results of these analyses indicate that during the mid-1980s, several metals in surface water posed a threat to both aquatic life and human health (see Appendix C, Figure 7-2 and Map 1). Arsenic, cadmium, lead, and zinc levels exceeded human health standards, while cadmium, copper, lead, and zinc exceeded aquatic life standards.

Although STORET data for the Warm Springs Ponds are limited, the federal Superfund remedial process (see Section 2.2.2) required extensive sampling data. EPA requires ARCO to conduct quarterly monitoring of the Warm Springs Ponds that includes sampling of influent and discharge. In 2000, EPA issued a five-year review report for the Warm Springs Ponds (EPA, 2000). While EPA deemed the overall performance on the interim remedy completed in 1995 to be good to excellent, compliance of the ponds discharge with water quality criteria was less than consistent for arsenic, copper, and zinc. For the pond discharge samples taken between January 1992 and October 1997, levels of arsenic and copper failed to meet surface water chronic standards approximately 15% of the time and zinc approximately 8% of the time. However, considering flow volumes along with concentration, results are less favorable, with as much as 75% of the water leaving the Warm Springs Ponds exceeding some standard (Reed, 2004). The removal of tailings from Silver Bow Creek's floodplain should decrease loading of metals to Warm Springs Ponds over time. A potential exists that, even when Silver Bow Creek remediation and restoration is complete and all the flow into the Warm Springs Ponds meets applicable water quality standards, arsenic or other contaminants from the pond discharge may still exceed state standards (Reed, 2004).

Biological Indicators of Water Quality Impairment from Metals

Biological indicators provide an additional means to evaluate biological integrity and the response of biological assemblages to specific environmental stressors. Macroinvertebrates and periphyton are commonly assessed assemblages. Macroinvertebrates include visible, aquatic invertebrates such as insects, worms, and crustaceans. Periphyton refers to attached algae, which includes a diverse mix of green algae, cyanobacteria, diatoms, among others. These assemblages respond predictably to environmental stressors, including metals and nutrients, the major pollutants of concern in the Silver Bow Creek watershed. Evaluations of these assemblages allow inference on the role of individual pollutant classes and evaluation of trends following remediation or restoration.

Evaluations of biological integrity based on macroinvertebrate and periphyton community composition varied among sites on Silver Bow Creek and among years beginning in 1978 and extending to 2000 (McGuire, 2001 and Weber, 2001). On Silver Bow Creek, there was a tendency for declining water quality from the Blacktail Creek site to the site below the Colorado tailings and the Butte and Rocker WWTPs. Samples from the site above the Butte WWTP had indications of severe impairment in all years except 2000. The improvement in 2000 was apparently in response to remediation activities that removed contaminated tailings from the stream channel and floodplain. The site near Rocker demonstrated the most severely impaired conditions of all sites in the Clark Fork Basin Project in all years. Both macroinvertebrate and periphyton assemblages indicated metals pollution contributed to severe impairment. Investigations at the Rocker site in July 2002 and September 2003 indicated a marked improvement in indicators of metals contamination, attributed to remediation of the stream channel and floodplain (Confluence, 2002a and Confluence, 2004).

While biological indicators suggest improvement downstream of the Rocker site on Silver Bow Creek, severe to moderate impairment was still evident. Assemblages at the Silver Bow Creek at Opportunity site indicated moderate to severe impairment from metals. Conditions improved somewhat at the next station downstream below the Warm Springs Ponds. Biological indicators of metals pollution suggested slight to moderate impairment with an improving trend since 1993.

The USGS sampled metal concentrations in macroinvertebrate tissue in the UCFRB over a 10-year period from 1992-2002 (Dodge, et al. 2003). These data indicate elevated concentrations of metals in the four macroinvertebrate species sampled in Silver Bow Creek near Opportunity. Although the impact of metals on individual species is unknown, the metals are available for movement into the food chain via ingestion. Numerous studies suggest that fish that consume macroinvertebrates with elevated concentrations of metals exhibit a reduction in normal growth patterns (Stratus, 2002).

Benthic Sediment Sampling

Benthic sediment data collected by the Montana Bureau of Mines and Geology from the late 1980s indicate metals posed a significant threat to aquatic life for most of Silver Bow Creek (MBMG, 1984 and 1987). Arsenic, copper, lead, and zinc exceeded concentrations reported to have severe effects on aquatic life at many sampling locations. Cadmium concentrations were typically at levels associated with chronic toxicity as opposed to the more acute concentrations of other metals (see figures in Appendix C).

Removal of metals-contaminated tailings and introduction of gravels in the SSTOU will likely decrease metals loading and ultimately metals in benthic sediments over time. Analysis of metals in sediment following remediation suggests that the effect will not be immediate. Metal concentrations were still elevated immediately following remediation in 2002 and 2003 in Subarea 2, Reach C sediment samples (Appendix C); however, concentrations were found to be greatly reduced by 2004 (MBMG, 2004). A possible explanation for the elevated sediment metals in 2002 and 2003 is that a sampling bias exists due to a scarcity of fine sediment in the channel. Remediation activities introduced mostly large gravels to the streambed and finer fractions were relatively sparse. Contaminated upstream areas may presently contribute metals to the scarce finer fractions found in remediated stream reaches, causing the high metals concentrations. Over time, it is expected that clay and silt fractions from uncontaminated sources (remediated stream banks and Blacktail Creek) will represent a higher proportion of sediment in the remediated stretches, resulting in decreased metals concentrations in benthic sediments. Montana DEQ's routine quarterly monitoring of remediated reaches will provide for further evaluation of trends in metal concentrations over time.

Nutrient Sampling

Calculation of ammonia toxicity for samples in the STORET database indicate ammonia concentrations frequently exceeded chronic toxicity standards for salmonids and occasionally exceeded acute toxicity standards at several locations along Silver Bow Creek (Table 7-1, Figure 7-2 and Map 1) from the mid 1970s through the 1990s. Ammonia toxicity is calculated using both temperature and pH (see Montana DEQ, 2002a for equations). Ammonia concentrations below the Butte WWTP exceeded chronic aquatic life standards in 65% of the 111 samples collected. While not an acute problem, ammonia toxicity presents a significant constraint on aquatic life in Silver Bow Creek for a significant distance below the municipal discharges.

Table 7-1: Sampling stations on Silver Bow Creek with ammonia concentrations exceeding either chronic or acute aquatic life standards (1975-1996). (Refer to cautionary note about chronic exceedances on page 101.)

Station ID	*Approximate Location by Subarea (SA) and Creek Mile*	*# of Samples*	*Percent of Samples Exceeding Chronic Aquatic Life Criteria for Ammonia*	*Percent of Samples Exceeding Acute Toxicity Criteria for Ammonia*	*Average Ammonia Value Expressed as Percent of Chronic Aquatic Life Criteria*	*Average Ammonia Value Expressed as Percent of Acute Toxicity Criteria*
3127SI01	SA1, mile 1 above WWTP	49	0%	0%	5%	0%
3127SI10	SA 1, mile 1 WWTP	6	100%	67%	1233%	297%
3127SI07	SA 1, mile 1 below WWTP	111	65%	2%	181%	35%
3126SI01	SA 2, mile 9	110	21%	2%	77%	16%
3125SI02	SA 4, mile 16	7	86%	0%	138%	31%
3225SI01	SA 4, mile 17	44	5%	0%	27%	5%
3225SI05	SA4, mile 21	3	0%	0%	10%	0%
3225SI03	SA4, mile 21	8	63%	0%	117%	0%
3225SI04	SA4; mile 22	59	3%	0%	29%	6%
3326SI01	SA4; below WSPs	23	4%	0%	21%	4%

Ammonia concentrations on Silver Bow Creek were elevated compared to other streams in the Montana Valley and Foothill Prairies Ecoregion. The 95th percentile for total ammonia concentration for sampling stations in this ecoregion was 1.50 mg/L. Ammonia concentrations on Silver Bow Creek frequently exceeded this value at site 3127SI07 below the Butte WWTP discharge (Figure 7-2 and Map 1).

Other types of nutrient pollution are elevated on Silver Bow Creek compared to concentrations measured throughout the ecoregion. Total Kjeldahl nitrogen, total phosphorus, and dissolved ortho-phosphorus were often considerably higher than 95th percentile of values for the ecoregion. Below the Butte WWTP, concentrations of these parameters exceeded the 95th percentile in more than 75% of the samples. For each of these parameters, there is a marked jump in concentrations at the station below the Butte and Rocker WWTPs indicating these facilities are a primary point source of nutrient loading along the stream. The Butte WWTP delivers considerably more effluent to Silver Bow Creek than the Rocker WWTP and is therefore responsible for the majority of this nutrient loading. This outfall accounts for 60% of baseflow in Silver Bow Creek and has a profound influence on downstream water quality.

The Tri-State Water Quality Council monitoring data also indicate that nutrient loading probably exceeds state standards in Silver Bow Creek below the Butte WWTP (Table 7-2, Figure 7-2 and Map 1). Although concentrations of ammonia + ammonium were not reported, we applied state standards to ammonium concentrations. Water discharged by the Butte WWTP exceeded chronic criteria in 97% of samples (Table 7-2). This point source contributed to ammonium concentrations exceeding chronic criteria in 67% of the 117 samples collected below the Colorado tailings, a sampling station that captures effects of effluent from both the Rocker and Butte WWTPs. Note that this is within the mixing zone allowed by the MPDES permit issued to the Rocker WWTP, which extends to the Interstate 15 crossing of Silver Bow Creek. Nevertheless, as a major contributor of flow to Silver Bow Creek, the Butte WWTP is a significant source of potentially toxic concentrations of ammonia to the system.

Similar to data in the STORET database, sampling by Tri-State Water Quality Council indicated nutrients in Silver Bow Creek were markedly elevated compared to other streams in the ecoregion. Ammonium concentrations discharged into Silver Bow Creek exceed the ecoregion concentrations for total ammonia considerably (Appendix C). Likewise, concentrations of nitrate + nitrite were generally within the 90th to 95th percentile for the ecoregion. Total Kjeldahl nitrogen exceeded the 95th percentile for the ecoregion at both the WWTP discharge and at the site below the Colorado tailings (Figure 7-2 and Map 1).

Table 7-2: Sampling stations on Silver Bow Creek with ammonium concentrations exceeding either chronic or acute aquatic life standards for NH_3 + NH_4 (Tri-State Water Quality Council data). (Refer to cautionary note about chronic exceedances on page 101.)

Station	*Number of Samples*	*Percent of Samples Exceeding Chronic Aquatic Life Criteria for NH3 + NH4*	*Percent of Samples Exceeding Acute Toxicity Criteria for NH3 + NH4*	*Average NH3 + NH4 Value Expressed as Percent of Chronic Aquatic Life Criteria*	*Average NH3 + NH4 Value Expressed as Percent of Acute Toxicity Criteria*
Above WWTP	142	1%	1%	5%	1%
WWTP Discharge	88	97%	3%	439%	69%
Below CO Tailings near Rocker	117	67%	1%	123%	20%
Near Ramsey	104	13%	1%	61%	12%
At Opportunity	43	7%	0%	26%	5%

As part of groundwater studies in the Butte area, the MBMG sampled nitrates at several locations on a section of Silver Bow Creek from the confluence with Blacktail Creek to about 1 ½ mile below this point in October 2001 and May 2002 (LaFave, 2002). Results from 2001 indicated elevated nitrate levels between 1 and 2 mg/L at sampling locations near the confluence and ½ mile downstream of the confluence. The sample collected 1 mile downstream just below the Butte WWTP discharge measured below 0.5 mg/L. Results from 2002 indicated nitrate levels between 1.0 and 2.0 mg/L at the three stations located about ½ mile, 1 mile, and 1-1/2 mile downgradient of the confluence. Although more data would strengthen conclusions about the levels and sources of nitrates, the data are consistent with other data summarized above, indicating nitrate levels in Silver Bow Creek between its confluence with Blacktail Creek and Ramsey to be elevated compared to concentrations typical of the ecoregion (Table 4-3, Table 4-4, and Appendix C).

Biological Indicators of Nutrient Impairment

Both macroinvertebrate and periphyton assemblages indicated nutrient enrichment contributes to severe impairment in Silver Bow Creek. Unlike metals concentrations, which have improved since the 1970s, nutrient enrichment remained elevated in 2002 as indicated by biocriteria metrics and the superabundance of macrophytes (*Potamogeton pectinatus*, *Elodea* sp.) and filamentous algae (*Cladophora*) in this reach (Confluence, 2002a). Sampling results from 2003 for macroinvertebrate and periphyton assemblages in this reach also showed severe impairment from nutrient pollution. The dominant diatoms collected in 2003 were species tolerant of heavy metals and nutrient enrichment (Confluence, 2004). The improvement in metals and high level of nutrients suggests that remediation efforts are successfully decreasing the effect of injury due to mining. In time, it is expected that nutrient loading from the Butte and Rocker WWTPs will replace mining-related injuries as the most significant constraint on aquatic life in Silver Bow Creek.

While biological indicators suggest improvement downstream of the Rocker site on Silver Bow Creek, severe to moderate impairment was still evident. Assemblages at the Silver Bow Creek at Opportunity site indicated slight impairment from nutrients. Conditions improved somewhat at the next station downstream below the Warm Springs Ponds. Organic loading appeared to be the principal factor limiting biological integrity at this site.

7.1.2 Water Quantity

Unlike many other rivers in southwestern Montana, Silver Bow Creek itself is not extensively dewatered for irrigation. However, several factors contribute to flow reductions in Silver Bow Creek. These include:

- minor diversions of Blacktail Creek and Basin Creek water for irrigation,
- diversion of Basin Creek water for the Butte municipal water supply,
- diversion of Yankee Doodle Creek water (Moulton Reservoir) for Butte municipal water supply,
- capture of uncontaminated water from Yankee Doodle Creek and uppermost Silver Bow Creek in the Yankee Doodle tailings impoundment,
- irrigation diversion from Browns Gulch,
- irrigation diversion from German Gulch, and
- Willow Creek and Mill Creek no longer connect with Silver Bow Creek and flow into the Mill-Willow Bypass.

Due to water quality issues, Silver Bow Creek itself has little water legally appropriated for irrigation. ARCO holds water rights on Silver Bow Creek for pollution mitigation purposes. This legally appropriates most of Silver Bow Creek flow for treatment in Warm Springs Ponds.

7.1.3 Fisheries

Based on professional knowledge of distribution and abundance of fish in healthy western Montana streams, Silver Bow Creek possibly supported the following fish community prior to the advent of mining:

- three species of salmonid (westslope cutthroat trout [*Oncorhynchus clarki lewisii*], mountain whitefish [*Prosopium williamsoni*], and possibly bull trout [*Salvelinus confluentus*]);
- two species of sucker (largescale and longnose sucker [*Catostomus macrocheilus* and *C. catostomus*]);
- one species of sculpin (slimy sculpin [*Cottus cognatus*]);
- several members of the minnow family, including longnose dace (*Rhinichthys cataractae*), and redside shiner (*Richardsonius balteatus*).

The absence of most of these species in Silver Bow Creek is a clear indication of the level of impairment in this stream. Toxic conditions precluded fish from inhabiting Silver Bow Creek since as early as the late 1800s. Montana FWP rates Silver Bow Creek as currently unable to support a fishery and, until recently, there were no efforts to evaluate the fishery. Remediation activities, including the removal of contaminated tailings, and restoration activities conducted to augment remediation, are improving the long-term prospects for a fishery in Silver Bow Creek. In November 2002, an electrofishing survey of a 1000-foot reach near Rocker found 77 fish (Confluence, 2002a). The majority (75 fish) were longnose sucker (*Catostomus catostomus*). There were also two slimy sculpin (*Cottus cognatus*). Significantly, there were at least three age classes of sucker represented in this sample, including sensitive juvenile fish. In October 2003, Montana FWP conducted an electrofishing study again in the Rocker section and in two downstream sections near Ramsey and the confluence with German Gulch (Spoon, 2004a). Sampling of the Rocker section showed similar results to the sampling conducted in 2002, with 48 longnose suckers and one slimy sculpin captured. Sampling of the Ramsay and German Gulch sections found no fish, indicating these downstream, unremediated areas were still devoid of fish as of 2003. In a stream considered too toxic to support fish of any kind, the simple presence of fish is a promising sign for Silver Bow Creek. Moreover, the relative abundance and presence of several year classes indicates that successful reproduction is occurring somewhere in the basin. It is likely that the water quality improvements associated with remediation are responsible for Silver Bow Creek's ability to support these fish.

Sampling conducted in the spring of 2004 in 1000 ft. section of Silver Bow Creek about 0.5 miles downstream of the mouth of German Gulch recovered five fish—2 cutthroat trout, 1 brook trout, and 2 suckers (Spoon, 2004b). However, no fish were recorded at this location in an October 2004 sampling event. The fall 2003 and 2004 sampling events below German Gulch confirm that water quality is not suitable for fish, however, the spring 2004 sampling results indicate that brook trout and cutthroat trout from German Gulch migrate downstream into Silver Bow Creek. These observations indicate that German Gulch can be an important source of native trout for the Silver Bow Creek fishery in the future provided that water quality sufficiently improves due to remediation and restoration efforts.

Where remedial activities have not yet taken place, water quality is the primary limiting factor on viable fisheries. The condition of the instream habitat in Silver Bow Creek is also a constraint on the potential of this fishery. Accumulations of tailings limit riparian stands and their important functional attributes in filtering sediments, reducing erosion, and providing shade and overhead cover. In addition, elimination of riparian shrubs has limited the recruitment of woody debris, which provides cover and habitat complexity. Similarly, alterations to channel morphology have eliminated pools and other important habitat components for fish.

Comparison of metal concentrations with avoidance thresholds (Idaho DEQ, 2000 and Table 4-2) suggests that metal concentrations throughout the Silver Bow Creek watershed present a chemical barrier to migration of fish in the basin. Copper concentrations frequently and substantially exceeded the avoidance threshold for copper on Silver Bow Creek and at the upper German Gulch sampling stations (Appendix C). Moreover, zinc pollution likely inhibits fish movement on Silver Bow Creek and possibly the upstream sites on German Gulch with concentrations substantially above 28 µg/L (Appendix C). Therefore, chemical barriers to spawning areas may result in another cause of impairment to this important fishery.

7.1.4 Vegetation

The earliest descriptions of the Silver Bow Creek area (Freeman, 1990) make reference to "furzy grass," which most likely describes shrubs called furze, a common name for spiny, evergreen shrubs common in western Europe. Native shrubs that this furze reference may correspond to include wolf willow (*Salix wolfii* sp.), shrubby cinquefoil (*Potentilla fruticosa*), snowberry (*Symphoriocarpos sp*), or sagebrush (*Artemesia* sp.). Descriptions fitting other shrubs or riparian trees such as cottonwood or alder are absent from these accounts.

Subsequent placer mining, logging, and contamination by mine and smelter wastes have destroyed most of the historic floodplain vegetation in the Silver Bow Creek corridor (NRDP, 1995b). Soils in this area are severely phytotoxic and support little or no vegetation. Injuries to vegetation include reductions in cover, forest/shrub communities, and habitat complexity. In addition, contamination of floodplain soils has led to the development of a pollution-tolerant plant community that is not representative of historic baseline conditions. Analysis of the USGS GAP vegetation data yields similar information. Notably, low cover grasslands as opposed to riparian vegetation dominate the Silver Bow Creek corridor. Moreover, riparian cover classes occur along only 5% of the Silver Bow Creek corridor. Remedial actions that are currently under way will greatly improve the conditions necessary to support a healthy riparian zone (see Section 2.2).

7.1.5 Wildlife

Releases of hazardous substances into Silver Bow Creek (NRDP, 1995b) have injured wildlife populations along the river corridor through poor water quality and degradation or elimination of riparian vegetation communities, which supply an important component of habitat to many species of wildlife. For example, disruption in stands of riparian vegetation reduces nesting and foraging habitat available to riparian obligate songbirds such as the yellow warbler, northern waterthrush, and American redstart. Similarly, riparian shrubs provide both cover and forage to ungulates such as white-tailed deer and moose. Exposure to toxic substances and elimination of a forage base has contributed to reductions or eradication of furbearing mammals including otter, mink, beaver, and raccoon.

Following completion of remediation activities, the Silver Bow Creek corridor will have a greatly enhanced potential to support healthy wildlife populations. Wildlife that will benefit from remediation includes big game species such as whitetail and mule deer and moose; semi-aquatic furbearers such as otter, mink, and raccoon; waterfowl, and non-game species such as raptors, songbirds, reptiles, and amphibians. This potential will follow re-establishment of riparian and floodplain vegetation. Establishment of shrub communities, grasslands, and wetland vegetation will provide both habitat features and forage for the various species of wildlife.

7.1.6 Recreation

Recreational activity in the Silver Bow Creek corridor takes place in the upstream part of this planning area along the lowermost reach of Blacktail Creek. Through much of this area, a popular trail system provides walking, biking, and nature watching opportunities to local residents. In contrast, minimal recreation takes place in the Silver Bow Creek corridor downstream of Butte with the exception of Warm Springs Ponds. The release of hazardous substances has rendered most of the Silver Bow Creek corridor an unhealthy and undesirable place to recreate. Recreational opportunities that have been lost include hunting, fishing, hiking, wildlife viewing, and other water recreation. The Warm Springs Ponds area (see Section 2.2.2) contains abundant habitat for waterfowl and fish, and although it is a superfund operable unit, it offers recreational opportunities. Currently, Montana FWP manages the recreational areas.

Following the completion of remedial actions on Silver Bow Creek (Section 2.2), recreation in the Silver Bow Creek corridor will eventually improve. Additional trails are planned for the Silver Bow corridor as remedial actions progress. Local citizens are optimistic that the Greenway trail system will provide quality recreational opportunities. The recovery of fisheries, riparian vegetation, and wildlife in the Silver Bow Creek corridor will greatly influence the amount of recreational use and quality of recreational experiences of the Silver Bow Creek corridor.

7.1.7 Public Input

The number one priority for the Silver Bow Creek corridor identified by participants in several focus groups was creation of a continuous Greenway and trail system. Several Greenway supporters referenced the vision developed through substantial public input in 1995 that served as a basis for the 1998 trail system design (GSD, 1998). This trail system vision is consistent with the vision developed for this plan and includes “a greenway, 26 miles in length, along the Silver Bow Creek corridor with clean water, an abundance of native, streamside vegetation, linear parks, trails, wildlife habitat areas, preserved historic sites, and economic development (Design Workshop, 1995). A second priority was establishment of a viable trout population. Removal of streamside tailings and reestablishment of floodplain vegetation and wetlands were other closely related restoration priorities.

Focus group participants expressed a number of concerns about Silver Bow Creek. One widely shared concern was the threat of continuing contamination from upstream sources, such as contaminated storm water and groundwater from the Butte area, after restoration is complete. Separate, but related, some groups noted the existence of non-mining impairments such as nutrients, temperature and substrate limitations, and asked that these too be addressed. Several groups noted the recreational potential of the comparatively wild Durant Canyon, though agreement regarding preferred management options was lacking. Noxious weeds also present serious problems basin-wide. One concern mentioned as a management challenge was the probability of greater human/wildlife conflicts with increased recreational use and the associated expanded responsibilities for natural resource managers above current funding levels. Table 7-3 below summarizes the public comments received on the Silver Bow Creek corridor. Comments are sorted by topic (water quality, vegetation, fisheries, etc.) and type (priority, concern).

Table 7-3: Summary of public comments on the Silver Bow Creek corridor.

Topic	*Type*	*Comments*
Recreation	Priority	Creation of a continuous Greenway and trail system was the #1 priority of several groups.
Recreation	Concern	Potential conflicts between humans and wildlife.
Fisheries	Priority	Establishment of a thriving trout population in Silver Bow Creek was also a priority.
Pollution Source	Priority	Removal of streamside tailings.
Vegetation	Priority	Re-establish vegetation and create wetlands in floodplain.
Pollution Source	Concern	Upstream contamination may continue to threaten Silver Bow Creek after restoration.
Pollution Source	Concern	How will other impairments such as nutrients, temperature, and substrate be addressed?
Wildlife	Concern	Durant Canyon needs active management to protect wildlife.
Weeds	Concern	Noxious weeds are a problem basin-wide.
Management	Concern	Increased responsibilities for natural resource managers.
Wildlife, fisheries, recreations	Priority	Preservation of Warm Springs Ponds for a recreation area and waterfowl habitat.

7.1.8 Sources of Environmental Impairment

Several pollution sources continue to degrade water quality and aquatic and terrestrial habitat. The resulting impairments greatly limit recreational use of the Silver Bow Creek corridor. Table 7-4 lists the known sources of water quality impairment in the Silver Bow Creek corridor. For more information on sources related to federal Superfund sites or with pending litigation, see Section 2.2. Note that this list does not include contaminant sources that may reach Silver Bow Creek via tributary streams.

Table 7-4: Sources of water quality impairment in the Silver Bow Creek corridor.

Impairment Source	*Contaminants*
Streamside tailings and railroad grades	Metals – being addressed by ongoing remediation
Storm water from mining wastes in the Butte area*	Metals
Contaminated groundwater from mined areas near Butte*	Metals
Contaminated groundwater from the Opportunity Ponds	Metals (Mn, Fe) and suflates(SO_4)
Contaminated groundwater and discharge water from Warm Springs Ponds	Metals
Butte waste water treatment facility	Nutrients
Rocker waste water treatment facility	Nutrients
Rhodia Phosphate Processing facility	See Section 7.4.8
Opportunity residential septic systems (impacts are unknown)	Nutrients

*Final remedy decision and litigation are pending

7.1.9 Restoration Needs

Restoration will follow remediation and build on the foundation of a dynamically stable stream that meets water quality standards and supports aquatic life. Activities involved in the remediation process include removal of contaminated soils in the Silver Bow Creek channel and floodplain. Final design recommendations for remedial actions include complete tailings removal rather than a combination of removal and in-situ treatment as previously planned (Pioneer, 2003). As part of the remediation efforts, the entire Silver Bow Creek channel from Butte to Warm Springs Ponds will be reconstructed with the possible exception of certain reaches in Durant Canyon. Remediation efforts will focus on contaminant reduction and the development of a stable channel with balanced sediment supply and transport capacity. In general, remediation success is achieved by providing surface water and instream sediments that could support fish and restoration success is considered achieved if the trout species' number and population structure classes indicate a self-reproducing trout fishery in the watershed utilizing Silver Bow Creek (Montana DEQ and NRDP, 2004). Goals for the remediated channel include removal of contaminated sediments and reconstruction of the floodplain with clean substrate; allowing the channel to migrate across the floodplain; and construction of basic bed forms such as riffles, runs, and pools to initiate the development of habitat for fish. Following removal, the floodplain and stream banks will be re-vegetated with native plants. The channel reconstruction and revegetation efforts associated with remediation will fall short of complete restoration in the following ways:

Figure 7-3: Silver Bow Creek remediated and restored channel and floodplain.

- the channel may lack the level of structural complexity commonly found in natural channels,
- the floodplain may lack oxbows and other wetlands,
- floodplain vegetation may lack species diversity and structural complexity, and
- floodplain sediments may lack sufficient organic matter to support thriving plant communities.

Nevertheless, the remediated stream corridor may support trout provided water quality from upstream sources is adequate. In time, the channel will develop into a more natural system with habitat diversity similar to nearby undisturbed streams. Restoration activities to address shortcomings of remediation should be coordinated with remediation when possible.

The elimination of salmonids by toxic substances in Silver Bow Creek creates an opportunity to emphasize restoration for native westslope cutthroat trout in much of the watershed. Recent electrofishing studies have found pure westslope cutthroat trout, cutthroat/rainbow trout hybrids, and brook trout in tributaries upstream of Warm Springs Ponds. As previously discussed, the absence of rainbow trout precludes genetic introgression (interbreeding) found in watersheds where westslope cutthroat and rainbow trout coexist. Additionally, the absence of rainbow and brown trout reduces the number of non-native competitors with westslope cutthroat trout.

Unfortunately, the presence of brook trout and cutthroat/rainbow hybrids in tributary streams may make it difficult or impossible to develop a native-only fishery. Removal or eradication of brook trout is difficult and costly. The presence of cutthroat/rainbow hybrids will hinder the restoration of a 100% pure westslope cutthroat trout gene pool. Perhaps the most reasonable strategy would be to manage for a fishery that emphasizes native fish by creating habitat that favors westslope cutthroat trout over brook trout, and by protecting existing pockets of genetically pure westslopes in headwaters streams. This management compromise would allow for some cutthroat/rainbow hybrids as well as brook trout.

In addition to westslope cutthroat trout, it is possible that bull trout were historically present in the Silver Bow Creek watershed. Restoration of bull trout populations would require transplanting fish from another source because the dam at Warm Springs Ponds prevents bull trout from migrating upstream from the Clark Fork River and tributaries below the dam. However, because bull trout readily interbreed with brook trout, it would be impossible to maintain pure bull trout genetics with brook trout present in the system. In addition, restoration of bull trout would require transplanted stock to have a relatively non-migratory life history due to the lack of connectivity between the Silver Bow Creek watershed and Clark Fork River. These factors may make bull trout restoration infeasible in Silver Bow Creek.

The Warm Springs Ponds dam and the liming facility above the ponds, combined with poor water quality in Silver Bow Creek, currently protect the fishery by preventing brown and rainbow trout from migrating into upstream reaches of the watershed. The effectiveness of this liming facility as a migration barrier is questionable and may become entirely inadequate as water quality improves in Silver Bow Creek (Hadley, 2004). Consequently, a permanent fish barrier may need to be designed for Silver Bow Creek to prevent non-native trout in Warm Springs Ponds from becoming established in the watershed upstream of the barrier.

Restoration needs for the Silver Bow Creek corridor, beyond current remedial actions include enhancing fish habitat and riparian vegetation, and coordination with Montana FWP regarding installation of migration barriers for native fish recovery (Table 7-5). Many of these restoration needs/goals have been or are in progress through the Bighorn Environmental and Greenway restoration grants. An explanation of the rank, category, and agency/other responsibility columns in Table 7-5 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-5: Restoration needs for the Silver Bow Creek corridor.

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
3	Fisheries	The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	Investigation should be conducted as to the ultimate fate and the implications of changing the configuration of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River. It is important to keep the Warm Springs Ponds wet to prevent significant releases of metals to the By-Pass and River and to continue to provide fish and wildlife habitat. See also deferred category #60.	ARCO, EPA, Montana DEQ, NRDP, FWP
5	Pollution Mitigation	Mining related contaminants continue to enter Silver Bow Creek and degrade water quality. Storm water from the Butte area and groundwater in Butte Area One are the primary sources.	Ongoing and future remediation and the outcome of current litigation may address some of these sources of contamination. Seek effective remediation of BPSOU. Following the ROD, update the State's restoration plan for Butte Area One. Eliminate or isolate remaining sources of water quality impairment.	PRP GROUP, EPA, Montana DEQ, NRDP
6	Protect Existing Resources	Remediation and restoration actions along the Silver Bow Creek floodplain on private lands need to be protected from potentially detrimental land management activities in the long term.	Acquire land or conservation easements along the Silver Bow Creek corridor to protect restored areas. Subarea 2 contains about 320 acres and Subarea 4 contains about 500 acres of private lands that should be considered for acquisition or easements.	Montana DEQ, NRDP
10	Recreation	Recreational opportunities are minimal due to historic mining impacts.	Implement a greenway trail system along the entire length of Silver Bow Creek. Acquire/develop access for fishing and water recreation. Create a series of trails connecting to nearby communities (Anaconda and Butte). These needs are reflected in the 1998 Silver Bow Creek Greenway design document. Public land managers believe this trail should be low impact where it bisects important wildlife habitat and should allow foot, bicycle, or horse access only.	Greenway Service District (GSD)
15	Fisheries	Remedial actions will fall short of creating an optimal fishery.	Enhance fish habitat diversity and structural complexity; improve substrate in future reaches where appropriate. Approved Greenway funding will address this need in Reaches A - J. Coordinate with installation of migration barriers as needed to promote native fishery.	GSD, NRDP, FWP
24	Vegetation	Remedial actions will fall short of restoring a healthy riparian vegetation zone along Silver Bow Creek and its floodplain. Wildlife populations are limited in the corridor.	Enhance riparian vegetation. Wetlands creation may be appropriate locally and will have a beneficial impact on water quality. Establishment of a healthy riparian zone along Silver Bow Creek will create the opportunity for wildlife to reoccupy this area. Approved Greenway funding will address Reaches A-J & P-R. .	GSD, NRDP

Rank	Category	Issue/Problem	Restoration Needs	Agency/Other Responsibility
31	Pollution Mitigation	Nutrients are discharged to Silver Bow Creek from the Butte and Rocker wastewater treatment facilities.	Improve/upgrade treatment of municipal effluent. Proportionately, the Butte wastewater treatment plant contributes far greater amounts of nutrient loading to Silver Bow Creek than the Rocker wastewater treatment plant. Butte-Silver Bow has obligations to further reduce its nutrient discharge by 2007 via the Clark Fork River voluntary nutrient reduction program.	Local Government
NA	Pollution Mitigation	Groundwater is contaminated beneath and to the north of the Warm Springs Ponds.	Under remedy, metals contamination from this source is being collected and pumped back to Pond 2 for treatment. The groundwater flowing from the system is expected to improve to the point that inception, pumping and treating will no longer be necessary in a few years to decades.	ARCO, EPA, Montana DEQ, NRDP

7.1.10 Data Gaps

Due to the amount of activity related to Superfund sites in the Silver Bow Creek corridor, abundant scientific information is available for this area. However, a significant number of data gaps still exist (Table 7-6). In many cases, lack of data may pose limitations for restoration project planning. In these instances, restoration activities should begin with a thorough assessment of conditions that will influence the chosen location for restoration, baseline conditions, and likelihood for success of restoration.

Table 7-6: Data gaps for the Silver Bow Creek corridor.

Data Gap	Uses
Record of decision for addressing contaminant sources in Butte Priority Soils Operable Unit (ROD)*	Evaluating restoration needs beyond remedy is difficult without this information.
The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	An important part of stream restoration in the Silver Bow Creek corridor is to determine the ultimate fate of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River.
Detailed soils mapping	Planning vegetation and/or soil amendment projects. NRCS personnel report this data will be available in 2005. These activities should be coordinated with remedial actions as much as possible.
Water quality data for Rhodia Phosphate facility	Evaluation of environmental impact of this site. EPA is currently conducting site investigations.
Water quality data for groundwater in the Opportunity area	Evaluation of the potential impact of groundwater contamination to Silver Bow Creek surface water.
Aquatic habitat data for Silver Bow Creek	This information will be necessary for planning additional stream habitat enhancement post-remedy. Restoration in the Silver Bow Creek corridor should be coordinated with remedy as much as possible.

*Litigation is pending on these issues.

7.2 Mill and Willow creeks Sub-watershed

The Mill and Willow creeks sub-watershed includes the contributing drainage area of Mill and Willow creeks as well as smaller drainages to the south such as Gregson Creek and Whitepine Creek, which drain directly into Silver Bow Creek (Figure 7-4). In addition, this planning area includes the Anaconda and Opportunity Tailings areas and surrounding wetlands. This planning area is the largest of the eight in the Silver Bow Creek watershed at 99.3 square miles. Average elevation is 6270 ft., and average annual precipitation is 19.2 inches/year. Land ownership is 65% private, 32% Montana FWP, 1% State, and less than 1% USFS. Geology in this planning area is the most diverse in the Silver Bow Creek watershed, consisting mostly of Quaternary alluvium, Tertiary volcanic rocks, and Cretaceous intrusive rocks. Minor but significant amounts of Tertiary sedimentary rocks, Proterozoic sedimentary rocks, and Paleozoic sedimentary rocks also occur in the sub-watershed (Figure 6-8).

7.2.1 Water Quality

Inclusion of Mill Creek and Willow Creek on Montana's 303(d) list of impaired streams indicates probable impairment of water quality. Generation of this list is a requirement of the Clean Water Act of 1972, which requires states to identify waters within their boundaries that are not meeting water quality standards or fully supporting beneficial uses. Metals contamination and perturbations associated with fine sediment were among the probable causes of impairment in these streams (Table 7-7, Table 7-8). Both streams have multiple sites where concentrations of metals exceeded state standards. In addition, the Montana DEQ 303(d) listing information describes conditions implicating land use practices in increasing sediment production and delivery and impairing the functional attributes of riparian vegetation. For example, local heavy grazing, evidence of siltation, and local occurrences of nuisance algae in the reaches near Opportunity (indicative of nutrient enrichment) are consistent with impaired water quality. Other information suggesting impairment in these streams is their inclusion of both streams on the Montana FWP list of chronically dewatered streams (MFISH, 2003).

More recently, EPA consultants collected surface water data for Mill Creek and its tributaries and Willow Creek during five storm events during the summers of 2001 and 2002 (CDM, 2001 and CDM, 2002) (see Table 7-9). Results from these events showed some elevated metal and arsenic concentrations in Mill Creek, Willow Creek, and tributaries to Mill Creek that exceeded state acute and chronics standards (Table 4-1). The highest metals concentrations in Mill Creek and its tributaries exceeded state standards. At 428 µg/L, the highest arsenic value among the Mill Creek sites substantially exceeded the acute aquatic life standard of 340 µg/L. In contrast to Willow Creek, zinc concentrations in Mill Creek did not exceed state standards for aquatic life beneficial uses. The highest concentration of arsenic on Willow Creek (237 µg/L) exceeded chronic aquatic life use standards (150 µg/L). Assuming hardness of 150 mg/L, the highest copper concentration (55 µg/L) in Willow Creek exceeded acute aquatic life standard (7.3 µg/L) while the highest zinc concentration of 173 µg/L was slightly above the 168 µg/L acute standard.

Figure 7-4: Map of the Mill and Willow creeks sub-watershed planning area.

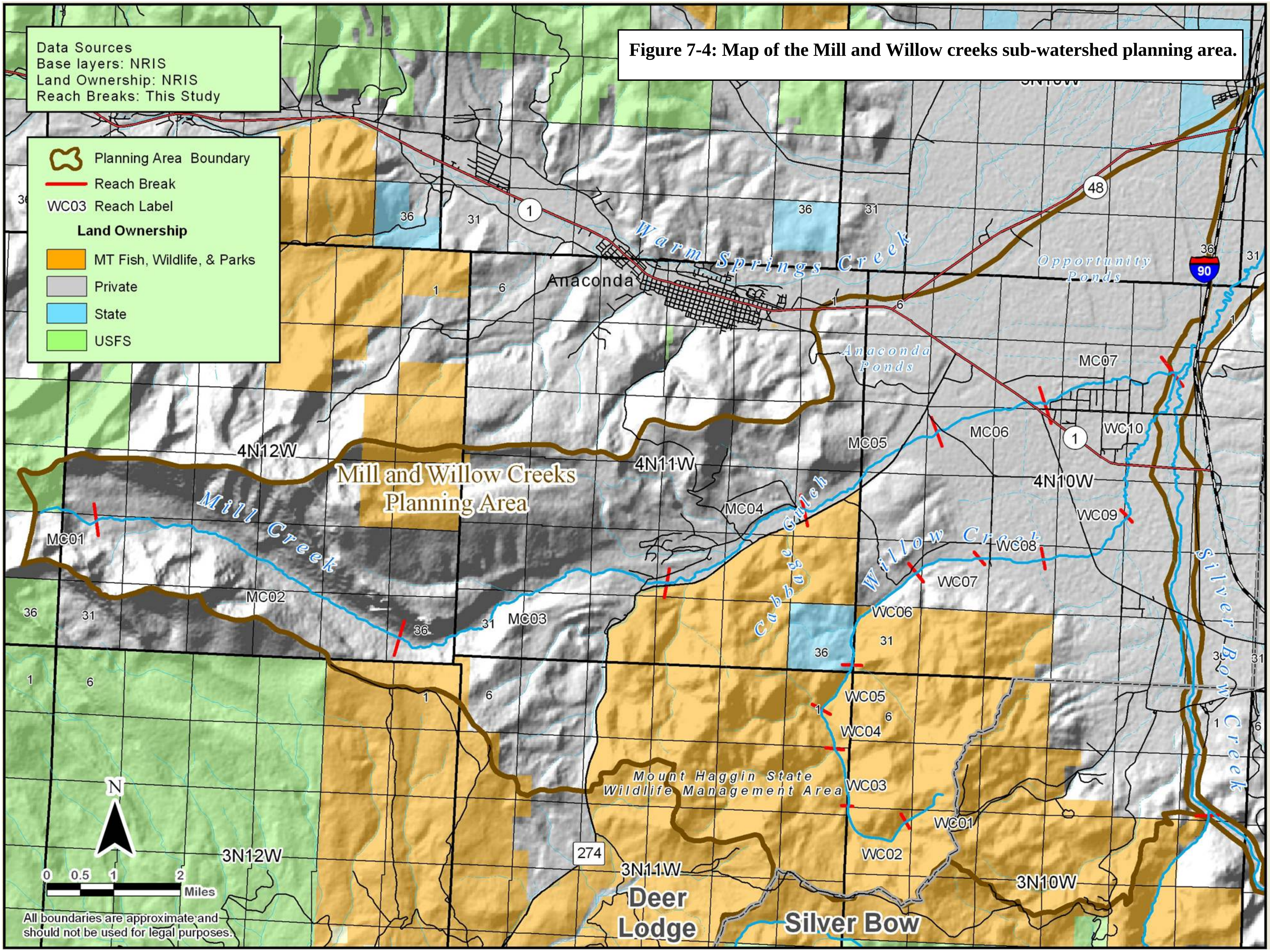


Table 7-7: 303(d) listing information for Mill Creek (Montana DEQ, 2002b).

Mill Creek Reach	***Condition***	***Summary Comments***	***Observations***
0.5 miles upstream from the confluence with Cabbage Gulch	Severe impairment	Metals contaminants (primarily cadmium, lead, copper) exceed aquatic life standards; sedimentation.	• Hill erosion from roadside • Cadmium, copper, lead, exceed aquatic life acute and chronic standards.
At old townsite of Mill Creek	Severe impairment	Metals contaminants (primarily cadmium, lead, copper) exceed aquatic life standards; arsenic exceeds drinking water standard. Chronic near-total dewatering due to diversions. Sparse vegetation in floodplain due to Anaconda smelter emmissions. Sedimentation is evident.	• Sparse vegetation in floodplain due to Anaconda smelter emmissions. Moderate amounts of FeOH precipitation. Trout common. Stream substrate cobble; sediment source to stream is old collapsing bridges. Some water diversions noted, as well as trash in creek. • From 35 to 95% of stream flow is diverted during the summer months. • Evidence of acid mine drainage and sediment from roadway crossing • Flow ~ 6.0 CFS in summer/fall. • Cadmium, copper, lead, iron exceed aquatic life standards; arsenic exceeds human health standards. • Sulfate concentration (total) 16-50 mg/L in August, 1978. • Metals are present in sediments of creek.
Within the town of Opportunity	Severe impairment	Metals contaminants (primarily cadmium, lead, copper) exceed aquatic life standards; arsenic exceeds drinking water standard. Chronic near-total dewatering due to diversions. Evidence of nutrient problem based on algal blooms (no nutrients data available). Sedimentation is evident.	• Filamentous algae are abundant, unusually high for streams. • Stream flows along N edge of golf course. Silt covers much of bottom. Some upstream diversions reduce water flow. • Between 35 to 95% of stream flow is diverted during the summer months. • Stream diversions present; algal growth appears heavy; surface scum thick.
Mouth (confluence with Willow Creek)	Severe impairment	Metals contamination (aluminum, zinc, cadmium, lead, copper) and arsenic exceed aquatic life standards and drinking water standards. Dewatering is common.	• Willows thick. • Between 35 to 95% of stream flow is diverted during the summer months. • Aluminum, arsenic, cadmium, copper, lead, zinc all exceed human health, and aquatic chronic and acute standards (1970s data) • Elevated hardness at mouth (1970s data), to 1800 mg/L as $CaCO_3$; elevated sulfate as well (to 1600 mg/L in October 1970).

Table 7-8: 303(d) listing information for Willow Creek (Montana DEQ, 2002b).

Willow Ck Reach	*Condition*	*Comments*	*Observations*
Near section 28-29 border, T.4N, R.10W	Severe impairment	Some habitat degradation, severe impairment for metals that exceed acute and chronic aquatic life standards (cadmium, copper, lead).	• Heavily grazed; a small jeep trail is washed out in several places along the creek. • Chronically dewatered • Chronic or acute standards were exceeded for cadmium, copper, lead. (n=7). Human health (drinking water) standards not exceeded.
At the Highway 441 crossing	Moderate impairment	Habitat degradation and dewatering, siltation.	• Stream intermittent due to irrigation removals; heavily grazed (bank instability). • Sedimentation • Chronically dewatered • The Yellow Ditch (~0.5 miles upstream) is main interceptor of water from Willow Creek. • Heavily grazed to edge of stream; no notable bank trampling.
At Highway 1 crossing, SE of Opportunity	Severe impairment	Aquatic life standards (acute and chronic) exceeded for arsenic, cadmium, copper, and lead. Human drinking standard exceeded by arsenic, cadmium, and lead.	• Common, filamentous algae • Sedimentation • Summer/early fall flows: 0.7 to 15 CFS • Chronic or acute standards exceeded for arsenic, cadmium, copper, lead (n=17).Human health (drinking water) standard exceeded for arsenic, cadmium and lead. • Historical stack fallout (Anaconda smelter) has introduced metals into the stream sediments.
Mouth (confluence with Silver Bow Creek)	Severe impairment	Copper exceeds aquatic life chronic and acute standards, arsenic exceeds human drinking standards.	• Flow never lower than 5 CFS throughout the year (maximum -212 CFS). • Chronic or acute standards exceeded for copper (n=4). Human health (drinking water) standard exceeded for arsenic. • Flooding from Silver Bow has deposited metals into the lower end of Willow Cr.

Table 7-9: Storm water sampling results, Mill and Willow creeks (CDM, 2002).

Location	*As (ppb)*	*Cd (ppb)*	*Cu (ppb)*	*Pb (ppb)*	*Zn (ppb)*
Mill Creek (reach MC03)	Below standards	Below standards	Below standards	Below standards	Below standards
Mill Creek (reach MC04)	27.2 (1 sample)	Below standards	Below standards	Below standards	Below standards
Mill Creek (reach MC07)	45.1 (2 sample average)	Below standards	14.8 (1 sample)	Below standards	191.0 (1 sample)
Ceanothus Creek (trib of Mill Ck)	65.8 (3 sample average)	Below standards	16.3	15.2 (1 sample)	51.2 (2 sample average)
Joiner Gulch (tributary of Mill Creek)	410 (3 sample average)	Below standards	27.6 (3 sample average)	Below standards	Below standards
Willow Creek (reach WC08)	69.0 (1 sample)	Below standards	35.0 (1 sample)	Below standards	71.1 (1 sample)
Willow Creek (reach WC10)	30.6 (5 sample average)	Below standards	Below standards	Below standards	Below standards

7.2.2 Water Quantity

The Montana DNRC water rights database lists 608 water right points of use in the Mill and Willow creeks sub-watershed corresponding with 322 water rights (Table 7-10). The majority of these are listed as for agricultural (irrigation and stock) purposes (49.3%) and residential domestic and lawn and garden use (43.2%). The remaining water right points of use are for commercial, industrial, and other purposes. The total maximum acreage associated with irrigation water rights is 17,771 acres with a maximum total flow rate of 431 cfs. These numbers reflect permitted acreages and flow rates, and likely overstate actual usage.

Table 7-10: Water right points of use in the Mill and Willow creeks sub-watershed (DNRC database).

Purpose	***No. of Water Rights (Points of Use)***	***% Water Rights (Points of Use)***
Commercial	24	3.9%
Industrial	8	1.3%
Geothermal	3	0.5%
Municipal	1	0.2%
Domestic	205	33.7%
Lawn and garden	58	9.5%
Irrigation	256	42.1%
Stock	44	7.2%
Other purpose	2	0.3%
Recreation	7	1.2%
TOTAL	608	

The number of water rights and permitted irrigation withdrawals from Mill and Willow creeks are the largest in the Silver Bow Creek watershed. These withdrawals typically dewater both Mill and Willow Creek during mid-to-late summer and likely result in impairments to fish habitat and water quality.

7.2.3 Fisheries

Fisheries information is scarce for the majority of this planning area. Fish population data for the Mill and Willow Creek drainages include electrofishing surveys conducted near the mouths of Mill Creek and Willow Creek in 1989, 1990, and 1991(MFISH, 2003). Brown trout (*Salmo trutta*) was the only species reported for these sampling events. Population estimates in Mill Creek ranged from 21 to 350 brown trout per 1000 feet. Population estimates in Willow Creek ranged from 118 to 313 brown trout per 1000 feet. Fish biologists generally consider these population ranges as low to moderate.

Although fisheries data are lacking for the majority of the watershed above the mouth, local fisheries biologists provided best professional judgment on species composition (MFISH, 2003). In Mill Creek, westslope cutthroat trout, Yellowstone cutthroat trout, mountain whitefish (*Prosopium williamsoni*), brook trout (*Salvelinus fontinalis*), brown trout, and westslope cutthroat trout × Yellowstone cutthroat trout hybrids are likely. Presumably, Yellowstone cutthroat trout are present in the drainage due to stocking Miller Lake, although no records to substantiate this were present in the MFISH database. Species presumed to be present in the Willow Creek sub-drainage include westslope cutthroat trout and brook trout. There are also some unsubstantiated reports of bull trout (*Salvelinus confluentus*) occurring in the Willow Creek sub-watershed. Bull trout are a federally threatened species under the Endangered Species Act and their persistence in any portion of the Silver Bow Creek watershed would be an important component of the biodiversity of the area.

Montana FWP angling pressure data are available for Mill Creek and Willow Creek (MFISH, 2003) and indicate that Mill Creek is the most heavily fished stream in the Silver Bow Creek watershed. Total fishing pressure in Mill Creek ranges as high as 1,300 angler days per year. The majority of the use is from in-state anglers, although non-residents accounted for nearly 90 angler days in the most heavily fished year. Willow Creek receives considerably less fishing pressure from both in state and resident anglers. Focus groups indicated that the Mill Creek watershed supports a robust fishery although access is limited.

Information on habitat conditions is limited for streams in the Mill and Willow Creek watershed. A conceptual restoration plan developed by Interfluve (2003) for lower Willow Creek provides the most detailed information but only covers a small area. Montana DEQ 303(d) listing information (Table 7-7 and Table 7-8) provides some water quality and habitat information on select locations. Focus group meetings generated a source of local knowledge of conditions. Finally, the aerial assessment conducted as part of this study (Appendix D) provides an overview of conditions potentially affecting habitat.

The upper (montane) reaches of Mill Creek appear to have localized areas of degraded riparian vegetation (Appendix D). Very little habitat information is available since this is primarily private land. Moving downstream, upland smelter impacts appear more prevalent on aerial photography. The valley foothill portion of Mill Creek is reported to have habitat impacts from dewatering (up to 95% of flows locally), lack of vegetation from smelter emissions, siltation, channelization, and nuisance algae growth (Montana DEQ, 2002b; Table 7-7). Information gathered during focus groups confirms many of these findings.

Smelter fallout and land uses in the montane portions of Willow Creek have likely increased production and delivery of sediment to surface waters. The upper (montane) reach of Willow Creek have been logged locally, and when combined with reduced vegetation from smelter fallout, has caused severe erosion problems such as head-cutting and gully formation. Roads are locally abundant, further contributing to erosion. Focus group participants reported heavy siltation in downstream reaches resulting from these land uses.

The valley foothill portions of Willow Creek exhibit habitat impacts related to grazing, dewatering, and residential land uses as indicated by Montana DEQ 303(d) listing information (Montana DEQ, 2002b), focus group comments, and the aerial assessment. The Inter-Fluve (2003) conceptual restoration plan identifies habitat impacts in Willow Creek from historic and current grazing practices, tailings deposited in the floodplain from the 1908 flood on Silver Bow Creek, culverts at major road crossings, and channelization. The reach of Willow Creek examined by Inter-Fluve corresponds to reach WC10 in this study (Figure 7-4).

The presumed presence of westslope cutthroat trout, lack of human disturbance, and size of the Mill Creek watershed indicates that this drainage shows promise as a refuge for westslope cutthroat trout as well as non-native fish species. As such, the Mill Creek sub-watershed also provides a source of recruitment for the Silver Bow Creek watershed as a whole, although, water quality problems may limit this potential. We recommend that fish species composition, water and sediment quality, and habitat quality be assessed in streams in the Mill and Willow creeks sub-watershed. Macroinvertebrate and periphyton sampling is also recommended to assist in identification of limiting factors and rating overall biological integrity. Baseline assessments in this watershed may identify management opportunities to promote native species conservation and/or a recreational fishery.

7.2.4 Vegetation

The USGS GAP vegetation data in Figure 6-10 and Figure 6-11 illustrates the distribution of land cover types in this planning area. Note the abundance of grasslands and shrubland in high elevation, north-facing slope portions of Mill Creek where coniferous forest should be typical. This reflects impairment of soils from decades of smelter fallout. The USGS NLCD (National Land Cover Database) data gives similar results for the Mill and Willow creeks sub-watershed (Table 7-11).

Table 7-11: Land Cover types in the Mill and Willow creeks sub-watershed.

Cover Type	***Mill and Willow Creeks***
Urban/Commercial	0.47%
Mines/Quarries	6.56%
Forest	27.07%
Shrubland	14.51%
Grassland	42.15%
Pasture/Hay	4.77%
Crops	0.46%
Wetlands	1.70%

Percent coniferous forest cover is considerably lower than comparable sub-watersheds with large upland components (German Gulch and Basin/Blacktail Creeks). Percent cover by low and moderate cover grasses, shrubs, and bare areas is significantly higher than the comparable sub-watersheds. Both indicate injury to soils from smelter fallout. This injury is a subject of pending litigation as described in Section 2.2.4.

7.2.5 Wildlife

The Mill and Willow creeks sub-watershed contains a portion of the Mount Haggin State WMA, specifically managed for big game and other wildlife and is the largest area of its type in Montana. Montana FWP statewide wildlife distribution data (GIS) and conversations with Montana FWP personnel indicate that both deer and elk winter ranges are common in this planning area and the adjacent German Gulch sub-watershed (Figure 6-13). Montana FWP personnel also indicate that moose, antelope, and upland game birds are important species in this planning area. Focus group information concurs with this assessment and emphasizes the high value of hunting opportunities. Recently compiled Montana FWP winter aerial wildlife surveys indicate that critical wildlife winter range exists along the public/private land boundary along the northeast boundary of the Mount Haggin State WMA (Montana FWP, 2004 and Appendix E). The suitability of this area for game species suggests it also provides suitable habitat for non-game species of wildlife. Private lands along this boundary are good candidates for acquisition to protect this valuable resource.

7.2.6 Recreation

Although much of the upper Mill Creek drainage is privately owned and closed to public use, fishing, hunting, OHV riding, horseback riding, and snowmobiling are still popular activities in the Mill and Willow creeks sub-watershed. Focus group comments indicate that the lack of access to upper Mill Creek is a big loss to the public. The focus groups reported high quality fishing opportunities, although a lack of public access was a considerable constraint. The majority of the Mount Haggin State WMA provides excellent hunting opportunities and is highly valued by local residents.

7.2.7 Public Input

Group participants identified several restoration opportunities in these two tributaries. These included development of wetlands between Crackerville and Warm Springs Ponds; improving public access to the headwaters area of Mill Creek for recreation and hunting; acquisition of land adjacent to the Mount Haggin State WMA; and construction of a connector trail to Anaconda. Concerns raised included potential contamination in upper Mill Creek, noxious weeds and the possibility for subdivision of lands adjacent to the Mount Haggin State WMA.

Table 7-12: Summary of public input for the Mill and Willow creeks sub-watershed.

Topic	***Type***	***Comments***
Wildlife/Vegetation	Priority/concern	Improve vegetative cover for wildlife; address weed problems
Wildlife/Vegetation	Priority	Develop wetlands between Crackerville and Warm Springs Ponds
Recreation/Access	Priority	Improved public access to Mill Creek headwaters would be desirable
Recreation	Priority	Connector trail to Anaconda
Pollution sources	Concern	Potential contamination in upper Mill Creek from storm water
Land Acquisition Wildlife/protection of existing resources	Concern and priority	Potential for subdivision on lands adjacent to Mt. HagginWMA;.acquire land to protect wildlife resources

7.2.8 Sources of Environmental Impairment

There are several potential sources of environmental impairment in the Mill and Willow creeks sub-watershed (Table 7-13). Metals, fine sediment, and nutrients are the primary pollutants of concern in this basin. Sources of metals include storm water runoff from smelter-contaminated hillslopes, contaminated groundwater from the Opportunity Ponds (NRDP 1995c), railroad and road crossings over streams, and the Yellow Ditch.

Nuisance algae growth in both Mill Creek and Willow Creek indicate that nutrients are also potentially impairing water quality. The high density of old septic systems in Opportunity suggests this could be a source of impairment. However, recent sampling of groundwater in and around the town of Opportunity indicates nitrate levels below water quality standards, ranging from 0.05 to 0.6 mg/l (WET, 2003). High groundwater flux may be mitigating any nutrient impact from septic tanks. The source of nuisance algae is still unknown.

Excessive sediment is entering Mill Creek and Willow Creek from several sources. These include cattle grazing, riparian degradation, hillslope erosion exacerbated by timber harvests, and road and railroad stream crossings. The aerial assessment (Appendix D) performed as part of this study identifies potential impairments by reach. Reaches correspond to those displayed in Figure 7-4.

Table 7-13: Sources of water quality and habitat impairments in the Mill and Willow creeks sub-watershed.

Impairment Source	***Contaminants***	***Data Sources***
Storm water runoff from smelter impacted hillsides	Metals	NRDP 2002b, 2002c, and 2002d; CDM (2001 and 2002)
Yellow ditch	Metals	Focus groups
Mine waste rock in railroad beds at stream crossings	Metals	Montana DEQ, 2002b
Unknown source of nuisance algae in Mill and Willow creeks near the town of Opportunity.	Nutrients	Montana DEQ, 2002b, WET, 2003
Stream dewatering	Exacerbates any pollutants present	MFISH, 2003; Montana DEQ 2002b
Cattle Grazing	Sediment	Public Input, Interfluve, 2003, Montana DEQ, 2002b
Riparian degradation	Sediment	Montana DEQ, 2002b
Roadway crossings	Sediment, metals (locally)	Montana DEQ, 2002b
Timber harvest (Willow Ck headwaters)	Sediment	Public input, aerial assessment

7.2.9 Restoration Needs

Historically, Willow Creek and Mill Creek both drained directly into Silver Bow Creek. Mill Creek was a braided stream that occupied several channels after reaching the valley foothills. One of these channels reached Willow Creek near the present day confluence of these two streams and others flowed to the north directly into Silver Bow Creek. Mill Creek also appears to have fed a large wetland complex in the current location of the Opportunity tailings (GLO, 1869). Around 1969 or 1970, the Anaconda Company constructed the Mill-Willow bypass along the western edge of the Warm Springs Pond system (EPA, 2000). This prevents Mill Creek and Willow Creek from discharging into Silver Bow Creek until downstream of Warm Springs Ponds.

An important part of stream restoration in the Mill and Willow creeks sub-watershed is to determine the ultimate fate of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River. Currently, the entire discharge of Silver Bow Creek undergoes treatment in the Warm Springs Ponds to remove metals and arsenic and is isolated from the Clark Fork River with respect to fish passage. After remedial actions in the Silver Bow Creek SSTOU are complete, improved water quality in Silver Bow Creek may alleviate or reduce this requirement. The intent of Silver Bow Creek basin-wide remedial actions at the Silver Bow Creek/Butte Area NPL site is to allow clean Silver Bow Creek water to flow directly to the Mill Willow Bypass and into the Clark Fork River (EPA, 2000). The Mill-Willow Bypass channel was therefore constructed to safely route flood flows up to 70,000 cubic feet per second for the combined flows of Silver Bow, Willow and Mill Creeks during a probable maximum flood event. The timeframe for this to occur is unknown, however, this may occur in a matter of decades. The majority opinion is that the Warm Springs Ponds need to remain saturated to minimize release of contaminants to groundwater and to preserve existing wildlife habitat (wetlands, ponds). Recent public discussions of this issue brought forth the following questions:

- Can Willow Creek be re-connected to Silver Bow Creek after Silver Bow Creek water quality improves?
- Can the Clark Fork River fishery be reconnected to Silver Bow Creek to link the habitats?
- Can Silver Bow Creek flow be split between the Warm Springs Ponds and the Mill-Willow Bypass?
- Is removal of the Warm Springs Ponds the optimal remedy?

Restoration activities potentially impacted by decisions regarding this issue should not necessarily wait until this issue is resolved. However, restoration planning should take into account how future changes in the connection of Silver Bow Creek and the Clark Fork River could affect restoration. Table 7-14 identifies restoration needs for this watershed. An explanation of the rank, category, and agency/other responsibility columns in Table 7-14 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-14: Restoration needs for the Mill and Willow creeks sub-watershed.

Rank	***Category***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***
3	Fisheries	The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	Investigation should be conducted as to the ultimate fate and the implications of changing the configuration of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River prior to EPA's determination of a final remedy for the Ponds. See also deferred category #59.	ARCO, EPA, Montana DEQ, NRDP, FWP
12	Protect Existing Resources	Critical wildlife winter range exists along the public land/private land boundary and could be developed.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.	
13	Water Quantity	Dewatering for irrigation impairs fisheries and exacerbates water quality problems.	Increase instream flow during critical life stages of fish through water leasing, conservation and other measures.	
21	Pollution Mitigation	Storm water runoff from smelter fallout contaminated hillslopes continues to deliver metals to Mill Creek and to a lesser extent, Willow Creek.	The outcome of pending remedial action/remedial design and litigation may address part of this issue. The State's restoration claim and plan cover the needed actions.	ARCO, EPA, Montana DEQ, NRDP
26	Vegetation	Smelter emissions have caused widespread contamination of soils with metals and arsenic in upland areas around Anaconda, degrading vegetation and wildlife habitat.	The outcome of current remediation and litigation is anticipated to address this problem. Restoration of the upland areas is addressed in the State's 2002 restoration plan.	ARCO, EPA, Montana DEQ, NRDP
29	Pollution Mitigation	The Yellow Ditch, the Blue Lagoon, and railroad and road crossings over streams are all sources of metals contamination to Mill and Willow creeks.	Ongoing remediation and the outcome of current litigation may address some of these sources of contamination. Identify, assess, and restore those not the subject of these efforts.	ARCO, EPA, Montana DEQ, NRDP
37	Vegetation	Livestock grazing degrades riparian vegetation and causes bank erosion.	Restore healthy riparian zones through better grazing management and re-vegetation. Stream restoration measures may be necessary locally. See also deferred restoration need #60.	
45	Recreation	Public access is lacking.	Seek recreational access through easements, acquisitions, or access programs.	

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
46	Pollution Mitigation	Mining related contaminants are present in groundwater underneath the Opportunity Ponds. These contaminants may eventually reach Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek.	Metal contamination from this source should be minimized to limit impact to these streams. Current amounts of contaminants (metals) from this source reaching Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek are believed to be low. Identified contaminant plumes of cadmium, lead, zinc, and arsenic are believed to be slow moving. Secondary contaminants iron, manganese, and sulfate are faster moving and at higher levels, but do not present significant environmental impacts.	ARCO, EPA, Montana DEQ, NRDP
47	Pollution Mitigation	Nuisance algae is observed in both Mill and Willow creeks. Sources and impacts to fisheries are unknown.	Investigate potential sources and impacts. Reduce nutrient loading as determined necessary from studies.	
48	Pollution Mitigation	Excessive siltation is reported in both Mill and Willow creeks. Reduced vegetative cover resulting from smelter impacts exacerbates erosion.Other known sources are timber harvest in the upper reaches of Willow Creek, road and railroad crossings, and cattle grazing.	Via remediation and restoration activities in the Anaconda Uplands, vegetation cover will be increased (refer to restoration need #26). Address other known sources of siltation through implementing better timber harvest and grazing management and restoration measures where appropriate.	
NA	Pollution Mitigation	Tailings from the 1908 flood of Silver Bow Creek have been deposited in the floodplain of Willow Creek.	This area is currently the subject of joint restoration and remedy planning and likely to be adequately addressed via that process.	ARCO, EPA, Montana DEQ, NRDP

7.2.10 Data Gaps

Like many of the tributaries to Silver Bow Creek, streams in the Mill and Willow creeks sub-watershed have received little scientific investigation leading to significant data gaps (Table 7-15). As a result, there is an overall lack of information regarding water quality, vegetation, stream habitat, fisheries, and land use throughout the tributary sub-watersheds. Lack of these types of data may pose limitations for restoration project planning. Therefore, restoration of this sub-watershed should begin with an assessment of conditions that will influence the location for restoration, baseline conditions, likelihood for success, and cost effectiveness of restoration.

Table 7-15: Data gaps in the Mill and Willow creeks sub-watershed.

Data Gap	***Uses***
General information on tributaries to Willow Creek or Silver Bow Creek such as Gregson and Whitepine Creeks in the southest portion of the sub-watershed.	Assessing riparian degradation, siltation, and other issues that may degrade water quality in Willow Creek or Silver Bow Creek
The cause of nuisance algae in the Opportunity area is unknown.	Determine if nuisance algae is caused by nutrient enrichment which may pose risks to fisheries.
Water quality data for the upper reaches of Willow Creek and more recent water quality data for the upper reaches of Mill Creek.	Evaluating baseline conditions for planning projects that may benefit water quality.
Stream habitat data.	Planning appropriate stream restoration measures
Riparian vegetation inventory	Planning grazing management and riparian restoration
Detailed soils mapping. Preliminary detailed soils mapping is available for Deer Lodge County. However, Silver Bow County soils mapping will not be available until 2005.	Planning vegetation, soils, and stream restoration in the southeast portion of this sub-watershed that is in Silver Bow County.
The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	An important part of stream restoration in the Mill and Willow creeks sub-watershed is to determine the ultimate fate of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River.

7.3 German Gulch Sub-watershed

The German Gulch sub-watershed lies in the southwest portion of the study area and is approximately 51 square miles (32,528 acres) in size (Figure 7-6). The sub-watershed includes German Gulch and major tributaries such as Beefstraight Creek and Norton Creek. The watershed also includes Lone Tree Gulch (to the east of German Gulch) and its upstream area that drains directly into Silver Bow Creek at Miles Crossing. Average elevation is 6,666 feet above sea level and average annual precipitation is 20.67 inches/year, the highest elevation and precipitation of the sub-watersheds in the study area. Land ownership is 66% USFS, 16% Montana FWP, and 18% private. Geology consists primarily of Tertiary volcanic rocks, Tertiary sedimentary rocks, and Cretaceous intrusive rocks.

Figure 7-5: German Gulch downstream of Beefstraight Creek.

German Gulch is highly valued for its native westslope cutthroat trout. However, there are several threats to the health and persistence of this population, including metals and cyanide contamination and competition from non-native brook trout. Water quality and fish tissue sampling since 2001 revealed the presence of excess selenium, most likely originating from the closed Beal Mine, which puts this resource at risk. Selenium bioaccumulates and may decrease reproductive viability of this population. Cyanide, a recently discovered pollutant, is a toxic compound comprised of carbon and nitrogen that inhibits oxygen metabolism in organisms exposed to toxic concentrations. Habitat alterations are also a limitation that restricts the amount and quality of available habitat. Historic placer mining in the watershed has disturbed riparian vegetation and stream habitat. The designation of the placer mined reaches as a cultural resource presents an important consideration in restoration activities in the German Gulch basin.

The German Gulch sub-watershed is also rich in wildlife resources. It encompasses a portion of the Mount Haggin State WMA (the largest management area of this type) and the smaller Fleecer Mountain StateWMA. These areas support abundant deer, moose, and elk populations and provide critical winter range to these big game species.

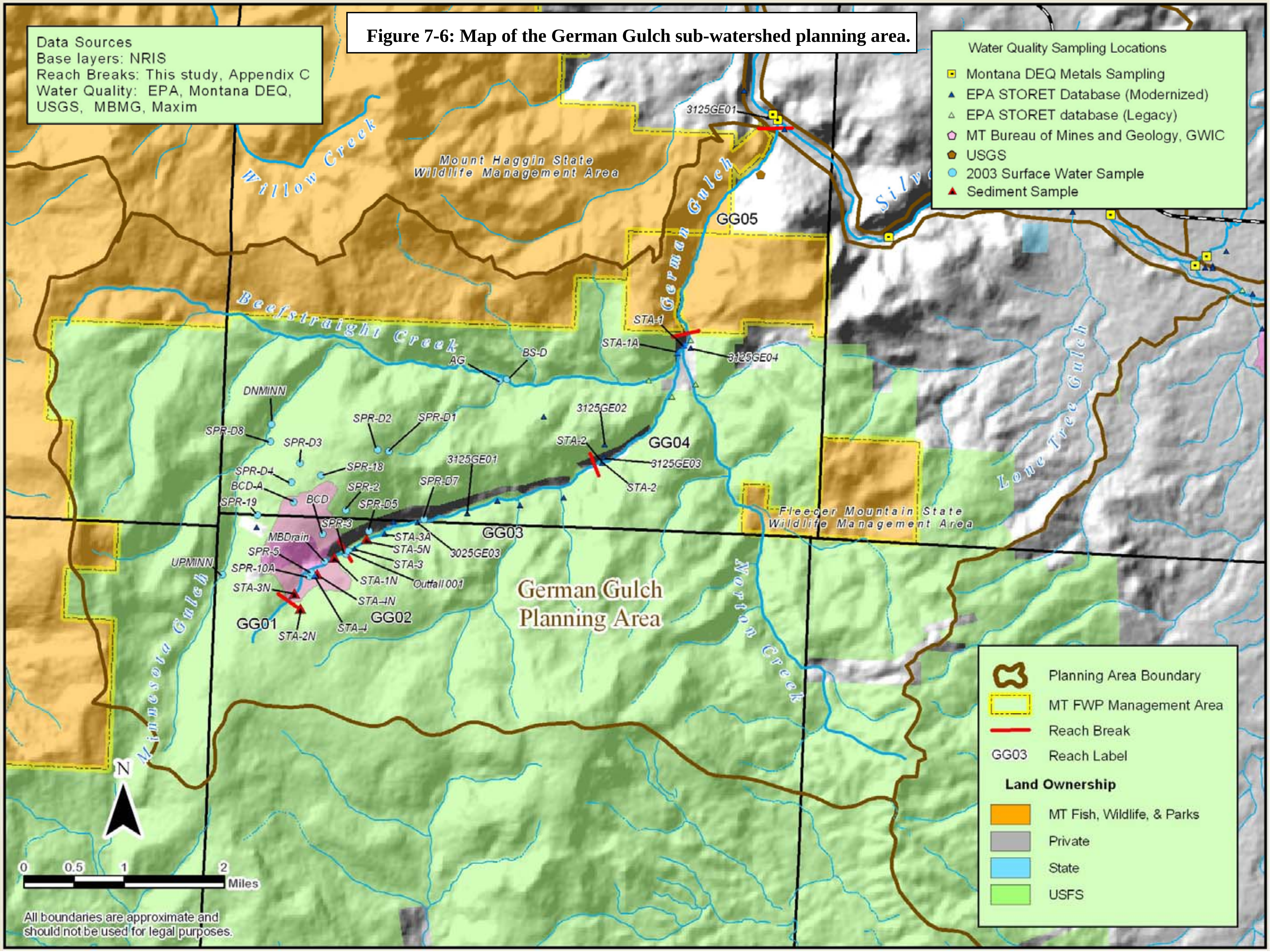


Figure 7-6: Map of the German Gulch sub-watershed planning area.

7.3.1 Water Quality

German Gulch is a new addition to Montana's 303(d) list of impaired waters due to recently documented violations of state water quality standards and only partial support of beneficial uses (see Section 6.11.2). Important environmental considerations in the rationale for inclusion of German Gulch on the 303(d) list include evidence of elevated selenium (Table 7-16). Data collected by the USFS in 2003 confirm selenium as a probable cause of impairment and indicate elevated cyanide concentrations in German Gulch and several tributaries (Beaverhead Deerlodge National Forest, 2003c). In addition, these data also indicate nitrogen loading, probably from previous mining activities at the Beal Mine, exceeds narrative standards aimed at preventing eutrophication. Montana DEQ is the party responsible agency in compilation of the 303(d) list and may decide to include cyanide and nutrients on the 2006 303(d) list following their regular list review activities. Despite these water quality concerns, there has been improvement in water quality following cessation of mining activities and subsequent reclamation in the German Gulch watershed judged by the 2003 dataset.

Metals and Cyanide

Data collected prior to closure and subsequent reclamation at the Beal Mountain Mine in 1998 indicated mining activities contributed metals in excess of state water quality standards between 1987 and 1994. STORET and Legacy STORET sampling activities on German Gulch indicated probable impairment from metals and arsenic contamination. Concentrations of metals and arsenic in German Gulch were generally higher at the upper sites located close to the Beal Mine (see Appendix C for data; Map 1 and Figure 7-6 for sampling locations). According to state standards, occurrence of at least one cadmium, copper, selenium, and zinc concentrations in excess of the acute aquatic life standard is sufficient for these pollutants to be considered a probable cause of impairment. Similarly, arsenic concentrations in excess of the human health standard (18 µg/L) were consistent with impairment for this element, as state standards require no sample exceed this concentration.

Impairment from cadmium, copper, selenium and arsenic was most apparent near the Beal Mountain Mine. Concentrations of these constituents decreased in a downstream direction with concentrations of arsenic and metals at downstream sampling sites frequently below detection limits. Nevertheless, a single copper concentration in excess of the acute aquatic life standard at the lowest station presented a violation of state water quality standards. No data were available to evaluate the spatial persistence of selenium in this data set.

Table 7-16: 303(d) listing in formation for German Gulch (Montana DEQ, 2002b).

Beneficial Use	*Sufficient Credible Data*	*Level of Support*	*Summary of Montana DEQ listing comments*
Aquatic Life	Yes	Partial Support	The acute aquatic life standards for selenium, cadmium, copper and arsenic were exceeded during sampling events conducted between 1997-1995 and between 1997-1998, with the most frequent water quality violations occurring for selenium. Nitrogen levels observed in 1994 exceeded Montana DEQ guidance levels.
Cold Water Fishery	Yes	Partial Support	Based on USFS sampling in 2001 and 2002, levels of selenium were found in fish tissues above background levels, including a sample measured at more than 200% of background levels.
Agriculture	Yes	Full Support	Although selenium concentrations exceeded reference conditions, the water is still suitable for agricultural purposes.
Industrial	Yes	Full Support	Specific conductivity levels were in the low to medium ranges.
Drinking Water	Yes	Full Support	In 1997, selenium levels exceeded drinking water standards at a location of a new waste rock dump for the Beal, which was subsequently reclaimed. Resampling in 1999 and 2002 indicated selenium levels declined to below standards.
Contact Recreation	No	Full Support	Information is lacking on Chlorophyll A data and observations about algae blooms.

In addition to presenting toxic conditions, metals concentrations in German Gulch related to mining may also have limited available habitat for fish by creating zones of fish avoidance. Copper concentrations frequently and substantially exceeded the Idaho DEQ (2000) avoidance threshold for copper (3 µg/L) at upstream German Gulch sampling stations (see Appendix C, Map 1, Figure 7-6). In addition, zinc pollution likely inhibited fish movement in German Gulch with concentrations substantially exceeding the Idaho DEQ (2000) avoidance level of 28 µg/L. These chemical barriers to spawning areas may have resulted in impairment of this important fishery.

Data collected following cessation of mining activities and subsequent reclamation activities provide a more current picture of water quality in the German Gulch watershed. These include assessments of water chemistry, fish tissue analyses, and benthic sediment. These more recent data present a picture of continued impairment; however, pollutants of concern have changed since closure of the Beal Mountain Mine.

In 2003, water chemistry data collected at locations throughout the watershed (Figure 7-6 and Map 1) by the USFS confirms impairment from selenium (Beaverhed Deerlodge National Forest, 2003c). Selenium concentrations exceeded chronic aquatic life concentrations at all sites and among all samples (see Appendix C). Selenium concentrations were the highest near the Beal Mountain Mine where they exceeded acute aquatic life standards and human health standards. Selenium concentrations declined in the downstream direction although impairment was evident to the mouth.

This monitoring effort also provided evidence that cyanide impaired surface water quality in German Gulch. Cyanide concentrations peaked near the mine and declined in a downstream direction (see Appendix C). These elevated concentrations typically exceeded the chronic aquatic life standard indicating moderate impairment from this pollutant.

Cyanide concentrations were also elevated in other streams in the German Gulch drainage (see Appendix C). Cyanide concentrations frequently exceeded both the chronic and acute aquatic life standards in Minnesota Gulch and Beefstraight Creek. The two samples from an unnamed tributary (BCD-A) exceeded the higher, human health standard for cyanide. While sources of cyanide are still being determined, groundwater contamination and land application of wastewater from the Beal Mine are possible routes of delivery.

The water quality sampling in 2003 indicated several pollutants of concern have diminished as water quality concern in German Gulch or its tributaries. Arsenic, a carcinogenic constituent, was frequently below detection limits and never exceeded any of the numeric standards. Copper, a pollutant that frequently exceeded acute aquatic life standards in the 1980s and 1990s, was also frequently below detection limits. Copper exceeded water quality standards only once among the 101 samples collected in this effort, although it was in excess of the acute aquatic life use standard. This sample was collected in Beefstraight Creek. This represents a violation of state water quality standards as no sample may exceed the acute aquatic life standard.

Zinc concentration in 2003 did not violate state standards; however, this pollutant may still have negative effects on the German Gulch fishery by creating zones of fish avoidance. The 75th percentile of zinc concentrations were at the threshold of 3 µg/L for the sampling stations closest to the mine (see Appendix C). This presents a borderline case for fish avoidance; however, the data suggest at least temporary barriers to fish movement.

Analyses of fish tissue also provide recent evidence of selenium contamination in German Gulch and its tributaries (La Marr, 2002 and 2003a). Selenium levels found in whole fish tissue samples collected in 2002 at stations in upper and middle German Gulch were above the range of suggested toxic effects threshold levels (La Marr, 2002). Evaluations of aquatic macroinvertebrate tissues and fish eggs also implicate selenium as a contaminant on Beefstraight Creek upstream of its confluence with German Gulch, and three stations located in upper, middle, and lower German Gulch (LaMarr 2003a). Using an aquatic hazard assessment method, the results indicate a high hazard ranking based on selenium concentrations found in fish eggs at the middle and lower German Gulch stations and in macroinvertebrates at all sampling locations. La Marr (2003a) concluded that at least 4.25 miles of the main stem of German Gulch appears to be experiencing elevated selenium levels in aquatic fauna consistent with this high hazard ranking.

Macroinvertebrate and periphyton evaluations did not provide evidence of metals contamination in German Gulch (McGuire and Weber, 1997; McGuire and Weber, 2000). Sampling occurred on two locations on German Gulch, just inside the Beal Mountain Mine property boundary just downstream of the mine and approximately 1.75 miles downstream. A site on Greenland Gulch upstream of the confluence with German Gulch provided an internal reference. These studies did not indicate metals pollution on German Gulch. However, the percent abnormal cells metric (a diatom metric sensitive to metals contamination) was not included in the suite of reported metrics.

The trend of higher concentrations of metals in the headwaters of German Gulch is a significant concern for westslope cutthroat trout in this drainage. Resident and migratory westslope cutthroat trout rely on small headwater streams for spawning and rearing habitat (Rieman and Apperson, 1989). Elevated arsenic and metals concentrations in these important areas may increase risks to sensitive juvenile life history stages. Furthermore, even temporary concentrations of metals that cause fish avoidance may limit fish movement in the basin.

Benthic Sediments

Benthic sediments sampled near the mouth of German Gulch in 1987 were below levels associated with risks to fisheries and aquatic life (CDM 2004, Appendix C). Metals analyzed in this effort included arsenic, cadmium, copper, lead, and zinc. This sampling predated the identification of selenium as a probable cause of impairment in German Gulch. Additional information on concentrations of selenium in benthic sediments would strengthen the understanding of risks to aquatic life associated with this potential source.

Benthic sediment sampling in 2003 identified arsenic and selenium concentrations as contaminants of concern (Dodge, 2004). These concentrations were greatest at sampling stations near the Beal Mountain Mine. Elevated concentrations of selenium and arsenic may be toxic to benthos and provide a route of bioaccumulation of selenium.

Siltation

Results of biomonitoring (McGuire and Weber, 1997; McGuire and Weber, 2000) indicate minor impairment from siltation near the Beal Mine. Conditions improved downstream of the mine, to a rating of excellent biological integrity. Greenland Gulch, a tributary stream, was sampled as an internal reference. This site demonstrated excellent biological integrity in both 1997 and 2000.

Nutrients

Elevated nitrogen levels frequently result in blooms of nuisance algae. A 1994 sampling event on German Gulch showed nitrogen levels above the Montana DEQ guidance level of 350 µg/L, with 80,000 µg/L detected at a station downstream of the Beal Mine and 500 µg/L detected about 0.35 mile downstream of that location (Montana DEQ, 2002b). Potential sources identified included the presence of blasting agent (ANFO) residues on waste rock and ore and the use of nitrogen-based fertilizers for reclamation activities. Nitrogen levels may have changed considerably since this sampling event in 1994, given the mine shutdown in 1998 and scaled back reclamation activities. Activities associated with the TMDL development process will address this issue further (Section 6.11.2). TMDLs for German Gulch are currently scheduled for completion in 2007.

Water quality monitoring in 2003 provides additional evidence of elevated concentrations of nitrate + nitrite as nitrogen. Comparing concentrations of this parameter to those measured throughout the Middles Rockies ecoregion indicates that concentrations were substantially greater than "typical" for the ecoregion (Table 4-4, Richards and Miller, 2000, and Appendix C). Concentrations of this parameter habitually exceeded the maximum measured for the ecoregion near the mine. These levels diminished substantially at the lower sampling stations. Nevertheless, it is apparent that nutrient loading from the Beal Mine site presents a localized risk of eutrophication to German Gulch. Potential sources of this nitrogen include residues from blasting agents used in mine operations and cyanide, which readily breaks down in water to form nitrate and ammonia. Both constituents have potential to cause eutrophication at concentrations below numeric standards to prevent toxicity.

7.3.2 Water Quantity

Both public comment and the Montana DNRC water rights database note the presence of a large irrigation diversion just upstream from the confluence of German Gulch with Silver Bow Creek. This diversion reportedly traps fish at times. In 2005, the State approved NRD grant funding to replace the irrigation headgate and to lease 2 cfs of an irrigation water right in order to provide for fish passage and connectivity between German Gulch and Silver Bow Creek.

Examination of the DNRC water rights database indicates the presence of 219 water right points of use corresponding to 83 water rights (Table 7-17). The maximum permitted water withdrawal for all 83 water rights is 151.5 cfs. The majority of these are for irrigation (30.1%, 124.5 cfs) and mining (24.2%, 24 cfs). Maximum and minimum daily mean flows recorded at the USGS station at the mouth of German Gulch (station 12-3235) between 1955 and 1969 were 300 cfs and 2.8 cfs, respectively.

Table 7-17: Water rights in the German Gulch sub-watershed (DNRC database).

Purpose	***No. of Water Rights (Points of Use)***	***Percent of Water Rights (Points of Use)***	***Maximum Permitted Withdrawal (cfs)***	***% of Maximum Permitted Withdrawal***
Domestic	25	11.4%	1.1	0.7%
Fish and Wildlife	2	0.9%	<0.1	<0.1%
Irrigation	66	30.1%	124.5	82.2%
Lawn and Garden	3	1.4%	<0.1	<0.1%
Mining	53	24.2%	24.0	15.9%
Power Generation, Nonconsumptive	1	0.5%	1.9	1.2%
Stock	69	31.5%	<0.1	<0.1%
TOTAL	219		151.5	100%

7.3.3 Fisheries

The German Gulch basin has perhaps the most highly valued fishery in the Silver Bow Creek watershed. German Gulch rates as an outstanding to high-value fishery resource using Montana FWP's rating system, which incorporates information on species composition, abundance, fish size, and recreational values. The presence of westslope cutthroat trout contributes to this high rating.

Compared to other sub-watersheds in the Silver Bow Creek basin, the German Gulch fisheries are well studied. Fisheries investigations conducted over three decades have provided a wealth of information (Cook, 2003; La Marr, 2002 and 2003a; Leary, 1984; Montana FWP, 1984; Peters, 1980; Tohtz, 1992). Westslope cutthroat trout and brook trout are both abundant within the watershed. Rare observations of brown trout have also been made in lower reaches of German Gulch. However, more recent sampling efforts have not encountered any brown trout (Spoon, 2004c). Westslope cutthroat trout genetics results from a set of 9 samples collected in Clear Creek (tributary to Beefstraight Creek) in 2003 suggest that this population may be genetically pure (Spruell, 2004). These findings are likely to apply to 0.5 mile of stream habitat. Additional sampling is needed to confirm this suggestion with greater statistical validity.

In 2003, genetic sampling of westslope cutthroat trout in German Gulch indicated genetic introgression in the population, with two cutthroat trout having rainbow trout diagnostic alleles. Fish biologists consider the population 99.5% pure as opposed to 100% (Shepard, 2003). Despite this, conservation of the westslope cutthroat trout in the German Gulch watershed is a management priority for Montana FWP. Management strategies under development for the German Gulch watershed are likely to include a fish barrier at the mouth to prevent further introgression of rainbow trout and invasion of other non-native fish (Spoon, 2002). Brook trout suppression is also under consideration for this basin to reduce brook trout competition with cutthroat trout. In 2003, the USFS and Montana FWP initiated a multi-year cooperative project to suppress brook trout in Norton Creek, an important tributary to German Gulch not affected by selenium contamination (Montana FWP, 2003b). As discussed in section 7.1.9, a permanent fish barrier may need to be designed for Silver Bow Creek to prevent non-native trout in Warm Springs Ponds from becoming established in the watershed upstream of the barrier.

Angling pressure data are available for several streams in the German Gulch sub-watershed (MFISH, 2003). Norton Creek received the greatest overall fishing pressure of any of the streams in this sub-watershed. German Gulch and Beefstraight Creek experience similar levels of angling pressure with generally less than 400 angling days per year. Resident anglers were responsible for the majority of angler days on these streams; use by out of state anglers was negligible.

Habitat assessments of German Gulch describe a range of habitat degradations from Edwards Creek to Silver Bow Creek (Confluence and Kingfisher, 2002). Historic and current land use practices include placer mining, large-scale hydraulic mining, lode mining, timber harvest, and livestock grazing. The impacts of these activities include the following (Confluence and Kingfisher, 2002):

- Removal of fines from channel and floodplain substrates, causing increased hydraulic conductivity and consequent reductions in surface water flows;
- Removal of small gravels and elimination of natural bedload sorting processes from the channel resulting in a reduction in spawning habitat;
- Removal of boulders, large woody debris (LWD) and other pool forming agents from the channel causing the elimination of a majority of adult and overwintering habitat for westslope cutthroat trout; and
- Removal of riparian vegetation and soils on the floodplain prevents the reestablishment of a healthy riparian corridor, and promotes the spread of noxious weeds.

To summarize, the German Gulch drainage provides a refuge for slightly-hybridized westslope cutthroat trout, a species of special concern and a management priority for state and federal agencies. The presence of habitat degradation, metals contamination, and competing species are concerns for the persistence of westslope cutthroat trout in German Gulch and the Silver Bow Creek watershed. Habitat information on tributary streams would be helpful in guiding restoration to benefit this important population.

7.3.4 Vegetation

The USGS GAP vegetation (Figure 6-10 and Figure 6-11) and the USGS NLCD data sets indicate three major cover types present; forest (68%), grass (24%), and shrubs (8%). USGS GAP vegetation analysis data indicate slightly more shrublands and correspondingly fewer grasslands than the NLCD data. Both datasets indicate the presence of approximately 1% riparian or wetland areas in the German Gulch sub-watershed.

Bitterroot Restoration (2002) conducted vegetation sampling in the German Gulch sub-watershed as part of baseline vegetation analysis for restoration planning in the Stucky Ridge, Mount Haggin, and Smelter Hill injured areas. This study identified 18 distinct vegetation habitat types based on moisture requirements. Overall results of the Bitterroot Restoration study reflect the same general pattern of forest/grassland/shrubland as the NLCD or GAP data and provide detailed information for these areas.

Prodgers (2003) conducted a vegetative survey of the upland and riparian areas in lower German Gulch and concluded that vegetation along German Gulch has largely recovered from a history of destructive land uses. However, some areas remain impacted. Deciduous tall shrubs, such as dogwood and alder dominate the riparian zone. Understory vegetation is variable but consists mostly of grasses. Vegetation in the upland zones is primarily coniferous forest with Douglas fir as the main overstory species. As typical in Douglas fir forest communities, shrubs and grasses make up the understory. Weeds, particularly Canada thistle and knapweed, are a major concern to natural recovery of the area. To promote natural recovery at impacted sites, this study recommended: 1) removing or isolating the mine-waste roadbed material near the confluence of German Gulch and Silver Bow Creek; 2) controlling weeds throughout the area; and 3) eliminating human and livestock instances of weed dispersal to the extent possible.

Prodgers (2003) identified livestock exclusion as a more effective restoration measure than livestock fencing.

7.3.5 Wildlife

The German Gulch sub-watershed contains the southern portion of the Mount Haggin State WMAand the Fleecer Mountain State WMA. The Mount Haggin WMA is the largest management area of its type in the state. Montana FWP statewide wildlife distribution data (Figure 6-13) shows the presence of a large concentration of mule deer and elk winter range in both the German Gulch and Mill and Willow creeks sub-watersheds. Analysis of detailed aerial winter sighting data collected by Montana FWP from 1977 to 2002 provided a second data source to identify seasonal habitat use (Montana FWP, 2004 and Appendix E). These data also indicate important elk winter habitat exists in this planning area. Conversations with Montana FWP personnel indicate that lion, bear, and mountain grouse are also important wildlife species in this planning area. The suitability of this area for game species suggests it also provides suitable habitat for non-game species of wildlife.

7.3.6 Recreation

German Gulch is a popular recreational area for local residents. Fishing, hunting, camping, horse riding and motorized trail riding are all popular. Montana FWP angling use surveys indicated that German Gulch, Beefstraight Creek, and Norton Creek all experience moderate angling use almost exclusively from residents. Portions of the Continental Divide National Scenic Trail will be in this sub-watershed (Beaverhead-Deerlodge National Forest, 2003a).

7.3.7 Public input

Focus group comments identified a number of priorities for the German Gulch sub-watershed addressing fisheries, recreation, environmental contamination, and weeds (Table 7-18). Several focus groups noted the opportunity that German Gulch presents as an important spawning tributary to Silver Bow Creek. Shared priorities identified by the groups were (1) acquisition of mining claims along the riparian corridor; (2) restoration of trout habitat and floodplain vegetation; and (3) development of a trail connecting the area to the Silver Bow Creek Greenway.

Several concerns arose regarding conditions that threaten potential restoration priorities. Among these were protection of genetically pure westslope cutthroat trout populations and addressing competition from non-native brook trout. Several groups shared serious concerns regarding long-term care and restoration of Beal Mine. There was also uncertainty regarding ownership of mining claims along the stream corridor and the potential effects of land development on agricultural water rights. Other German Gulch concerns included conflicts involving off-road vehicle uses, stream dewatering and noxious weeds.

Table 7-18: Summary of public comment for the German Gulch sub-watershed.

Topic	*Type*	*Comments*
Fisheries	Priority	Important spawning tributary to Silver Bow Creek
Protection of existing resources	Priority	Acquisition of mining claims along riparian corridor
Fisheries and vegetation	Priority	Restoration of trout habitat and floodplain vegetation
Recreation	Priority	Trail connecting to Greenway
Recreation	Priority	Public access is important and additional access points are desired.
Fisheries	Concern	Protection of genetically pure westslope cutthroat trout
Fisheries	Concern	Competition with non-native brook trout
Pollution sources	Concern	Prolonged effects of Beal Mine
Recreation	Concern	Conflicts with OHV usage
Water Quantity	Concern	Dewatering
Weeds	Concern	Control of noxious weeds

7.3.8 Sources of Environmental Impairment

A significant source of environmental contamination in the German Gulch sub-watershed is the closed Beal Mountain Mine. Pegasus Gold developed and operated the mine from 1988 until January 1998 when the company filed for bankruptcy. The bankruptcy trustee then assumed reclamation and closure work using reclamation surety bonds held by Montana DEQ and the USFS. Current known sources of environmental impairment in the German Gulch sub-watershed from the Beal mine include selenium from the waste rock dump and areas where waste rock was used and selenium in solution contained within the leach pad. Necessary reclamation activities have already exceeded the existing bonds, and the USFS and Montana DEQ are now addressing the site under the federal Superfund process. Public input identified livestock grazing as another potential current source of impairment in the German Gulch sub-watershed. Confluence and Kingfisher (2002) and Prodgers (2003) also identified livestock grazing as a source of impairment. Table 7-19 lists the known impairment sources, contaminants likely to originate from those sources, and available data sources.

Table 7-19: Sources of water quality and habitat impairments in the German Gulch sub-watershed.

Impairment Source	*Contaminants/Disturbance*	*Data Sources*
Selenium from the waste rock dump and land application of treated leach pad solution water at the Beal Mine.	Selenium	Montana DEQ (2002b), La Marr, 2002 and 2003[a].
Metals from various aspects of mining operations at the Beal Mine	Copper, arsenic, cadmium, zinc	STORET, Montana DEQ (2002b), La Marr, 2002 and 2003a.
Blasting agents or reclamation activities at the Beal Mine and cyanide	Nitrogen in excess of narrative standards	Montana DEQ (2002b)
Grazing has impacted stream habitat.	Siltation	Public comment, Confluence and Kingfisher, 2002, and Prodgers, 2003.

7.3.9 Restoration Needs

Restoration needs summarized in Table 7-20 include addressing current sources of pollution or impairment to German Gulch and tributary streams as well as historic disturbances that may still pose limitations to aquatic or terrestrial habitats. In addition, there are private lands with either critical fish habitat or wildlife winter range that are at risk for development. Protection of these high quality existing resources is a priority. An explanation of the rank, category, and agency/other responsibility columns in Table 7-20 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-20: Restoration needs of the German Gulch sub-watershed.

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
7	Protect Existing Resources	A significant native WCT population needs preservation and protection. Chronic competition from brook trout may jeopardize native WCT populations.	Continue actions by Montana FWP and USFS to suppress brook trout. See deferred need #57 associated with Beal Mine.	Montana FWP, USFS
8	Water Quantity	Much of German Gulch is diverted for irrigation just before reaching Silver Bow Creek. This water could significantly help water quality problems in Silver Bow Creek, especially during low flows.	Explore the best alternative for obtaining adequate flows for connectivity with Silver Bow Creek. Alternatives include water conservation, water leasing, alternative irrigation source, or acquisition. In 2005 the State approved funding to the George Grant Chapter of Trout Unlimited to provide for fish passage and this connectivity.	
22	Protect Existing Resources	Riparian lands along lower German Gulch adjacent to the Fleecer Mountain and Mt. Haggin Wildlife Management Areas are at risk for potentially detrimental development. These lands are part of the elk and deer winter range in this area.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.	
27	Recreation	Public input indicates a desire for trail access from Silver Bow Creek.	Examine feasibility and appropriateness of a trail from Silver Bow Creek to German Gulch. In 2005, the State approved for a footbridge and a 2 mile trail in lower German Gulch.	
33	Vegetation	Noxious weed infestations are present and associated with historic placer mining disturbance, grazing, modern mining, and roads.	Take actions to reduce spread of noxious weeds. (See #34 regarding grazing.)	Multiple landowners
34	Vegetation	Livestock grazing has reportedly had a detrimental impact on stream habitat.	Examine grazing practices and implement appropriate grazing management strategies to minimize impacts.	Multiple landowners
38	Recreation	OHV use in the area has caused disturbances.	Examine restrictions on motorized access.	USFS, FWP

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
41	Protect Existing Resources	Private lands (old placer mining claims within the USFS land) along German Gulch are at risk for potentially detrimental development. Already, historic access to private lands in this area has been lost after change in ownership.	Acquire lands or conservation easements to protect these areas from potentially detrimental development. In 2005 the State approved funding to aquire 82 acres of riparian-corridor in lower German Gulch.	
44	Fisheries	Historic placer mining has disturbed both aquatic and riparian habitat.	Restore stream and riparian habitat where habitat has not recovered from placer mining. In 2005 the State approved funding of a stream restoration demonstration project in placer-impacted areas of lower German Gulch.	
NA	Pollution Mitigation	Seepage from a waste rock dump at the Beal Mine has caused releases of selenium and other metals. Selenium levels found in fish tissue exceed aquatic toxicity levels and in down gradient waters exceed aquatic life standards.	Wait for outcome of pending remedial actions by the USFS and Montana DEQ to evaluate need for additional actions to reduce impacts from the seepage and address the future needed treatment of the leachate from the leach pad.	USFS, Montana DEQ

7.3.10 Data Gaps

Several significant data gaps exist for the German Gulch sub-watershed. It appears well established that the waste rock dump and areas within the Beal Mountain mine site where waste rock was used for construction of the main haul road and leach pad dike are the primary source of elevated selenium concentrations in German Gulch. Selenium is also elevated within the leach pad, but off-site selenium contamination has not been detected from this source (Dodge, 2004). Elevated concentrations of copper are restricted to leach pad solution, and arsenic to leach pad solution and German Gulch sediment. Although not a problem at this time, other areas of future concern may include potential acid rock drainage from the waste rock dump and declining pH and alkalinity of the leach pad solution (Plattenberg, 2002). Increasing volume in the leach pad solution may prolong the water treatment requirements for selenium, copper, arsenic, and cyanide. The source for the increased leach pad volume is assumed to be continued draindown, but further monitoring is needed.

Table 7-21: Data gaps for the German Gulch sub-watershed.

Data Gap	***Uses***
Sources of metals and arsenic exceedences are likely from the Beal Mine. Additional sources of concern exist such as additional low pH water infiltrating through the Beal Mountain leach pad and residual nitrogen levels from mine blasting and reclamation activities. More sampling data are needed to confirm.	Planning remedial or restoration activities and TMDL planning. Note: this mine is in the process of becoming a designated Superfund site. Remedial actions associated with this designation will hopefully take care of all contamination problems.
No recent cadmium data is available to evaluate this pollutant following mine closure and reclamation.	Planning remedial or restoration activities and TMDL planning.
Noxious weed inventory spatial data.	USFS noxious weed inventory data cover only a small portion of this watershed. Section based mapping is too coarse to be useful here and does not show weed presence in infested areas identified through the public participation process.
Detailed soils mapping. Preliminary detailed soils mapping is available for Deer Lodge County. Silver Bow County soils mapping is not yet available.	Planning vegetation, soils, and stream restoration in the portion of this sub-watershed that is in Silver Bow County.

7.4 Sand Creek Sub-Watershed

The Sand Creek sub-watershed lies in the south central portion of the Silver Bow Creek watershed and is 54 square miles (34,609 acres) in size. Average annual precipitation is 14.56 inches/year and mean elevation is 5827 feet above sea level. Land ownership is 77% private, 17% USFS, and 6% state. Sand Creek runs from south to north parallel to Interstate 15 and the Union Pacific railroad line and usually has surface flow only during high runoff. The sub-watershed planning area also contains several small tributaries such as Sheep Gulch, Hansen Gulch and Sawmill Gulch (Figure 7-8). Poorly consolidated Tertiary sedimentary rocks dominate the geology of the Sand Creek sub-watershed (Figure 6-8). This rock formation in southwest Montana typically forms soils with high infiltration rates and low available water capacity. As a result, these soils only support dry land vegetation such as low to moderate cover grass and shrubs. These soils also allow rapid infiltration of surface water to groundwater, minimizing surface flows. Land use is primarily grazing, low density residential, and industrial. Industrial facilities are located in the northern part of the sub-watershed and include a closed phosphate processing facility owned by Rhodia, Inc. EPA is currently investigating this facility to determine necessary cleanup actions.

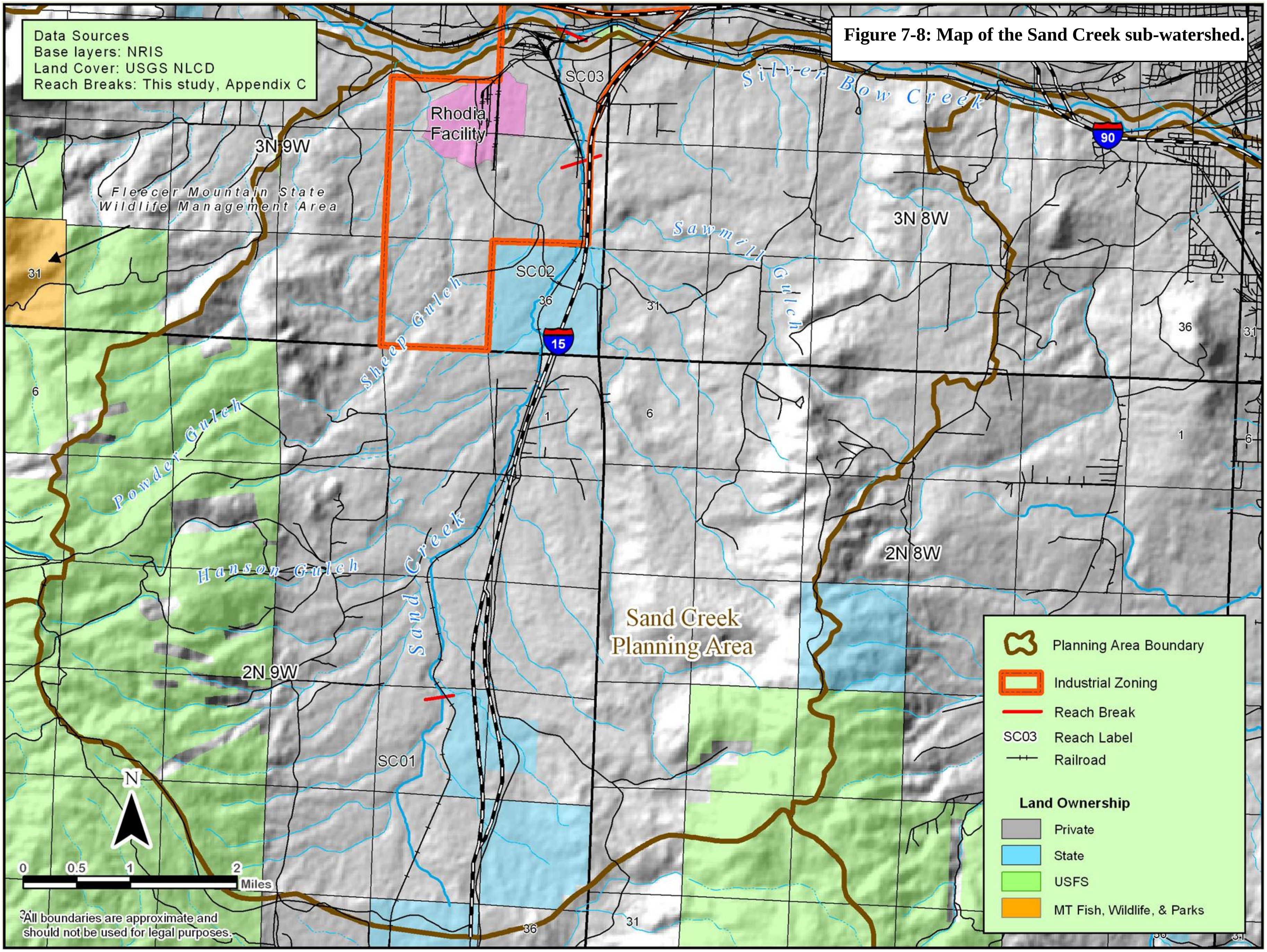
Figure 7-7: Sand Creek near its confluence with Silver Bow Creek.

7.4.1 Water Quality

Water quality information from readily available databases for the Sand Creek sub-watershed is limited and consists solely of groundwater sampling data. Surface water quality data obtained from 1997 investigations of the Rhodia facility are available for Sheep Gulch, a tributary to Silver Bow Creek in the Sand Creek sub-watershed unit. These data indicate Sheep Gulch upstream of the Rhodia facility is calcium-sulfate type water with trace amounts of arsenic, barium, cadmium, iron, and manganese (Montana DEQ, 2001). The northern portion of Sheep Gulch loses water to groundwater aquifers, and as a result, only flows during spring runoff and storm events. Groundwater sampling data are from monitoring at industrial facilities and a few local residential water wells.

7.4.2 Water Quantity

The Montana DNRC water rights database identifies 369 permitted water rights within the Sand Creek sub-watershed corresponding to 220 permitted points of use (Table 7-22). Most of these points of use (46.6%) are for domestic purposes with stock and irrigation the next common permitted water uses. The database also indicates a maximum of 914



Data Sources
Base layers: NRIS
Land Cover: USGS NLCD
Reach Breaks: This study, Appendix C
Figure 7-8: Map of the Sand Creek sub-watershed.
Rhodia Facility
SC03
SC02
SC01
3N 9W
3N 8W
2N 8W
2N 9W
Fleecer Mountain State Wildlife Management Area
Silver Bow Creek
Sawmill Gulch
Sheep Gulch
Powder Gulch
Hanson Gulch
Sand Creek
Sand Creek Planning Area
90
15
Planning Area Boundary
Industrial Zoning
Reach Break
SC03 Reach Label
Railroad
Land Ownership
Private
State
USFS
MT Fish, Wildlife, & Parks
0 0.5 1 2 Miles
All boundaries are approximate and should not be used for legal purposes.

irrigated acres associated with the irrigation points of use. Visual examination of aerial photography suggests that the actual irrigation use is significantly less and is limited to areas immediately downstream of the forested portions of this sub-watershed. The industrial complex in the Sand Creek sub-watershed (Figure 7-8) contains several facilities that obtain water from outside the watershed using the Silver Lake pipeline.

Table 7-22: Water rights summary for the Sand Creek sub-watershed (DNRC database).

Water Right Purpose	*Number of Water Rights (Points of Use)*	*Percent of Water Rights (Points of Use)*
COMMERCIAL	6	2.7%
DOMESTIC	103	46.6%
INDUSTRIAL	15	6.8%
IRRIGATION	26	11.8%
LAWN AND GARDEN	5	2.3%
MINING	4	1.8%
STOCK	61	27.6%
TOTAL:	220	100%

Sand Creek itself is an intermittent stream that flows only during spring runoff or storm events. Borduin (1999) studied the geology and hydrogeology of the Sand Creek sub-watershed and the adjacent portion of Silver Bow Creek. He concluded that Sand Creek loses its water to groundwater through porous alluvium and Silver Bow Creek apparently captures much of this groundwater between Rocker and Miles Crossing. In March 2003, an early spring warming event combined with rain caused Sand Creek to flow at near bankfull levels (Mullen, 2003).

7.4.3 Fisheries

Fisheries data are lacking for this drainage. Sand Creek probably has naturally low potential to support a substantial fishery due to a sandy substrate and low quantities of water. For much of its length, this is a losing reach with water flowing subsurface for most of the year. Still, it is possible that the headwater tributaries, particularly on the west side of the drainage support fish, including westslope cutthroat trout.

7.4.4 Vegetation

A major influence on the vegetation in the Sand Creek sub-watershed is the poorly consolidated Tertiary sedimentary rocks that cover the majority of this area. Soils derived from these rocks in southwest Montana generally have high infiltration rates, inability to fix nitrogen, and low available water capacity, and thus have very low vegetation productivity. Table 7-23 lists the major vegetation types present in the Sand Creek sub-watershed. Forest cover represents only about 17% of the area. The Warm Springs Ponds sub-watershed by contrast has an average elevation 200 feet lower than that of the Sand Creek watershed yet has approximately 30% forest cover. Nearly equal amounts of very low cover grasses, low to moderate cover grasses, and sagebrush cover the remainder of the area in the Sand Creek sub-watershed.

Table 7-23: Vegetation cover types in the Sand Creek sub-watershed (USGS GAP).

Cover Type	*Percent of Area*
Mixed Broadleaf and Coniferous Forest	16.78%
Low/Moderate Cover Grasslands	26.62%
Very Low Cover Grasslands	27.37%
Sagebrush	25.73%
Shrubs	0.79%
Barren Sites	0.20%
Riparian Areas	1.94%
Montane Parks and Meadows	0.28%
Urban Areas	0.00%

7.4.5 Wildlife

The Sand Creek sub-watershed supports a significant wildlife population in its headwaters and range front areas. Montana FWP statewide elk and deer distribution data indicate a significant amount of winter range in the southwest and southeast portions of this planning area (Figure 6-13). Additional Montana FWP winter survey data also indicates the presence of significant elk and deer winter range along the southwest portion of the watershed (Montana FWP, 2004 and Appendix E). The Montana FWP aerial survey did not include the southeast portion of the watershed. This sub-watershed also has a small herd of antelope associated with it. Wildlife habitat is generally in poor condition primarily due to noxious weed infestations, particularly leafy spurge (Douglass, 2003).

7.4.6 Recreation

The relatively small proportion of public lands (23%) is a significant limitation to recreational opportunities in the Sand Creek sub-watershed. Access roads in this sub-watershed that connect to the upper reaches of Norton Creek in the German Gulch sub-watershed are used primarily during hunting season. Winter snowmobile riding is also popular in the German Gulch sub-watershed and some access is possible from the Sand Creek area.

7.4.7 Public Input

Focus groups shared several concerns regarding the Sand Creek tributary area of Silver Bow Creek (Table 7-24). Foremost among these concerns were: inadequate water flows; potentially negative effects that development and associated infrastructure could have on wildlife and recreational opportunities; noxious weeds; and contamination from industrial sources. Due to a chronic lack of flow in Sand Creek, however, public input on this stream was not as abundant as it was for other sub-watersheds within the Silver Bow Creek watershed.

Table 7-24: Summary of public input for the Sand Creek sub-watershed.

Topic	***Type***	***Comments***
Water Quantity	Observation	Sand Creek flows intermittently.
Weeds	Concern	Noxious weed infestations are a problem.
Pollution Source	Concern	Rhodia: pollution problem from radiation and elemental phosphorus wastes; report on why there is a holdup and on what they are doing.
Pollution Source	Observation	Sand Creek is channelized by railroad and highway. Railroad grades are a potential pollution source. Bank erosion from other sources is also present.
Land Use	Concern	Subdivision is threatening open space and wildlife habitat.
Land Acquisition	Priority	Private in-holdings in USFS lands in the southwest portion of the watershed are a low priority for acquisition.

7.4.8 Sources of Environmental Impairment

Sources of environmental impairment in the Sand Creek sub-watershed include those associated with railroad and road infrastructure and historical industrial activities in the basin (Table 7-25). Mine wastes used to construct railroad grades are a potential source of metals contamination. In addition, both the railroad and roads, where they cross or are adjacent to drainages, are a potential source of siltation.

A significant potential source of environmental contamination in the Sand Creek sub-watershed is a phosphate processing facility located in the northern portion of the watershed, approximately ¼ mile south of Silver Bow Creek. Victor Chemical Company constructed the facility in the early 1950s to produce elemental phosphorous by reducing phosphate ore with electrical energy and elemental carbon (Tillman, 1999). Rhodia is the current owner, although it has not been in operation since 1997. The property changed hands five times between 1962 and 1987 including acquisition by Rhone Poulenc. Rhodia subsequently purchased Rhone Poulenc.

The Maiden Rock Mine, 17 miles to the south along the Big Hole River, supplied phosphate ore and silica (for flux) the phosphate plant. In the late 1960s, the Wooley Valley in Idaho became the source of phosphate ore due to cost considerations. In the early 1970s, the processing facility added a new wet scrubbing circuit, which required large volumes of water. This required expansion of the existing settling pond to its current size of 90 acres. Wash plant solids, tailings and native clays were used as lining materials for the settling pond dikes. According to interviews with past employees (Tillman, 1999), no impervious layer was installed on the pond bottom. Construction of the settling pond dikes required diversion of Sheep Gulch, a small ephemeral tributary to Silver Bow Creek. The original stream channel deposits, consisting primarily of sand and gravel, underlie the unlined tailings basin, providing a potential conduit for contaminants to reach Silver Bow Creek. The current Sheep Creek channel is a permitted discharge site for cooling water used at the ASIMI silicon wafer production plant, upstream of the Rhodia site.

The Rhodia site has been the subject of several investigations by the Montana DEQ and the EPA Superfund and Hazardous Waste Programs. Those studies indicated potential sources of contamination at the facility include the on-site landfills, dredged pond sediments, and seepage from a settling pond (Montana DEQ, 1997). These studies found elevated metals and polynuclear aromatic hydrocarbons in settling pond sediments, and elevated uranium and gross alpha radiation levels in some on-site monitoring wells. EPA found elemental phosphorus in the sediments of Sheep Gulch and Silver Bow Creek (EPA, 2004).

A 2003 investigation related to Montana DEQ's remediation work in the Silver Bow Creek floodplain indicated slag from the Rhodia facility overlies and is mixed with tailings along Silver Bow Creek, north of the plant site and west of the Port of Butte (MBMG, 2003b). This study estimates the volume of slag overlying the tailings at 6,210 yd^3 on 3.8 acres. An estimated 8,140 yd^3 of radiation-contaminated tailings underlie the slag, for a total volume of radioactive material of 14,350 yd^3. Investigations also suggested that leaching of radioactive wastes occurred, however, consultants for Rhodia refute this conclusion (SENES, 2003). Montana DEQ intends to remove radioactive slag and underlying radiation-contaminated tailings and transfer them to the Rhodia facility prior to remediation of the Silver Bow Creek floodplain in this area. It is unknown to what extent further contamination from the Rhodia facility affected the Silver Bow Creek corridor.

In addition to these investigations of the Rhodia facility conducted by governmental entities, a master's thesis completed in 1999 assessed the risks associated with contaminants of concern found at the Rhodia facility (Tilman, 1999). It concluded the largest risk associated with closing the Rhodia site is the potential for human and ecological contact with on-site waters. The thesis did not examine risks associated with on-site waste. Tilman (1999) also offered several recommendations for further investigations and corrective actions to consider in addressing this facility.

Currently, the EPA is investigating the facility and addressing site cleanup activities. In January 2004, EPA and Rhodia reached a settlement agreement for two criminal felony counts of illegal storage. The agreement includes fines for illegal storage of hazardous waste at the facility and an order for cleaning up the entire facility and any off-site releases. Rhodia has continued interim measures initiated in 2000 through 2005 that primarily involve wast containment and groundwater monitoring (Rhodia, 2005).

Table 7-25: Potential sources of environmental impairment in the Sand Creek -sub-watershed.

Impairment Source	***Contaminants***	***Data Sources***
Rhodia (formerly Stauffer Chemical then subsequently Rhone Poulenc) Phosphate facility	Metals (As, Cd, Se, Hg, Mn), chloride, sulfate, phosphorous polynuclear aromatic hydrocarbons, uranium, gross alpha radiation	Tillman, 1999; Montana DEQ, 1997 and 2003; EPA, 2004
Mine waste rock in Union Pacific railroad bed material along Sand Creek	Metals	Public comment, aerial assessment (Appendix C)
Eroding banks and road and rail disturbances along Sand Creek	Siltation	Public comment, aerial assessment (Appendix C)

7.4.9 Restoration Needs

A lack of information on the status and potential of this watershed limits the understanding of both restoration needs and opportunities. Nevertheless, a number of identifiable opportunities exist (Table 7-26). Land managers considered land acquisition a low priority compared to other watersheds. Since many data gaps exist for this sub-watershed, some restoration needs relate to obtaining additional data to help determine potential restoration activities in this sub-watershed. An explanation of the rank, category, and agency/other responsibility columns in Table 7-26 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-26: Restoration needs of the Sand Creek sub-watershed.

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
49	Fisheries	Fisheries data in the headwater tributaries is lacking. Small headwater tributaries in the southwest portion of the sub-watershed may host isolated populations of native fish.	Investigate the presence of fisheries and nature of these streams for stocking potential and protection/restoration needs.	
51	Protect Existing Resources	Land development is threatening open space and wildlife habitat in the higher elevation areas of the sub-watershed.	Acquire land or conservation easements along the private/public land boundary in the southwest portion of the watershed to protect wildlife winter ranges. This area is of lower priority to agency land managers than winter range in the Mill and Willow creeks and German Gulch sub-watersheds.	
52	Protect Existing Resources	Private land in-holdings in USFS land are at risk for development.	Acquire land or conservation easements. (USFS considers these areas to be low priority).	
53	Pollution Mitigation	Surface water quality data for Sand Creek is lacking. Mine waste in rail beds adjacent to Sand Creek may be a source of metals contamination to Sand Creek and Silver Bow Creek. Bank erosion and road and rail disturbances along Sand Creek may be producing excess fine sediment that is ultimately delivered to Silver Bow Creek.	Investigate the presence and impacts from these potential sources. Take appropriate actions. See also deferred action #58.	
55	Vegetation	Noxious weeds restrict growth of native vegetation.	Work with county and conservation officials to develop and implement appropriate weed management strategies that take into consideration findings of the BSB soils survey.	Multiple landowners
NA	Pollution Mitigation	Detailed nature and potential impacts of Rhodia phosphate facility are not fully known. The site is currently undergoing investigations and cleanup under an EPA order.	Wait for outcome of current investigations and cleanup of this site, which is to cover the entire site and any off-site releases. Evaluate following cleanup.	Rhodia, EPA, Montana DEQ

7.4.10 Data Gaps

Data gaps listed in Table 7-27 for the Sand Creek sub-watershed pose significant limitations to restoration planning at this time. Additional data are necessary in order to assess the impacts of potential pollution sources as well as the nature of existing natural resources. Moreover, assessment to fill data gaps will probably lead to identification of additional restoration needs for this sub-watershed.

Table 7-27: Data gaps for the Sand Creek sub-watershed.

Data Gap	***Uses***
More detailed information regarding the Rhodia Phosphate facility. EPA investigations are in progress.	This site has the potential to become a significant pollution source to Silver Bow Creek if not adequately addressed.
Surface water quality data for Sand Creek.	Determine if water quality is impaired from potential pollution sources along Sand Creek (mining waste rock in rail bed, other unknown sources). Could influence Silver Bow Creek water quality.
Fisheries data on headwater tributaries.	Determine fisheries resource value for potential protection or restoration planning. Isolated populations of westslope cutthroat trout could be present in these streams. If so, this could be a stocking source.

7.5 Basin and Blacktail creeks Sub-Watershed

The Basin and Blacktail creeks sub-watershed forms the southeast part of the Silver Bow Creek watershed and is approximately 93.6 square miles (59,924 acres) in size, the second largest planning area in the watershed. This sub-watershed also includes the small tributaries Grove Gulch and Sand Creek, which drain directly to Silver Bow Creek, and the Timber Butte area. Mean elevation is 6207 feet above sea level and average annual precipitation is 16.7 inches/year. Land ownership is 52% private, 47% USFS, and 1% State. Private land covers most of the northern portion and USFS land covers the southern portion of this planning area (Figure 6-15). Geology of the sub-watershed consists almost entirely of Cretaceous granitic rocks with Quaternary alluvium covering much of the valley bottom. Small amounts of Paleozoic sedimentary rocks outcrop in the headwaters of both Basin and Blacktail creeks. Two reservoirs on Basin Creek serve as an important part of the city of Butte's municipal drinking water supply (Figure 7-9). The forested portion of this planning area is heavily impacted by a pine beetle infestation, which poses wildfire threats to the Basin Creek water supply, native fisheries, and private property.

7.5.1 Water Quality

Neither Basin Creek nor Blacktail Creek are on Montana's 303(d) list of impaired streams. In addition, surface water quality data are lacking for much of the sub-watershed. The EPA STORET database provides limited information on water quality for metals, nutrients, and biological parameters. Additional information was available from the USGS and Montana GWIC databases. Table 7-28 below summarizes available water quality information for the Basin and Blacktail creeks sub-watershed.

Table 7-28: Surface water quality sampling data available in the Basin and Blacktail creeks sub-watershed.

Data Source	*Sample Sites*	*General Location(s)*	*Comments*
EPA STORET (modernized)	1	Basin Creek 6 miles south of Butte	Samples were collected twice in 1975 and once in 1976. Location data indicate samples are from Basin Creek, however, sample descriptions list Silver Bow Creek as the locations. Results are suspect.
EPA STORET (legacy)	3	Basin Creek just below Reservoir, just above reservoir and just below Highland Mine	Sample below Highland Mine exceeded human health and aquatic life standards for As and Hg (1970s sampling, will need to be re-sampled before drawing conclusions).
MBMG GWIC	14	Groundwater wells and throughout the valley south of Butte and surface water samples on Blacktail Creek and Silver Bow Creek.	See section below on nutrients (LaFave, 2002).
Montana DEQ Abandoned Mines stream sediment sampling	1	Basin Creek just below Highland Mine	1 sample collected contained elevated levels of Pb, Zn (levels which are above background but effects on benthic organisms are unknown, (CDM, 1994).

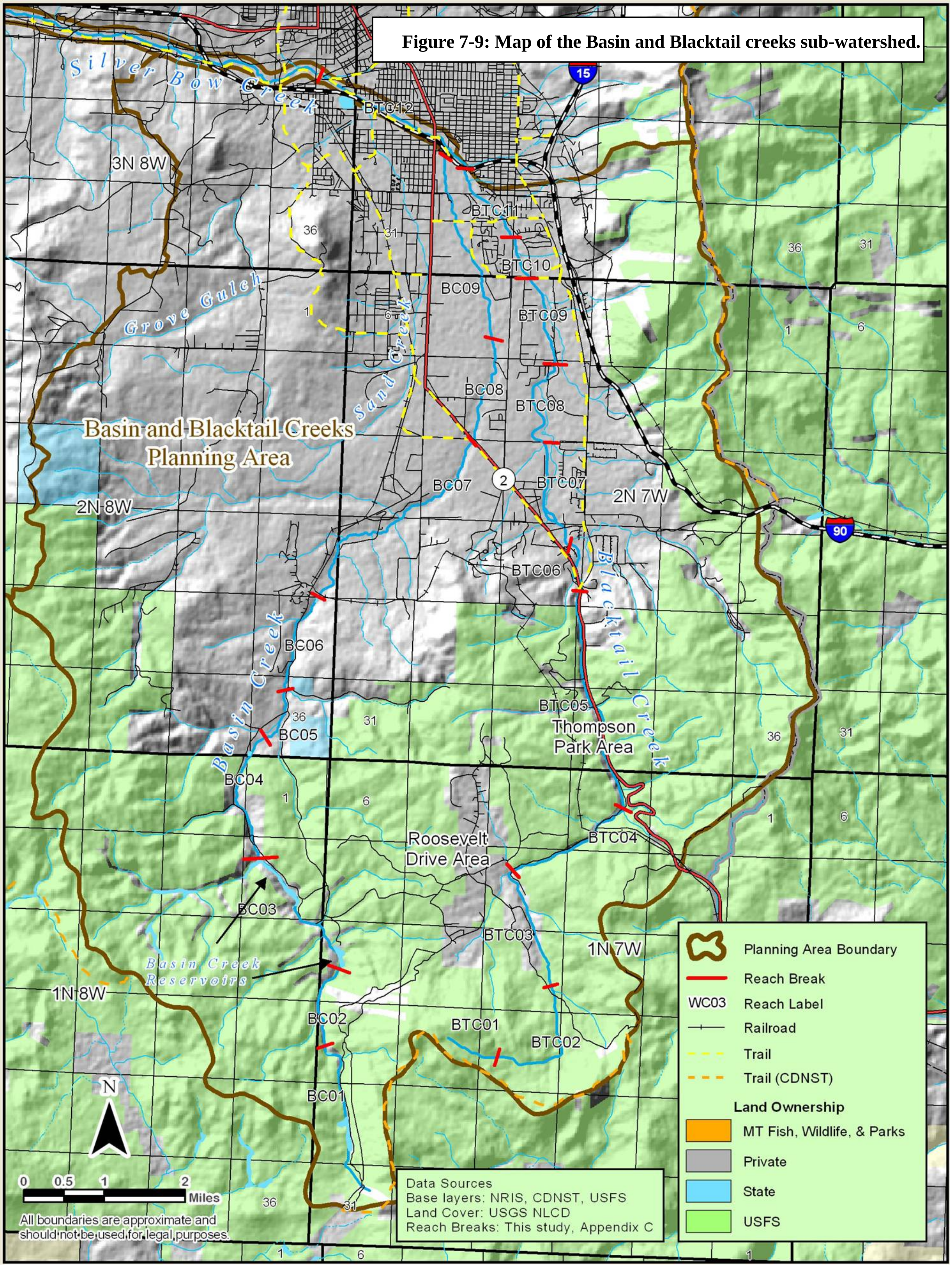


Figure 7-9: Map of the Basin and Blacktail creeks sub-watershed.
Silver Bow Creek
Basin and Blacktail Creeks Planning Area
Grove Gulch
Sand Creek
Basin Creek
Blacktail Creek
Basin Creek Reservoirs
Thompson Park Area
Roosevelt Drive Area
3N 8W
2N 8W
2N 7W
1N 8W
1N 7W
BTC12
BTC11
BTC10
BTC09
BTC08
BTC07
BTC06
BTC05
BTC04
BTC03
BTC02
BTC01
BC09
BC08
BC07
BC06
BC05
BC04
BC03
BC02
BC01
15
90
2
Planning Area Boundary
Reach Break
WC03 Reach Label
Railroad
Trail
Trail (CDNST)
Land Ownership
MT Fish, Wildlife, & Parks
Private
State
USFS
Data Sources
Base layers: NRIS, CDNST, USFS
Land Cover: USGS NLCD
Reach Breaks: This study, Appendix C
N
0 0.5 1 2 Miles
All boundaries are approximate and should not be used for legal purposes.

Metals

The STORET database contains minimal useful water chemistry data for Basin or Blacktail creeks. STORET lists one sampling site on Basin Creek with six sampling events. These water quality samples were collected in 1975 when detection limits were too high to adequately evaluate threats to aquatic life. Still, the available data suggest metals and arsenic may be a constraint on fish and aquatic life in Basin Creek. Arsenic exceeded human health standards in most of the six samples (Appendix C). Since these analyses did not report hardness, it is not possible to assess whether cadmium exceeded acute or chronic aquatic life standards. However, using typical hardness values reported for tributaries in the Silver Bow Creek basin (mean = 180 mg/L), most samples would have exceeded both chronic and acute aquatic life standards for cadmium.

Zinc, lead and copper were also elevated at the sampling station on Basin Creek (Appendix C), recorded in the STORET database. Using the mean hardness for tributaries in the Silver Bow Creek basin, these data would indicate violation of state standards. Zinc exceeded 197.2 µg/L, the standard for acute toxicity based on hardness of 180 mg/L in all six samples. Similarly, lead exceeded chronic toxicity standards (6.7 µg/L). Copper concentrations were markedly elevated compared to acute toxicity standards (24.4 µg/L) with the median value of 264 µg/L.

Potential sources of metals contamination are limited near the STORET sampling stations. However, the rail bed of the Milwaukee Road railroad presents a possible source of metals contamination. Typically, rail beds in the area were constructed with readily available mine waste. Note that the rail line crosses Basin Creek just above the sampling site. We recommend further sampling in Basin Creek to verify metals contamination and determine current water quality conditions.

The STORET Legacy database contains data for three sampling sites on Basin Creek, below the lower reservoir, above the lower reservoir and below the Highland Mine. Each site was sampled once, in either 1975 or 1976. The sample from below the lower reservoir met state water quality standards for metals or other constituents. The sample from above the reservoir also met water quality standards; however, metals were not within the suite of assessed parameters. The sample from below the Highland Mine contained 3000 µg/L of arsenic and 300 µg/L of mercury, both above human health and aquatic life standards. It is important to reiterate that sampling conducted in the 1970s and prior must be replicated using modern analysis techniques before drawing definitive conclusions.

Although limited data exist for Blacktail Creek, there are indications that metals cause impairment in this stream. Metals in benthic sediments in Blacktail Creek were at levels observed to have moderate to severe effects on aquatic life using toxic thresholds compiled by CDM (1994). It is important to be cautious in interpreting these data given the relatively old dates and limited temporal and spatial coverage. Similarly, limited water quality sampling on Basin Creek reduces the reliability of these data. Elevated metals concentrations measured in the 1970s should be a trigger for additional assessment aimed at providing a better picture of the condition and potential of this stream.

Evaluations of biological indicators on Blacktail Creek above its confluence with Grove Gulch provide information on biological integrity and the influence of key pollutants (McGuire, 2001; Weber, 2001). Biological integrity ranged from slightly to moderately impaired in most years between 1993 and 2000 with a trend towards improved water quality conditions from 1998 through 2000. The most recent sampling results indicated full support of beneficial uses. Community composition suggested that siltation, low levels of metals contamination, and nutrient enrichment were causes of impairment in most years. Diatom associations yielded similar results as macroinvertebrates on Blacktail Creek. No biological assessment data are available for Basin Creek.

Nutrients

Nutrient data from the STORET database are limited in terms of data currency and spatial coverage for Blacktail Creek. Still, because of concerns regarding biological indicators of nutrient loading and identified sources of nutrients, these data warrant investigation. Additional investigations to evaluate potential sources and degree of nutrient enrichment will be an important component of restoration planning.

The Montana Bureau of Mines and Geology (MBMG) is completing fieldwork in the upper Clark Fork drainage basin to characterize groundwater conditions. Preliminary results from an October 2001 sampling event of 15 existing wells in the Butte area revealed somewhat elevated nitrate concentrations in all the wells above background concentrations (assumed to be 2.0 mg/L) and in three of the wells above the human health standard of 10 mg/L (LaFave, 2002). Most of the wells were in the Blacktail/Basin sub-watershed. A subsequent database review of the recent and historic groundwater sampling data for wells the Butte area indicated that the majority of groundwater wells sampled had similar elevated concentrations. Elevated nitrate concentrations occurred in wells in both sewered and unsewered residential areas, as well as in shallow (<50 feet deep) wells and deep (>200 feet deep) wells.

As part of the same study, MBMG sampled Blacktail and Silver Bow creeks in 2001 and 2002 for nitrates (LaFave, 2002). Section 7.1.1 discusses the results for the Silver Bow Creek samples. For samples collected in November 2001 on Blacktail Creek, nitrates levels measured less than 0.5 mg/L at locations near Thompson Park and two miles below Thompson Park. Nitrate levels measured between 1 mg/L and 2 mg/L at the four stations farther downgradient that covered about 2-½ stream miles from about 1 mile upstream of the confluence of Basin and Blacktail creeks to just above the confluence of Blacktail Creek with Silver Bow Creek. In contrast, samples collected from Blacktail Creek in May 2002 had nitrate levels exceeding 1 mg/L only at a station located ½ mile upstream of the confluence with Silver Bow Creek. The study concluded that elevated nitrate in the groundwater impacts the surface water in the Summit Valley during low-flow conditions; however, this conclusion was based on very limited sampling data.

This study also involved analyzing nitrogen and oxygen isotopes from 14 wells in different aquifers and land use settings to identify sources of nitrates. The results showed that nitrate in all the samples had a similar isotopic signature. Measured isotope values were suggestive of animal or septic waste sources but not fertilizer sources.

7.5.2 Water Quantity

The Montana DNRC water rights database identifies 1152 permitted water rights within the Basin and Blacktail creeks sub-watershed (Table 7-29). The majority of these (72.3%) are for domestic purposes (wells). The 95 permitted irrigation diversions total approximately 43 cfs and the city of Butte has a permitted water right for approximately 26.7 cfs for its municipal water supply. Note that these numbers reflect permitted amounts and often differ from actual usage.

Table 7-29: Water rights summary for the Basin and Blacktail creeks sub-watershed (DNRC database).

Water Right Purpose	*Number of Water Rights (Points of Use)*	*Percent of Water Rights (Points of Use)*
COMMERCIAL	25	2.2%
DOMESTIC	833	72.3%
FISH AND WILDLIFE	5	0.4%
INDUSTRIAL	2	0.2%
IRRIGATION	95	8.2%
LAWN AND GARDEN	63	5.5%
MINING	1	0.1%
MULTIPLE DOMESTIC	9	0.8%
MUNICIPAL	6	0.5%
OTHER PURPOSE	1	0.1%
RECREATION	7	0.6%
STOCK	105	9.1%
TOTAL:	1152	100%

7.5.3 Fisheries

Both the Basin Creek and Blacktail Creek drainages host significant native fisheries in their headwaters as well as recreational fisheries in valley foothill reaches. An understanding of the fisheries potential and conservation issues will be invaluable in guiding restoration in the area.

Fisheries information for Blacktail Creek basin is limited (MFISH, 2003), although some descriptions are possible with existing information. The valley portions of Blacktail Creek support a recreational fishery dominated by the non-native brook trout. Fish abundance data from Montana FWP collected at the mouth of Blacktail Creek indicated 480 brook trout per 1,000 feet in 1992, a respectable density for an urban fishery. A suspected limitation to stream channel and floodplain function is a four-mile reach where valley bottom roads closely parallel Blacktail Creek along reaches BTC-9, BTC-10, and BTC-11 (Figure 7-9, Appendix D).

Montane reaches of Blacktail Creek support westslope cutthroat trout at least in a 7.4 mile reach extending from the north end of Thompson Park to the headwaters of Blacktail Creek (La Marr, 2003b). Westslope cutthroat trout genetics results from a set of 25 samples collected in Blacktail Creek within Thompson Park in 2003 indicate that this population is likely 100 percent genetically pure (Spruell, 2004). This determination likely applies to at least 7.5 miles of stream from the northern Thompson Park boundary to the headwaters. If there are no barriers present downstream of the northern Thompson Park boundary, these results should also likely be considered to apply throughout the westslope cutthroat trout distribution in Blacktail Creek. Based on this information, USFS personnel consider Blacktail Creek a high priority area for aquatic restoration of national forest lands in the Silver Bow Creek watershed (La Marr,2005). Blacktail Creek best fits the description of “adjunct habitat” (see Section 3.3). USFS restoration goals would be to establish focal habitat areas where brook trout can be suppressed or eliminated and then expand restoration efforts outward from these areas. Spot sampling of westslope cutthroat trout populations in Blacktail Creek conducted by the USFS (Beaverhead Deerlodge National Forest, 2003b) indicates modest numbers (26 per 100 meters of stream) comparable to other streams in the watershed such as Beefstraight Creek (37 per 100 meters) and Minnesota Gulch (24 per 100 meters), both of which are tributaries to German Gulch. Note that these numbers are spot samples and not accurate population estimates.

Additional information on fisheries values in Blacktail Creek includes a fish habitat survey conducted by the USFS associated with an environmental assessment under development for the potential Thompson Park Salvage Timber Sale (La Marr, 2004). This assessment involved standard fish habitat methodologies and comparison with reference values obtained from least-impaired streams in Idaho (Overton et al., 1995). Parameters assessed included channel unit type composition, Rosgen channel type classification (Rosgen, 1996), cross sectional dimensions, pool dimensions, woody debris counts, and substrate composition. Comparison of observed conditions with Idaho reference streams allowed inference on existing habitat quality and recommendations for habitat improvements.

Results of this investigation suggested degraded habitat limits the westslope cutthroat trout in Blacktail Creek. Specific concerns included low pool quality as described by low residual volumes, a relative lack of large woody debris, and accumulations of sand sized particles on substrate surfaces. The authors attributed low pool quality to the lack of large woody debris and accumulations of sand. Sediment delivery from roads, primarily Roosevelt Drive and Highway 2, was the only source of degradation identified in this assessment.

Several considerations require cautious application of these results to watershed planning efforts in the Blacktail sub-watershed. First is the appropriateness of the use of woody debris counts from Idaho as a reference for the eastern edge of the Silver Bow Creek watershed. Differences in climate between these regions may result in different forest types with a naturally different potential for size and quantity in large woody debris. Use of a more local or internal reference may be useful in evaluating the potential amount of woody debris recruitment to montane streams in the Silver Bow Creek watershed.

The other consideration is the relative roles of sediment delivery from roads and natural, background levels from the granitic geology of the basin. Field observations suggested roads were a source of sand to surface waters; however, there was no estimation of loads from this source. As a result, it is not possible to determine whether roads constitute a significant source of fine sediment in a basin with high, natural loading from the basin's geology.

Fisheries data for Basin Creek consist of fish surveys conducted in the montane portions of the watershed. USFS data for Basin Creek (La Marr, 2003b) identify 3.2 miles of fish bearing stream in the Basin Creek sub-watershed surrounded by national forest lands. These 3.2 miles include 1.7 miles upstream of the upper Basin Creek Reservoir that contain genetically pure westslope cutthroat trout and are devoid of non-native species. Spot sampling of westslope cutthroat trout populations in Basin Creek conducted by the USFS (Beaverhead Deerlodge National Forest, 2003b) indicates 58 and 22 fish per 100 meters in two adjacent reaches. The larger of these numbers compares well with German Gulch (69 per 100 meters) and North Creek (53 per 100 meters). Note that these numbers are spot samples and not accurate population estimates. Upper Basin Creek therefore constitutes a high quality westslope cutthroat trout refuge. Based on this information, USFS personnel regard Basin Creek as a high priority area for aquatic restoration of national forest lands in the Silver Bow Creek watershed. Basin Creek above the lower reservoir represents a "focal" habitat area (see Section 3.3) where westslope cutthroat trout are unhindered by competition from brook trout. USFS aquatic restoration activities would focus on protection and enhancement of these focal habitat areas. Water quality protection is also a USFS priority for Basin Creek since it serves as a portion of Butte's municipal water supply.

Angling pressure data are available for Blacktail Creek and Basin Creek, but none of the other tributaries or reservoirs (MFISH, 2003). According to these data, Blacktail Creek receives a modest amount of angling pressure. In contrast, Basin Creek receives approximately half the angling pressure of Blacktail Creek. Angling pressure is almost entirely from in-state anglers.

7.5.4 Vegetation

USGS GAP vegetation analysis data indicate three vegetation types cover the majority of the Basin and Blacktail creeks sub-watershed (Figure 6-10). Mixed broadleaf and coniferous forest is the single dominant vegetation type covering 52% of the watershed, followed by sagebrush (19.2%) and low to moderate cover grasses (12.7%). Figure 6-11 illustrates how the mixed forest cover occurs almost entirely in the montane portions of the sub-watershed whereas the low to moderate cover grasslands and sagebrush occur in the valley foothill part of the sub-watershed. Other important cover types present include very low cover grasses (5.2%), riparian (2.9%), and montane parks and meadows (1.6%). Urban areas make up an additional 4.1% of the watershed. Beaverhead Deerlodge National Forest data indicate the presence of significant old growth timber in the Basin Creek watershed (Beaverhead Deerlodge National Forest, 2003b). Comments received during public input for watershed plan indicate the presence of a significant pine beetle infestation, particularly in the Thompson Park area. Trees impacted by this infestation are easily visible when approaching Butte from east on Interstate 90.

Table 7-30: Major vegetation types in the Basin and Blacktail creeks sub-watershed (USGS GAP data).

Cover Type	***Percent of Watershed***
Mixed Broadleaf and Coniferous Forest	52.2%
Low/Moderate Cover Grasslands	12.7%
Very Low Cover Grasslands	5.2%
Sagebrush	19.2%
Riparian Areas	2.9%
Montane Parks and Meadows	1.6%
Urban Areas	4.1%

A mountain pine beetle epidemic has been moving through lodgepole forests in the upper portion of this planning area since the late 1980s. Lodgepole mortality rates from this epidemic reach 80-90% in the lower reaches of the basin (Beaverhead-Deerlodge National Forest, 2004).

The Beaverhead-Deerlodge National Forest is in the process of revising its forest plan (Beaverhead-Deerlodge National Forest, 2003a). Part of this process includes defining a forest-wide desired condition and resultant objectives for vegetation, wildlife, hydrology, aquatic species, recreation and travel, fire, livestock grazing, and timber harvest. The Plan's forest-wide vegetation objectives that are relevant to the Basin and Blacktail creeks sub-watershed are to:

- manage noxious weeds,
- reduce threat to human life and property from wildfire,
- develop stable or upward trends for unique or declining habitats such as ponderosa pine, aspen, and willows,
- minimize the influx of non-native species, and
- develop or retain a mosaic of forest stand age classes to provide a diversity of wildlife habitat and reduce the adverse effects of wildfire.

The Beaverhead-Deerlodge Forest Plan Revision identifies two management areas within the Basin and Blacktail creeks sub-watershed: the Backyard Butte Management Area and the Basin Creek Municipal Watershed Management Area. The Backyard Butte Management Area includes the headwaters of Blacktail Creek and the lower reaches of Basin Creek. Proposed management is for an urban interface area, with local concentrated development and disbursed recreation. This area will also provide a variety of forest products for both personal and commercial purposes. The Basin Creek Municipal Watershed Management Area is the montane portion of Basin Creek, which serves as a designated class "A" watershed that provides drinking water to the city of Butte. Proposed management of this area is for protection of water quality. Activities in this area are restricted to uses related to the water supply or watershed protection and a few existing roads and trails and their uses. Activities deemed inappropriate for this area include timber harvest, grazing, wildland fire use, other forest products, utility transmission corridors, recreation facilities, and motorized winter use.

To meet the objectives of the proposed forest plan revision, the Beaverhead Deerlodge National Forest prepared an EIS for a hazardous fuels reduction project for the Basin Creek area (Beaverhead Deerlodge National Forest, 2004). The USFS considered five alternatives and chose alternative 3, which prescribes hazardous fuel reductions on 2600 acres in the Basin and Blacktail creeks sub-watershed.

The public input part of this project also provided an opportunity for citizens and land managers to provide information on vegetation issues. Comments received expressed concern about two issues: pine beetle infestations as well as implications of management activities to address this problem, and a lack of riparian structure and diversity along Basin Creek below the lower reservoir and nearby tributary streams.

7.5.5 Wildlife

Montana FWP statewide wildlife distribution data indicate the presence of elk and mule deer winter range along Basin and Blacktail creeks, along the sub-watershed boundary with the Sand Creek planning area, and along the forest/valley foothill boundary (Figure 6-13). Moose are abundant along Blacktail Creek as observed by numerous citizens although the Montana FWP statewide wildlife distribution data indicate only a small area of moose winter range along the forest/valley foothill boundary between Basin and Blacktail creeks. Montana FWP land managers noted that while there is not survey data for moose, the agency has received numerous complaints about moose in urban areas in the past 5 years (Douglass, 2004).

Input from focus group meetings with USFS biologists on this sub-watershed indicated a lack of willow and aspen communities in the riparian areas along the Blacktail and Basin creeks as well as their tributary drainages. While the cause of this habitat impairment is unknown, severe browse damage by big game and conifer encroachment may be contributing factors (Butte-Silver Bow and USFS, 2003). The poor habitat has resulted in increased conflicts between human and wildlife as moose have moved out of the highlands into the more populated lowlands for forage. USFS biologists also believe fire suppression activities and resulting conifer encroachment, as well as residential development in the Roosevelt Drive area, have caused significant reduction in the open sagebrush/grass parklands in the Blacktail Creek sub-watershed (Butte-Silver Bow and USFS, 2003). Open sagebrush/grassland habitats are important for a variety of wildlife species.

The Beaverhead-Deerlodge National Forest released a Record of Decision and Final EIS for proposed fuels reduction activities in the Basin Creek and Blacktail Creek drainages (Beaverhead-Deerlodge National Forest, 2004). Wildlife habitats identified as part of this effort are:

- Low elevations comprised of scattered patches of aspen and a mix of Douglas-fir, Douglas-fir/lodgepole, fescue/blue bunch wheat grassland parks, and willow/aspen riparian areas that provide habitat for species such as elk, moose, northern goshawks, flammulated owl, blue grouse, woodpecker, and snowshoe hare;
- Mid-elevations with dominantly Douglas-fir/lodgepole forests; and

- High elevations consisting of a mix of lodgepole pine, subalpine fir, spruce, whitebark pine, and intermixed spruce/fir riparian areas and wet meadows that provide habitat for lynx and wolverine.

Wildlife species known or suspected to occur in the EIS study area include:

- Gray wolf
- Canada lynx
- Bald eagle
- Flammulated owl
- Northern goshawk
- Peregrine falcon
- Black-backed woodpecker
- Western big-eared bat
- Wolverine
- Fisher
- Northern bog lemming
- Pine marten
- Pileated woodpecker
- Hairy woodpecker
- Three-toed woodpecker
- Elk
- Moose
- Mule deer
- Blue grouse

7.5.6 Recreation

The Basin and Blacktail creeks sub-watershed is a popular recreational area for the citizens of Butte and nearby communities. In the montane portion of Blacktail Creek, Thompson Park is a Congressionally Designated Municipal Recreation Area on National Forest and Butte Silver-Bow lands and is jointly managed by the USFS and Silver Bow County. The montane portion of the sub-watershed supports recreational activities year-round including hiking, biking, horse riding, and OHV riding in summer and cross-country skiing and snowmobiling in winter. The planned Continental Divide National Scenic Trail (CDNST) also follows parts of the watershed boundary.

The valley foothill portion of the Basin and Blacktail creeks sub-watershed supports a modest recreational fishery and has a significant trail network, which connects to the Greenway and Butte area trails. Focus group meeting participants favored expansion of the current trail system and improvement of existing and creation of new recreational fishing opportunities.

7.5.7 Public Input

Focus group participants identified concerns about water quality, recreation, and fisheries issues (Table 7-31) in the Blacktail and Basin creeks sub-watershed. Protection of the water quality in the headwaters of Basin Creek and Blacktail Creek was a widely shared public priority. Correspondingly, safeguarding Basin Creek, a major source of Butte's municipal water supply, was the foremost concern. Improvement of water quality in Blacktail Creek was also a priority. The poor condition of recreational facilities in the Thompson Park area was also a common concern. Increasing recreational opportunities by creating a connector trail from Butte to Thompson Park was also among the recommendations.

Shared concerns regarding Blacktail and Basin creeks included: sediment problems in the headwaters; the need to protect resident populations of westslope cutthroat trout; pine beetle infestations in upland forests; low stream flows resulting from dewatering;

nutrients from the golf course, agriculture, and septic systems in the valley bottom; and urban interface issues such as fire protection in the upland areas.

Table 7-31: Public input summary, Basin and Blacktail creeks sub-watershed.

Topic	***Type***	***Comments***
Source Water Protection	Priority	Protect Butte's municipal water supply in Basin Creek
Water Quality	Priority	Improve and protect water quality in Blacktail Creek
Recreation	Priority	Provide connector trails from Butte to Thompson Park to CDNST
Recreation	Priority	Improve Thompson Park recreational facilities and trails
Habitat	Concern	Sediment problems in headwaters
Fisheries	Concern	Protection of westslope cutthroat trout
Water Quality	Concern	Nutrients from golf course and septic systems
Water Quantity	Concern	Low flows due to dewatering
Vegetation	Concern	Significant pine beetle infestations
Recreation	Concern	Thompson Park is in poor condition
Recreation	Concern	Lack of urban fishing areas for kids, such as fishing ponds.

Butte-Silver Bow and the USFS jointly applied for NRD funding to improve natural resources and recreational opportunities in the Blacktail Creek watershed, mostly within Thompson Park (Butte-Silver Bow and USFS, 2003). The project represented input from the public and area land managers as to the desired natural resource and recreational improvements to this area. The major components of the request involved improving 10 dilapidated recreation sites, 33 miles of hiking trails, three road access bridges, and 1.8 miles access roads in Thompson Park and improving aquatic, riparian, and upland habitat in the Blacktail Creek watershed. The proposed natural resource habitat improvements primarily involved:

- instream placement of woody-debris to improve westslope cutthroat habitat;
- fencing of riparian areas to protect willows from browsing wild ungulates and domestic animals;
- conifer removal and prescribed burning to reestablish open sagebrush/grassland habitats;
- weed control;
- and providing off-stream watering and fencing for livestock in USFS grazing allotments to reduce grazing impacts.

Although the project did not receive funding in the 2003 grant cycle, both the county and USFS plan to continue their efforts to secure funding of the proposed improvements.

7.5.8 Sources of Environmental Impairment

Potential sources of water quality impairment in the Basin and Blacktail creeks sub-watershed include metals and arsenic from the historic Highland Mine in the headwaters of Basin Creek, mine waste rock used in railroad beds, nutrients from septic systems and a golf course, and excess sediment from roads. The specific nature of water quality impairment from many of these sources is unknown. Further sampling and analysis is required to address these concerns. Another type of potential source of impairment is the threat posed by recent pine beetle infestations in the montane portions of Basin and

Blacktail creeks. Large areas of coniferous forest killed by pine beetles pose a wildfire threat. A large wildfire could threaten homes in the Blacktail Creek drainage and could create excess sediment loads in both Basin and Blacktail creeks. The results of this could be devastating to Butte's Basin Creek municipal water supply and fish habitat. The Beaverhead-Deerlodge National Forest is currently planning thinning efforts to mitigate this risk (Beaverhead-Deerlodge, 2003b).

Table 7-32: Potential sources of environmental impairment in the Basin and Blacktail creeks sub-watershed.

Potential Impairment Source	***Contaminants***	***Data Sources***
Pine beetle infestations	Pine beetles have killed a significant amount of coniferous forest. Wildfire could result in significant sediment loading.	Beaverhead-Deerlodge National Forest, 2003b, Public Input.
Highland Mine	Metals	EPA STORET (Legacy) database and Montana DEQ abandoned mines stream sediment sampling data (NRIS). 1970s sampling needs verification before drawing conclusions.
Railroad bed mine waste rock crossing Basin Creek (this source is suspected but not confirmed)	As, Zn, Pb, Cu	EPA STORET water quality samples collected from Basin Creek (Note: these data need to be verified; the location of samples is not clear.)
Nutrients from residential septic systems in the valley foothill portions of Blacktail and Basin Creek. Residential density is higher along Blacktail Creek.	Nutrients	Public Input, LaFave 2002
Nutrients from golf course runoff along reach BTC10 (Appendix C)	Nutrients	Public Input
Sediment from road crossings and encroachment on Blacktail Creek	Sediment	Public Input
Land use along the valley foothill reaches of Basin Creek and Blacktail Creek	Sediment, nutrients, riparian degradation	Public input, reconnaissance assessment, aerial assessment.

7.5.9 Restoration Needs

The most important restoration need for the Basin and Blacktail creeks sub-watershed is the protection of Basin Creek as a drinking water supply for the city of Butte (Table 7-33). Some institutional controls are in place for protection of this resource such as Butte's Source Water Delineation and Protection Report (Butte-Silver Bow Water Department, 2003) and the USFS Proposed Forest Plan Revision (Beaverhead Deerlodge National Forest, 2003a). Part of this protection should include mitigation of wildfire threat and resultant sediment loading risk (Beaverhead Deerlodge National Forest, 2003b). Genetically pure native westslope cutthroat trout are present in Basin Creek in a 1.7 mile reach free of non-native brook trout and represent a significant high quality existing resource that needs to be protected. Thompson Park is in need of improvements to access and recreational opportunities. An explanation of the rank, category, and agency/other responsibility columns in Table 7-33 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-33: Restoration needs for the Basin and Blacktail creeks sub-watershed.

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
1	Protect Existing Resources	Limited drinking water sources for the city of Butte make Basin Creek a critical source of water.	Protect Basin Creek from potential pollution sources and activities that may threaten water quality. Mitigate risk of wildfire and potential sediment loading.	USFS, BSB, Montana DEQ
4	Protect Existing Resources	Genetically pure population of native westslope cutthroat trout exist in focal habitat in upper Basin Creek and need protection.	Activities to protect the upper Basin Creek water supply will help protect westslope cutthroat trout. Reservoirs form a fish passage barrier to prevent introgression of non-native species. Evaluate adjunct WCT habitat in other parts of Basin Creek.	BSB, USFS
16	Fisheries	Genetically pure westslope cutthroat are likely present in upper Blacktail Creek.	Evaluate focal and adjunct westslope cutthroat trout habitat in Blacktail Creek. Take appropriate restoration measures to improve/protect these habitats.	
20	Recreation	Thompson Park recreation facilities are in need of upgrade or repair. A consistent funding source is needed to maintain these facilities.	Obtain funding for renovation and maintenance of facilities. Undertake renovation activities.	USFS, BSB
32	Vegetation	Riparian degradation and channelization along Blacktail Creek were detected in the aerial photography assessment.	Improve aquatic habitat and riparian vegetation along Blacktail Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.	
35	Pollution Mitigation	High density of septic systems south of Butte may be contributing nutrients to ground and surface water.	Evaluate the impact of septic systems. Take appropriate actions such as expansion of Butte waste water treatment facility to incorporate some residential areas currently on septic systems.	Local Government
39	Recreation	Recreational fisheries along the valley foothill portions of Basin and Blacktail creeks are marginal.	Subsequent to or concurrent with needed fishery improvements (#32), improve recreational fishing access opportunities via trail access and fishing access sites.	
42	Pollution Mitigation	The historic Highland Mine may be a source of metals contamination in the headwaters of Basin Creek.	Additional water quality and site sampling is necessary; water quality sampling from the 1970s is suspect. Contamination problems, if any, are predicted to be minor given the site's location and small area of disturbance.	
43	Pollution Mitigation	Limited 1970s water quality sampling on the valley foothill portion of Basin Creek (downstream of municipal source water area) indicates metals contamination.	Re-sample Basin Creek water quality. Evaluate railroad bed as a possible source. Mitigate pollution source(s) if water quality impairment is confirmed.	

Rank	Category	Issue/Problem	Restoration Needs	Agency/Other Responsibility
50	Vegetation	Riparian degradation and channelization along Basin Creek was detected in the aerial photography assessment. Riparian vegetation along Basin Creek below the reservoirs is sparse and lacks diversity.	Improve aquatic habitat and riparian vegetation along Basin Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.	

7.5.10 Data Gaps

Significant data gaps exist for the Basin and Blacktail creeks sub-watershed (Table 7-34). Existing water quality sampling data, both physicochemical and biological, are limited and in many cases too old to be reliable indicators of impairment. Stream condition, fish population, fish habitat, and riparian vegetation condition inventories are practically non-existent for both Basin and Blacktail creeks. This severely limits the ability to assess whether restoration is warranted and feasible on these streams. Additional assessment should precede most restoration in this sub-watershed.

Table 7-34: Data gaps for the Basin and Blacktail creeks sub-watershed.

Data Gap	Uses
Adequate water chemistry sampling. STORET water quality sampling conducted in the 1970s is not reliable and has been supplanted by more accurate methods.	Assess existence and status of metals and nutrient impairments
Biological (periphyton and macroinvertebrates) sampling of Basin and Blacktail Creek	Additional biological sampling is needed to assess whether Basin and Blacktail creeks are meeting their beneficial uses.
Detailed fish population and fish habitat data for the montane portion of Basin and Blacktail creeks	Evaluate the current condition and restoration potential of native fisheries
Detailed fish population and fish habitat data for the valley foothill portion of Basin and Blacktail creeks	Evaluate the current condition and restoration potential of recreational fisheries

7.6 Butte Area Sub-Watershed

The Butte area sub-watershed lies in the eastern portion of the Silver Bow Creek sub-watershed and covers approximately 38 square miles (24,560 acres, Figure 2-3). This area encompasses the City of Butte, the largest population center in the Silver Bow Creek watershed (Figure 7-11). The sub-watershed also includes the West Camp area to the west of the city of Butte. Mean elevation in the sub-watershed is 6187 feet and average annual precipitation is approximately 16.5 inches/year. Land ownership is approximately 88% private with the remaining 12% administered by the USFS. The geology of the Butte area sub-watershed consists dominantly of Cretaceous intrusive rocks that hosted the rich ore deposits mined for more than a century. The lower elevation portions of this sub-watershed are covered by thick Quaternary alluvial deposits. Minor amounts of Cretaceous volcanic rocks outcrop in the headwaters of the sub-watershed and west of the city of Butte (West Camp area). Lastly, minor amounts of Tertiary sedimentary rocks occur in the far western portion of this sub-watershed.

Figure 7-10: Metro Storm Drain in Butte.

Silver Bow Creek was the largest stream in this area; however, historic mining activities obliterated the upper reaches of the Creek. Maps of the Butte area from the late 1800s illustrate that tailings from the Parrot Smelter significantly altered Silver Bow Creek by this time (Houdini and Associates, 2002). Other alterations included periodic dredging to alleviate flooding concerns. For example, public works funding in the 1930s allowed extensive dredging and armoring of Silver Bow Creek. At this time, it became known as Metro Storm Drain. Metro Storm Drain approximately follows the course of historic Silver Bow Creek in Butte from the Butte Civic Center to Harrison Avenue. In 2005, ARCO constructed a pipeline to convey treated water from the Horseshoe Bend treatment plant to the confluence of Blacktail Creek and Silver Bow Creeks under Metro Storm Drain, along with a surface storm water channel. Currently, Montana Resources uses this treated water in its active mine operations. Plans are under way to modify this surface channel to create an aesthetic asset to the community with adjacent parkland and trails.

Above the Yankee Doodle tailings impoundment, the headwaters of Silver Bow Creek flow year round and are in good condition (NRDP, 1995a). Due to its inaccessibility, this small, high gradient drainage has extensive beaver ponds, with an aspen dominated riparian zone extending several hundred feet on either side of the creek. Typically, in

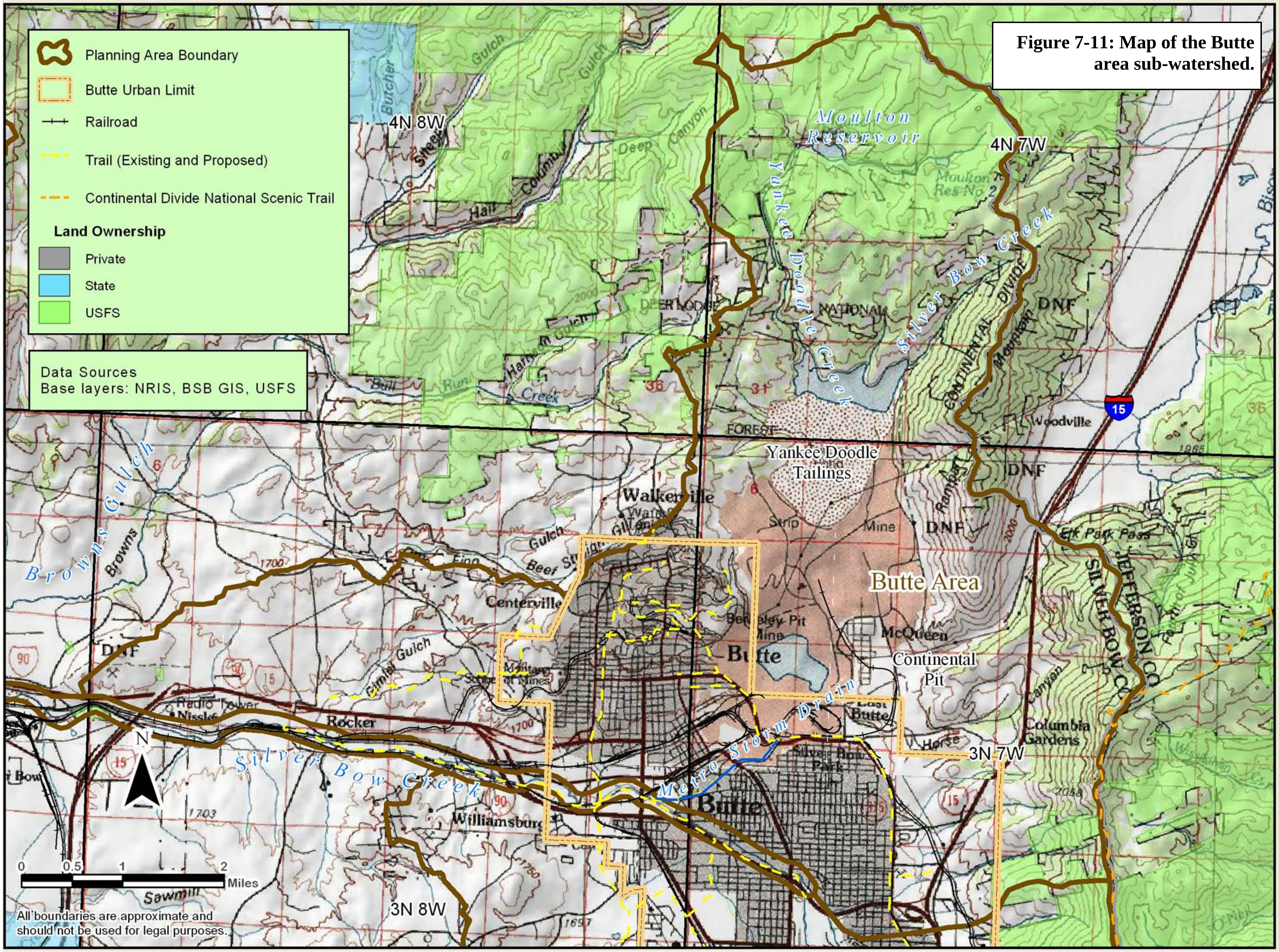


Figure 7-11: Map of the Butte area sub-watershed.

western Montana, similar streams have undergone beaver removal with resultant conifer encroachment and narrowing of the riparian zone. This stream serves as an interesting reminder of what many Montana streams may have looked like before beaver eradication. Yankee Doodle Creek is another small stream above the Yankee Doodle tailings impoundment and supplies water to Moulton Reservoir, an important source of drinking water for the city of Butte. Moulton Reservoir supplies up to ten percent of Butte's drinking water.

The Anaconda Mining Company started mining the Berkeley Pit and the East Continental Pit in Butte before enactment of Metal Mine Reclamation Act. They obtained an Operating Permit in 1973. Anaconda Mining Company expanded the mining operation with additional permits in 1976 and 1981. Montana Resources assumed the Anaconda Mining Company's Operating Permits in Butte in 1986.

Montana Resources permitted area covers approximately 5,725 acres of which 4,808 acres are disturbed. The disturbance includes: the Precipitation Plant (72 acres), Weed Concentrator (93 acres), Granite Mountain area (32 acres), Yankee Doodle Tailings (1,230 acres), embankment and waste dumps (681 acres), leach areas (693 acres), Berkeley Pit (690 acres), Continental Pit (668 acres), and miscellaneous areas approximately (683 acres).

Uncertainty exists about how long the mine will be operational. Though it is estimated that Montana Resources will mine until 2025, mining could continue longer or cease operations sooner for a myriad of reasons. The corresponding reclamation would vary depending upon the amount of needed reclamation when mining ceases and how much reclamation has been done concurrent with mining.

The approved permit calls for the tailings areas to be reclaimed to wetlands, the embankment and waste dumps to be revegetated as uplands, the leach area to be capped and revegetated, and the pits to be reclaimed as talus slopes with revegetated benches. The approximately 200-acre area that was disturbed prior to regulation under the Metal Mine Reclamation Act is not be required to be reclaimed.

7.6.1 Water Quality

Widespread mine waste causes significant contamination of storm water runoff in Metro Storm Drain by metals and arsenic (Gammons et al., 2003; Frandsen and Hills, 2003; PRP Group, 2001). The remedial investigation of the BPSOU assessed hazardous substance releases by storm water runoff of mine waste in the Butte area. EPA is currently evaluating alternatives for control of this runoff and will identify a preferred alternative. This watershed planning effort does not cover reporting on water quality data collected as part of remedial investigation for BPSOU. More information is available in Section 2.2, which describes in detail the history of environmental remediation and ongoing claims in the Silver Bow Creek watershed.

7.6.2 Water Quantity

Although mining operations obliterated much of the headwaters of Silver Bow Creek in the 1870s, the Butte area sub-watershed still contains significant surface water resources. Currently, the Berkeley Pit captures metals and arsenic contaminated storm water and groundwater that historically would flow to Silver Bow Creek. The Horseshoe Bend water treatment facility began operations in November 2003 and is currently treating approximately two million gallons per day of contaminated water from springs that flow through mine waste. Montana Resources currently uses all of this water for processing ore from its Continental Pit mining operations. At full capacity, the Horseshoe Bend treatment plant can treat seven million gallons of contaminated water per day and will eventually need to be expanded to accommodate 10.85 million gallons per day (Bertram and Chavez, 2002). Treatment of Berkeley Pit water will commence in approximately 2018.

Figure 7-12: Yankee Doodle tailings impoundment.

Yankee Doodle Creek and the headwaters of Silver Bow Creek are two small streams with important fresh water resources. Moulton Reservoir captures the upper portion of Yankee Doodle Creek and supplies the city of Butte with up to ten percent of its drinking water. The lower portion of Yankee Doodle Creek and upper Silver Bow Creek both drain into the Yankee Doodle tailings impoundment. This water then either infiltrates into groundwater or evaporates. Contact with mining waste rock or tailings contaminates water that eventually flows into the Berkeley Pit, Horseshoe Bend, or other groundwater in the Butte area. Although relatively small, surface water from these sources is a significant source of fresh water potentially for beneficial uses in the Butte area. Examples include irrigation water for trees, shrubs, and grasses planted for aesthetic purposes or surface water for an artificial stream channel through the Metro Storm Drain.

The Butte-Silver Bow city-county government currently controls a significant water right from the Silver Lake system, located to the northwest of the Silver Bow Creek watershed. The Silver Lake system includes three lakes (Silver Lake, Storm Lake, and Georgetown Reservoir) and an extensive pipeline conveyance system reaching the active mining areas above Butte. Butte-Silver Bow is obligated to supply a portion of this water to ARCO for remediation purposes, local irrigators, and other industrial users (Pioneer, 2002). Currently, the ASIMI silicon product facility in the Sand Creek sub-watershed and Montana Resources Continental Pit mining operations are the other industrial users of this water. Unallocated water from this source has potential for beneficial uses throughout the Silver Bow Creek watershed. This water is under consideration as a source for surface water in an artificial channel in the Metro Storm Drain corridor.

7.6.3 Fisheries

Little information is available on fisheries in the Butte area sub-watershed. Two small headwaters streams, Yankee Doodle Creek and the uppermost portion of Silver Bow Creek may host important fisheries (La Marr, 2003c); however, little data are available on fishery resources in these streams. Since Yankee Doodle Creek serves as a source of fresh water for the city of Butte, USFS fisheries biologists rank this stream as high priority for protection. However, the remainder of the sub-watershed is devoid of fish due to channel obliteration and severe contamination. No fish occur downstream of these headwater areas in this sub-watershed.

7.6.4 Vegetation

USGS GAP vegetation data indicate a large proportion of cover types associated with urban areas and land disturbances such as mining (Table 7-35) in the Butte Area sub-watershed. Barren sites account for 16% of the area while urban areas account for 7.67%. Mixed forest accounts for 34% of the watershed, almost entirely in the montane northern and eastern portions of the sub-watershed. Interestingly, the proportion of forest cover types is larger than two other sub-watersheds in the study area, the Sand Creek and Warm Springs Ponds area sub-watersheds. Other dominant cover types are sagebrush (18.5%) and low to moderate cover grasses (13.5%). Riparian and wetland areas constitute less than 1% of the sub-watershed. Mining and urban development have both contributed to a lack of vegetation in the Butte area. Contaminated soils and limited water resources altered vegetation communities throughout the sub-watershed and impede efforts to enhance vegetation.

Table 7-35: Major vegetation cover types in the Butte area sub-watershed (GAP).

Cover Type	***Percent Area***
Mixed Broadleaf and Coniferous Forest	34.03%
Low/Moderate Cover Grasslands	13.55%
Very Low Cover Grasslands	0.25%
Sagebrush	18.55%
Shrubs	3.85%
Barren Sites	16.06%
Riparian Areas	0.86%
Rock	1.26%
Montane Parks and Meadows	0.95%
Urban Areas	7.67%

Statewide section-based weed mapping indicates the presence of significant spotted knapweed, toadflax, and leafy spurge in the area (Figure 6-12). The Butte-Silver Bow Weed District also mapped significant weed infestations in the area. Input gathered during focus group meetings concurred with these assessments.

7.6.5 Wildlife

Montana FWP statewide wildlife distribution data indicate small areas of deer winter range along the western boundary of the sub-watershed and elk winter range scattered along the East Ridge area (Figure 6-13). Conversations with Montana FWP personnel indicate the presence of elk winter range and migration corridors from the East Ridge to Browns Gulch (Montana FWP, 2003a). USFS proposed management objectives in this area (Beaverhead-Deerlodge National Forest 2003a) include forest-wide objectives of maintaining and enhancing wildlife values and local objectives of improving sustainability of vegetation for ecosystem health and scenery.

7.6.6 Recreation

The Moulton Reservoir area north of Butte is popular for recreation year-round. Camping, hiking, and OHV riding are popular in summer, and snowmobiling and cross-country skiing are popular in winter. The proposed non-motorized Continental Divide National Scenic Trail (CDNST) runs along the crest of the East Ridge (Beaverhead Deerlodge National Forest 2003a.).

The communities of Butte and Anaconda, as well as nearby smaller communities and the Silver Bow Creek corridor, now host a number a recreational trails developed as part of a mining and smelting heritage park called Montana's Copperway. This proposed trail system covers a lot of the Butte urban area and includes a trail along the Butte Anaconda & Pacific railroad corridor, as well as the Silver Bow Creek Greenway Continued implementation of this Plan will provide recreational and economic opportunities for the citizens of the Silver Bow Creek watershed.

7.6.7 Public Input

Protection of water quality emanating from waste areas in the BPSOU through adequate source reduction, storm-water controls, and revegetation was the most commonly voiced priority for citizens in the Butte area (Table 7-36). Also important to locals is the "greening" of Butte by planting and maintaining trees, shrubs, and grass. Entryway corridors are in particular need of this improvement. A related concern was that inadequate vegetative cover on capped, remediated waste areas in BSPOU would lead to further erosion and pollution of Silver Bow Creek, weed infestations, and unaesthetic open spaces that curb economic growth. A strong desire for recreational enhancements in the urban area for the benefit of all citizens is also a high priority. Suggestions included more trails, pond and stream fishing opportunities, and more open space/parklands.

The Butte-Silver Bow planning department produced a Master Plan in 1995 that identifies planning goals and objectives for economic development, transportation, natural resources, public facilities, and community design and development (Butte-Silver Bow, 1995). The stated goal is to "develop a land use plan which encourages the utilization, conservation, and protection of agricultural, mineral, soil, timber, water and wildlife resources by promoting land use patterns which will provide optimum, long-term economic benefits, while maintaining balance with the social and aesthetic needs of the citizens of Butte-Silver Bow." The two objectives to achieve this goal in the master plan that are most pertinent to this planning effort are:

- to encourage reclamation strategies to utilize a variety of plant materials (including trees, shrubs and grasses) compatible to the area; and
- to maintain the quality and quantity of surface and groundwater resources for both consumptive and non-consumptive purposes.

These objectives are consistent with the input provided at focus group and other public group meetings summarized in Table 7-36.

In March 2001, Butte-Silver Bow identified the county's priority projects to restore and/or replace natural resources in the UCFRB (Butte-Silver Bow, 2001). The community's priority projects center on addressing the extensive groundwater injuries in the Butte area. The outlined projects and possible NRD future funding request estimates are:

1) Drinking water distribution infrastructure improvements – $15 million to be requesed over 15 years.
2) Drinking water source improvements for the Basin Creek Filtration Plant – estimated at $10 to 14 million.
3) Development of the Silver Bow Creek Greenway – estimated at $18 million.
4) Storm water system Improvements – estimated at $15 million.
5) METRO system upgrade – estimated at $15 million.
6) Urban revitalization and land restoration in areas around Butte which have been neglected after adverse mining impacts – no cost estimates provided.
7) Butte-Anaconda Mining Heritage Park – no cost estimate provided.

Through 2005, about $6.2 million has been approved for drinking water distribution infrastructure improvements and about $10 million has been approved for the Silver Bow Creek Greenway. The other priority projects listed above have not yet been submitted by Butte-Silver Bow for NRD funding.

In 2002, Butte-Silver Bow, in conjunction with Montana FWP, conducted a survey to determine the outdoor recreation priorities of local residents. The survey indicated that skateboarding, an outdoor swimming pool, picnic areas, accessible walking trails, accessible play equipment, and accessible restrooms were outdoor recreation priorities in the community (Butte-Silver Bow, 2002).

In January 2004, Butte-Silver Bow produced a draft position paper on BPSOU remediation (Butte-Silver Bow, 2004). The paper provides an annotated outline of Butte-Silver Bow's draft recommendation for the various components of the BPSOU remediation, including contaminated source areas, surface water, storm water, and groundwater. The plan puts forth community opinion on the desired remediation of BPSOU. Although the plan does not cover desired restoration, it indicates a strong desire to integrate future restoration work with remediation work.

Several recent public meetings have focused on desires of area citizens for the remediation of BPSOU, including several meetings to introduce and solicit public input on Butte-Silver Bow's position paper. In late 2003, EPA facilitated the initiation of a citizen advisory group to provide input as the agency completes its proposed plan for remediation. In their comments to the EPA Remedy Review Board, that group offered similar concerns and priorities to those reflected in Table 7-36 regarding source control and reduction; effective, varied revegetation with native trees, shrubs, and grasses; joint restoration and remediation planning; and maximizing redevelopment potential (Priority Soils Citizen Working Group, 2004 and Appendix C).

EPA held a 90-day public comment period on its December 2004 Proposed Plan for BPSOU and held a public hearing in March 2005. Public comments on the plan generally focused on concerns about attic dust, capped waste areas on Butte Hill, and groundwater contamination associated with the Parrot Tailings. EPA's response to comments to public comments on the proposed plan will be issued in conjuction with the Record of Decision, expected in 2006.

Table 7-36: Summary of public input for the Butte area sub-watershed.

Topic	*Type*	*Comments*
Water Quality/ Land Use	Priority and Concern	Source reduction at BPSOU. Remediated waste areas on BPSOU will continue to erode and pollute Silver Bow Creek.
Water Quality/ Habitat	Priority	Restore the upper section of historic Silver Bow Creek channel (Metro Storm Dam corridor)
Water Quality	Concern	Inadequate conveyance structures and retention basins within BPSOU
Water Quantity	Priority	Use treated water from Berkeley pit for greening Butte and recreation before discharge to Silver Bow Creek.
Water Quantity	Priority	Use treated water from Berkeley pit to enhance flows in Silver Bow Creek
Water Quantity	Concern	Conflicting consumptive and non-consumptive demands/desires exist for the treated Berkeley Pit water; need water balance.
Vegetation	Priority	"Green" Butte, particularly the entryway to Butte, to improve aesthetics of area landscape and spur tourism and growth
Vegetation	Priority	Re-vegetate the East Ridge
Vegetation	Concern	Lack of trees, weed infestation, erosion gullies, non-native monoculture in remediated waste areas of BPSOU
Vegetation/ Habitat	Concern	Need for ecological risk assessment for BPSOU; urban area supports plant and animal life
Recreation	Priority	More recreational opportunities such as pond fishing near urban area that are inclusive for a variety of users (kids, elderly, disabled, others)
Recreation	Priority	More recreational opportunities in the urban area for the enjoyment of all – trails, fishing and swimming opportunities, parks, open spaces
Recreation	Priority	Develop trail from West Camp to Rocker
Recreation	Priority	Develop recreational management plan for West Camp, an area of high recreational use
Recreation	Priority	Butte Trail Plan identifies community priorities
Recreation	Concern	Potential damage from OHV use; need for alternate off-road use areas
Recreation	Concern	Abandoned mines in the Westside Soils OU present safety hazards to users
Recreation	Concern	Loss of/lack of pond fishing opportunities in/near Butte
Restoration	Priority	Incorporate history in to restoration vision
Restoration	Priority	Conduct remediation and restoration planning concurrently

7.6.8 Sources of Environmental Impairment

The Butte area sub-watershed includes almost all of the historic and current hard rock mining operations in the Silver Bow Creek watershed. As a result, it contains significant sources of environmental impairment, some of which may take decades to clean up. Others may never be completely addressed. Table 7-37 lists the major types of environmental impairment in the Butte area sub-watershed. Numerous sources of each type are present within the sub-watershed. For detailed information on these sources, see Section 2.2 of this report. Note that Silver Bow Creek itself is part of the Silver Bow

Creek corridor planning area in this report. Section 7.1.8 lists sources of environmental impairment in the Silver Bow Creek corridor.

Table 7-37: Sources of environmental impairment in the Butte area sub-watershed.

Potential Impairment Source	***Contaminants/Problem***	***Data Sources***
Butte Hill Groundwater	Metals and arsenic. The Berkeley Pit, the adjoining underground mine workings, and the bedrock and alluvial aquifers on Butte Hill constitute one of the most contaminated bodies of water in the world, currently containing over 60 billion gallons of contaminated water.	Butte Hill Mine Flooding Operable Unit Record of Decision (EPA, 1994)
Contaminated soils, solid media in residential living spaces, waste rock and tailings	Metals and arsenic. Mining operations created numerous waste rock dumps and tailings deposits along Silver Bow Creek, Metro Storm Drain, and throughout the City of Butte.	BPSOU Phase II Remedial Investigation Report (PRP Group, 2001)
Alluvial aquifer and bedrock water associated with Butte Area One and saturated mine wastes that are sources of metals contamination to groundwater and surface water resources.	Metals and arsenic. Mining operations created numerous waste rock dumps and tailings deposits along Silver Bow Creek, Metro Storm Drain, and throughout the City of Butte.	BPSOU Phase II Remedial Investigation Report (PRP Group, 2001)
Storm water runoff	Metals and arsenic. Mining operations created numerous waste rock dumps and tailings deposits along Silver Bow Creek, Metro Storm Drain, and throughout the City of Butte.	BPSOU Phase II Remedial Investigation Report (PRP Group, 2001)
Groundwater from Montana Resources current mining operations	Metals and arsenic. Current mining operation uses water to slurry tailings uphill to the Yankee Doodle tailings impoundment. A portion of this contaminated water reaches bedrock and alluvial aquifers.	Montana Resources unpublished water balance diagram (Montana Resources, 2000)

7.6.9 Restoration Needs

The restoration needs identified within the Butte area sub-watershed and summarized in Table 7-38 are those identified primarily through public input rather than an evaluation by the State and its consultants of the physical condition of this sub-watershed. The EPA Superfund is currently addressing historic mining impacts in the BPSOU, which includes the majority of the Butte urban area. In addition, the NRDP has pending litigation against ARCO for injuries to surface water and groundwater resources in Butte Area One, which is a small part of BPSOU (Figure 2-3). Restoration planning efforts for areas with pending or ongoing remedial work must wait until the outcomes of remedial actions are clear. Thus, this plan does not detail potential restoration actions within the boundaries of the BSPOU. This plan will be updated as information on these pending actions becomes available. Following the Record of Decision for BPSOU, the NRDP will update its litigation claim for Butte Area One, which will identify what additional restoration actions are necessary to return the groundwater and surface water resources in Butte Area One to a baseline condition. As part of this update effort, the NRDP will identify where there are opportunities for joint remediation/restoration actions. An explanation of the rank, category, and agency/other responsibility columns in Table 7-38 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-38: Restoration needs for the Butte area sub-watershed.

Rank	***Category***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***
2	Protect Existing Resources	Limited drinking water supplies for the city of Butte make Moulton Reservoir a critical source of water.	Protect Yankee Doodle Creek from potential pollution sources and activities that may threaten water quality.	BSB, Montana DEQ
5	Pollution Mitigation	Mining related contaminants continue to enter Silver Bow Creek and degrade water quality. Storm water from the Butte area and groundwater in Butte Area One are the primary sources.	Ongoing and future remediation and the outcome of current litigation may address some of these sources of contamination. Seek effective remediation of BPSOU. Following the ROD, update the State's restoration plan for Butte Area One. Eliminate or isolate remaining sources of water quality impairment.	PRP GROUP, EPA, Montana DEQ, NRDP
11	Recreation	Additional trails between the Greenway and urban residential areas are desired.	Develop additional connecting trails.	
17	Recreation	The Westside Soils Operable Unit area currently has a high level of recreational use but has impacts from this use and hazards associated with historic mining activity, such as abandoned mine dumps.	EPA decisions on the needed remediation, if any, of the Westside Soils Operable Unit has been deferred until the Agency is funded to address this area. Restoration planning should be deferred until completion of a final remedy decision. ARCO owns the majority of lands and seeks a recreational land use scenario. Anticipated recreational needs are likely to be limited to trails for dispersed recreation.	PRP GROUP, EPA, Montana DEQ
18	Recreation	The upper reaches of Silver Bow Creek were obliterated by historic mining activities. A replacement surface water feature is desired.	Create a surface water feature with adjacent parkland and trails along the upper reaches of Silver Bow Creek between Texas Ave and the Blacktail Creek confluence. Plans are under way to accomplish this using water from the Silver Lake water system. Treated Berkeley Pit water is also a possible future water source if this treated water is not needed for mining operations. Current mining operations consume all of the current output of the Horseshoe Bend treatment plant.	BSB
19	Recreation	Butte area residents have not had access to a variety of recreational features as a result of mining activities and contamination.	Develop a variety of recreational features such as parks, open spaces, swimming areas and trails that are readily accessible for citizens of all ages. Benefits will vary based on number and magnitude of these features; cost assumes 3 of these features.	
25	Vegetation	Contaminated soils and lack of fresh water supplies have prevented vegetation from surviving and thriving in the Butte area. Entryway corridors and open spaces are in need of "greening."	Identify limiting factors to vegetation survival and address these issues. Develop alternative water sources that will enable vegetation to survive. One option is to utilize water that flows from upper Silver Bow Creek and Yankee Doodle Creek into the Yankee Doodle tailings impoundment. Use of this water is limited by current mining operations. Plant metals-tolerant trees, shrubs, and grasses (preferably native species) along entryway corridors and open spaces.	

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
28	Recreation	Nearby recreational fishing opportunities are not available to local residents.	Develop recreational (stream and/or pond) fishing opportunities in the Butte area. One such opportunity in Butte is currently being considered.	

7.6.10 Data Gaps

Most data gaps for the Butte area sub-watershed relate to the uncertainty involved with the pending Records of Decision for the BPSOU and unresolved Montana NRDP litigation for Butte Area One (Table 7-39). Also, the scope of future reclamation activities of the Butte Active Mine area remain to be determined. Other data gaps involve assessing the feasibility of vegetation restoration in the Butte area.

Table 7-39: Data gaps for Butte area sub-watershed.

Data Gap	*Uses*
Final Record of Decision for the BPSOU (which also includes Butte Area One)	Determine additional restoration needs beyond planned remedial actions
Water source availability from uppermost Silver Bow Creek and Yankee Doodle Creek	Determine if this is a viable water resource for various beneficial uses in the Butte area
Information assessing the viability of planting trees, shrubs, and grasses in open spaces and along entryway corridors.	Plan vegetation restoration projects
Scope of reclamation activities of the Butte Active Mine Area.	Assess potential impacts and solutions.

7.7 Browns Gulch Sub-Watershed

The Browns Gulch sub-watershed is located in the northeastern portion of the Silver Bow Creek watershed and covers approximately 85 square miles (54,380 acres), making it the third largest sub-watershed in the study area. The sub-watershed consists of two distinct ecological settings; a forested montane region, and a drier valley foothill region. Restoration planning challenges will differ greatly between these two areas. Mean elevation is 6242 feet above sea level and average annual precipitation is approximately 16.8 inches/year. Land ownership is approximately 52% private, 47% USFS, and 1% state. The geology of the sub-watershed consists mostly of Cretaceous Lowland Creek Formation volcanic rocks with minor amounts of Cretaceous granitic rocks and Tertiary Bozeman Formation sedimentary rocks. Land use is primarily agricultural in the lower elevation, valley foothill portions of the sub-watershed. Coniferous forest covers much of the higher elevation, montane portion of the watershed (USFS ownership). Several tributary streams contribute significant flow to Browns Gulch. These include Meadow Gulch, Telegraph Gulch, Flume Gulch, American Gulch, Alaska Gulch, Hail Columbia Gulch, Bull Run Creek, and Orofino Gulch (Figure 7-14).

Figure 7-13: Browns Gulch.

7.7.1 Water Quality

Limited water quality data are available for the Browns Gulch sub-watershed. The EPA STORET Legacy database contains data for seven sampling locations on Browns Gulch and tributaries (Figure 7-14). One 1970s surface water sampling event on American Gulch indicated a high value of aluminum exceeding both acute and chronic aquatic life standards. Subsequent samples, also from the 1970s, did not exceed water quality standards. Limitations in the analysis technology in the 1970s make these results unreliable. The Montana Bureau of Mines and Geology Groundwater Information Center (GWIC) database contained water quality information from a spring adjacent to Browns Gulch. This sample did not exceed water quality standards.

Reconnaissance and aerial photography assessments (Appendix D) of the Browns Gulch sub-watershed and information gathered at focus group meetings indicate the presence of land use activities that may be degrading water quality and aquatic habitat. These include riparian clearing, dewatering, and livestock grazing. Impairments to water quality from these types of land uses are typically siltation, elevated water temperatures, and nutrient enrichment. Additional water quality sampling is necessary to provide a clear picture of conditions in the Browns Gulch sub-watershed.

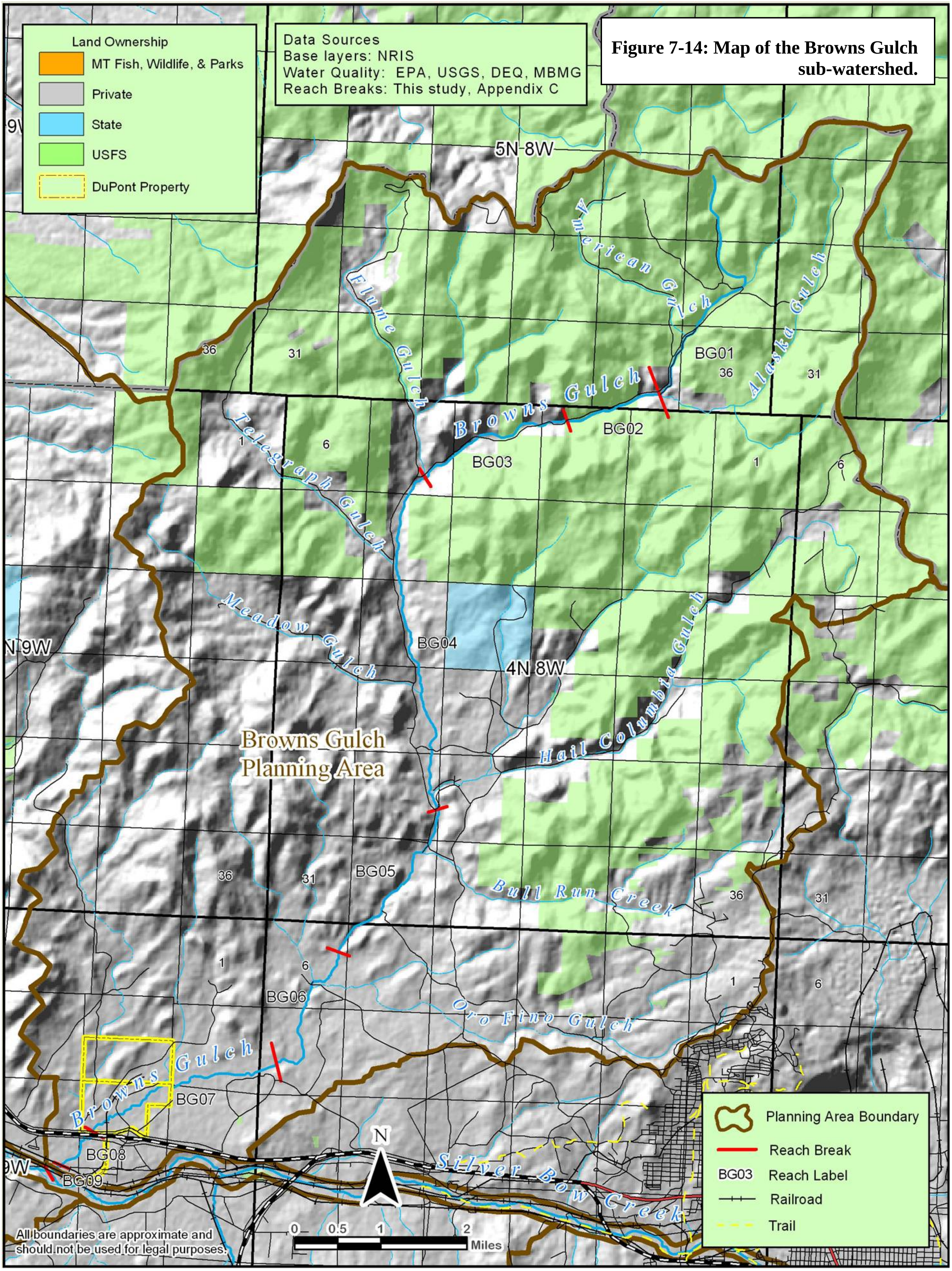


Figure 7-14: Map of the Browns Gulch sub-watershed.

7.7.2 Water Quantity

Participants in this planning effort's focus group meetings indicated that a lack of stream flow in Browns Gulch is a significant concern. The lower sections of Browns Gulch are typically dewatered two to three months of the year (Payne, 2004a). Some believe that low flow is partially a natural condition due to abundant southern exposure and loss of surface water to groundwater. Irrigation is common and most likely contributes to low flows.

Initial efforts to organize and form a Browns Gulch watershed group have been underway since 2003. This group has targeted flow augmentation and water conservation as one of seven resource areas of concern (Payne, 2004b; Section 7.7.7).

Borduin (1999) studied the geology and hydrogeology of the Sand Creek watershed and the adjacent portion of Silver Bow Creek. Stream flow data collected from Browns Gulch near its confluence with Silver Bow Creek indicate less than a 1 cfs flow rate on August 27, 1998. Borduin concluded that Sand Creek is a losing stream and that Silver Bow Creek, with a high conductivity alluvial aquifer, is a gaining stream from Rocker to Miles Crossing. Due to the similarity in geology between the lower reaches of Sand Creek and Browns Gulch, it is reasonable to assume that both Sand Creek and Browns Gulch contribute groundwater to the Silver Bow Creek alluvial aquifer.

The Montana DNRC water rights database lists 576 permitted water right points of use in the Browns Gulch sub-watershed (Table 7-40). Of these, 486 (84.4%) are for agricultural purposes (irrigation and stock water) and 74 (12.9%) are for domestic purposes (domestic wells and lawn and garden). Two commercial and 10 municipal water rights are associated with the town of Ramsey. The 576 permitted points of use correspond to 270 permitted water rights.

Table 7-40: Browns Gulch sub-watershed water rights (DNRC database).

Water Right Purpose	*Number of Water Rights (Points of Use)*	*Percent of Water Rights (Points of Use)s*
Commercial	2	0.3%
Mining	0	0.0%
Industrial	0	0.0%
Municipal	10	1.7%
Irrigation	265	46.0%
Stock	221	38.4%
Domestic	61	10.6%
Lawn and Garden	13	2.3%
TOTAL	576	

This distribution of water rights by purpose illustrates the agricultural nature of the Browns Gulch sub-watershed. Analysis of the water rights database also indicates that the permitted points of use apply to a maximum of 6097 acres and that the total permitted water appropriation is 7790 acre-feet. Note that these numbers represent permitted amounts, not actual usage.

In 1994, the Soil Conservation Service (now NRCS) and USFS in cooperation with Montana DNRC and Montana FWP, conducted a study of potential water storage (dam) sites in the upper Clark Fork River basin (SCS and USFS, 1994). Consultants hired for this project evaluated eight potential storage sites identified through a preliminary screening process. Two of these sites are in the Browns Gulch sub-watershed. The report evaluated potential size, engineering requirements, spillway requirements, and other factors, and generated cost estimates for construction, engineering, permitting, land purchase, and infrastructure relocation. Cost estimates were $4,470,000 and $8,068,000 for the two sites with amortized installation costs (4.6% for 70 years) of $39.90/acre-ft and $44.00/acre-ft respectively. The report did not estimate operations and maintenance costs, conveyance costs, or dam life. Two other studies of storage potential in Browns Gulch indicated estimated annual costs of storage for reservoirs in Browns Gulch from $35 to $55 per-acre foot (ESA, 1990) and indicated that creation of water impoundments in Browns Gulch would result in high hazard dam classification (Aquoneering, 1990). Based on these studies, the NRDP concluded that storage reservoirs in Browns Gulch would be cost-prohibitive (NRDP, 2004). Unfortunately, no stream gage data are available to better assess the availability of water in the Browns Gulch sub-watershed. This information, as well as additional information on the fisheries of Browns Gulch, will be critical for any restoration planning and may indicate the need for exploring water storage options in this subwatershed.

7.7.3 Fisheries

USFS data indicate the existence of approximately 27.5 miles of fish-bearing stream within or surrounded by National Forest lands (La Marr, 2003b). Brook trout inhabit all of these streams and some support westslope cutthroat trout. A set of 10 genetic samples collected from westslope cutthroat trout in Alaska Gulch in 2003 by the USFS indicated that this population is likely 100 percent genetically pure (Spruell, 2004). An additional set of 19 samples collected in 2004 also tested as genetically pure (Spruell, 2005). There are approximately 3 miles of stream in Alaska Gulch to which these results likely apply. Westslope cutthroat trout genetics results from a set of 26 samples collected in American Gulch in 2004 indicate that this population is also likely 100 percent genetically pure (Spruell, 2005). There are approximately 2.5 miles of habitat in this stream to which these results likely apply.

Spot-checking of fish populations by USFS personnel indicate low numbers of westslope cutthroat trout relative to brook trout (La Marr, 2003b and La Marr, 2005). USFS fish biologists believe that the Browns Gulch sub-watershed lacks true refugia or focal habitats (Section 3.3.1) and therefore ranked this area as a moderate priority for aquatic restoration of westslope cutthroat trout (La Marr, 2003b). Restoration would therefore be more costly and take longer than areas containing focal habitats. Consequently, USFS goals are to establish focal habitats for westslope cutthroat trout where brook trout can be suppressed, then expand restoration to adjacent areas. The presence of genetically pure westslope cutthroat trout indicated by the 2004 sampling of Alaska and American Gulches offers the possibility of recruitment of these populations to the Silver Bow Creek fishery, however, dewatering issues in the lower main stem of Browns Gulch would have to be resolved in order to reestablish secure connectivity between Browns Gulch and Silver Bow Creek (La Marr, 2005).

The only fisheries information available for the lower reaches of the sub-watershed is a single sampling event in 1992. Montana FWP personnel estimated 227 brook trout per 1,000 feet of channel near the mouth of Browns Gulch, a relatively low number that reflects the impaired nature of lower Browns Gulch (MFISH, 2003). Montana FWP biologists indicated in focus group meetings that, while the lower reaches of Browns Gulch currently do not support habitat for trout spawning and rearing, such habitat would follow from instream flow enhancement.

Montana DEQ recently produced remedial design documents for the confluence of Silver Bow Creek and Browns Gulch (Maxim, 2003). About 1000 feet of lowermost Browns Gulch between its confluence with Silver Bow Creek and the railroad bed is scheduled for reconstruction to coordinate with Silver Bow Creek tailings cleanup and channel reconstruction in 2006. Increased sinuosity and other aquatic enhancements in this stream channel are part of this Plan. A culvert conveying Browns Gulch through an Interstate 90 overpass just above the confluence with Silver Bow Creek appears to be a potential fish passage barrier.

The MFISH (2003) database contains fishing pressure data for Browns Gulch for two years, 1985 and 2001. Fishing pressure was 308 angling days in 1985 and 53 days in 2001. Resident anglers are the primary users of this stream.

7.7.4 Vegetation

USGS GAP vegetation analysis data indicate that three vegetation types cover the majority of the Browns Gulch sub-watershed (Figure 6-10 and Figure 6-11). Mixed broadleaf and coniferous forest (60%) dominate the higher elevation areas in the northern part of the sub-watershed, whereas sage brush (21%) and very low to moderate cover grasslands (13%) dominate the southern, lower elevation part of the watershed. Minor vegetation types present include mixed shrubs (3%) and mixed riparian vegetation (2.7%). Table 7-41 summarizes the significant vegetation types in the Browns Gulch sub-watershed as reported in the USGS GAP vegetation data set.

Table 7-41: Vegetation types in the Browns Gulch sub-watershed (USGS GAP).

Cover Type	***Percent of Watershed***
Mixed Broadleaf and Coniferous Forest	59.71%
Low/Moderate Cover Grasslands	12.50%
Very Low Cover Grasslands	0.53%
Sagebrush	21.01%
Shrubs	2.89%
Barren Sites	0.10%
Riparian Areas	2.69%
Rock	0.02%
Montane Parks and Meadows	0.33%
Urban Areas	0.00%

Statewide section based weed occurrence mapping indicates the presence of significant leafy spurge and spotted knapweed infestations in the Browns Gulch sub-watershed (Figure 6-12). Comments received from focus group participants also indicate that noxious weeds are a significant concern. The USFS conducted detailed weed mapping for portions of the Silver Bow Creek watershed and identified leafy spurge infestations on USFS lands in the Browns Gulch sub-watershed. Available Butte-Silver Bow weed district mapping data does not cover this area. Information gathered during focus groups indicate that riparian areas show varying degrees of degradation from livestock grazing practices.

7.7.5 Wildlife

Montana FWP statewide wildlife winter range mapping data shows the presence of significant elk and deer winter range in the Browns Gulch sub-watershed (Figure 6-13). Recently compiled Montana FWP winter aerial elk sighting data indicates significant winter range in the sub-watershed as well (Montana FWP, 2004 and Appendix E). A similar data set for deer does not extend to the Browns Gulch sub-watershed. Anecdotal data from Montana FWP also indicates the presence of significant elk and deer habitat and winter range in this planning area. Limited information on antelope and moose populations in the Silver Bow Creek watershed does not extend to the Browns Gulch sub-watershed. Focus group meeting participants mentioned the presence of mountain lions in this planning area.

7.7.6 Recreation

The Browns Gulch sub-watershed is a popular recreation area used primarily by local residents. Summer activities include fishing, hunting, hiking, horseback riding, and OHV riding. The northeastern portion of the sub-watershed coincides with the continental divide and the Continental Divide National Scenic Trail (CDNST). Management of a non-motorized CDNST is a USFS priority. Winter activities include extensive snowmobile riding and cross-country skiing. The Moulton cross-country ski area includes trails in both the Browns Gulch and Butte area sub-watersheds.

7.7.7 Public Input

Several focus group participants identified the Browns Gulch sub-watershed as a high priority area for restoration. A need to improve grazing practices in riparian areas and lack of flow in the lower reaches were the two most commonly repeated topics.

Participants also shared a number of concerns about Browns Gulch. A lack of fisheries data precludes a good understanding of fishery resources. Overgrazing, which may be causing sediment, nutrient and temperature problems, was another concern raised by focus group participants. Fragmented land ownership and noxious weed problems in the headwaters were other concerns described by several groups.

Table 7-42: Summary of public input for the Browns Gulch sub-watershed.

Topic	*Type*	*Comments*
Restoration	Priority	Considered a high priority sub-watershed by several groups
Wildlife	Priority	Opportunities exist for upland improvements for wildlife
Vegetation/Land Use	Priority	Riparian grazing management needed on USFS lands.
Water Quantity	Priority	Increased instream flows needed to support fisheries
Water Quantity	Concern	Water quantity lacking to support fish in lower stream reaches
Water Quantity	Concern	Southern exposure and climatic conditions limit ability to enhance flows.
Fisheries	Concern	Upper reaches heavily populated by non-native brook trout
Fisheries	Concern	Lack of recent fisheries data.
Water Quality/Land Use	Concern	Over grazing may be causing sediment, nutrient, and temperature problems
Water Quality	Concern	Possible impacts from the defunct DuPont facility
Land Ownership/Access	Concern	Fragmented land ownership
Recreation	Priority	Very good recreational opportunities but limited public access
Recreation	Priority	Secondary trail connecting Brown's Gulch and Greenway
Recreation	Concern	Recreational management needed given varied and high use
Weeds	Concern	Noxious weed problems in headwaters

In 2003, stakeholders in the Browns Gulch sub-watershed began organizing and planning of a watershed group. A public meeting in June 2003 identified strong public support for watershed planning and restoration efforts in the area. A subsequent public meeting held on January 20, 2004 presented a plan and schedule for Browns Gulch watershed activities (Payne, 2004b). The overall goal for these efforts is "to restore the high quality natural resources of Browns Gulch, and preserve and protect the social and economic fabric." The group requested funding from the NRDP in 2004 to conduct a comprehensive watershed assessment that focuses on the following seven areas of concern:

- stream flow,
- invasive species (weeds),
- forest health and management,
- wildlife management,
- fisheries enhancement and recreation,
- riparian corridor management/water quality, and
- conservation easements.

The State approved part of the requested funding in December 2004 (see Section 2.2.4).

7.7.8 Sources of Environmental Impairment

The Browns Gulch sub-watershed is primarily rural with some recent residential development. Observed environmental impairments relate to land uses and include riparian degradation and siltation. Nutrient and temperature impairments can be associated with the current agricultural land uses. Residential development, although limited at this time, can be a source of nutrients to streams from septic systems and fertilizer use. Table 7-43 lists potential sources of environmental impairment.

Recent data collected on the historic DuPont explosives production facility near the mouth of Browns Gulch indicates that the contamination from the facility has been adequately remediated (DuPont, 2005). DuPont completed an environmental assessment and voluntary cleanup of the facility in 2005. Environmental assessment results indicated that on-site groundwater is not contaminated but that some on-site soils are contaminated with lead, arsenic, and semi-volatile organic compounds (Vetter, 2004). The cleanup involved removal of 2,688 tons of mine tailings, 3,478 tons of contaminated soils, and 222 tons of DNT/TNT contaminated soil and debris from various locations over the 200-acre manufacturing site.

Table 7-43: Sources of environmental impairment in the Browns Gulch sub-watershed.

Potential Impairment Source	***Contaminants/Problem***	***Data Sources***
Historic DuPont explosives production facility near the mouth of Browns Gulch	Lead, arsenic, DNT/TNT, and various volatile organic compounds.	Site adequately remediated in 2005.
Livestock grazing/Riparian degradation	Siltation, nutrients, temperature, habitat degradation	Public comment, aerial assessment indicates riparian degradation.
Channelization	Siltation, channel incision, habitat degradation	Aerial assessment identifies channelized reaches.
Dewatering	Habitat alteration, temperature, nutrients.	Public comment, DNRC water rights database, limited flow data.

7.7.9 Restoration Needs

Restoration needs are only partially understood at present. Reconnaissance observations and public input suggest that current land uses could be impairing water quality, which in turn would limit fisheries. Creating a viable Silver Bow Creek fishery will require healthy, connected tributary streams. Browns Gulch has potential to serve in this capacity. In addition, a potential exists to create and maintain focal habitats for westslope cutthroat trout in the headwaters of Browns Gulch and headwater tributaries.

Table 7-44 presents a list of restoration needs and goals for the Browns Gulch sub-watershed. An explanation of the rank, category, and agency/other responsibility columns in Table 7-44 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapter 8.0.

Table 7-44: Restoration needs for the Browns Gulch sub-watershed.

Rank	***Category***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***
9	Fisheries	Current conditions of fisheries are not well understood.	Conduct additional fisheries assessment in the upper and lower reaches of Browns Gulch and major tributaries. In 2004 the State approved funding for such assessment work.	
14	Water Quantity	Stream flow is inadequate for fisheries in the lower reaches of Browns Gulch. Lack of flow is the greatest limiting factor to fishery improvements.	Identify and implement means to augment stream flow. Water conservation and water leasing are possibilities. In 2004 the State approved funding for a project to conduct needed flow studies.	

Rank	Category	Issue/Problem	Restoration Needs	Agency/Other Responsibility
23	Fisheries	Establish focal habitat for westslope cutthroat trout.	Assess feasibility of and establish isolated westslope cutthroat trout habitat in headwater areas, particularly in Alaska Gulch, via fish passage barriers and limited habitat improvement.	
30	Pollution Mitigation	Water quality (siltation, nutrients, temperature) may be impaired.	Address water quality impairments via improvement in land use practices.	
36	Fisheries	Improve fisheries habitat in lower reaches of Browns Gulch. Connecting a lower Browns Gulch fishery to a future Silver Bow Creek fishery is desired.	Assess feasibility of adequately addressing limiting factors to fisheries of water quantity, water quality, and habitat issues. Subsequent to addressing the water quantity and quality problems that limit fisheries in Brown's Gulch, improve aquatic habitat to further improve fishery populations.	
40	Recreation	Better public access is desired.	Identify and pursue public access opportunities in cooperation with current landowners.	

7.7.10 Data Gaps

Significant gaps exist in the knowledge base for the Browns Gulch sub-watershed. Water flow, water quality, and habitat sampling and assessment data are lacking. Restoration planning efforts in the Browns Gulch area should commence with adequate assessment before on the ground restoration is considered. In the lower reaches of Browns Gulch where mid-to-late summer flows are reported very low, water quantity may be a limiting factor. The feasibility of maintaining sufficient flows in this reach requires evaluation prior to habitat assessments.

Table 7-45: Data gaps for the Browns Gulch sub-watershed.

Data Gap	*Uses*
No stream flow data are available for the sub-watershed.	Any fisheries restoration will depend on whether there is an adequate supply of water. This information should ideally be gathered before initating stream habitat restoration.
Insufficient fisheries data for both montane and valley foothill portions of the Browns Gulch sub-watershed.	Assess current status of fisheries. Determine feasibility and priority of fisheries restoration efforts.
Insufficient water quality sampling data.	Determine whether suspected nutrient and temperature impairment exists. Assess level of effort necessary to rectify problems.
Insufficient riparian habitat, stream habitat, and channel condition data.	Assess whether siltation is impairing fisheries. Assess level of effort necessary to improve habitat to acceptable levels to meet overall restoration goals.

7.8 Warm Springs Ponds Area Sub-Watershed

The Warm Springs Ponds sub-watershed lies in the north central portion of the Silver Bow Creek watershed and covers approximately 47 square miles (30,314 acres). The sub-watershed includes the area east of, but not including, the Warm Springs Ponds and borders the Silver Bow Creek corridor on its south and west sides and the Browns Gulch sub-watershed to the east. Since the Warm Springs Ponds themselves connect to Silver Bow Creek, they are part of the Silver Bow Creek corridor planning area and not included in the Warm Springs Ponds sub-watershed. Mean elevation is 5539 feet above sea level and average annual precipitation is 13.84 inches, making it the second driest planning area. Land ownership is almost entirely private (95.1%) with small amounts of state land (2.6%) and USFS land (2.3%). The geology of the watershed consists of 33% Tertiary sedimentary rocks, 29% Cretaceous intrusive rocks, and 28% Tertiary volcanic rocks. Land use is primarily agricultural, grazing and a limited amount of irrigated pasture and hay production. Several small intermittent tributary streams are located in the Warm Springs Ponds sub-watershed. These include, from north to south, Cook Creek, Witchcraft Gulch, Hensley Gulch, Sheep Gulch, and Flint Creek. There are no perennial streams in this area.

7.8.1 Water Quality

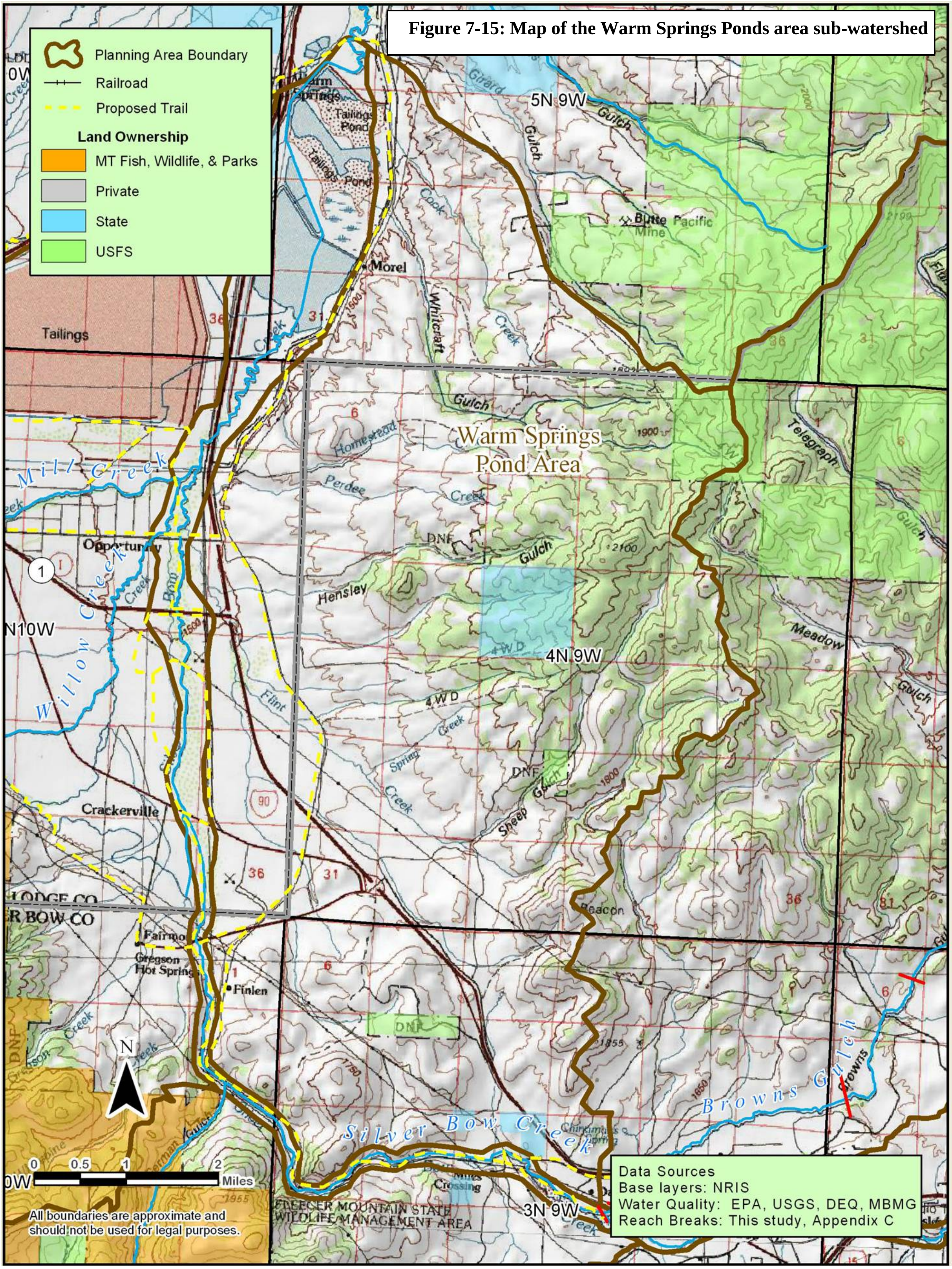
Very limited water quality information is available for the Warm Springs Ponds sub-watershed. In fact, no data exist for the significant streams occurring in the sub-watershed. However, indications of contamination of surface water include sample results from a ditch sampled by the Montana Bureau of Mines and Geology (GWIC database) in 1984 near Silver Bow Creek. This sample exceeded both acute and chronic aquatic life standards for copper (assuming a hardness of 50 mg/L). In addition, a water sample from a lysimeter installed adjacent to Silver Bow Creek sampled in 1987 (MBMG GWIC database) exceeded drinking water standards for arsenic, and both acute and chronic aquatic life standards for copper and zinc. The close proximity of the sample site with Silver Bow Creek and elevated metals and arsenic concentrations suggest that streamside tailings in Silver Bow Creek caused this contamination.

7.8.2 Water Quantity

Surface water quantity in the Warm Springs Ponds sub-watershed is limited. Soils derived from Tertiary sedimentary geology in the western portion of the sub-watershed (Figure 6-8) likely allow rapid infiltration to the extent that surface flow exists only during peak runoff and storm events. The upper reaches of Perkins Gulch and Girard Gulch immediately to the north of the sub-watershed are perennial whereas their lower reaches are intermittent. It is likely that the upper reaches of some of the larger tributary streams in the Warm Springs Ponds sub-watershed are also perennial; however, no data are available to confirm this.

The Montana DNRC water rights database lists 128 permitted water right points of use in the Warm Springs Ponds sub-watershed (water rights are also present. The 128 permitted points of use correspond to 81 actual water rights (Table 7-46). Of these, 67 (52%) are for agricultural purposes (irrigation and stock water) and 58 (45%) are for domestic purposes (domestic wells and lawn and garden). Three small commercial (groundwater, 1 gpm)

Figure 7-15: Map of the Warm Springs Ponds area sub-watershed



water rights are also present. The 128 permitted points of use correspond to 81 actual water rights.

Table 7-46: Water rights, Warm Springs Ponds sub-watershed (DNRC database).

Water Right Purpose	***Number of Water Right Points of Use***	***Percent of Water Right Points of Use***
Commercial	3	2.3%
Irrigation	14	10.9%
Stock	53	41.4%
Domestic	46	35.9%
Lawn and Garden	12	9.4%
TOTAL	128	

This distribution of water rights by purpose illustrates the lack of water in the Warm Springs Ponds sub-watershed. Analysis of the water rights database also indicates that the permitted points of use apply to a maximum of 379 acres. Total volume of appropriated water information is not available. Note that these numbers represent permitted amounts, not actual usage.

7.8.3 Fisheries

Fisheries data are scarce for the Warm Springs Pond sub-watershed. The only nearby sampling data were genetic testing of westslope cutthroat trout in Perkins Gulch (just to the north of the sub-watershed). These fish were 100% pure westslope cutthroat trout with no signs of introgression. Unfortunately, it is possible that extirpation of this population occurred following a large flood event in the late 1990s. This potential loss emphasizes the need to identify and protect westslope cutthroat trout populations throughout the basin.

7.8.4 Vegetation

Vegetation in the Warm Springs Ponds sub-watershed consists primarily of very low to moderate cover grasslands (49.4%), with coniferous forest in the eastern portion (29.4%), and abundant shrubs and sagebrush (20.3%). Very little riparian vegetation is present (0.9%) due to the lack of perennial streams (Table 7-47 and Figure 6-11). The Tertiary sedimentary rocks in the area (Figure 6-8) typically form soils that have high infiltration rates and low available water capacity, and only support grasses and shrubs. Decades of smelter fallout has likely further reduced the productivity of these soils. These attributes, combined with low average annual precipitation, greatly influence vegetation in the Warm Springs Ponds sub-watershed.

Table 7-47: Cover types in the Warm Springs Ponds sub-watershed (USGS GAP).

Vegetation Type	***Percent of Area***
Mixed conifer and broadleaf forest	29.4%
Low/moderate cover grassland	48.9%
Sagebrush	15.7%
Very low cover grassland	0.5%
Shrubs	4.6%
Mixed riparian	0.9%

Noxious weeds are a significant concern in the Warm Springs Ponds sub-watershed. The Montana Noxious Weed Trust Fund statewide section based weed mapping shows large areas of leafy spurge and spotted knapweed infestations (Figure 6-12). Focus group participants also mentioned noxious weeds as a significant problem. A large ranch owner in the area reportedly ceased grazing and aggressively sprayed noxious weeds over a five-year period. Native grasses have reportedly recovered resulting in greatly improved wildlife habitat and increased elk numbers.

7.8.5 Wildlife

Despite lacking the diversity of vegetation in other parts of the Silver Bow Creek watershed, the Warm Springs Ponds sub-watershed supports an abundance of wildlife. Montana FWP statewide wildlife distribution data indicate abundant antelope, mule deer, and elk winter range in this area. In addition, participants in focus groups reported large numbers of elk and deer.

7.8.6 Recreation

Recreation is limited in the Warm Springs Ponds sub-watershed due to the large proportion of private land in the area (95.1%). Some hunting occurs on private land but access is limited. Focus group participants expressed a desire for better public access.

7.8.7 Public Input

Focus group participants voiced several concerns for the Warm Springs Ponds sub-watershed. Many of these comments refer to water quality and waterfowl habitat in and around the Warm Springs Ponds proper. Since the Warm Springs Ponds connect to Silver Bow Creek, the section on the Silver Bow Creek corridor (Section 7.1) addresses these issues. Other comments refer to public access, noxious weeds, and improving stream and riparian habitat.

Table 7-48: Summary of public input for the Warm Springs Ponds sub-watershed.

Topic	***Type***	***Comments***
Access, recreation	Concern	Poor access exists between Warm Springs Ponds and Browns Gulch. Access problems have been ignored.
Weeds	Concern	Leafy spurge infestations are common.
Soils	Concern	Historic smelter emissions may have impaired soils to the extent that native vegetation is reduced.
Habitat	Opportunity	Improve stream habitat and riparian condition in tributary streams.

7.8.8 Sources of Environmental Impairment

Noxious weeds and smelter fallout are the two identified issues of concern that affect water quality and habitat in this planning area (Table 7-49).

Table 7-49: Sources of impairment in the Warm Springs Ponds sub-watershed.

Potential Impairment Source	*Contaminants/Problem*	*Data Sources*
Noxious weeds	Noxious weeds can out-compete native grasses, reduce wildlife habitat, and lead to increased erosion and sediment load to Silver Bow Creek, Warm Springs Ponds, or the Clark Fork River.	Focus groups
Smelter fallout	Historic smelter fallout may cause reduced vegetation growth and can lead to increased erosion and sediment load to Silver Bow Creek, Warm Springs Ponds, or the Clark Fork River.	Focus groups

7.8.9 Restoration Needs

Restoration needs in the Warm Springs Ponds sub-watershed are minor compared to many other areas within the Silver Bow Creek watershed (Table 7-50). An explanation of the rank, category, and agency/other responsibility columns in Table 7-50 and detailed information on the prioritization process and restoration needs for the entire Silver Bow Creek watershed is in Chapters 4.0 and 8.0.

Table 7-50: Restoration needs of the Warm Springs Ponds area sub-watershed.

Rank	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
54	Vegetation	Noxious weeds restrict growth of native vegetation. Wildlife habitat is also reduced. Historic smelter fallout may have rendered soils slightly phytotoxic, restricting plant growth.	Work with county and conservation officials to develop appropriate weed management strategies that takes into consideration findings of the BSB soils survey. Take appropriate actions to improve upland vegetation.	Multiple landowners
56	Recreation	Access is restricted to private lands.	Pursue easement or other access possibilities such as Montana FWP block management as appropriate.	

7.8.10 Data Gaps

Due to the large amount of private land and lack of perennial streams in the Warm Springs Ponds area, little scientific work is available. The Natural Resource Conservation Service (NRCS) is close to completing soils mapping for Silver Bow County. This information will be extremely valuable for the entire Silver Bow Creek watershed for restoration planning purposes. Potential uses include:

- assessing soil phytotoxicity;
- determining optimal locations for riparian and upland vegetation restoration; and
- determining relative soil erodibility.

8.0 Restoration Prioritization

The primary objective of this planning document is to identify and prioritize restoration needs and opportunities in the Silver Bow Creek watershed. This will determine the best use of the NRDP administered funds and other available funding sources to realize the consensus vision statement developed for this watershed (Chapter 5.0):

> In the 21st century, the Silver Bow Creek watershed is a vibrant place to live, work and recreate. The watershed is protected from adverse impacts of mining contamination. The restored watershed supports viable, self-sustaining communities of fish, wildlife and vegetation, and high-quality water resources. Native species are maintained and restored where practicable. The watershed's healthy ecosystem provides for quality education and balanced recreation, contributing to a diverse and sustainable economy, improved aesthetics, and community well-being. Stable and healthy local communities of informed citizens actively protect and preserve the watershed's resources.

The primary goals of the vision statement are:

- protection from adverse impacts of mining contamination,
- self sustaining fisheries, wildlife and vegetation,
- high-quality water resources, and
- native species restoration where practicable.

Secondary goals include:

- a healthy ecosystem that provides for quality education and balanced recreation, and contributes to a diverse and sustainable economy, improved aesthetics, and community well being, and
- informed citizens actively protect and preserve the watershed's resources.

Given the degree and extent of impairments in the watershed, it is possible that currently available restoration funds could fall short of requirements needed to meet the goals of this vision. Consequently, it is critical that projects that benefit the watershed in the most cost-effective manner receive funding priority.

8.1 Review of Prioritization Process

Section 4.4.2 presents the detailed methodology used to prioritize restoration efforts in the Silver Bow Creek watershed. In review, three distinct processes assisted with the determination of restoration priorities. Figure 8-1 illustrates the process.

First, data review and analysis combined with public input allowed creation of a list of 60 restoration needs for the Silver Bow Creek watershed that collectively meet the goals of the vision statement. Restoration needs by planning area are presented in Chapter 7.0 along with detailed information about current watershed conditions, public priorities and concerns, known and potential sources of environmental impairment, and data gaps. The restoration needs fit well with the types of projects eligible for NRDP funding consideration: projects that improve water quality, fishery populations and habitat, wildlife populations and habitat, and natural resource based public recreation. These needs also fit well with funding criteria for other programs identified in Section 9.2.

Next, we developed a series of six restoration categories (Table 4-8) based on the watershed planning and restoration concepts presented in Chapter 3.0. The restoration categories were compared to the vision statement goals and modified as needed to ensure compatibility. This resulted in strong agreement between the restoration categories and vision statement. All restoration needs identified in the previous step were placed into one or more of the restoration categories, with some restoration needs falling under more than one category. These categories are presented in order of priority with the first two categories considered equally important:

- Preservation/Protection of Existing Resources
- Pollution Mitigation
- Water Quantity Improvement
- Fishery Restoration
- Vegetation/Wildlife Restoration
- Recreation Development

Finally, based on public input, input from resource managers, information in Chapter 7.0, the restoration categories and vision statement, and best professional judgement, we developed a relative ranking of watershed benefits, local (planning area) benefits, and estimated cost to address each restoration need. We then combined these rankings into an overall ranking for each restoration need. This provided the first pass ranking of restoration needs. Four of the restoration needs have a deferred priority because regulatory or other actions that are either currently underway or planned may address these needs.

8.2 Watershed Scale Prioritization Results by Restoration Category

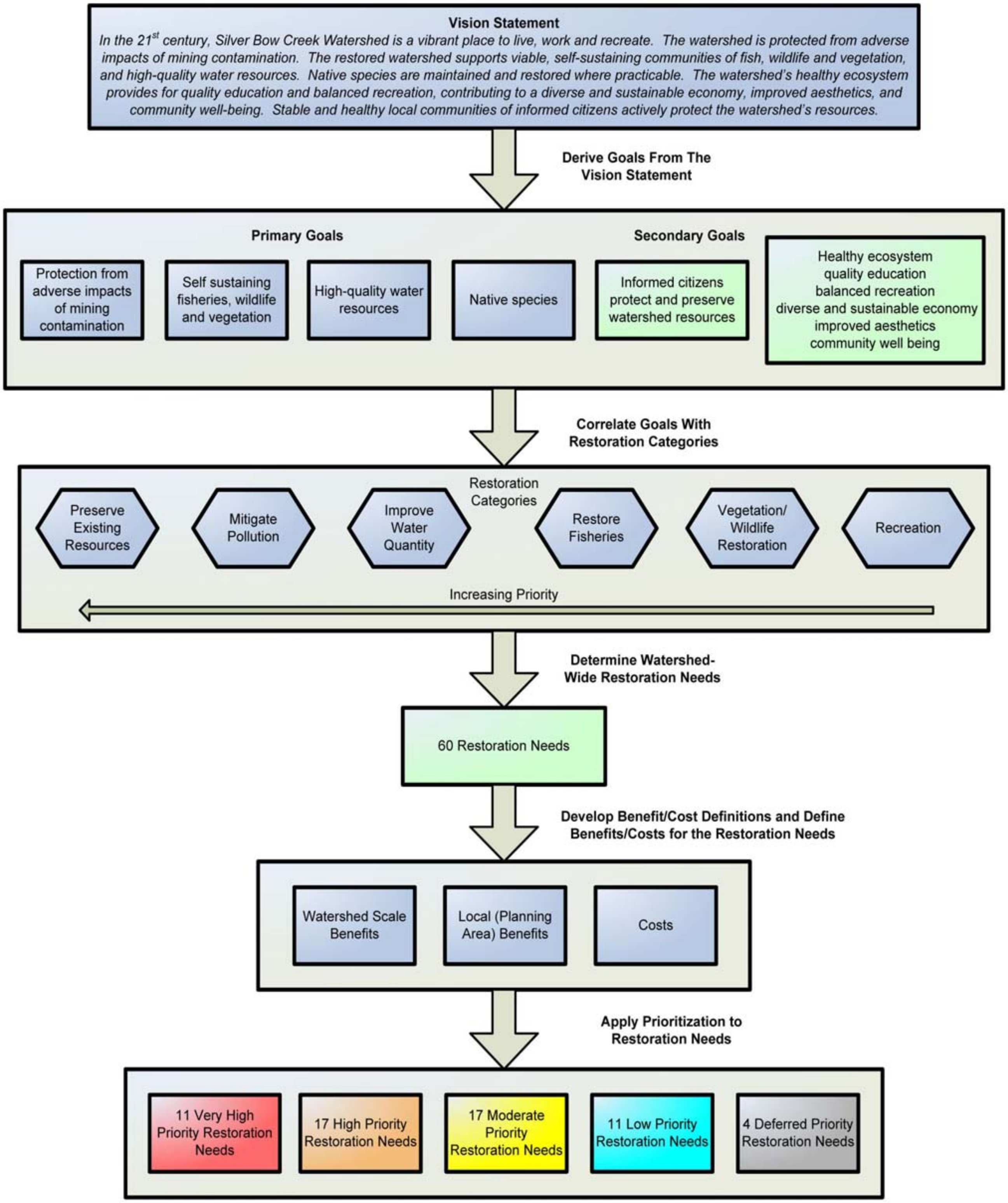
The restoration category that each restoration need falls into is presented by sub-watershed in Chapter 7.0 and for the entire Silver Bow Creek watershed in Table 8-1 and Table 8-2. The following sections describe watershed-scale prioritization results for each of the six restoration categories.

Preservation/Protection of Existing Resources

Due to widespread habitat degradation in the watershed, protection of remaining critical fish and wildlife habitat is essential for effective long-term recovery efforts. If existing high quality resources face threats from current or future land uses, preservation and protection of these resources would provide significant ecological benefit. Preservation costs are typically lower than restoration costs.

The Silver Bow Creek watershed contains some existing natural resources that have high value to the ecosystem, notably uncontaminated water, healthy fisheries and vegetation, and healthy wildlife populations. These resources provide habitat for fish and wildlife in an impaired ecosystem and are important for repopulating impacted areas following remediation and restoration. Thus, existing high quality resources are important to protect from potentially detrimental future land use activities.

Figure 8-1: Diagram illustrating the watershed restoration plan development.



The impacts of historic mining severely limit the available drinking water supplies in the Silver Bow Creek watershed. As a result, the existing municipal water supplies in Basin Creek and Moulton reservoir are critical resources to protect from degradation. The utility of the municipal water supplies can also be maximized through conservation efforts, such as improvements to transportation infrastructure to prevent leakage and use of water metering to curb wasteful watering practices.

For fisheries, preservation and protection of existing resources means protecting existing fish populations from future activities that could impair water quality or habitat. In the Silver Bow Creek watershed, opportunities to preserve and protect high quality native fisheries exist in the Blacktail Creek, Basin Creek, German Gulch, and Browns Gulch drainages. In Blacktail Creek, genetically pure westslope cutthroat trout inhabit areas in the Thompson Park boundary and are likely to occur to at least 7.5 miles of the stream from the northern Thompson Park boundary to the headwaters. In Basin Creek, genetically pure westslope cutthroat trout inhabit the upper reaches above the Basin Creek reservoir. In German Gulch, westslope cutthroat trout are relatively abundant, but threatened by contamination from the Beal mine and introgression from non-native species. In Browns Gulch, genetically pure westslope cutthroat trout inhabit the upper reaches of the American Gulch and Alaskan Gulch tributaries. Areas such as these are good candidates for acquisition or easements to protect the existing fishery resource. Other opportunities to preserve and protect existing fisheries exist throughout the watershed but are of lower priority.

Wildlife face threats similar to fish. Land development can reduce and/or fragment key migration corridors or winter range. Significant populations of deer and elk exist throughout the Silver Bow Creek watershed with the exception of areas heavily impacted by mining and smelting operations (Figure 6-13). The German Gulch and Mill and Willow Creek sub-watersheds contain elk, deer, and moose winter range considered critical by Montana FWP personnel (Montana FWP, 2003a). Development for residential and commercial purposes threatens private lands in these sub-watersheds. Areas such as these are good candidates for acquisition or easements to protect the existing wildlife resource. Other areas with elk, deer, and moose winter range identified by Montana FWP include parts of the Butte and Browns Gulch planning areas from Yankee Doodle Creek to Browns Gulch, plus a resident population of antelope occurs in the Sand Creek and Mill/Willow planning areas. Restoration plans tied to protecting and preserving wildlife need to minimize potential conflicts between wildlife and humans.

While this planning effort does not focus on cultural and historic resources, the identification, preservation, identification, and protection of such resources is important to consider in restoration planning, as further detailed in Section 8.3.1.

Pollution Mitigation

Concurrent with efforts to secure protection for high quality resources, restoration efforts should focus on improving water quality by mitigating pollution. Pollution sources that degrade water quality and soils will pose limitations to restoring fisheries, vegetation, wildlife, and associated natural-resource baased recreational opportunities. Consequently, the pollution sources that impose these limitations should be addressed before undertaking other types of restoration measures such as fishery, vegetation, or wildlife restoration. Similarly, it is recommended that pollution mitigation be given greater priority than recreation development.

Pollution sources that potentially pose limitations to the future restoration of the Silver Bow Creek watershed include but are not limited to:

- streamside mine tailings,
- waste rock used in the construction of railroad grades,
- metals-bearing storm water and groundwater,
- metals contaminated soils,
- phosphate processing waste,
- nutrients from municipal waste water treatment facilities,
- nutrients from non-point sources such as residential septic systems,
- sediment pollution from land use activities, and
- thermal pollution from stream dewatering.

Actions that remove or isolate wastes from the environment, reduce discharges from point or non-point sources, or increase instream flow can mitigate pollution sources. Basin-wide restoration efforts should initially focus on mitigating the highest risk pollution sources. Metal bearing wastes in streamside tailings and railroad beds along Silver Bow Creek, metal bearing storm water runoff from the Butte area, and contaminated groundwater from the Butte area are the highest risk pollution sources. At this time, Butte area storm water and groundwater are still subject to pending remedy decisions and natural resource damage litigation (see Section 2.2.2). Therefore, it is unknown how well future remedial actions will mitigate these pollution sources. These areas will be the subject of further restoration planning as discussed in Section 2.2.2. While this plan does recognize the importance of pollution mitigation in the Butte area , it should be understood that the responsibility of adequately cleaning up wastes in the Butte area to levels and conditions that are protective of public health and the environment in the long-term and that meet all applicable standards is a requirement of remediation, and not a restoration responsibility.

Currently, metal bearing wastes in streamside tailings and railroad beds along Silver Bow Creek are the highest priority pollutants for restoration. However, the NRDP believes that remediation activities or restoration activities that have already been approved should adequately address these pollutants. Only the Ramsay Flats area along the Silver Bow Creek corridor will require additional streamside tailings removal beyond planned remediation. Restoration funds have been awarded for that additional removal. After remediation of Silver Bow Creek is complete, reassessment of restoration needs related to metal-bearing waste may be necessary.

Water Quantity Improvement

Water quantity closely ties to water quality and is essential for developing fish, vegetation, wildlife, and recreational opportunities. Opportunities to increase instream flow will be critical to the restoration of the Silver Bow Creek watershed. Increased instream flow can mitigate the negative impacts of contaminants (metals, nutrients, thermal) which in turn can mitigate pollution impacts to fisheries and vegetation. Increased instream flow can also be critical to maintaining and enhancing fish populations where habitat is degraded. Wildlife populations can also benefit from increased vegetation as the result of increased flow. Finally, improved fisheries, vegetation, and wildlife resulting from increased instream flow will enhance recreational opportunities.

In the Silver Bow Creek watershed, significant opportunities exist to augment instream flows in both the Mill and Willow creeks and German Gulch planning areas. Irrigation practices extensively dewater both Mill and Willow creeks from late June through September. Water leasing or conservation measures have potential to improve instream flow in both these streams and Silver Bow Creek. A large irrigation diversion on German Gulch just upstream from its confluence with Silver Bow Creek diverts much of German Gulch during low flow periods. Water leasing and efficiency improvements here would primarily benefit instream flow in Silver Bow Creek. The State approved funding in 2005 for such efforts.

An interesting water quantity opportunity exists in the Butte area sub-watershed through use of the Silver Lake water right. Montana Resources currently uses water from this source in the Continental Pit mining operation. Some of this water could meet restoration needs of vegetation enhancement and a surface water feature in the Butte area. Section 6.3.5 describes this in more detail.

Additional opportunities exist for moderate improvements in instream flow in the Browns Gulch and Basin and Blacktail creeks planning areas. In Browns Gulch, water leasing and irrigation efficiency projects have potential to increase instream flow in lower Browns Gulch, which could improve the local fishery and also benefit Silver Bow Creek. Additional assessment is necessary to determine the magnitude of such potential benefits. The State approved funding for some of these needed assessments in 2004. Much of Basin Creek flow is stored in the Basin Creek reservoirs for the Butte municipal water supply and is not available to augment instream flow. Based on limited information, other planning areas are believed to have minimal opportunities for water leasing or water conservation.

Fishery Restoration

A fishery arguably is the natural resource that is most sensitive to watershed conditions. Since fisheries respond to factors influencing the health of the entire watershed, fisheries serve as a bellwether for the condition of the watershed. Consequently, fishery health is an important measure of watershed restoration success, but fishery restoration per se should receive a lower priority than pollution mitigation or water quantity improvement.

Several indicators of a healthy fishery provide the basis to evaluate the success of remediation and restoration activities in the Silver Bow Creek watershed. Species composition is one. At a minimum, the fish community in the Silver Bow Creek watershed should, over time, move towards a composite of species similar in number and proportion to healthy streams in the region. Moreover, the vision statement emphasizes native species strategies where practicable, so priority should be placed on establishing and protecting populations of native fish where this can reasonably be accomplished.

Another component of a healthy fishery is a diverse population structure, which indicates that conditions are suitable in the watershed for reproduction and maintenance of populations over the course of several years. In time, fish-bearing streams in the Silver Bow Creek watershed should include presence of at least three year-classes for both salmonids and suckers. There should also be balance between the contaminant tolerant species such as suckers and intolerant taxa such as salmonids. Measures of fish abundance and biomass are important considerations as well. By evaluating density and biomass of juvenile and adult salmonids on reference streams, general targets can be inferred to measure restoration and remediation success in the Silver Bow Creek watershed.

We consulted with area fisheries biologists (Tim La Marr of the USFS Beaverhead Deer Lodge National Forest, Ron Spoon of Montana FWP Region 3, and Eric Reiland of Montana FWP Area 2) to determine priorities for fisheries restoration in the Silver Bow Creek watershed. They provided information on the priority of fishery restoration needs in the various planning areas in the Silver Bow Creek watershed, reflected in the restoration needs identified in Chapter 7.0 and listed in Table 8-1. Montana FWP biologists also offered the following perspectives regarding what types of actions would help to restore a thriving trout fishery in Silver Bow Creek:

- Any project on Silver Bow Creek expected to reduce concentrations of metals or other pollution will help promote aquatic life and development of a fishery. These should be high priority projects.
- Any project that increases the flow of clean water in Silver Bow Creek or its tributaries, regardless of the source, will help dilute pollutants in Silver Bow Creek. If this flow augmentation is from a tributary that also allows the tributary to function as a resident fishery or a spawning/rearing area, it should receive higher priority.
- Restoration of native fish populations should be emphasized. The unique circumstance of Silver Bow Creek being virtually devoid of salmonids due to toxic conditions makes restoration for native fish populations more plausible than in other watersheds where non-native fish are prevalent. As previously discussed, the absence of rainbow trout precludes genetic introgression (interbreeding) found in watersheds where westslope cutthroat and rainbow trout coexist. Additionally, the absence of rainbow and brown trout reduces the number of non-native competitors with westslope cutthroat trout. Note, however, the presence of brook trout in tributary streams may make it difficult or impossible to develop a native-only fishery. If some unforeseen condition (e.g. nutrients, ammonia, temperature, or habitat) prevents establishment of mostly native fishery within a reasonable timeframe, then restoration may ultimately have to consider non-native salmonids to provide a recreational fishery in Silver Bow Creek.
- Projects such as barriers may be needed to protect native stock in core areas. Barrier designs should consider attributes that allow spawning/rearing of fish

downstream of the barrier. For example, the proposed German Gulch fish passage barrier should be located a sufficient distance upstream of the mouth of German Gulch to provide refuge and spawning habitat in the lower reaches of that stream.

- Any project that improves a fishery in a core area that can supply excess production to Silver Bow Creek should be a higher priority than projects that only improve the tributary fishery without aiding Silver Bow Creek recovery. In the case of native species, however, fish enhancement in isolated headwaters may be needed to secure core areas to repopulate other tributaries with better connectedness to Silver Bow Creek.
- Projects that reduce pollutants from tributaries to Silver Bow Creek are a high priority to encourage continued improvement of Silver Bow Creek water quality.
- Assessment of less-known watershed areas is necessary to completely understand the nature of opportunities in the watershed. The Browns Gulch assessment effort is a good example.
- Fisheries projects that also promote vegetation and wildlife benefits should receive additional priority in the ranking.
- In most cases, restoration efforts should promote access to improved fisheries to allow the public to enjoy the benefits of enhancement projects. However, some native species core areas may not be appropriate for easy access.

Ron Spoon also offered the following observations regarding the future species composition in Silver Bow Creek, noting that this issue requires further evaluation (Spoon, 2003). In the short-term, Silver Bow Creek may only be suitable for more pollution tolerant species.

- Based on observations in the upper Clark Fork and Warm Springs Creek, brown trout would likely become the first sport-fish species capable of establishing in Silver Bow Creek as water quality improves. Establishment of brown trout could be controlled by installing migration barriers to encourage recovery of native fishes instead in Silver Bow Creek.
- Westslope cutthroat trout are effective at radiating outward from core population areas and are able to thrive in larger, mainstem waters. Facilitating the downstream migration of westslope cutthroat trout from core areas is therefore desirable.
- In contrast, larger, warmer waters such as Silver Bow Creek are not good habitat for brook trout. Thus, even though most of the tributaries of Silver Bow Creek are dominated by brook trout, brook trout core areas will not likely provide much recruitment to Silver Bow Creek.
- If a brown trout fishery is to be established, spawning/rearing areas with groundwater inflow will be needed to provide recruitment of older and more tolerant individuals that can survive in Silver Bow Creek. Tributaries and springs along Silver Bow Creek will provide much-needed refuge for trout and other fish species during undesirable flow events in Silver Bow Creek.

Tim La Marr developed basin wide concepts for preserving and restoring fisheries (La Marr, 2003b) to address streams in the study area administered by the USFS (See Chapter

7.0). This included categorization of fish habitat types (see Section 3.3.1). The principles he presented that are most applicable to the Silver Bow Creek watershed are as follows:

- Maintenance and restoration of a well-dispersed network of core habitat areas that provide for all life history needs, when combined with relatively intact connecting stream segments, is necessary to sustain current native fish populations. Restoration that secures and improves habitat will have the greatest immediate effect on protecting and increasing existing native fish populations.
- Restoration that first secures existing good habitat areas and then re-establishes similar and nearby habitat that requires little adjustment of life history patterns for subject biota, is most likely to provide the habitat critical to existing fish populations. Restoration should therefore take place near existing fish habitat to provide an opportunity for expansion of habitat.
- Providing a network of core habitat areas throughout the watershed in viable tributary streams will be important for the long-term survival of non-native fish species as well. Adequate core habitat would ensure survival of local fish populations that could later re-populate impacted areas such as along the mainstem of Silver Bow Creek.

These restoration concepts focus primarily on conservation of threatened or sensitive native fisheries, with westslope cutthroat trout being the focus of native fishery restoration in the Silver Bow Creek watershed. This is consistent with the vision statement's emphasis on native species restoration where practicable. Although native to the upper Clark Fork watershed, bull trout restoration in Silver Bow Creek may be infeasible due to a lack of connectivity with the Clark Fork River (Warms Springs Ponds dam creates a migration barrier) and the presence of brook trout (which readily interbreed with bull trout) in Silver Bow Creek tributaries.

Restoration may ultimately have to consider non-native fish if unforeseen conditions (e.g. nutrients, ammonia, temperature, or habitat) prevent establishment of a native fishery within a reasonable timeframe. Due to the high level of impairment in the Silver Bow Creek watershed, however, all fish species (native and non-native) may be considered "sensitive" or impaired. Accordingly, conservation strategies developed for native fish are relevant to restoration for non-native fish species in the Silver Bow Creek watershed. Note that many of these principles also apply to vegetation and wildlife populations and may be adapted to address restoration of these resources.

The identified restoration needs presented below (Section 8.3) and the prioritization of these needs integrate the restoration perspectives, observation, and principles offered by area fisheries biologists.

Vegetation/Wildlife Restoration

Wildlife will respond primarily to vegetation because wildlife populations rely on plant communities for browse and cover habitat. Consequently, wildlife populations will most directly benefit from projects that protect quality habitat, which falls under the preservation/protection of existing resources category, and vegetation restoration. Healthy riparian vegetation also benefits water quality and improves cover and shade for fish. Critical habitat includes a mosaic of montane meadows, coniferous forest, and riparian and wetland areas distributed across a range of elevations, and provide both winter and summer range. Migration corridors provide important connections between each of these habitat types.

Wildlife resources that were lost in the Silver Bow Creek watershed due to release of hazardous substances include beaver, mink, elk, deer, and birds. Much of the loss is due to destruction of riparian habitat along Silver Bow Creek. On going stream and vegetation remediation and restoration efforts along Silver Bow Creek will improve wildlife habitat as a collateral benefit. The other significant injury to wildlife habitat is the loss of vegetation and soils due to the release of hazardous substance in the Anaconda Upland injured areas, which are the subject of pending litigation.

Opportunities exist to improve riparian vegetation throughout the watershed, but are most notable along Silver Bow Creek and in the Anaconda Uplands injured areas. Remediation will not completely address riparian vegetation issues along the Silver Bow Creek corridor and additional riparian restoration will be necessary for this area. The Silver Bow Creek Greenway project is addressing some of these needs. Needed vegetation improvements in the Anaconda Uplands are covered under the State's 2002 restoration plan. All restoration involving vegetation, as well as many recreation projects, will require an effective integrated weed management component. Effective integrated weed management is critical to successful reestablishment of the native plant species that provide quality wildlife habitat. Weed management should include re-seeding of native species, especially in areas where invasive weed presence has depleted native seed sources.

Recreation Development

Although important, the development of natural resource-based recreation opportunities such as trails, access, or facilities is most successful if the natural resources are in good condition. Consequently, development of recreation opportunities may occur concurrently with or subsequent to, but should not occur in place of, the restoration of natural resources.

Given the diverse nature and size of the Silver Bow Creek watershed, outdoor recreation opportunities are scattered throughout the watershed. These include hunting, fishing, hiking, horseback riding, bird watching, mountain biking, cross-country skiing, target shooting, golf, snowmobiling, and OHV riding. Information gathered during the public participation process indicates there is strong community desire for trails, notably the Greenway trail system and other connections between population centers with natural resources, and lakes or ponds for fishing and/or swimming. OHV riding is popular in some areas but has led to conflicts with non-motorized users and damage of natural resources in some watershed areas. Identifying appropriate locations for motorized recreation are important issues in recreation development projects in these areas. OHV use should not occur in restored areas to assure successful restoration in the long-term. Refer to Chapter 7.0 for more detail.

8.3 Restoration Prioritization Results by Restoration Need

Table 8-1 lists 56 prioritized restoration needs for the Silver Bow Creek watershed and includes the following fields:

- ***Rank*****:** Numerical rank among the 60 identified restoration project.
- ***Planning Area:*** The portion of the watershed with the restoration need.
- ***Restoration Category:*** Types of restoration needs described in Section 4.4.
- ***Issue/Problem:*** Definition of the issue or problem leading to the restoration need.
- ***Restoration Need:*** What is necessary to address the issue or problem.
- ***Agency/Other Responsibility:*** What parties may be responsible for addressing the restoration need.
- ***Watershed Scale Benefits:*** Benefits to the entire watershed (defined in Table 4-11).
- ***Local Benefits:*** Benefits to the planning area sub-watershed or stream (defined in Table 4-11).
- ***Cost:*** Cost ranges are defined in Table 4-11.
- ***Restoration Importance:*** Relative ranking of the importance of the restoration need base on overall score.
- ***Score:*** Combined numerical scores for watershed benefits, local benefits, and cost.

Table 8-2 lists an additional five restoration needs with a deferred priority that are predicted to be addressed through ongoing or planned efforts, giving 60 identified restoration needs.

Each of the 56 prioritized restoration needs has a numeric score that represents the combination of scores for watershed benefits, local benefits, and cost as described above. We assigned a qualitative "Restoration Importance" (Table 8-1) to each restoration need based on natural breaks in the distribution of scores. In this case, 6-7 = low, 8-10 = moderate, 11-12 = high, and 13-16 = very high. Of the 56 prioritized needs, 11 ranked very high, 17 ranked high, 17 ranked moderate, and 11 ranked low in restoration importance. The restoration needs with a high or very high restoration importance will be favorable funding prospects for natural resource damage grant funds or other funding sources. Those of moderate importance are likely to derive sufficient benefits to warrant funding consideration for natural resource damage grant funds or other funding sources. Restoration needs with low restoration importance are likely to have insufficient benefit to warrant funding in the near future.

The "agency/other" responsibility column identifies agencies or entities that may have some legal responsibility to address the indicated restoration need. Specifically, the table indicates any potential responsible party (PRP) that has a legal responsibility to partially or fully address a specific restoration need or any agency that has a regulatory obligation associated with the restoration needs. An indication in Table 8-1 that an agency or other entity has responsibilities tied to a restoration need does not imply any predetermination of funding. Such determination can only be made on a project-specific basis. Nor does the information in the "Agency/Other Responsibility" category constitute a predetermination of the State's evaluation of the "Normal Government Function" *RPPC* criterion, which is described in Section 9.1.1. Finally, we only indicated an entity under the "Agency/Other Responsibility" category if a formal regulatory action has been taken or an entity has been involved in addressing a restoration need. For those needs with no indicated responsible entity, it is likely that some entity or multiple entities may have some responsibility.

Table 8-1: Prioritized restoration needs for the Silver Bow Creek watershed.

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
1	Basin and Blacktail creeks	Protect Existing Resources	Limited drinking water sources for the city of Butte make Basin Creek a critical source of water.	Protect Basin Creek from potential pollution sources and activities that may threaten water quality. Mitigate risk of wildfire and potential sediment loading.	USFS, BSB, Montana DEQ	Very High	Very High	Low	Very High	16
2	Butte Area	Protect Existing Resources	Limited drinking water supplies for the city of Butte make Moulton Reservoir a critical source of water.	Protect Yankee Doodle Creek from potential pollution sources and activities that may threaten water quality.	BSB, Montana DEQ	Very High	Very High	Low	Very High	16
3	Mill and Willow creeks and Silver Bow Creek corridor	Fisheries	The future configuration of connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River is unknown.	Investigation should be conducted as to the ultimate fate and the implications of changing the configuration of the connections between Mill Creek, Willow Creek, the Mill-Willow Bypass, Silver Bow Creek, the Warm Springs Ponds, and the Clark Fork River. prior to EPA's determination of a final remedy for the Ponds. See also deferred category #59.	ARCO, EPA, Montana DEQ, NRDP, FWP	Very high	Very High	Moderate; Study only	Very High	15
4	Basin and Blacktail creeks	Protect Existing Resources	Genetically pure population of native westslope cutthroat trout exist in focal habitat in upper Basin Creek and need protection.	Activities to protect the upper Basin Creek water supply will help protect westslope cutthroat trout. Reservoirs form a fish passage barrier to prevent introgression of non-native species. Evaluate adjunct WCT habitat in other parts of Basin Creek.	BSB, USFS	High	Very High	Low	Very High	14

Final Rank	***Planning Area***	***RestorationCategory***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***	***Watershed-scale Benefit***	***Local Benefit***	***Cost***	***Restoration Importance***	***Score***
5	Butte Area and Silver Bow Creek corridor	Pollution Mitigation	Mining related contaminants continue to enter Silver Bow Creek and degrade water quality. Storm water from the Butte area and groundwater in Butte Area One are the primary sources.	Ongoing and future remediation and the outcome of current litigation may address some of these sources of contamination. Seek effective remediation of BPSOU. Following the ROD, update the State's restoration plan for Butte Area One. Eliminate or isolate remaining sources of water quality impairment.	PRP GROUP, EPA, Montana DEQ, NRDP	Very High	Very High	Very High	Very High	13
6	Silver Bow Creek corridor	Protect Existing Resources	Remediation and restoration actions along the Silver Bow Creek floodplain on private lands need to be protected from potentially detrimental land management activities in the long term.	Acquire land or conservation easements along the Silver Bow Creek corridor to protect restored areas. Subarea 2 contains about 320 acres and Subarea 4 contains about 500 acres of private lands that should be considered for acquisition or easements.	Montana DEQ, NRDP	Very High	Very High	Very High	Very High	13
7	German Gulch	Protect Existing Resources	A significant native WCT population needs preservation and protection. Chronic competition from brook trout may jeopardize native WCT populations.	Continue actions by Montana FWP and USFS to suppress brook trout. See deferred need #57 associated with Beal Mine.	Montana FWP, USFS	High	High	Low	Very High	13
8	German Gulch	Water Quantity	Much of German Gulch is diverted for irrigation just before reaching Silver Bow Creek. This water could significantly help water quality problems in Silver Bow Creek, especially during low flows.	Explore the best alternative for obtaining adequate flows for connectivity with Silver Bow Creek. Alternatives include water conservation, water leasing, alternative irrigation source, or acquisition. In 2005 the State approved funding of a project to provide for fish passage and this connectivity.		Very High	Moderate	Moderate	Very High	13
9	Browns Gulch	Fisheries	Current conditions of fisheries are not well understood.	Conduct additional fisheries assessment in the upper and lower reaches of Browns Gulch and major tributaries. In 2004 the State approved funding for such studies.		High	High	Low; study only	Very High	13

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
10	Silver Bow Creek corridor	Recreation	Recreational opportunities are minimal due to historic mining impacts.	Implement a greenway trail system along the entire length of Silver Bow Creek. Acquire/develop access for fishing and water recreation. Create a series of trails connecting to nearby communities (Anaconda and Butte). These needs are reflected in the 1998 Silver Bow Creek Greenway design document. Public land managers believe this trail should be low impact where it bisects important wildlife habitat and should allow foot, bicycle, or horse access only.	Greenway Service District (GSD)	Very High	Very high	Very High	Very High	13
11	Butte Area	Recreation	Additional connecting trails between the Greenway and urban residential areas are desired.	Develop additional connecting trails.		High	Very High	Moderate	Very High	13
12	Mill and Willow creeks	Protect Existing Resources	Critical wildlife winter range exists along the public land/private land boundary and could be developed.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.		High	Very High	High	High	12
13	Mill and Willow creeks	Water Quantity	Dewatering for irrigation impairs fisheries and exacerbates water quality problems.	Increase instream flow during critical life stages of fish through water leasing, conservation and other measures.		High	Very High	High	High	12
14	Browns Gulch	Water Quantity	Stream flow is inadequate for fisheries in the lower reaches of Browns Gulch. Lack of flow is the greatest limiting factor to fishery improvements.	Identify and implement means to augment stream flow. Water conservation and water leasing are possibilities. In 2004 the State approved funding for a project to conduct needed flow studies.		High	Very High	High	High	12
15	Silver Bow Creek corridor	Fisheries	Remedial actions will fall short of creating optimal fish habitat.	Enhance fish habitat diversity and structural complexity; improve substrate in future reaches where appropriate. Approved Greenway funding will address this need in Reaches A - J. Coordinate with installation of migration barriers as needed to promote native fishery.	GSD,NRDP,FWP	Very High	High	Very High	High	12

Final Rank	***Planning Area***	***RestorationCategory***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***	***Watershed-scale Benefit***	***Local Benefit***	***Cost***	***Restoration Importance***	***Score***
16	Basin and Blacktail creeks	Fisheries	Genetically pure westslope cutthroat are likely present in upper Blacktail Creek.	Evaluate focal and adjunct westslope cutthroat trout habitat in Blacktail Creek. Take appropriate restoration measures to improve/protect these habitats.		High	Very High	High	High	12
17	Butte Area	Recreation	The Westside Soils Operable Unit area currently has a high level of recreational use but has impacts from this use and hazards associated with historic mining activity, such as abandoned mine dumps.	EPA decisions on the needed remediation, if any, of the Westside Soils Operable Unit has been deferred until the Agency is funded to address this area. Restoration planning should be deferred until completion of a final remedy decision. ARCO owns the majority of lands and seeks a recreational land use scenario. Anticipated recreational needs are likely to be limited to trails for dispersed recreation.	PRP GROUP, EPA, Montana DEQ	Moderate	Very High	Low	High	12
18	Butte Area	Recreation	The upper reaches of Silver Bow Creek were obliterated by historic mining activities. A replacement surface water feature is desired.	Create a surface water feature with adjacent parkland and trails along the upper reaches of Silver Bow Creek between Texas Ave and the Blacktail Creek confluence. Plans are under way to accomplish this using water from the Silver Lake water system. Treated Berkeley Pit water is also a possible future water source if this treated water is not needed for mining operations. Current mining operations consume all of the current output of the Horseshoe Bend treatment plant.	BSB	High	Very High	High	High	12

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
19	Butte Area	Recreation	Butte area residents have not had access to a variety of recreational features as a result of mining activities and contamination.	Develop a variety of recreational features such as parks, open spaces, swimming areas and trails that are readily accessible for citizens of all ages. Benefits will vary based on number and magnitude of these features; cost assumes 3 of these features.		High	Very High	High	High	12
20	Basin and Blacktail creeks	Recreation	Thompson Park recreation facilities are in need of upgrade or repair. A consistent funding source is needed to maintain these facilities.	Obtain funding for renovation and maintenance of facilities. Undertake renovation activities.	USFS, BSB	High	Very High	High	High	12
21	Mill and Willow creeks	Pollution Mitigation	Storm water runoff from smelter fallout contaminated hillslopes continues to deliver metals to Mill Creek and to a lesser extent, Willow Creek.	The outcome of pending remedial action/remedial design and litigation may address part of this issue. The State's restoration claim and plan cover the needed actions.	ARCO, EPA, Montana DEQ, NRDP	High	Very High	Very High	High	11
22	German Gulch	Protect Existing Resources	Private lands along lower German Gulch adjacent to the Fleecer Mountain and Mt. Haggin Wildlife Management Areas are at risk for potentially detrimental development. These lands are part of the elk and deer winter range in this area.	Protect these critical lands from potentially detrimental development through land acquisition and conservation easements.		High	Very High	Very High	High	11
23	Browns Gulch	Fisheries	Establish focal habitat for westslope cutthroat trout.	Assess feasibility of and establish isolated westslope cutthroat trout habitat in headwater areas, particularly in Alaska Gulch, via fish passage barriers and limited habitat improvement.		Moderate	Very High	Moderate	High	11

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
24	Silver Bow Creek corridor	Vegetation	Remedial actions will fall short of restoring a healthy riparian vegetation zone along Silver Bow Creek and its floodplain. Wildlife populations are limited in the corridor.	Enhance riparian vegetation. Wetlands creation may be appropriate locally and will have a beneficial impact on water quality. Establishment of a healthy riparian zone along Silver Bow Creek will create the opportunity for wildlife to reoccupy this area. Approved Greenway funding will address Reaches A-I &P-R..	GSD, NRDP	High	Very High	Very High	High	11
25	Butte Area	Vegetation	Contaminated soils and lack of fresh water supplies have prevented vegetation from surviving and thriving in the Butte area. Entryway corridors and open spaces are in need of "greening."	Identify limiting factors to vegetation survival and address these issues. Develop alternative water sources that will enable vegetation to survive. One option is to utilize water that flows from upper Silver Bow Creek and Yankee Doodle Creek into the Yankee Doodle tailings impoundment. Use of this water is limited by current mining operations. Plant metals-tolerant trees, shrubs, and grasses (preferably native species) along entryway corridors and open spaces.		High	Very High	Very High	High	11
26	Mill and Willow creeks	Vegetation	Smelter emissions have caused widespread contamination of soils with metals and arsenic in upland areas around Anaconda, degrading vegetation and wildlife habitat.	The outcome of current remediation and litigation is anticipated to address this problem. Restoration of the upland areas is addressed in the State's 2002 restoration plan.	ARCO, EPA, Montana DEQ, NRDP	High	Very High	Very High	High	11
27	German Gulch	Recreation	Public input indicates a desire for trail access from Silver Bow Creek.	Examine feasibility and appropriateness of a trail from Silver Bow Creek to German Gulch. In 2005 the State approved funding for a footbridge and 2 mile trail in lower German Gulch.		Moderate	High	Low	High	11

Final Rank	***Planning Area***	***RestorationCategory***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***	***Watershed-scale Benefit***	***Local Benefit***	***Cost***	***Restoration Importance***	***Score***
28	Butte Area	Recreation	Nearby recreational fishing opportunities are not available to local residents.	Develop recreational (stream and/or pond) fishing opportunities in the Butte area. One such opportunity in Butte is currently being considered.		Moderate	High	Low	High	11
29	Mill and Willow creeks	Pollution Mitigation	The Yellow Ditch, the Blue Lagoon, and railroad and road crossings over streams are all sources of metals contamination to Mill and Willow creeks.	Ongoing remediation and the outcome of current litigation may address some of these sources of contamination. Identify, assess, and restore those not the subject of these efforts.	ARCO, EPA, Montana DEQ, NRDP	Moderate	Very High	High	Moderate	10
30	Browns Gulch	Pollution Mitigation	Water quality (siltation, nutrients, temperature) may be impaired.	Address water quality impairments via improvement in land use practices.		Moderate	Very High	High	Moderate	10
31	Silver Bow Creek corridor	Pollution Mitigation	Nutrients are discharged to Silver Bow Creek from the Butte and Rocker wastewater treatment facilities.	Improve/upgrade treatment of municipal effluent. Proportionately, the Butte wastewater treatment plant contributes far greater amounts of nutrient loading to Silver Bow Creek than the Rocker wastewater treatment plant. Butte-Silver Bow has obligations to further reduce its nutrient discharge by 2007 via the Clark Fork River voluntary nutrient reduction program.	Local Government	High	High	Very High	Moderate	10
32	Basin and Blacktail creeks	Vegetation	Riparian degradation and channelization along Blacktail Creek were detected in the aerial photography assessment.	Improve aquatic habitat and riparian vegetation along Blacktail Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.		Moderate	Very High	High	Moderate	10
33	German Gulch	Vegetation	Noxious weed infestations are present and associated with historic placer mining disturbance, grazing, modern mining, and roads.	Take actions to reduce spread of noxious weeds. (See #34 regarding grazing.)	Multiple landowners	Moderate	High	Moderate	Moderate	10

Final Rank	***Planning Area***	***RestorationCategory***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***	***Watershed-scale Benefit***	***Local Benefit***	***Cost***	***Restoration Importance***	***Score***
34	German Gulch	Vegetation	Livestock grazing has reportedly had a detrimental impact on stream habitat.	Examine grazing practices and implement appropriate grazing management strategies to minimize impacts.	Multiple landowners	Moderate	Moderate	Low	Moderate	10
35	Basin and Blacktail creeks	Pollution Mitigation	High density of septic systems south of Butte may be contributing nutrients to ground and surface water.	Evaluate the impact of septic systems. Take appropriate actions such as expansion of Butte waste water treatment facility to incorporate some residential areas currently on septic systems.	Local Government	Moderate	High	High	Moderate	9
36	Browns Gulch	Fisheries	Improve fisheries habitat in lower reaches of Browns Gulch. Connecting a lower Browns Gulch fishery to a future Silver Bow Creek fishery is desired.	Assess feasibility of adequately addressing limiting factors to fisheries of water quantity, water quality, and habitat issues. Subsequent to addressing the water quantity and quality problems that limit fisheries in Brown's Gulch, improve aquatic habitat to further improve fishery populations.		Moderate	High	High	Moderate	9
37	Mill and Willow creeks	Vegetation	Livestock grazing degrades riparian vegetation and causes bank erosion.	Restore healthy riparian zones through better grazing management and re-vegetation. Stream restoration measures may be necessary locally. See also deferred restoration need #60.		Moderate	High	High	Moderate	9
38	German Gulch	Recreation	OHV use in the area has caused disturbances.	Examine restrictions on motorized access.	USFS, FWP	Low	High	Low	Moderate	9
39	Basin and Blacktail creeks	Recreation	Recreational fisheries along the valley foothill portions of Basin and Blacktail creeks are marginal.	Subsequent to or concurrent with needed fishery improvements (#32), improve recreational fishing access opportunities via trail access and fishing access sites.		Moderate	High	High	Moderate	9
40	Browns Gulch	Recreation	Better public access is desired.	Identify and pursue public access opportunities in cooperation with current landowners.		Moderate	Moderate	Moderate	Moderate	9

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
41	German Gulch	Protect Existing Resources	Riparian lands (old placer mining claims within the USFS land) along German Gulch are at risk for potentially detrimental development. Already, historic access to private lands in this area has been lost after change in ownership.	Acquire lands or conservation easements to protect these areas from potentially detrimental development. In 2005 the State approved funding for public acquisition of 82 acres of riparian corridor in lower German Gulch.		Low	High	Moderate	Moderate	8
42	Basin and Blacktail creeks	Pollution Mitigation	The historic Highland Mine may be a source of metals contamination in the headwaters of Basin Creek.	Additional water quality and site sampling is necessary; water quality sampling from the 1970s is suspect. Contamination problems, if any, are predicted to be minor given the site's location and small area of disturbance.		Low	Moderate	Low	Moderate	8
43	Basin and Blacktail creeks	Pollution Mitigation	Limited 1970s water quality sampling on the valley foothill portion of Basin Creek (downstream of municipal source water area) indicates metals contamination.	Re-sample Basin Creek water quality. Evaluate railroad bed as a possible source. Mitigate pollution source(s) if water quality impairment is confirmed.		Low	Moderate	Low for Study Only	Moderate	8
44	German Gulch	Fisheries	Historic placer mining has disturbed both aquatic and riparian habitat.	Restore stream and riparian habitat where habitat has not recovered from placer mining. In 2005 the State approved funding of a stream restoration demonstration project in placer-impacted areas of lower German Gulch.		Low	Moderate	Low	Moderate	8
45	Mill and Willow creeks	Recreation	Public access is lacking.	Seek recreational access through easements, acquisitions, or access programs.		Moderate	High	High	Moderate	8

Final Rank	***Planning Area***	***RestorationCategory***	***Issue/Problem***	***Restoration Needs***	***Agency/Other Responsibility***	***Watershed-scale Benefit***	***Local Benefit***	***Cost***	***Restoration Importance***	***Score***
46	Mill and Willow creeks	Pollution Mitigation	Mining related contaminants are present in groundwater underneath the Opportunity Ponds. These contaminants may eventually reach Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek.	Metal contamination from this source should be minimized to limit impact to these streams. Current amounts of contaminants (metals) from this source reaching Mill Creek, the Mill-Willow Bypass, and Silver Bow Creek are believed to be low. Identified contaminant plumes of cadmium, lead, zinc, and arsenic are believed to be slow moving. Secondary contaminants iron, manganese, and sulfate are faster moving and at higher levels, but do not present significant environmental impacts.	ARCO, EPA, Montana DEQ, NRDP	Moderate	Moderate	Very High	Low	7
47	Mill and Willow creeks	Pollution Mitigation	Nuisance algae is observed in both Mill and Willow creeks. Sources and impacts to fisheries are unknown.	Investigate potential sources and impacts. Reduce nutrient loading as determined necessary from studies.		Low	Moderate	Moderate	Low	7
48	Mill and Willow creeks	Pollution Mitigation	Excessive siltation is reported in both Mill and Willow creeks. Reduced vegetative cover resulting from smelter impacts exacerbates erosion.Other known sources are timber harvest in the upper reaches of Willow Creek, road and railroad crossings, and cattle grazing.	Via remediation and restoration activities in the Anaconda Uplands, vegetation cover will be increased (refer to restoration need #26). Address other known sources of siltation through implementing better timber harvest and grazing management and restoration measures where appropriate.		Low	Moderate	Moderate	Low	7
49	Sand Creek	Fisheries	Fisheries data in the headwater tributaries is lacking. Small headwater tributaries in the southwest portion of the sub-watershed may host isolated populations of native fish.	Investigate the presence of fisheries and nature of these streams for stocking potential and protection/restoration needs.		Low	Low	Low	Low	7

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
50	Basin and Blacktail creeks	Vegetation	Riparian degradation and channelization along Basin Creek was detected in the aerial photography assessment. Riparian vegetation along Basin Creek below the reservoirs is sparse and lacks diversity.	Improve aquatic habitat and riparian vegetation along Basin Creek, primarily in the valley foothill sections. A field assessment is needed first to assess degraded conditions and potential solutions.		Low	High	High	Low	7
51	Sand Creek	Protect Existing Resources	Land development is threatening open space and wildlife habitat in the higher elevation areas of the sub-watershed.	Acquire land or conservation easements along the private/public land boundary in the southwest portion of the watershed to protect wildlife winter ranges. This area is of lower priority to agency land managers than winter range in the Mill and Willow creeks and German Gulch sub-watersheds.		Low	Moderate	High	Low	6
52	Sand Creek	Protect Existing Resources	Private land in-holdings in USFS land are at risk for development.	Acquire land or conservation easements. (USFS considers these areas to be low priority).		Low	Moderate	High	Low	6
53	Sand Creek	Pollution Mitigation	Surface water quality data for Sand Creek is lacking. Mine waste in rail beds adjacent to Sand Creek may be a source of metals contamination to Sand Creek and Silver Bow Creek. Bank erosion and road and rail disturbances along Sand Creek may be producing excess fine sediment that is ultimately delivered to Silver Bow Creek.	Investigate the presence and impacts from these potential sources. Take appropriate actions. See also deferred action #58.		Low	Low	Moderate	Low	6

Final Rank	*Planning Area*	*RestorationCategory*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*	*Watershed-scale Benefit*	*Local Benefit*	*Cost*	*Restoration Importance*	*Score*
54	Warm Springs Ponds	Vegetation	Noxious weeds restrict growth of native vegetation. Wildlife habitat is also reduced. Historic smelter fallout may have rendered soils slightly phytotoxic, restricting plant growth.	Work with county and conservation officials to develop appropriate weed management strategies that takes into consideration findings of the BSB soils survey. Take appropriate actions to improve upland vegetation.	Multiple landowners	Low	Moderate	High	Low	6
55	Sand Creek	Vegetation	Noxious weeds restrict growth of native vegetation.	Work with county and conservation officials to develop and implement appropriate weed management strategies that take into consideration findings of the BSB soils survey.	Multiple landowners	Low	Moderate	High	Low	6
56	Warm Springs Ponds	Recreation	Access is restricted to private lands.	Pursue easement or other access possibilities such as Montana FWP block management as appropriate.		Low	Moderate	Moderate	Low	5

Table 8-2: Deferred restoration needs for the Silver Bow Creek watershed.

Rank	*Planning Area*	*Category*	*Issue/Problem*	*Restoration Needs*	*Agency/Other Responsibility*
Deferred (57)	German Gulch	Pollution Mitigation	Seepage from a waste rock dump at the Beal Mine has caused releases of selenium and other metals. Selenium levels found in fish tissue exceed aquatic toxicity levels and in down gradient waters exceed aquatic life standards.	Wait for outcome of pending remedial actions by the USFS and Montana DEQ to evaluate need for additional actions to reduce impacts from the seepage and address the future needed treatment of the leachate from the leach pad.	USFS/Montana DEQ
Deferred (58)	Sand Creek	Pollution Mitigation	Detailed nature and potential impacts of Rhodia phosphate facility are not fully known. The site is currently undergoing investigations and cleanup under an EPA order.	Wait for outcome of current investigations and cleanup of this site, which is to cover the entire site and any off-site releases. Evaluate following cleanup.	Rhodia, EPA, Montana DEQPRP/EPA
Deferred (59)	Silver Bow Creek corridor	Pollution Mitigation	Groundwater is contaminated beneath and to the north of the Warm Springs Ponds.	Under remedy, metals contamination from this source is being collected and pumped back to Pond 2 for treatment. The groundwater flowing from the system is expected to improve to the point that inception, pumping and treating will no longer be necessary in a few years to decades.	ARCO, EPA, Montana DEQ, NRDP
Deferred (60)	Mill and Willow creeks	Pollution Mitigation	Tailings from the 1908 flood of Silver Bow Creek have been deposited in the floodplain of Willow Creek.	This area is currently the subject of joint restoration and remedy planning and likely to be adequately addressed via that process.	ARCO, EPA, Montana DEQ, NRDP

8.3.1 Additional Components of Successful Restoration

It is likely that concerned individuals will identify additional restoration needs for the Silver Bow Creek watershed that are not in this document. In addition, new information may emerge that changes the priority of restoration needs. The outcome of pending litigation or ongoing remediation and restoration will also require reevaluation of restoration needs and priorities. Therefore, users of this document should recognize that the conclusions reached in this document are not absolute.

Certain restoration needs for the Silver Bow Creek watershed are applicable to the entire watershed or should be a component of many of the identified restoration needs. These include adequate assessment, education on the importance of a healthy watershed, integrated weed management, cultural and historic resources, monitoring, maintenance of restored areas, and recreational features associated with restored areas.

Assessment

A critical component to restoration planning is assessment of the condition of the natural resources and the causes of impaired conditions. Prospective applicants should evaluate whether a sub-watershed has been adequately assessed to determine limiting factors. This should be the first step before restoration is proposed. Without adequate assessment, it is impossible to fully understand cause and affect relationships that are critical to successful restoration.

Education

The watershed restoration process often neglects community education. Long-term restoration success in the Silver Bow Creek watershed depends on educating the public on the importance of a healthy watershed, the connection between river health and economic development, and the direct and indirect costs borne by communities from environmental degradation. Educational programs should include both adult awareness and public school system programs. The NRDP has available two multi-media CDs and an educational trunk for basin schools that focus on the injury and restoration on natural resources in the UCFRB. One CD is specific to Silver Bow Creek. Educational efforts can help ensure the long-term effectiveness of restoration activities and thus may be appropriate components of restoration projects. For example, the Silver Bow Creek Greenway will have information signage and trailside interpretive areas aimed at educating recreational users about the need to protect the restored Silver Bow Creek floodplain corridor. These efforts will foster local communities that focus on natural resource protection and help reach one of the goals of the vision statement, “stable and healthy local communities of informed citizens who actively protect and preserve the watershed's resources.”

Weed Management

Noxious weeds are a growing concern throughout Montana and other western states. The Montana Weed Control Association estimates that if noxious weeds continue to spread at their current rate, they will dominate western rangelands in 100 years. Noxious weeds can alter the function of riparian zones, reduce wildlife forage and cover, reduce forage for livestock, reduce crop production, and diminish recreational opportunities. Future restoration activities in the Silver Bow Creek watershed represent an opportunity to incorporate noxious weed management as part of the project restoration plan. Efforts to control noxious weeds should be from an integrated approach, which involves the use of the best control techniques described for target weed species in a planned, coordinated program to limit the impact and spread of the weed and the uses of a variety of control methods targeted to the site-specific conditions.

Cultural and Historic Resources

This planning effort did not entail compiling information about or prioritizing cultural and historical resources in the Silver Bow Creek watershed. While the vision statement does not specifically address the importance of these resources, some public input received in the focus group meetings stresses the importance of these resources and the need to balance environmental cleanup, historic preservation, and economic development. The Regional Historical Preservation Plan for the Anaconda-Butte Heritage Corridor (RHPP Joint Committee, 1993) was noted as a resource to use in coordinating historical preservation with restoration. The Silver Bow Creek Greenway design (GSD, 1998) also incorporates the goal historical preservation. In addition, the Butte Priority Soils Superfund Site Citizens' Working Group recognized preservation of history and culture in their long-term vision for the Butte area (Appendix A). The State also recognizes the importance of cultural and historic resources in its restoration planning process through one of the *RPPC* criteria (further described in Chapter 9.0) used to evaluate proposed projects: "Resources of Special Interest to the Tribes and DOI." Through this criterion, the State is to pay particular attention to natural resources of special environmental, recreational, commercial, historic, or religious significance, with preference given to those projects that benefit these resources. Thus, prospective applicants for NRD funding will need to identify such resources that might be affected by their projects as a component of restoration project planning. The protection and preservation of such resources is encouraged.

Monitoring

A basin-wide monitoring strategy is critical to evaluate progress toward reaching the goals put forth in the vision statement. The Montana DEQ and NRDP have jointly developed a comprehensive monitoring plan for the aquatic, terrestrial and groundwater resources in the injured Silver Bow Creek corridor (Montana DEQ and NRDP, 2004). This plan includes targets for successful remediation and restoration of Silver Bow Creek including quantitative goals for desired water quality, riparian condition, fluvial geomorphology, and aquatic biological assemblages. Similarly, proposed restoration projects should include a monitoring component to help determine if projects were properly implemented, if they are effective, and whether future changes are needed in project planning. In addition, given that we are in the early stages of a very extensive and ambitious remediation and restoration effort in the watershed, a 5 to 10-year review process should be conducted to evaluate long-term success and adjust this plan and the strategies and priorities recommended as dictated by monitoring results.

Maintenance

Maintenance of restored areas and recreation sites is an important part of basin-wide restoration planning. Proposed restoration projects should identify short and long term maintenance requirements, including any increased management responsibilities by land managers, as well as responsible parties and sources of funding.

8.4 Prioritization Results by Planning Area

The prioritization results were analyzed by planning area to evaluate whether prioritization followed a reasonable pattern across planning areas. The restoration needs rankings for each planning area were averaged. Similarly, restoration needs scores were averaged within each planning area. This produced average restoration needs ranks and scores that may be compared across planning areas (Table 8-3). The results of this analysis indicate a similar pattern of increasing priority across planning areas, with the Silver Bow Creek corridor area having the highest overall priority and Warm Springs Ponds having the lowest priority. Moreover, the average rankings fall into three distinct categories of high, medium, and low priority. The resulting patterns of priority by planning area seem reasonable based on degree of natural resource injury, potential to contribute to natural resource recovery, and general feedback from public participants in the planning process.

Table 8-3: Restoration needs summarized by planning area.

Planning Area	*Average Rank*	*Average Score*	*Priority*
Silver Bow Creek corridor	13.4	12.4	High
Butte Area	15.6	12.5	
Browns Gulch	25.3	10.7	Moderate
Basin and Blacktail creeks	28.2	10.5	
German Gulch	28.2	10.3	
Mill and Willow creeks	29.7	9.9	
Sand Creek	52.0	6.2	Low
Warm Springs Ponds	55.0	6.0	

Average Rank and Average Score are the averages values of these variables for all restoration needs in a given planning area.

8.5 Limitations of the Prioritization Process

Our present understanding of watershed conditions forms the basis of the prioritization of restoration needs in the Silver Bow Creek watershed. This understanding is limited due to gaps in available data and pending litigation in several areas. Data gaps include insufficient information regarding soils, detailed assessment of conditions in tributary streams, actual amounts of irrigation diversion, etc. Another type of limitation is the adaptive management strategy for water quality in Warm Springs Ponds, which limits our ability to predict when, if ever, Mill Creek and Willow Creek may reconnect to Silver Bow Creek. A remedy decision is pending for the BPSOU and litigation is pending for the Butte Area One portion of the BPSOU and the Mount Haggin, Stucky Ridge, and Smelter Hill Injured Areas (see Section 2.2.2). Until these claims are settled, it is not possible to know how much restoration funding may be required to bring these areas into accord with the vision statement presented in this Plan (Chapter 5.0). As additional information becomes available and litigation concludes, understanding of the condition of the watershed and the need for restoration funding will improve. Moreover, the relative importance of restoration needs identified in this plan may change as additional restoration needs within the broader UCFRB are considered. Restoration priorities laid out in this Plan will change accordingly. Given that we are in the early stages of an extensive remediation and restoration effort in the basin, a 5 to 10 year review process should be conducted to evaluate long-term success and adjust this plan and the strategies and priorities recommended as dictated by monitoring results.

9.0 Proposal Development

This chapter contains two sections. The first details how prospective applicants for NRDP funding should use the *UCFRB Restoration Plan Procedures and Criteria* (*RPPC*) (NRDP, 2002a) and the information presented in the *Silver Bow Creek Watershed Restoration Plan* to guide their project planning and proposals. The second portion of this chapter identifies some additional funding opportunities for projects that are outside the scope or priorities of NRDP grant funding. These additional funding sources can diversify the participation of granting agencies, as many watershed or environmental grant programs, including the NRDP, give preference to proposals that cost share through cash or in-kind donations from other funding sources.

9.1 NRDP Funding Opportunities

This section summarizes the criteria used by NRDP to qualify project proposals for funding. These criteria are described more fully in the *RPPC*. This section also provides guidance for prospective applicants regarding the integration of the *RPPC* and the *Silver Bow Creek Watershed Restoration Plan*.

9.1.1 NRDP Project Evaluation Criteria in the RPPC

The *RPPC* details the criteria the State uses to evaluate and rank proposals for funding (NRDP, 2002a). Projects must meet five minimum qualification criteria in order to be eligible for funding consideration. Projects must restore or replace injured natural resources or lost services in the UCFRB, must be located in the UCFRB, with limited exceptions, and must not have the potential to interfere with pending remediation decisions and unresolved litigation. In addition, the project application must be complete and the project applicants must have adequate qualifications to undertake the project.

If an application meets minimum qualifications, then the State evaluates the project using multiple criteria to determine which eligible projects merit funding and how they rank against each other. The criteria fall into two categories:

1) Stage 1 Legal Criteria are derived from the legal requirements set forth in federal natural resource damage regulations specific to expenditures of natural resource damages. There are nine Stage 1 criteria that apply to all projects.

2) Stage 2 Policy Criteria reflect matters of special interest to the State and promote the State's goals and policies of restoring the natural resources in the UCFRB. There are nine Stage 2 criteria that apply to all projects; two apply only to land acquisition projects; and two apply only to monitoring or research projects.

The *RPPC* sets forth a non-quantitative project evaluation and ranking process using these criteria that the State follows to determine the best mix of restoration and replacement projects to fund. The State assesses the degree to which proposed projects meet each criterion, compares the projects on a criterion-specific basis, and then ranks the projects against each other. The *RPPC* does not rank criteria in terms of importance or assign numeric values to the criteria, noting that "each criterion as applied to individual projects will vary in its importance depending on the nature of the project and unique issues it raises." A project does not need to meet all the preferences reflected in Stage 1 and Stage 2 criteria in order to merit funding. A project may rank poorly compared to others for a particular criterion, but that criterion may be inapplicable or relatively unimportant for that type of project. Similarly, the merits of a project based on some number of criteria may significantly outweigh its deficiencies noted for a particular criterion or multiple criteria. The following section provides brief descriptions of each *RPPC* criterion and the preferences for funding that are reflected in these criteria.

Stage 1 Legal Criteria

1. Technical Feasibility: Evaluates the degree to which a project employs well-known and accepted technologies and the likelihood that a project will achieve its objectives, with preference given to projects that are technically feasible.

2. Relationship of Expected Costs to Benefits: Evaluates the degree to which project costs are commensurate with project benefits. The State will fund projects that have a favorable benefit:cost relationship.

3. Cost-Effectiveness: Examines whether a particular project accomplishes its goals in the least costly way possible, with preference given to projects with demonstrated cost-effectiveness.

4. Environmental Impacts: Evaluates whether and to what degree the project will have an adverse impact on environmental resources, with preference given to those projects with beneficial impacts.

5. Human Health and Safety Impacts: Evaluates whether and to what degree the project will have an adverse impact on human health and safety, with preference given to those projects with beneficial impacts.

6. Results of Superfund Response Actions: Examines the relationship between projects and completed, planned, or anticipated Superfund response actions. A preference exists for projects that coordinate with and augment ongoing or planned remedies.

7. Recovery Period and Potential for Natural Recovery: Evaluates whether and to what degree a project affects the time frame for natural recovery of the injured resources to their baseline conditions. Reduction of the recovery period benefits a project's overall ranking.

8. Applicable Policies, Rules, and Laws: Evaluates to what degree the project is consistent with all applicable policies of state, federal, local and tribal government and in compliance with applicable laws and rules. Consistency with applicable policies, rules, and laws benefits a project's overall ranking.

9. Resources of Special Interest: Addresses natural resources of special interest to the Confederated Salish and Kootenai Tribes (Tribes) and the Department of Interior (DOI)

in its restoration planning process, with preference given to those projects that beneficially impact these resources.

Stage 2 General Policy Criteria

10. Project Location: Evaluates the proximity of the project to the injured resources it restores or replaces. A preference exists for projects that occur at or near the site of injury.

11. Actual Restoration of Injured Resources: Evaluates whether and to what extent a project actually restores an injured resource. A preference exists for projects that constitute actual restoration (i.e., they operate directly on the injured resources).

12. Relationship between Service Lost and Service Restoration: Examines the connection between the services that a project seeks to address and the services that were lost or impaired. Projects that focus on providing the same or similar services as those lost or impaired will be favored over projects that focus on providing dissimilar services.

13. Public Support: Assesses the level of public support. Substantial public support can benefit a project's overall ranking.

14. Matching Funds: Evaluates the extent to which a project entails cost sharing. Significant matching funds can benefit a project's overall ranking.

15. Public Access: Evaluates whether a project will affect public access and the positive or negative aspects of any increased or decreased public access associated with the project.

16. Ecosystem Considerations: Examines the relationship between the project and the overall resource conditions of the UCFRB. A preference exists for projects that fit within a broad ecosystem concept.

17. Coordination and Integration: Examines whether, how, and to what extent a restoration project is coordinated and integrated with other on-going or planned actions in the UCFRB besides the coordination with Superfund remedial actions addressed under Criterion #6. Projects that can be efficiently coordinated with other actions may achieve cost savings that will benefit the project's overall ranking.

18. Normal Government Functions: Assesses the extent to which the proposed actions are ones for which a governmental entity would normally be responsible or would receive funding in the normal course of events. Projects that are outside or augment normal government functions can be funded. Projects that are wholly within normal government function will not be funded.

Stage 2 Land Acquisition Criteria

19. Desirability of Public Ownership: Assesses the potential benefits and detriments associated with putting privately owned land, or interests in land, under public

ownership. Acquisition projects that benefit injured natural resources or provide lost services are favored over those that do not.

20. Price: Evaluates whether the proposed land, easements, or other property interests are being offered for sale at fair market value. A more favorable price compared to market can benefit a project's overall ranking.

Stage 2 Monitoring and Research Criteria

21. Overall Scientific Program: Considers the extent to which the proposed monitoring and research efforts coordinate or integrate with other scientific work in the UCFRB. Greater benefits can be achieved when monitoring and research projects can use and assist other projects.

22. Assistance with Restoration Planning: Assesses whether the knowledge that might be gained from a monitoring or research project will directly assist with future restoration efforts.

9.1.2 Integration of the Silver Bow Creek Watershed Restoration Plan and the RPPC

All grant proposals are evaluated using the above criteria as set forth in the *RPPC*. Approval of a final *Silver Bow Creek Watershed Restoration Plan* does not change the process set forth for funding decisions in the *RPPC*. Rather, the link between this plan and a proposed project in the Silver Bow Creek watershed will be considered in evaluation of existing *RPPC* criteria, particularly the "Ecosystem Considerations" criterion. The following is the current language in the *RPPC* that explains this criterion:

> Ecosystem Considerations: Under this criterion the State will examine the relationship between a particular project and overall resource conditions in the Upper Clark Fork River Basin. The UCFRB is a complex arrangement of interdependent components. To accomplish as much as possible, the State will view projects in the context of this complex system, attempting to understand the impact of a project on the ecosystem as a whole. The State will favor projects that fit within a broad ecosystem concept in that they improve a resource problem(s) when viewed on a large scale, are sequenced properly from a watershed management approach, and are likely to address multiple resource problems.

Since the priorities established in the *Silver Bow Creek Watershed Restoration Plan* are based primarily on watershed-scale benefits, it is appropriate to consider a proposed project's consistency with this plan when evaluating the existing "Ecosystem Considerations" *RPPC* criterion that gives preference to projects that fit within a broad ecosystem context. Proposals that are consistent with this plan will typically meet this criterion better than proposals that are inconsistent with this plan. If a project is inconsistent with the plan's priorities, the project can still be considered for funding. However, the applicant will need to provide an adequate justification why the project should be funded despite this inconsistency with the *Silver Bow Creek Watershed Restoration Plan*. Inconsistency with the plan's priorities is not considered to be an outright cause for rejection of a proposal given that the plan relies in some cases on incomplete information and also because priorities can shift as remedy decisions and remedial designs are completed and litigation is resolved and as resource conditions change. An applicant may be able to provide additional information not considered in this plan and offer compelling scientific or administrative reasons for considering a proposal for funding despite its inconsistency with the plan's priorities.

As part of its public comment on the *Silver Bow Creek Watershed Restoration Plan*, the State sought public input on a proposed addition to the *RPPC* that would identify the consistency with the *Silver Bow Creek Watershed Restoration Plan* as one of the factors the State would consider in its evaluation of the "Ecosystems Considerations" criterion. Specifically, the following sentence was proposed to be added to description of the "Ecosystems Considerations" (provided above) in the *RPPC*:

"Under this criterion, for proposed projects located within the Silver Bow Creek watershed, the State will evaluate the consistency of the proposed project with the watershed-scale priorities established in the *Silver Bow Creek Watershed Restoration Plan*."

In December 2005, the Governor approved of this proposed change to the *RPPC*. This charge will be incorporated in a revised version of the *RPPC* in January 2006.

The State will ask applicants to address consistency of the proposed project with the priorities established in the *Silver Bow Creek Watershed Restoration Plan* as part of their "Ecosystems Considerations" criteria statement of their application. Having this information in the program application materials will assure that applicants have knowledge of the plan and need to address consistency with the plan's priorities.

Although the State will specifically evaluate how a proposed project in the Silver Bow Creek watershed fits or does not fit with the priorities provided in the "Ecosystems Considerations" criterion, information provided in the plan may also be relevant to the evaluation of other existing *RPPC* criteria. For example, the plan identifies restoration needs for the injured Silver Bow Creek floodplain corridor that would augment remediation activities. A project aimed at addressing these needs would likely meet the "Results of Superfund Response" criterion that gives preference to projects that coordinate with and augment ongoing or planned remedies. Similarly, the plan identifies restoration needs of importance to the public that are likely to meet the "Public Support" criterion. As another example, this plan identifies critical wildlife habitat areas that would be good targets for land acquisitions or easements. Such areas are likely to do well for the "Desirability for Public Ownership" criterion. This plan also provides information on activities in the Basin that will assist applicants in identifying opportunities for coordination and integration with other ongoing or planned actions in the watershed. Such coordinated efforts are favored under the *RPPC* "Coordination and Integration" criterion.

This extra step of evaluating consistency of a project with the priorities established in the *Silver Bow Creek Watershed Restoration Plan* under the Ecosystem Consideration criterion is applicable only to projects in the Silver Bow Creek watershed. For the proposed projects that are within the UCFRB but outside of this watershed, this criterion would be evaluated as indicated in the existing *RPPC* language without the added step of considering the consistency *Silver Bow Creek Watershed Restoration Plan*. Having this extra step for projects in the Silver Bow Creek watershed does not inherently disfavor projects outside this watershed. In fact, the relative priority of restoration needs presented in the Silver Bow Creek Watershed Restoration Plan may decrease (or increase) when considered in the broader context of all restoration needs within the entire UCFRB. Projects outside of the Silver Bow Creek watershed will be evaluated for the Ecosystem Considerations criterion just as they always have been, with those projects that fit within a broad ecosystem concept favored over those that do not.

While this plan is not directly applicable to projects outside the Silver Bow Creek watershed, it does summarize general principles of watershed-scale planning and prioritization in Chapter 3.0 and a hierarchy of restoration categories in Chapter 8.0 that are applicable to any restoration project regardless of its location. For example, this plan emphasizes the importance of protecting and preserving high quality resources from potentially detrimental future land use activities, which is applicable to restoration efforts in any watershed. Similarly, this plan identifies the need to protect the public drinking water reservoirs in the Silver Bow Creek as a very high priority for restoration; it's likely that protection of similar water supplies located outside this watershed is a very high priority. In addition, there are some general restoration needs identified in this plan that are analogous to other locations in the UCFRB, such as those needs identified for headwater streams that support populations of genetically pure native westslope cutthroat trout.

It should be understood that consideration of the *Silver Bow Creek Watershed Restoration Plan* does not diminish the multiple preferences built into the *RPPC* for actual restoration work in injured areas covered under <u>Montana v. ARCO</u>. Those preferences, are incorporated into the five *RPPC* criteria, "Results of Response Action," "Project Location," "Actual Restoration of Natural Resources," "Recovery Period and Potential for Natural Recovery," and "Relationship between Service Lost and Service Restoration," favor restoration occurring in injured areas over replacement projects outside of injured areas.

In conclusion, how a project fits with the priorities established in the *Silver Bow Creek Watershed Restoration Plan* will be specifically evaluated under one of the existing 22 *RPPC* criteria, "Ecosystem Considerations." The information provided in the plan may also be relevant to the evaluation of other *RPPC* criteria. The plan can be viewed as one of the many informational tools the State uses to judge the merit of project funding. A project that ranks a high priority under the *Silver Bow Creek Watershed Restoration Plan* may or may not be recommended for funding based on how it does for all the *RPPC* criteria overall. However, for proposed projects in the Silver Bow Creek watershed, those that address a very high or high priority restoration need in the plan <u>and</u> meet the many other preferences established in the *RPPC* criteria have the greatest probability of receiving funding. Finally, the relative importance of restoration needs identified in the plan that is restricted to the Silver Bow Creek watershed area may change as additional restoration needs within the broader UCFRB are considered.

9.2 Other Funding Opportunities

Additional potential funding sources exist for restoration in the Silver Bow Creek watershed. The following table (Table 9-1) outlines a number of grant programs, their focus, eligibility criteria, funding and match requirements, and application deadline. This table serves as a reference tool for watershed groups, private landowners, or government entities to use as a starting point for the grant procurement process and as potential funding sources to augment or match NRDP grant funding. The programs highlighted focus on natural resource improvements rather than recreational service improvements. Since new grant opportunities are continually arising, and application criteria continually changing, it is important to check the websites provided for up to date information.

Table 9-1: Watershed restoration funding sources.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Bonneville Environmental Foundation	This foundation is committed to restoring ecological integrity and native fish populations across the Pacific Northwest. There is also a Model Watershed Program which provides financial and scientific support to structure, develop, and sustain 10 year restoration and monitoring programs in selected priority watersheds.	Any private person, organization, tribe, or local government, within the Pacific Northwest (OR, ID, WA, MT), may submit a Letter of Inquiry. Funding, however, will only be considered where applicants 1) base proposed or existing actions on sound science; 2) exhibit strong community engagement; and 3) demonstrate a comprehensive, watershed-scale approach.	Grants generally range between $5,000 and $40,000. Although BEF does not maintain explicit cash or in-kind matching requirements, in all cases the Foundation expects Model Watershed program partners to specify and contribute valuable cash and/or in-kind resources that will augment BEF's watershed restoration investments.	Watershed Programs (503-248-1905) or watersheds@b-e-f.org; www.b-e-f.org	Letters of inquiry are accepted anytime.
Cinnabar Foundation	This foundation provides operating or special project funds to projects involving environmental stewardship and protection in Montana.	Applicants must be either a nonprofit organization (501c3) of have a fiscal sponsor that meets this criteria.	Awarded grant funds average $5000.	Jim Posewitz (406-449-2795) cinnabar@mt.net	March each year
Compton Foundation	This foundation funds land, river and watershed protection and management for purposes of long term habitat and ecosystem preservation and restoration, and changing the relationship between people and the natural environment.	No grants are awarded to private individuals.	Grant awards range from $10,000 to $100,000	www.compton foundation.org (650-328-0101)	Grants are considered twice a year (May and December).
Collaborative Science and Technology Network for Sustainability	The EPA National Center for Environmental Research will be funding innovative regional projects that address a stated problem or opportunity relating to sustainability and use of science to inform design, planning and decision-making at the local, state and industrial levels.	Institutions of higher education and not-for-profit institutions located in the U.S., and also tribal, state, and local governments, are eligible to apply.	Total funding is anticipated to be approximately $1.5 million. The potential funding per assistance agreement is $50,000 to $100,000 per year with a duration of one to three years, and no more than a total of $300,000, including direct and indirect costs.	http://es.epa.gov/ncer/rfa/2004/2004_collab_science.html	Varies, May 21 in 2004

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Conservation Reserve Enhancement Program (CREP)	This nationwide program has been established to help farmers improve water quality by enhancing riparian, instream and upland habitat on a watershed basis. The only program established is Montana to date is the Missouri-Madison corridor.	Eligible lands include cropland and marginal pastureland (adjacent or parallel to perennial or seasonal streams) and must be planted to trees. Lands must be kept out of agricultural production for 10-15 years. The following conservation measures are applicable (establishment of native grasses, shallow water areas, wildlife habitat, vegetative cover, riparian buffers, filter strips, and wetland restoration).	Grant funds include a signing incentive payment, annual rental payment, a 50% cost share assistance to implement practices, and an annual maintenance payment.	Contact the local NRCS office (www.nrcs.usda.gov)	Continuous sign-up process once a CREP area is established.
Conservation Reserve Program (CRP)	CRP is a voluntary program that offers long-term rental payments and cost-share assistance to establish long-term, resource-conserving cover on environmentally sensitive cropland or, in some cases, marginal pastureland. Increased rental payments are available on certain land areas (e.g., land within a wellhead protection area may receive an additional 10 percent payment).	Eligible groups include businesses, nonprofit groups, private landowners, local and state government, and Tribal Agencies. Land must be owned or operated for at least 12 months. Land must have a minimum acceptable erodibility index, be located in an approved conservation priority area, have evidence of scour erosion damage, or be a cropped wetland or cropland. The area of interest must have been farmed or used for commodity crops for the last 2 of 5 years or be marginal pastureland that is suitable for use as a riparian buffer to be planted to trees. Land must also be suitable for any of the following; riparian buffers, filter strips, grassed waterways, shelter belts, field windbreaks, and living snow fences.	There is a rental payment and cost-share up to 50%, with a signing incentive bonus.	Contact the local NRCS office (www.nrcs.usda.gov)	General sign-up is late spring/early summer. There is a continuous sign-up for high priority practices on eligible land.
Conservation Security Program (CSP)	CSP is designed to assist agriculture producers in implementing conservation practices and rewarding past stewardship on working lands.	Only private landowners are eligible. Landowners must enter into a conservation security contract. CRP, WRP, or GRP lands are not eligible and cannot have been cropped for 4 of last 6 years.	Grant amounts vary based on level of conservation but include rental payments and cost-share grants for maintenance and implementation of practices.	Contact the local NRCS office (www.nrcs.usda.gov). This program is still awaiting final approval and funding details.	This program is still in development. Refer to website for application deadlines.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Cooperative Forestry Assistance Programs	Through its Forest Legacy Program (FLP), the USDA Forest Service supports state efforts to protect environmentally sensitive forest lands. Designed to encourage the protection of privately owned forest lands, FLP is an entirely voluntary program. The program helps fund the acquisition of forest land or partial interests in privately owned forest lands. It encourages and supports the acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership or the local tax rolls. FLP conservation easements restrict development, require sustainable forestry practices, protect a range of public vales, and sometimes require public access for recreation.	Eligible groups include businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, conservation districts, water and wastewater utilities, local and state government, and tribal agencies.	Average grant award amounts range from $500,000 to $1,000,000. The federal government may fund up to 75% of program costs, with at least 25% coming from private, state or local sources.	www.fs.fed.us/ spf/coop/flp.htm	Applications are submitted to the state lead agency in each participating state. While some states have discrete open seasons, others accept applications year-round.
Environmental Quality Incentives Program (EQIP)	NRCS's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. It provides technical, financial, and educational assistance; sixty percent of it is targeted to livestock-related natural resource concerns and the rest to more general conservation priorities. EQIP promotes agriculture production and environmental quality as compatible goals. The program is particularly interested in funding cross fencing, stream restoration, off-site water options, and irrigation efficiency.	Eligible organizations included businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, water and wastewater utilities, and state and tribal agencies. Landowners must be non-federal (including American Indian tribes) engaged in livestock operations or agricultural production. Eligible land includes cropland, rangeland, pasture, private nonindustrial forestland, and other farm and ranch lands.	Typical median grant award is $8,200. Eligible practices will receive 75% cost-share; some eligible management practices can receive 100% cost-share. Typical match amounts are 25% to 50%.	Contact the local NRCS office www.nrcs.usda. gov/programs/ eqip/	Continuous sign-up process.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
EPA Brownfield Assessment and Cleanup Program	EPA's brownfield program helps communities clean up and redevelop properties. Brownfield sites are defined as "real property, the expansion, redevelopment, or reuse of which may be contaminated by the presence or potential presence of a hazardous substance, pollutant, or contaminant." The program helps mitigate potential health risks and assists in restoring economic vitality to areas where brownfields exist. Assessment Grants are directed toward environmental activities preliminary to cleanup, such as site assessment, site identification, site characterization, and site response or cleanup planning. Cleanup Revolving Grants target facilitating cleanup of brownfield sites contaminated with hazardous substances or petroleum products, as well as mine scarred land.	State, local government and tribal entities are eligible.	Grants awarded up to $200,000. No match is required.	www.epa.gov/ brownfields/	The deadline for proposals for the FY04 grant competition was December 4, 2003.
Farmland Protection Program	The USDA Natural Resources Conservation Service's Farmland Protection Program (FPP) is a voluntary program that helps farmers and ranchers keep their land in agriculture and prevents conversion of agricultural land to non-agricultural uses. The program provides matching funds to organizations with existing farmland protection programs that enable them to purchase conservation easements. These entities purchase easements from landowners in exchange for a lump sum payment, not to exceed the appraised fair market value of the land's development rights. The easements are for perpetuity unless prohibited by state law.	Eligible organizations include nonprofit groups, conservation districts, and local, state and tribal agencies. Private landowners must participate through an eligible entity. To be eligible, organizations must have an active conservation easement acquisition program in place. The easement program must prohibit the conversion of farmland to non-agricultural uses. Lands offered for easements must meet certain criteria: be at least 50 percent prime, unique, statewide, or locally important soil; contain historical or archaeological resources; and consist of cropland, rangeland, grassland, pastureland, and/or incidental forestland and wetlands that are part of an existing agricultural operation.	Grant awards range from $10,000 to $1,000,000. The federal share of any easement acquisition is limited to a maximum of 50 percent of the appraised fair market value of the conservation easement. A landowner donation of up to 25 percent of the appraised fair market value of the conservation easement is preferred.	www.nrcs.usda. gov/programs/ farmbill/2002/	Varies, usually 45 days after publication of a Request for Proposals in the Federal Register. Contact the local NRCS contact for current application deadline.
Fisheries Restoration and Irrigattion Mitigation Program	The U.S. Fish and Wildlife Servcice administers this grant program that funds fish passage and screening projects.	Project proposals which are eligible for consideration include design, construction, and installation of fish screens, fish ladders, and other fish passage devices associated with water diversions located in ID, OR, WA, and western MT. State, local, and tribal government entities are eligible to apply.	Project partners must identify at least 35% matching funds for the design and construction of an eligible project and must assume responsibility for operation and maintenance costs of the project.	www.r6.fws.gov/ fisheries/frima. htm	

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Future Fisheries Program (Montana Fish Wildlife and Parks (Montana FWP))	The focus of the Future Fisheries Program is to provide funding to restore essential habitats for the growth and propagation of wild fish populations in lakes, streams, and rivers. Commonly funded projects include riparian and instream restoration and fish passage improvements.	Good projects originating from virtually any source will be considered for funding. Potential projects must accomplish one or more of the following: improve or maintain fish passage; restore or protect naturally functioning stream channels or banks; restore or protect naturally functioning riparian areas; prevent loss of fish into diversions; restore or protect essential habitats for spawning; enhance streamflow in a dewatered reach to improve fisheries; restore or protect genetically pure native fish populations; improve fishing in a lake or reservoir; other projects that restore or protect habitat for wild fish populations.	Although there is no actual maximum grant cap, in the past the program has focused on funding projects less than $25,000. No funding match is required.	Glenn Phillips (406-444-5334) or http://Montana FWP.mt.gov	Grants are reviewed twice a year. Application deadlines are January and July 1st.
Grassland Reserve Program (GRP)	The 2002 Farm Bill established the Grassland Reserve Program (GRP) for the purpose of restoring and conserving two million acres of grassland, rangeland, and pastureland. GRP will do this through the use of up to 30-year rental agreements and 30-year or permanent easements. Rental and easement payments are based on a percentage of the fair market value of the land, less the grazing value of the land for the period during the contract or easement period. Total funding through 2007 is authorized at $254 million in easements, rental agreements, and cost-share payments for enrolling up to 2 million acres.	Only private landowners are eligible. GRP lands may be used for haying and grazing under a conservation plan. Private landowners must have more than 40 continuous acres of restored or improved private grassland.	Grant amounts vary depending on cultivation history, restoration cost-share, and rental payments.	www.usda.gov/ farmbill/	This program is still in development. Refer to website for application deadlines.
Habitat Montana (HB 526)	This program is administered by Montana FWP and provides funding for the protection and management of native prairie and riparian habitat. These funds can be used to purchase conservation easements and facilitate sound management of sagebrush grasslands, intermountain grasslands, and riparian areas.	Contact the local Montana FWP representative for more information.	Contact the local Montana FWP representative for more information.	Contact the local Montana FWP representative for more information.	Contact the local Montana FWP representa-tive for more information.
HB 223 Grant Program	This funding program is designed to provide Conservation Districts with funds for conservation related equipment purchases, saline seep and weed control projects, conservation education and information projects, soil surveys , and various other water and soil conservation related projects.	Only Conservation Districts are eligible to apply. Projects must show a public benefit as well as a conservation benefit.	Preferential consideration is given to grants less than $10,000 and that provide some type of in-kind service or dollar match.	http://www.dnrc. mt.gov/	Funding is provided quarterly.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Irrigation Development Grants	This program through DNRC has been established to new irrigation projects, test wells for irrigation, and feasibility studies for irrigation improvements or new systems.	Private and public entities are eligible.	Up to $15,000 is available per project.	http://www.dnrc.mt.gov/	Continuous
William C. Kenney Watershed Protection Foundation	The Kenney Foundation focuses on select natural resource campaigns to protect and restore key rivers and watersheds, with the purpose of developing a model for equitable and sustainable water use. The overall purpose of the campaign is to ensure execution of the Superfund cleanup, other government restoration activities, and removal of Milltown Dam; initiate and support a long-term economic and cultural restoration plan; create and implement a campaign that supports and responds to the community's social and cultural needs.	The Upper Clark Fork River has been selected in partnership with the Clark Fork Coalition as a key campaign.	There is currently no stated grant cap or match required.	Jay Kenney, Director (303-534-5722) or http://www.kenneyfdn.org	No application deadline
Landowner Incentive Program (Non-Tribal)	The U.S. Fish and Wildlife Service's Landowner Incentive Program (LIP) grant program provides competitive matching grants to states, territories, and the District of Columbia to establish or supplement landowner incentive programs. These programs provide technical and financial assistance to private landowners for projects that protect and restore habitats of listed species or species determined to be at-risk. LIP projects will likely involve activities such as the restoration of marginal farmlands to wetlands, the removal of exotic plants to restore natural prairies, a change in grazing practices and fencing to enhance important riparian habitats, instream structural improvements to benefit aquatic species, road closures to protect habitats and reduce harassment of wildlife, and acquisition of conservation easements. Although not directly eligible for these grants, third parties such as nonprofit organizations may benefit from these funds by working directly with their states to see if either grants or partnering opportunities are available.	Eligible organizations include businesses, community/watershed groups, nonprofit groups, private landowners, and state agencies.	Typically, awarded grants are over $180,000. A 25 percent non-federal match is required (cash, in-kind services, or a combination of the two are accepted as match).	www.fws.gov	Typically late summer or early fall. State wildlife agencies normally have 60 days once a Request for Proposals is published in the Federal Register and Grants.gov.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Local Empowerment Program (LEP)	The goal of this program, which is sponsored by Montana Association of Conservation Districts (MACD), is to maintain and improve the quality of Montana's watersheds by providing much-needed funding to those wishing to work on their watershed through locally-led and voluntary efforts.	Applicants must be Conservation Districts. No Conservation District, or local partner (watershed group) working through their CD(s), can receive more than $50,000 during the life of this grant program.	As long as the total request does not exceed the $50,000 limit, applicants may request any combination of operational or demonstration project funding. There is no stated match required, however, projects with a financial match are encouraged.	Contact the local Conservation District representative. http://www.macdnet.org/LEPapp.htm	This program has a number of rounds of funding allocation. Check with MACD to determine next cycle deadline (406-443-5711).
Migratory Waterfowl Stamp Program	This program, administered by Montana FWP, provides funds for the protection, conservation, and development of wetland habitat. Projects include development of native cover for ground nesting birds.	Contact the local Montana FWP representative for more information.	Contact the local Montana FWP representative for more information.	http://MontanaFWP.mt.gov/habitat/wildlifehabitat	Contact the local Montana FWP office for more information.
Montana Renewable Resource Grant and Loan Program/ Reclamation Resource Grant	This program, administered by DNRC, has been established to fund renewable resource related projects such as water conservation, water quality, forestry, air quality, resource education, and waste management. Projects may include feasibility, design, research, and resource assessment studies and preparation/ implementation of construction, rehabilitation, or production projects.	Eligible applicants include any division of state or tribal government, or other county, city, or local political subdivisions. (Other programs are available for private entities).	Maximum grant amount is $100,000 per project.	http://www.dnrc.mt.gov/	Application deadline is usually May 15 of even numbered years
National Fish and Wildlife Foundation	NFWF has a general matching grant program and a number of more specialized grants such as Bring Back the Natives, NRCS Conservation on Private Lands, Five Star Restoration Grants, Migratory Bird Conservation, Native Plant Conservation Initiative, and a Surface Mining Partnership Program.	Federal, state, local government, educational institutions, and non-profit organizations are eligible.	Grants range from $10,000-$150,000. A 1:1 non-federal match is required, however, as a policy, the Foundation seeks to achieve at least a 2:1 return on its project portfolio – $2 raised in matching funds to every federal dollar awarded.	www.nfwf.org/index.htm	Varies by grant program

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Non-point Source Implementation Grants (319 Program)	Through its 319 program, EPA provides formula grants to the states and tribes to implement non-point source projects and programs in accordance with section 319 of the Clean Water Act (CWA). The two types of funding provided are "base" funding to manage the core non-point source (NPS) water pollution program, including areas such as watershed restoration, groundwater, and information & education; and "incremental" funding which is specific to watershed based Total Maximum Daily Load (TMDL) planning along with projects to address NPS problems.	Eligible organizations include businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, conservation district, local, state, federal and tribal agencies.	No maximum grant amount is specified. Matching funds are required.	http://www.Montana DEQ. mt.gov/ wqinfo/non-point/319Grants	Draft applications are due in October and final applications are due in December of each year.
North American Wetlands Conservation Act Grants Program	The U.S. Fish and Wildlife Service's Division of Bird Habitat Conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training,educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act.	Those eligible for Act grants include public, private, for-profit, and nonprofit entities or individuals who have established a habitat conservation partnership.	Cost-share partners must match grant funds 1:1 with U.S. non-federal dollars.	http://birdhabitat. fws.gov	Small grants are due Dec 3, 2004 and IWJV cost share projects are due June 1, 2004.
Partners for Fish and Wildlife Program	Since 1987, the program has partnered with more than 28,725 landowners to restore over 639,000 acres of wetlands; 1,070,000 acres of prairie, native grassland, and other upland habitats; 4,740 miles of in-stream aquatic and riparian habitat. In addition, the program has reopened more than 300 miles of stream habitat for fish and other aquatic species by removing barriers to passage.	Eligible organizations include community/watershed groups, nonprofit groups, private landowners, and local and tribal agencies. Private landowners must enter into a cooperative agreement for a fixed term of at least 10 years.	Typically grant requests are for less than $25,000 and an applicant contributes 50% of the total project cost through matching funds or in-kind services although this amount is negotiable.	http://partners. fws.gov/	Continuous sign-up process.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Private Stewardship Grants Program	The U.S. Fish and Wildlife Service's Private Stewardship Grants Program (PSGP) provides grants and other assistance on a competitive basis to individuals and groups engaged in private conservation efforts that benefit species listed or proposed as endangered or threatened under the Endangered Species Act of 1973, as amended, candidate species, or other at-risk species on private lands within the United States. Examples of the types of projects that may be funded include managing nonnative competitors, reintroducing imperiled species, implementing measures to minimize risk from disease in imperiled species populations, restoring streams that support imperiled species, fencing to exclude animals from sensitive habitats, and planting native vegetation to restore a rare plant community.	Eligible organizations include businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, conservation districts, and local governments.	Grants requests typically range from $3000 to $300,000, with the median grant award being $70,000. A ten percent (10%) non-federal match of cash or in-kind contributions is required.	http://endangered .fws.gov/grants/ private_ stewardship.html	Application deadline has varied in the last two years. Check the website for the most recent updates.
Stewardship Incentive Program (SIP)	The Stewardship Incentive Program provides cost-sharing payments to encourage private landowners to manage forestlands for economic, environmental, and social benefits. SIP is a U.S. Forest Service's program that is administered by the State Forester.	Contact the local state forester for more information on this newly evolving program.	Contact the local state forester for more information on this newly evolving program.	Contact the local state forester for more information on this newly evolving program.	Contact the local state forester for more information on this newly evolving program.
Upland Game Bird Habitat Enhancement Program	This program through Montana FWP was established to provide private landowners with an opportunity to restore and enhance upland game bird habitat at little or no cost to themselves.	Eligible applicants must be private landowners and must provide reasonable public access for upland game bird hunting. Eligible projects include riparian and native prairie restoration and enhancement and are generally more than 160 contiguous acres.	Up to 75% of the cost of a landowner's upland bird habitat enhancement project can be reimbursed.	http://www.Mont ana FWP. mt.gov/ wildthings/ uplandgamebird/	Contact the local Montana FWP representa-tive for more information.
USFWS Cooperative Endangered Species Conservation Fund	Grants offered through this program fund participation in a wide array of voluntary conservation projects for candidate, proposed and listed species. These funds may in turn be awarded to private landowners and groups for conservation projects.	Eligible groups include businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, conservation districts, water and wastewater utilities, local and state government, and tribal agencies.		http://endangered .fws.gov/grants/ section6/index	

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Water Quality Cooperative Agreements	These EPA grants are provided to help states, Indian tribes, interstate agencies, and other public or nonprofit organizations develop, implement, and demonstrate innovative approaches relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. This includes watershed approaches for combined sewer overflow, sanitary sewer overflows, and storm water discharge problems, pretreatment and sludge (biosolids) program activities, decentralized systems, and alternative ways to measure the effectiveness of point source programs. The estimate of funds available for fiscal year 2003 includes $20 million that has been requested for a new Watershed Initiative (WSI) program. Details for that program are currently being developed. If funds are appropriated for this program separate guidelines will be developed for the submittal, review, and approval of WSI projects.	Eligible organizations include community/watershed groups, nonprofit groups, educational institutions, water and wastewater utilities, and local, state, and tribal agencies. Also eligible are state water pollution control agencies and interstate agencies.	Grants requests typically range from $5000 to $500,000, with the median grant award being $100,000. No match is required.	www.epa.gov/ owm/cwfinance/ waterquality.htm	
Watershed Assistance Grants (WAG)	EPA's Watershed Assistance Grants are founded on building cooperative agreements with one or more nonprofit organization(s) or other eligible entities to support watershed partnerships and long-term effectiveness. Funding then supports organizational development and capacity building for watershed partnerships with a diverse membership.	Grants will be distributed to a pool of applicants, which are diverse in terms of geography, watershed issues, the type of partnership, and approaches.	At this time there is no secure funding for the WAG program, check the website for updates.	www.rivernet work.org	At this time there is no secure funding for the WAG program, check the website for updates.
Watershed Initiative	EPA has asked governors and tribal leaders for nominations and selects up to 20 watershed organizations to receive grants to support innovative watershed based approaches to preventing, reducing, and eliminating water pollution. Nominations that are likely to result in environmental improvements in a relatively short time frame and that show broad stakeholder involvement are strong candidates. Preference is given to watershed plans that involve multiple states and/or tribes. The Initiative also supports local communities in their efforts to expand and improve existing protection measures with tools, training, and technical assistance.	Eliglible organizations include community/watershed groups, nonprofit groups , educational institutions, conservation districts, water and wastewater utilities, and local, state and agencies. Grants must be selected by the state governor for submittal to EPA.	Grant requests typically range from $500,000 to $1,000,000, with the median grant award being $700,000. A minimum non-federal match of 25% of the total cost of the project or projects is required. Match may include cash or in-kind goods and services.	www.epa.gov/ owow/watershed/ initiative.html	The application deadline for fiscal year 2005 has not yet been determined. The deadline for 2004 was January 15.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Watershed Protection and Flood Prevention Program	Also known as the 'Watershed Program' or the 'PL 566 Program,' this program provides technical and financial assistance to address water resource and related economic problems on a watershed basis. Projects related to watershed protection, flood mitigation, water supply, water quality, erosion and sediment control, wetland creation and restoration, fish and wildlife habitat enhancement, and public recreation are eligible for assistance. Technical and financial assistance is also available for planning new watershed surveys.	Projects are limited to watersheds containing < 250,000 acres. Eligible project sponsors are county agencies, soil and water conservation districts, flood prevention/flood control districts, or other subunits of state government with the authority and capacity to carry out, operate and maintain installed works of improvement.	Grant requests range from $25,000 to 10 million, with the median grant award being $400,000. Projects require a cost-sharing component. Approximate 75% match is required.	www.nrcs.usda.gov/programs/watershed	Eligible projects may submit requests to the local NRCS office at any time.
Wetlands Program Development Grants	The EPA's Wetland Program Development Grants are intended to encourage comprehensive wetlands program development by promoting the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. Projects build the capacity of states, tribes, and local governments to effectively protect wetland and riparian resources. Projects funded under this program support the initial development of a wetlands protection, restoration or management program or support enhancement/refinement of an existing program.	Eligible organizations include nonprofit groups (national headquarters only, not regional offices), and local, state and tribal agencies.	Grant requests range from $1,500 to $500,000. A 25% match is required.	www.epa.gov/owow/wetlands/grantguidelines/	Application dates are set annually. Check website for recent information.
Wetlands Reserve Program (WRP)	Through this voluntary program, the USDA Natural Resources Conservation Service (NRCS) provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. To participate in the program landowners may sell a conservation easement or enter into a cost-share restoration agreement (landowners voluntarily limit future use of the land, but retain private ownership). Landowners and the NRCS jointly develop a plan for the restoration and maintenance of the wetland.	Eligible organizations include businesses, community/watershed groups, nonprofit groups, educational institutions, private landowners, conservation districts, water and wastewater utilities, and local, state, and tribal agencies. Easement participants must have owned the land for at least 1 year and be able to provide clear title. Restoration agreement participants must show evidence of ownership. Owner may be an individual, partnership, association, corporation, estate, trust, business, or other legal entity; a state (when applicable); a political subdivision of a state; or any agency thereof owning private land. Land eligibility is dependent on length of ownership, whether the site has been degraded as a result of agriculture, and the land's ability to be restored.	For restoration cost-share agreements and 30-year easement participants, up to 25 % of the cost of restoring the acreage must be provided.	Contact the local NRCS office www.nrcs.usda.gov	Applications accepted year round.

Grant Program	*Description*	*Eligibility Criteria*	*Funding Amount & Match Requirements*	*Contact*	*Application Deadline*
Wildlife Habitat Incentives Program	The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat on private lands. It provides both technical assistance and cost sharing to help establish and improve fish and wildlife habitat. Participants work with the NRCS to prepare a wildlife habitat development plan in consultation with a local conservation district. The plan describes the landowner's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement.	Eligible organizations include nonprofit groups and private landowners. Individuals must own or have control of the land under consideration and cannot have the land already enrolled in programs that have a wildlife focus, such as the Wetlands Reserve Program, or use the land for mitigation. Landowners or lessees must have control of the land for the duration of the contract and a minimum of 5 years.	For cost-share assistance, USDA pays up to 75% of the cost of installing wildlife practices, and provides greater assistance for contracts greater than 15 years.	Contact the local NRCS office www.nrcs.usda.gov	Continuous sign-up process.

10.0 References Cited

Andrews, E.D., and J.M. Nankervis, 1995. Effective discharge and the design of channel maintenance flows for gravel bed rivers: In: Natural and Anthropogenic Influences in Fluvial Geomorphology: Geophysical Monograph 89, American Geophysical Union, 151-164.

Angermeier, P. L., 1997, Conceptual Roles of Biological Integrity and Diversity. Pages 49-64 in J.E Williams, C.A. Wood, and M.P. Dombeck, editors. Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda Maryland.

Aquoneering, 1990. Reconnaissance Investigations of Damsites, Upper Clark Fork River Basin, prepared for Montana Department of Natural Resources and Conservation, June 1990.

Beaverhead Deerlodge National Forest, 2003a. Proposed Action for Forest Plan Revision, August, 2003 (part of the EIS process).

Beaverhead Deerlodge National Forest, 2003b. Basin Creek Hazardous Fuels Reduction Project, Draft Environmental Impact Statement, Butte Ranger District Butte-Silver Bow County, Montana, September 2003.

Beaverhead Deerlodge National Forest, 2003c. 2003 Surface Water Quality Data Summary for Beal Mountain Mine, provided by Jocelyn Dodge of the Beaverhead Deerlodge National Forest to Carol Fox of the NRDP via a November 30, 2004 e-mail communication.

Beaverhead Deerlodge National Forest, 2004. Record of Decision and Final Environmental Impact Statement, Basin Creek Hazardous Fuels Reduction Project, Butte-Silver Bow County, MT, May 2004.

Bengsston, S.A.J. and E. Torbjorn, 1992. Archipelagoes and theories of insularity. In: L. Hansson (ed) *Ecological Principles of Nature Conservation* Elsevier Applied Science, London and New York, pp. 201-251, 1992

Bertram, R., and Chavez, J.C., 2002. Silver Bow Creek flow information provided in an 11/15/02 e-mail communication from Ron Bertram of EPA Helena office and Joel Chavez of Montana DEQ.

Bitterroot Restoration, 2002. Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Areas. Submitted to Montana Dept. of Justice, Natural Resource Damage Program, Helena, Montana.

Bollman, W. 1998. Improving stream bioassessment methods for the Montana valleys and foothill prairies ecoregion. MS Thesis. The University of Montana, Missoula, Montana.

Borduin, M.W., 1999. Geology and Hydrogeology of the Sand Creek Drainage Basin, Southwest of Butte, Montana. MS Thesis, Montana Tech, June 1999.

Butte-Silver Bow, 1995. Butte-Silver Bow Master Plan. Butte-Silver Bow joint City-County planning department.

Butte-Silver Bow, 2001. Draft Plan: A Look Forward to 2020: Butte-Silver Bow's Project Priorities for the Natural Resource Damage Program, provided by Butte-Silver Bow County as Appendix B to its 2001 Drinking Water Infrastructure Replacement NRD Grant Application, March 2001.

Butte-Silver Bow, 2002. Butte-Silver Bow Recreation Survey, provided by Butte-Silver Bow County. June 2002.

Butte-Silver Bow, 2004. Butte-Silver Bow Position Paper, Butte Priority Soils: A Proposed Solution, prepared by Butte-Silver Bow Technical Review Committee/Environmental, January 2004.

Butte-Silver Bow Water Department, 2003. Source Water Assessment and Delineation Report. Butte-Silver Bow Water Department, Public Works Water Utilities Division, Butte, Montana.

Butte-Silver Bow and USFS, 2003. Thompson Park and Blacktail Creek Rehabilitation and Restoration Project, UCFRB Restoration Grant Application, 2003 Grant Cycle, submitted by Butte-Silver Bow City-County government and the Beaverhead-Deerlodge National Forest. March 2003.

Canonie, 1992. Silver Bow Creek/Butte Area NPL Site. Streamside Tailings Operable Unit RI/FS. Preliminary Site Characterization Report prepared for ARCO. Canonie Environmental Services Corp., Bozeman, Montana.

CDM, 1994. Draft Baseline Risk Assessment. Streamside Tailings Operable Unit Silver Bow Creek NPL Site. Report prepared for Montana Department of Health and Environmental Sciences, Helena, Montana.

CCH, 1997. Technical Memorandum, Silver Bow Creek Hydrologic Model, HSPF, Subarea 1. Prepared for ARCO by Clear Creek Hydrology, Inc.

CDM, 2001. Data Summary Report for Surface Water Sampling During Storm Events, June 4, 2001 and July 16, 2001 Sampling Events, Anaconda Regional Water, Waste and Soils Operable Unit, prepared for the U.S EPA, September 2001.

CDM, 2002. 2002 Storm Water Sampling, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, Montana.

CH2MHill, Inc., 1989. Silver Bow Creek, Flood Modeling Study. Report prepared for State of Montana, Department of Health and Environmental Sciences, Helena, MT.

Confluence, 2002a. Biological integrity of assessed reaches of Divide, Silver Bow and Whitetail creeks based on periphyton and macroinvertebrate community structure. Report prepared for Natural Resources Damage Program, Helena, MT.

Confluence, 2004. 2003 Periphyton and macroinvertebrate sampling data, prepared for Natural Resource Damage Program, Helena, MT, April 2004.

Confluence and Kingfisher, 2002. Conceptual channel and floodplain restoration plan for German Gulch. Report prepared for Montana Fish, Wildlife & Parks, Missoula, Montana.

Cook, M., 2003. Genetic letter to Brad Shepard. University of Montana, Missoula MT. Deer Lodge County Soil Survey.

Desert Research Institute, 2003. Western Regional Climate Center, precipitation data. Available online at http://www.wrcc.dri.edu/.

Design Workshop, 1995. Silver Bow Greenway Conservation Corridor: A Public Planning Process. Concept plan for the Silver Bow Creek Greenway, prepared by Design Workshop, Denver, Colorado.

Dodge, K.A., Hornberger, M.I., and Lavigne, I.R., 2003. Water Quality, Bed-Sediment, and Biological Data (October 2001 through September, 2002) and Statistical Summaries of Data for Streams in the Upper Clark Fork Basin, Montana. USGS Open File Report 03-356 in cooperation with the U.S. EPA.

Dodge, J. 2004. Letter communication from Jocelyn Dodge of the Beaverhead Deerlodge National Forest to Carol Fox of the NRDP entitled "Review of Pre-Draft Silver Bow Creek Watershed Restoration Plan," dated November 30, 2004.

Doppelt, B., Scurlock, M., Frissell, C., and Karr, J. 1993. Entering the watershed: A new approach to save America's river ecosystems. Island Press, Washington D.C.

Douglass, K., 2003. E-mail comunication from Kriss Douglass of Montana FWP Region 3 office to Carol Fox of Natural Resource Damage Program, 12/29/03.

Douglass, K., 2003. E-mail comunication from Kriss Douglass of Montana FWP Region 3 office to Carol Fox of Natural Resource Damage Program, 12/6/04.

DuPont, 2005. Remedial Action Report, DuPont Ramsay Site, Ramsay, MT (EPID#MTR00202622), Project No. 502290-18983601.04007, prepared by DuPont Corporate Remediation Group, dated January 2005.

EPA, 1994: Record of Decision for the Butte Mine Flooding Operable Unit, Silver Bow Creek/Butte Area NPL site, EPA/ROD/R08-94/102, Sept. 1994.

EPA, 2000. Silver Bow Creek/Butte Area Superfund Site, Clark Fork River Basin, Montana, with Emphasis on the Warm Springs Ponds Operable Unit. Statutary Five-Year Review Report. U.S. Environmental Protection Agency, Region VIII, Montana Office.

EPA, 2004. Information provided in a 1/20/04 e-mail communication from Susan Zazzoli of USEPA Helena office to Carol Fox of the NRDP regarding 2003 site investigation results.

ESA, 1990. Evaluation of Browns Gulch and German Gulch storage areas, prepared for ARCO by ESA consultants, June 1990.

FEMAT (Forest Ecosystem Management Assessment Team), 1993. Forest Ecosystem Management: An Ecological ,economic, and social assessment. US Forest Service, Portland, Oregon.

Frandsen, A. and Hill, M., 2003. Storm Water and Superfund: EPA's Approach for Achieving Water Quality Standards in Silver Bow Creek and the Butte Priority Soils Operable Unit. Proceedings of the 20th Annual Meeting of the Montana Section of the American Water Resources Association, Butte, Montana.

Freeman, H.C., 1900. A brief hisorty of Butte, Montana, the world's greatest mining camp; including a story of the extraction and treatement of ores from its gigantic copper properties. Reprinted in 1969 by Caxton Printers. 123 p.

Frissell, C. A., 1997. Ecological principles. Pages 96-115 in J.E. Williams, C.A. Wood, and M.P. Dombeck, editors. Watershed restoration: principles and practices. American Fisheries Society, Bethesda, Maryland.

Gammons. C.H., Shope, C., Duaime, T.E., 2003. Water-quality monitoring of the Butte Metro storm drain during a storm event: June 26-27, 2002. Montana Bureau of Mines and Geology Open File Report 474.

GLO (Government Land Office), 1869. Historical GLO Map for Township 4 North, Range 10 West. Available from BLM Regional Offices.

GSD, 1998. Preliminary Design Report, prepared for the Greenway Service District by Pioneer Technical Services and EDAW, Inc., June 1998.

GSD, 2000. Silver Bow Creek Greenway, Pilot Year Proposal, submitted by the Greenway Service District, Anaconda-Deer Lodge and Butte-Silver Bow counties, April 2000.

Hadley, 2004. Information provided in via e-mail from Wayne Hadley, fisheries biologist for Region 2 of Montana FWP, to Greg Mullen of the NRDP dated 12/07/04.

Houdini and Associates, 2002, Summit Valley Watershed, Silver Bow Creek, Evolution of the Metro Storm Drain, prepared for the Butte-Silver Bow Planning Office by Houdini and Associates, Butte, December 2002.

Idaho DEQ (Department of Environmental Quality), 2000. Evaluation of Proposed New Point Source Dscharges to a Special Resource Water and mixing Zone Determinations: Thompson Creek Mine facility, Upper Salmon River Subbasin, Idaho. Moscow, Idaho.

Interfluve, 2003. Willow Creek Conceptual Restoration Plan, Opportunity, Montana. Prepared for Montana Fish, Wildlife, and Parks, September 5, 2003.

Kondolf, G.M., 2000. Assessing Salmonid Spawning Gravel Quality. Transactions of the American Fisheries Society 129:262-281.

LaFave, J., 2002. Nitrate in the Summit Valley of Southwest Montana. Powerpoint presentation by John LaFave of the Montana Ground-Water Assessment Program of the Montana Bureau of

Mines and Geology made to the Montana Section of American Water Resources Association, October 2002.

La Marr, T., 2002. Selenium and Copper Concentrations in Fish and Aquatic Macroinvertebrate Tissues in the German Gulch Sub-watershed, Prior to Land Application of Treated Mine Solution, Summer 2001. U.S. Forest Service, Beaverhead Deeelodge National Forest, Butte and Jefferson Ranger Districts internal report, December 2002.

La Marr, T., 2003a. Aquatic Hazard Assessment for Selenium in the German Gulch Sub-watershed, Based on 2001 and 2002 Data. U.S. Forest Service, Beaverhead Deeelodge National Forest, Butte and Jefferson Ranger Districts internal report.

La Marr, T., 2003b. Strategic Prioritization of Silver Bow Creek Sub-watersheds for Aquatic Restoration on National Forest Lands. Beaverhead Deerlodge National Forest Unpublished Report.

La Marr, T., 2003c. Comments provided on Yankee Doodle Creek fish presence at a meeting of NRDP, USFS, Montana FWP personnel.

La Marr, T., 2004: Unpublished information on fisheries in Blacktail Creek provided by Tim La Marr of the Beaverhead Deerlodge National Forest to Carol Fox of NRDP, December 7, 2004. Information includes two documents: "Stream Habitat Conditions in Blacktail Creek," prepared for the Thompson Park Salvage Timber Sale Environmental Assessment, which is to be released in 2005; and a 4/25/04 memorandum from Tim La Marr to Steve Egeline on the Highway 2/Roosevelt Dr. Hazard Tree removal.

La Marr, T. 2005. Letter from Tim La Marr of the Beaverhead Deerlodge National Forest to Carol Fox of the NRDP conveying USFS comments on the *December 2005 Draft Silver Bow Creek Watershed Restoration Plan* dated February 28, 2005.

Leary, R., 1984. Genetic letter to Bruce Rehwinkel. University of Montana, Missoula, Montana.

Levins, R., 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. Bulletin of the Entomological. Society of America. 15**:** 237-240.

Malone, 1981. The Battle for Butte. Mining and Politics on the Northern Frontier, 1864-1906. University of Washington Press, Seattle, Washington. Reprinted by the Montana Historical Society Press, Helena, Montana.

Maxim, 2003. Final Drawing for Remedial Action, SSTOU Subarea 2, Reaches F, G, and H. Prepared by Maxim Technologies for Montana DEQ, November 2003.

MBMG, 1984. Unpublished benthic sampling data for Silver Bow Creek from the Montana Bureau of Mines and Geology.

MBMG, 1987. Unpublished benthic sampling data for Silver Bow Creek from the Montana Bureau of Mines and Geology.

MBMG, 2002. Sediment reports prepared by Peter Norbeck of Montana Bureau Mines and Geology for Montana DEQ.

MBMG, 2003a. Sediment reports prepared by Peter Norbeck of Montana Bureau Mines and Geology for Montana DEQ.

MBMG, 2003b. Streamside Tailings Radioactivity Study, Final Report, Task Order 21, prepared by Peter Norbeck of Montana Bureau of Mines and Geology, November 2003.

McGuire, D.L. 1997. Clark Fork River macroinvertebrate community biointegrity: 1995 assessments. Report prepared for: Montana DEQ, Planning, Prevention and Assistance Division, Helena, MT.

McGuire, D.L. 2001. Clark Fork River macroinvertebrate community biointegrity: 2000 assessments. Report prepared for Montana DEQ, Planning, Prevention and Assistance Division, Helena, MT.

McGuire, D.L. and E. Weber, 1997. Aquatic biological monitoring in German Gulch below the Beal Mountain Mine during 1996. Report prepared for Beal Mountain Mining, Inc., Anaconda, MT.

McGuire, D.L. and E. Weber, 2000. Aquatic biological monitoring in German Gulch below the Beal Mountain Mine during 1999. Report prepared for Beal Mountain Mining, Inc., Anaconda, MT.

MEI, Inc., 1997. Channel Stability Analysis: Silver Bow3 Creek SSTOU Subarea 1. Report prepared for Montana DEQ, Helena, MT.

MFISH, 2003. Montana Fisheries Information System. On-line database application accessible at http://maps2.nris.mt.gov/wis/mfishapp/Intro2002.html.

Montana DEQ and US EPA, 1995. Record of Decision, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area, National Priorities List Site, Silver Bow and Deer Lodge Counties, Montana.

Montana DEQ, 1997. CECRA Priority List Summary for the Stauffer Chemical Company facility, Silver Bow County, Montana. http://www.deq.mt.gov/Rem/hwc/Srs/Site_Summaries/CECRA/STCC.pdf.

Montana DEQ and US EPA, 1998. Explanation of Significant Differences, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area (original Portion), National Priorities List Site, Silver Bow and Deer Lodge Counties, Montana.

Montana DEQ, 2001: Silver Bow Generation Plant Draft Environmental Impact Statement, Montana DEQ, Helena, Montana, December, 2001.

Montana DEQ, 2002a. Montana Numeric Water Quality Standards. Montana Dept. of Environmental Quality Circular WQB-7, Helena, Montana.

Montana DEQ, 2002b. SCD/BUD (Sufficient Credible Data/Beneficial Use Determination) 303(d) Listing Reports. Available at: http://nris.mt.gov/wis/environet/2002_303dhome.html.

Montana DEQ and NRDP, 2004. Comprehensive Long-term Monitoring Plan for Silver Bow Creek SSTOU, prepared by Montana DEQ and the Natural Resource Damage Program, January 2004.

Montana FWP, 1984. Aquatic evaluation and instream flow recommendations for selected reaches of German Gulch Creek, Silver Bow County, Montana; December 1984. Helena, Montana.

Montana FWP, 2003a. Information exchanged at a September, 2003, meeting between Montana FWP fish and wildlife biologists, NRDP, and consultants.

Montana FWP, 2003b. Norton Creek Westslope Cutthroat Trout Restoration Project. Environmental Assessment. Montana FWP, Helena, Montana.

Montana FWP, 2004. Unpublished Ungulate Winter Aerial Survey GIS data provided to NRDP by Dan Hook, formerly of Montana FWP.

Montana Resources, 2000. Unpublished water balance diagram outlining fate and transport of water throughout the Butte area mining operations. Distributed to participants on a tour of the Horseshoe Bend water treatment facility. October, 2003.

Mullen, G., 2003. Observations made by Greg Mullen of the Montana Natural Resource Damage Program, March, 2003.

NRCS, 2003. Unpublished digital soils data for Deer Lodge County, Montana.

NRDP, 1995a. Aquatic Resources Injury Assessment Report, Upper Clark Fork River Basin. State of Montana Natural Resource Damage Litigation Program.

NRDP, 1995b. Terrestrial Resources Injury Assessment Report, Upper Clark Fork River Basin. State of Montana Natural Resource Damage Litigation Program.

NRDP, 1995c. Anaconda Groundwater Injury Assessment Report, Deer Lodge Valley, Montana, prepared by Dr. William Woessner of the University of Montana.

NRDP, 1995d. State of Montana Restoration Determination Plan for the Upper Clark Fork River Basin. State of Montana Natural Resource Damage Litigation Program.

NRDP, 2002a. Upper Clark Fork River Basin Plan Procedures and Criteria. Montana Natural Resource Damage Program, Helena MT. March 2002. http://doj.mt.gov/lands/naturalresource/resources/grantprocess/ucfrbrestorationplanprocedures.pdf

NRDP, 2002b. Restoration Plan for the Mount Haggin, Stucky Ridge, and Smelter Hill Injured Areas. Montana Natural Resource Damage Program, Helena, MT.

NRDP, 2002c. Ecological Restoration Plan for the Stucky Ridge and Smelter Hill Injured Areas. Montana Natural Resource Damage Program, Helena, MT.

NRDP, 2002d. Ecological Restoration Plan for the Mount Haggin Injured Area. Montana Natural Resource Damage Program, Helena, MT.

NRDP, 2004. Draft UCFRB Restoration Work Plan, prepared by the Natural Resource Damage Program, Helena, MT, September 2004.

Overton, K., McIntryre, J., Armstrong, R., Whitwell, S., and Duncan, K, 1995. User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho. USDA Forest Service Intermountain Research Station General Technical Report INT-GTR-322, August 1995.

Payne, S., 2004a. Information provided regarding low flows in Browns Gulch by Scott Payne of KirkEnvironmental at the July 14, 2004 meeting of the UCFRB Remediation and Restoration Advisory Council meeting, Deer Lodge.

Payne, S., 2004b. Browns Gulch Watershed Project. PowerPoint presentation delivered on January 20, 2004 to the Browns Gulch Watershed Group by Scott Payne of KirkEnvironmental.

Peters, D., 1980. Inventories and Surveys of the Upper Clark Fork River and Blackfoot Drainages, July 1, 1976 to June 30, 1980; March 1980,Western Montana Fishery Investigation. Helena, MT.

Pioneer, 2002. Final Instream Flow Augmentation Pilot Demonstration Project, 1998-2002, Summary Report, prepared by Pioneer Technical Services, Inc. for ARCO, December 2002.

Pioneer, 2003. Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site, Final Design Development Report (DDR), Remedial Design, Subarea 4. Prepared for Montana DEQ, Mine Waste Cleanup Bureau and U.S. Environmental Protection Agemcy, Region VIII.

PitWatch, 2005. A semi-annual publication of the Berkeley Pit Public Education Committee, Volume 10, Number 2, dated Fall 2005.

Plantenberg, P., 2002. Conference call between Pat Plantenberg (Montana DEQ), Greg Mullen (NRDP), David Marshall (DTM Consulting, Inc.), and Kevin Harvey (Kevin C. Harvey, Inc.) regarding environmental management issues at the Active Mine Operable Unit, Butte, MT, and the Beal Mountain Mine in German Gulch. November 1, 2002.

Priority Soils Citizen Working Group, 2004. Letter to EPA Remedy Review Board from the Butte Priority Soils Citizen Working Group dated June 14, 2004.

Prodgers, R., 2003. German Gulch Vegetation Assessment for Restoration. Prepared by Rich Prodgers of Bighorn Environmental for the German Gulch Chapter of Trout Unlimited, April 2003.

PRP Group, 2001: BPSOU Silver Bow Creek/Butte Area Superfund Site Phase II Remedial Investigation Report, prepared by BPSOU PRP Group, May 2001.

PTI, 1989. Silver Bow Creek Water Quality and Sediment Sampling Data, Draft Report. PTI Environmental Services, Bellevue, Washington.

Reed, D., 2004. Personal communication from Daryl Reed of Montana DEQ to NRDP. Summary of 5-year Review Data and Metals Loading Analysis for Warm Springs Ponds.

Rhodia, 2005. Community Update, prepared by Rhodia, Inc., dated November 2005.

RHPP Joint Committee, 1993. Regional Historic Preservation Plan for the Anaconda-Butte Heritage Corridor, prepared under the guidance of the Regional Historic Preservation Plan Committee.

Richards, R.P. and N. Miller, 2000. Nutrient status of rivers and streams in Montana. Unpublished document, Montana DEQ, Helena, Montana.

Rieman, B. E., and K. A. Apperson, 1989. Status and analysis of salmonid fisheries: westslope cutthroat trout synopsis and analysis of fishery information Idaho Department of Fish and Game, Boise, ID. Job Performance Report, Project F-73-R-11, Subproject II, Job 1.

Rosgen, D.L., 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

SCS and USFS, 1994. Cooperative River Basin Study, Upper Clark Fork River Storage Sites. Prepared by the USDA Soil Conservation Service and Forest Service in cooperation with the Montana Department of Natural Resources and Conservation and Montana Department of Fish, Wildlife, & Parks.

SENES, 2003: 28 November 2003 letter to Dan Bersanti of Rhodia from Dr. Leo Loew of SENES consultants limited entitled “Review of Streamside Tailings Waste Repository – Final Report.”

Shepard, B., 2003. E-mail communication between Brad Shepard, Montana FWP and other fisheries biologists working in the German Gulch area.

Spoon, R., 2002. Information provided in an e-mail from Ron Spoon, fisheries biologist of Montana FWP Region 3, regarding a meeting held on Sept 10, 2002 covering fisheries issues on German Gulch.

Spoon, R., 2003. Information provided in an e-mail from Ron Spoon, fisheries biologist of Montana FWP Region 3, to Carol Fox, NRDP, September 14, 2003.

Spoon, R., 2004a. A Summary of Fish Sampling in Silver Bow Creek, 2002-2003, prepared by Ron Spoon of Montana FWP Region 3, March 2004.

Spoon, R. 2004b. Information provided in an e-mail from Ron Spoon, fisheries biologist of Montana FWP Region 3, to Carol Fox, NRDP, dated December 3, 2004.

Spoon, R. 2004c. Information provided in a telephone communication between Ron Spoon, fisheries biologist of Montana FWP Region 3 and Carol Fox, NRDP, on December 3, 2004.

Spruell, P. 2004. Letter to Jim Brammer, Forest Fisheries Biologist, Beaverhead-Deerlodge National Forest on westslope cutthroat trout genetics results.

Spruell, P. 2005. Fax to Jim Brammer, Forest Fisheries Biologist, Beaverhead-Deerlodge National Forest on westslope cutthroat trout genetics results dated January 31, 2005.

Stratus, 2002. Reduced Growth of Rainbow Trout Fed a Live Invertebrate Diet pre-Exposed to Metal-Contaminated Sediments Collected from the Clark Fork River Basin, Montana, prepared by Stratus Consulting, Inc. for the Montana NRDP, December 2002.

Thorud, D. B., Brown, G. W., Boyle, B. J., and Ryan, C.M., 2000. Watershed Management in the United States in the 21st Century. USDA Forest Service Proceedings, Rocky Mountain Research Station publication 13:57-64.

Tillman, E.R., 1999. Industrial Facility Closure Investigation Using Risk Analysis. Montana Tech of the University of Montana, Butte, Montana, Masters Thesis for Environmental Engineering.

Tohtz, J., 1992. Survey and Inventory of Coldwater Streams: Upper Clark EPP, October 21, 1991 through June 30, 1992,Statewide Fisheries Investigations. Helena, MT.

Vetter, D., 2004. Information provided in a 2/9/04 phone conversation between Carol Fox of the NRDP and Doug Vetter of URS, consultant for DuPont.

Weber, E.E., 2001. Clark Fork basin periphyton monitoring: An assessment of biological integrity and impairment based on algae associations during August of 2000. Report prepared for: Montana DEQ, Planning, Prevention and Assistance Division, Helena, MT.

WET, 2003. Domestic Well Sampling Program Summary Report and Recommendations Opportunity, Montana. Prepared by Water and Environmental Technologies, LLC for Anaconda–Deer Lodge County.

Williams, J.E., Wood, C.A., and Dombeck, M.P., 1997. Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda, Maryland.

US EPA, 2000. Statutory Five Year Review Report, Silver Bow Creek/Butte Area Superfund Site, Clark Fork River Basin, Montana, With Emphasis on the Warm Springs Ponds Operable Units.

Ziemer, R., 1997. Temporal and Spatial Scales. Pages 80-95 in Williams, J.E., Wood, C.A., and Dombeck, M.P., 1997. Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda, Maryland.

Appendix A Public Participation

Focus Group Participants

Following is a list of the individuals that participated in the focus group meetings held between July 2002 and March 2003.

Focus Group Meeting	***Participant and Affiliations***
Anaconda Government & Economic Development Interests	Jim Davison, Anaconda Local Development
	Milo Manning, Anaconda Environmental Education Institute
	Gene Vuckovich, NRDP Advisory Council
	Susan Blume, Anaconda-Deer Lodge County (ADLC) Planning
	Pete Boyce, ADLC Chief Executive
	David Elias, ADLC County Engineer
Butte Economic Development Interests	Evan Barrett, Butte Local Development Corporation and Project Green
	Jerry Harrington, UCFRB Remediation and Restoration Education Advisory Council
Butte-Silver Bow (BSB) Government	Jon Sesso, BSB Planning
	Tom Tully, BSB GIS
	Matt Vincent, BSB Planning
Conservation & Citizen's Technical Advisory Groups	Carolyn Moore, Citizen's Technical Environmental Committee (CTEC)
	Jill Larson, CTEC
	Joe Griffin, CTEC
	Scott Payne, CTEC and Water Restoration Council of the Upper Clark Fork
	Steve Luebeck, George Grant Chapter of Trout Unlimited
	Byron Mazurek, George Grant Chapter of Trout Unlimited
	Bruce Farling, Montana State Trout Unlimited
	Kathy Hadley, Citizen/Montana Wildlife Federation
	John W. Ray, Citizen/Montana Environmental Information Center
	Matt Clifford, Clark Fork Coalition
Conservation Districts, RC&D and Landowners	Dan Ueland, Landowner
	Don Ueland, Landowner
	Ole Ueland, Landower
	Jane Lewis, Landowner
	Doug Butori, Landowner
	P. T. (Percy) Craddock, Landowner
	W. J. Erickson, Landowner
	Dave Erickson, Landowner
	W. Jack Erickson, Landowner
	Mary Seccombe, Headwaters RC & D
	John Moodry, Mile High Conservation District
Greenway Service District	Dori Skrukrud, BSB Community Development & Greenway Service District (GSD)
	Pam Haxby-Cote', BSB Community Development & GSD
	Milo Manning, GSD Board
	Brian Holland, GSD Board
	Joe Shoemaker, GSD Board
	Joel Gerhart, Pioneer Consulting
	Byron Mazurek, George Grant Chapter of Trout Unlimited
	Lorry Thomas, Anaconda Sportsman Club and GSD Board
	Susan Blume, ADLC and GSD Board
	Larry Cragwick, Skyline Sportsmen and GSD Board
	Rick Griffith, Project Green

Focus Group Meeting	*Participant and Affiliations*
Horse riders Groups	Anaconda Saddle Club (several club members provided information at a 11/07/02 meeting)
	Mile High Backcountry Horsemen (several club members provided information at a 3/20/03 meeting)
OHV User Groups	Mining City Trail Riders (several club members provided information at a 3/5/03 meeting)
Railroads	Bill McCarthy, RARUS and Montana Western Railroad
	Paul McCarthy, RARUS and Montana Western Railroad
Sportsmen Groups	Rick Douglass, area sportsman
	Larry Craigwick, Skyline Sportsmen
	Larry Curran, UCFRB Remediation and Restoration Education Advisory Council
	Chris Marchion, Anaconda Sportsmen
U.S. Environmental Protection Agency (EPA)/Montana Department of Environmental Quality (Montana DEQ)	Ron Bertram – EPA
	Charlie Coleman – EPA
	Scott Brown – EPA
	Joel Chavez – Montana DEQ
	Kevin Kirley – Montana DEQ
	Robin Shropshire – Montana DEQ
	Robert Ray – Montana DEQ
	Pat Plantenberg – Montana DEQ
U.S. Forest Service	Tim La Marr - Beaverhead-Deerlodge National Forest
	Jocelyn Dodge - Beaverhead-Deerlodge National Forest
	Lorraine Clough - Beaverhead-Deerlodge National Forest
	Gary Howard - Beaverhead-Deerlodge National Forest
	Steve Gerdes - Beaverhead-Deerlodge National Forest
State and Federal Fish & Wildlife Managers	Bill Semmens, Montana Dept. of Fish, Wildlife & Parks (Montana FWP)
	Dave Dziak, Montana FWP
	Eric Reiland, Montana FWP
	Wayne Hadley, Montana FWP
	Kriss Douglass, Montana FWP
	Craig Fager, Montana FWP
	Ron Spoon, Montana FWP
	Bill Olsen, U.S. Fish & Wildlife Service

Ad Hoc Committee Participants

The following individuals participated on the Silver Bow Creek watershed Ad Hoc Committee.

Participant	*Affiliation*
Evan Barrett	Butte Local Development Corp.
Pete Boyce	ADLC Planning
Lona Braden	CTEC
Chris Bugni	Skyline Sportsmen
Larry Cragwick	Skyline Sportsmen
Larry Curran	Advisory Council
Jim Davison	Anaconda Local Development Corp.
Jocelyn Dodge	Butte Ranger District, U.S. Forest Service
Kriss Douglass	Montana FWP
Rick Douglass	Montana Tech
Joe Griffin	CTEC
Jerry Harrington	Advisory Council
Pam Haxby-Cote	Comm. Dev. Butte/Silver Bow

Participant	*Affiliation*
Tim La Marr	Butte Ranger District, U.S. Forest Service
Jill Larson	CTEC
Howard Lawson	Sportsman
Milo Manning	Anaconda Environmental Education Institute
Byron Mazurek	George Grant Chapter Trout Unlimited
John Moodry	Butte/Silver Bow Weed District
Scott Payne	CTEC
John Ray	MEIC
Eric Reiland	Montana FWP
Jon Sesso	Butte/Silver Bow
Joe Shoemaker	Greenway Service District Board
Dori Skrukrud	Butte/Silver Bow Community Development &Greenway Service District
Judy Tilman	Headwaters RC & D
Dan Ueland	Landowner
Matt Vincent	Butte/Silver Bow

Focus Group Results

Chapters 4.0 and 5.0 describe the public input process that facilitated collection of local knowledge about natural resource conditions, opportunities and priorities for restoration, and a vision for restoration in the Silver Bow watershed. Data collected at eleven focus group meetings, one public meeting, several Ad Hoc Committee meetings, and nine additional meetings with interested groups and individuals generated a detailed public information database. For each comment received, the database records the following:

- meeting date,
- meeting group,
- commentator(s),
- subject matter,
- applicable planning area,
- type of input (additional contact, concern, information, observation, opinion, priority, question, suggestion), and
- written comment summary.

We then used this database to generate summary tables of public input for each planning area. The public input sections found in Chapter 7.0 report this information. The summary public input information, combined with the information gathered from the data compilation and analysis portions of this projects, then formed the basis of the restoration needs reported in Chapters 7.0 and 8.0. The full public input database is available from the NRDP upon request.

Priorities for Silver Bow Creek Restoration

The public comment database helped summarize the top priorities for restoration identified by the public for each planning area or by focus group. The following paragraphs and table present this information. Global priorities are those shared by multiple groups.

Global Priorities

- Remove and/or reduce contaminant sources
- Restore and protect fishery resources and the tributaries, particularly German Gulch and Browns Gulch
- Address 'other' contaminant sources (nutrients, Beal Mountain, Rhodia, etc.)
- Protect drinking water quality in Basin Creek
- The Greenway: 'Green' Butte and the Anaconda entry corridor; create trails that connect human & natural resources
- Create recreational opportunities in the Butte area
- Preserve current recreational uses for sportsmen, hunters, horse riders, off-highway vehicles (OHVs) and non-motorized trail users.
- Look for land acquisition opportunities and/or conservation easements that would advance the above priorities.

Priorities by Focus Group

The following table lists the top restoration priorities expressed by participants of each focus group.

Group	***Priorities***
Anaconda Government & Economic Development Interests	Strong community desire for aesthetically appealing entryway corridor ('greened')
	Address the impacts from Beal Mine that could undo clean-up in Silver Bow Creek
	The Greenway is a priority, and tributary restoration tied to the Greenway goals is a priority
Butte Economic Development Interests	Preservation of Basin Creek's good water quality
	Greening of Butte is a high priority.
	Need for more recreational opportunities in the urban area, especially for youth and the elderly
Butte Public Meeting	Assure public access to Silver Bow Creek: the Greenway; create trails that connect Butte, Greenway, Thompson Park and the Continental Divide Scenic Trail
	Interpret and manage cultural and historic resources along the entire creek
	Priority for effective remediation and restoration of mining contaminated areas on Butte Hill
	Augment instream flows
Butte-Silver Bow Government	Contaminant source reduction and removal
	Greenway Project (connected to this is protecting the Silver Bow Creek floodplain)
	Tributary improvements that improve the water quality/fishery of Silver Bow Creek
	Protect Durant Canyon
	Address Westside Soils Operable Unit (recreation opportunities/health risks)
Conservation & Citizen's Technical Advisory Groups	Restore Silver Bow Creek and the tributaries (riparian areas and floodplain) for self-sustaining fishery populations—improve water quality, water quantity, and habitat
	Preserve upland habitat
	Protect/enhance native westslope cutthroat trout in German Gulch

Group	*Priorities*
Conservation Districts, RC&D and Landowners	Address noxious weed problems
	Address multitude of problems associated with the Beal Mountain site (adequate reclamation needed, water rights concerns, acquisition needs, weeds, detrimental development)
	Address impacts to landowners from restoration (e.g. weeds, trespass)
Greenway Service District & Economic Development Interests	Greenway is #1 priority
	Think connectivity – tributaries to mainstem; trails that connect humans to natural resources; Butte to Anaconda
	Revegetate (green) Butte: Silver Bow Creek corridor, the Continental Area; the East Ridge
	Remove pollution sources
Horse Riders Groups	Protect/enhance existing uses: Mt. Haggin Wildlife Management Area; Thompson Park; Continental Divide Scenic Trail
	Quiet trails (no all terrain vehicle use)
	Effective weed control needs to be component of all restoration activities on the land.
OHV User Groups	Priority is to maintain the existing OHV use and prevent closure of those areas to OHV use
	Desired access at Pipestone Pass
Railroads	Open to trade lands to benefit the railroads: locomotive facilities, shipping locations; storage areas
	Priority is safety for users of areas near/within railroad corridor
Sportsmen Groups	General priorities appear to be access to recreational lands and acquisition of lands, as possible, to insure access and to protect critical wildlife habitat such as winter range and transition areas for potentially detrimental development. Such areas include lands adjacent to Mt. Haggin Wildlife Management Area, the mouth of German Gulch, Railroad Gulch, Browns Gulch
	Opportunity for fishing near Butte such as pond fishing
EPA/Montana DEQ	This group did not identify specific priorities. Instead, members offered information about natural resource conditions and regulatory issues important to consider in establishing restoration priorities.
USFS	Long-term management/mitigation concerns related to Beal Mountain
	Protect native trout populations in tributaries
	Address sediment runoff problems in Blacktail Creek
	Rehabilitate Thompson Park
	Restore alder/willow communities in riparian areas in Basin Creek
Montana FWP Fish & Wildlife Managers	Address tributaries: Improve both water quality and quantity; address metals and non-metal pollutants
	Eliminate risk of future mining in German Gulch by land acquisition or easements
	Protect/enhance habitat in core fishery populations such as the native westslope cutthroat populations of German Gulch
	Consider long-term management ramifications
	Acquire via fee-title or easements for critical wildlife habitat
	Remove tailings from Silver Bow Creek floodplain and restore natural function of floodplain through connectivity and Revegetation
	Reduce conifer encroachment
Miscellaneous (includes comments from individuals)	A long-term vision is needed for Silver Bow Creek watershed restoration; then establish goals/priorities based on that vision
	Priority to restore westslope cutthroat trout fishery
	Weed problems are widespread and need aggressive management
	Restoration of trout populations in Silver Bow Creek should be a goal
	Removal of tailings in Silver Bow Creek is a priority

Group	Priorities
	Existing native fishery resources in German Gulch should be protected
	Beal Mountain is a serious cause for concern—today and in the future
	Acquire water rights along Silver Bow Creek and tributaries
	Maintaining viable trout populations in tributaries is key to reestablishment of fishery

Butte Area Citizens Meeting, December 2003

In late 2003, the EPA hired a facilitator to organize a citizen's working group (Butte Priority Soils Superfund Citizens' Working Group) to provide local input on the upcoming proposed plan for remediation of the Butte Priority Soils Operable Unit. In June 2004, this group developed a vision, guiding principles, and long-term goals for the BPSOU, and comments specific to certain sites or groups of sites within this operable unit. We have included their final product in this Appendix since the public input obtained via this process covers many issues pertinent to public concerns and priorities for the Butte Sub-watershed and Silver Bow Creek planning areas addressed in the *Silver Bow Creek Watershed Restoration Plan*.

June 14, 2004
To the Environmental Protection Agency (EPA) Remedy Review Board:

Please consider this document as the Butte Priority Soils Superfund Site Citizens' Working Group's comments and recommendations regarding the development of EPA's draft Proposed Plan for the Butte Priority Soils Operable Unit (BPSOU).

At the headwaters of Silver Bow Creek and the Clark Fork River in the BPSOU, huge volumes of waste are left in place and are a direct threat to human health. Leaving large amounts of waste in place, regardless of remedy, may not effectively protect human health. In addition, caps are not capable of sustaining woody vegetation and especially in drainage bottoms and on some slopes, caps will require unrealistic institutional controls, restrictive covenants, and costly repairs forever.

Silver Bow Creek and the Clark Fork River need to be permanently protected from future release of BPSOU metal contamination. Remediation and restoration are combining to great benefit on Silver Bow Creek and at the confluence of the Blackfoot River and the Clark Fork River at Milltown. Remedies at these two sites will be self-sustaining with minimal institutional controls. Anticipated BPSOU remedies emphasize leaving waste in place. Those remedies are in stark contrast because they are only minimally self-sustaining and recontamination in the Hill, as well as down-stream sites, is likely.

In BPSOU: (1) Waste piles in Butte are steep, are next to houses, and are near roads. Children play on them; dogs dig into them; and motorbikes and ATV's ride across them. (2) Butte topography is very much like that in San Francisco, except we have a large volume of mine, mill and smelter waste in residential districts that present significant health consequences from multiple pathways. (3) We are in a semiarid environment that has recorded storms which far exceed the design criteria for the reconstructed hillslopes and storm water conveyance systems.

We believe that both our products (cited in the following section) and those of the Superfund legislation (the Nine Superfund Evaluation Criteria and EPA's goal of making the site clean and free of contamination) are consistent. Both seek a post remediation vision of BPSOU as clean, healthful for humans, and vibrant. Both seek a permanent remedy. Both have the goal of promoting public health and a clean environment. Both Superfund and the Citizen's Advisory Group seek a reduction of toxics and a minimum use of institutional controls and restrictive covenants. Both are adverse to reliance on a waste-in-place solution. Both seek consideration of future productive land uses to affect the final remedy selection. Both are concerned with environmental justice. Both want a meaningful role for public participation. Both see cost as secondary to protecting human health and the environment.

The final selected remedies for BPSOU should be congruent with the vision, guiding principles, and goals we have articulated. We believe the community will judge the adequacy of the Proposed Plan in those terms. Thank you for considering our comments and recommendations.

Vision

Upon completion of comprehensive remediation and restoration, Butte, as headwaters of the Columbia River, will be a healthy and environmentally safe place where people want to live, raise a family, work, invest, and recreate. Butte citizens deserve, expect, and assume responsibility for their part in attaining good public health and well being, a strong, diverse and sustainable economy, new and improved recreational opportunities, preservation of their history and culture, and an attractive community.

Guiding Principles

We believe:

- Protecting human health and the environment is the highest priority and that people in Butte should be able to expect health statistics similar to areas not impacted by toxic waste.
- Remedies must be evaluated for their human health and ecological impacts on the entire Columbia River system.
- A preventative, pro-active human health approach must be emphasized and monitoring of human health and the environment must be performed in perpetuity.
- In continued citizen involvement with maximum local control.
- Economic and community development should be based on local, existing expertise and the desire of locals to invest and develop.
- Remedies and restoration should guarantee future productive land use.
- Reclaimed sites should be self-sustaining, low maintenance, and highlight diverse native re-vegetation.
- Emphasis should be placed on removal and treatment of waste.
- Institutional Controls (IC's) should be used when removal and treatment are technically impracticable or when IC's can be tools to achieve long-term community vision and goals.
- Remedial and restoration activities should be conducted in such a manner as to cause no harm to the citizenry, but if such harm does occur, resources should be provided to compensate those who suffer environmental damage.

Long Term Goals

Through appropriate remedial and restoration actions:

1. Apply a proactive, preventative, comprehensive approach to eliminate the sources of contamination identified as contributing to chronic and acute health problems.
   Recognize health impacts identified in recent data, establish a data-driven health baseline, and assure measurable, ongoing improvements.
   Complete the cleanup within 5 years in order to eliminate the stigma and lingering myths about Butte and Superfund, with end the result being that Butte is considered one of the "most livable communities" in the Country.
   Assure that remedial and restoration actions are conducted in such a manner that no segment of the community suffers a disproportionate economic or environmental hardship.
2. Assure funds and resources are available for long term monitoring of public health as well as testing of residential yards, indoor dust, and attic dust.
3. Assure that the Record of Decision is consistent with the Community's land use plans.
4. Guarantee permanent funds that insure against failure of remedy components and insure against future contamination release from wastes left in place.
5. Guarantee permanent funds that allow for future remedy re-design and/or waste removals and adequately provide for long term Operations and Maintenance of all selected remedies.
6. Pursuant to the mandates of the Superfund Redevelopment Initiative and the Superfund Land Revitalization Initiative and Action Agenda, assure that remediation and restoration are linked to the maximum allowable extent.
7. Assure that remediation and restoration dollars are spent/used efficiently with maximum benefit to community vision and goals (e.g., Silver Bow Creek, Milltown).
8. Assure that caps are stable and effective with natural, sustainable vegetation and bio-diversity.

Comments and Recommendations Related To Health Issues

We recommend establishment of a current, data-driven community health baseline done by an independent entity, and that the baseline directs a comprehensive approach to remedy decisions. We believe that the original Human Health Risk Assessment is insufficient and that remedy selection cannot be based on a fatally flawed Human Health Risk Assessment. New and more comprehensive survey data (Imagine Butte Health Information for Program Design Health Survey, Spring 2004; National Cancer Institute – State Cancer Profiles, 1998-2000 data) concerning residents living within BPSOU indicate that they exhibit a pattern of illness and significantly higher levels of serious conditions than national averages. For example, the lack of any information about trivalent or inorganic arsenic (characteristically found in copper smelting activities and measured in Butte) in the original Assessment resulted in an inadequate picture of human health risks and consequently, no action strategies related to this particularly poisonous toxin.

Comments and Recommendations Related To Specific Sites or Groups of Sites

Criteria used by the Working Group for determining if a remedy for a particular site or group of sites is problematic within the Butte Priority Soils Superfund area

- Remedies should permanently protect individual human and community health.
- Remedies should not have potential detriment to the local economy; not have negative impacts visually; and not be a barrier to accomplishing community vision and goals.
- The remedy should favor permanence over perpetual maintenance to the extent possible (recognizing that cleanup will not occur overnight and that maintenance and Institutional Controls in some situations, are necessary).
- Remedies should maximize protection of the watershed and improvement of surface and groundwater quality in the BPSOU.

Specific sites or groups of sites the Working Group identified as problematic in achieving the community's vision and/or leaving waste in place, and suggested alternative approaches

Missoula Gulch/Buffalo Gulch – The current remedy in Missoula Gulch is a start, but to fulfill the vision that this Working Group has outlined, the Gulch should look more natural, with rock and vegetation to slow storm flow. It goes beyond "looks" and needs to be permanent. The concrete ditches in upper Missoula Gulch and Buffalo Gulch were not adequately designed to handle reasonably projectable volumes and velocities of storm water in steep gulches. A big "gully washer" will overshoot, undermine, and erode the channels outside of the concrete thalweg ditches. A superior approach to runoff would include:

- Planting the gulch bottoms with aspen, alder, cottonwood and willows.
- Constructing the channel from large rocks/deadfall to a more naturalized stream bed.
- Creating a reclaimed gulch that becomes an asset and attractive feature to the community while achieving the desired erosion and runoff controls

The appearance of the ditches is contrary to our vision and long-term goals to require the cleaned-up Hill to be aesthetically pleasing, and for open space to appear natural. It also presents a distinct disincentive to economic development because of appearance alone. Our group has emphasized aesthetics wisely and it is future generations that will assume responsibility for maintaining controls and avoiding problems to the Clark Fork River. The ditches, as big as they are, are only designed to handle a 10-year event. This means that storm events above that threshold will overflow the Buffalo Ditch to Silver Bow Creek and the Clark Fork River. If the sites upstream of the Buffalo Ditch are not redesigned and reconstructed, we will not have sufficiently protected downstream reaches and the tremendous investments that have been made in cleaning and restoring them. Finally, the Buffalo Ditch is simply allowing for a lower standard for cleanup upstream of the ditch because the ditch is there to prevent contaminated runoff from reaching Silver Bow Creek and the Clark Fork River. An economically reasonable alternative would be to clean sites upstream of the Buffalo Ditch to a level that will allow the elimination of the ditch. This will eliminate one of the most glaringly offensive aesthetic remnants of the past remedial actions and allow the community to achieve an attractive site that is both protective of human health and the environment.

Railroad Slope Foundations (EPA RR TCRA, 2000-2001) – The cellular confinement geo-textile materials used to stabilize steep RR side slopes throughout Butte are not an acceptable long-term remedy. These “polyethylene honeycomb” devices were filled or covered with approximately 6 inches of crushed rock (≥1.5 inch). After only three years, the rocks have continued to gravity settle, and have sloughed so that significant areas of the honeycomb structures are clearly visible. These sites will require continuing and repeated long-term maintenance. The failing confinements are not protective of human health or the environment. No vegetation has been or will be established. The sites are aesthetically displeasing. Where room permits, the toe of the RR foundations should be extended to an approximate slope of 3:1, if possible. These slopes should then be backfilled and re-vegetated. Where a 3:1 slope can not be achieved, the honeycomb structures should be filled with soils and re-vegetated. This approach was successfully used on one stretch of RR slopes during the 2001 RR TCRA. This single site now appears to be stable, protective, vegetated, green and aesthetically pleasing. If it can be used successfully at one site it can, and should be used at the remaining sites.

Lexington Mine/Walkerville baseball field (Lexington Terrace, Gray Rock Mines, Corra Mines, Moose Mine, Valdemere Mine, Magna Charta Mine, and Mountain Consolidated Mine) – Lexington Mine and the old Walkerville baseball field were used as waste repositories in 1988. Problems with these areas include waste left in place, areas as yet reclaimed, and/or waste re-deposited in these areas resulting in contaminant threats to the surrounding residences and downstream where surface water drains into residences and the Missoula and Buffalo Gulch Drainage’s. Waste needs to be stabilized or removed and the sites re-contoured and vegetated.

Timber Butte Mill Site – When the area was cleaned up in the eighties, the toxic waste was collected and moved to a pile on the easternmost portion of the site, capped, and fenced. If this cap fails, toxic materials will move downhill into a residential area about 100 yards North of the capped dump. An alternative is to remove the cap and the waste, re-plant, and turn the property back into productive use.

Tullamore Subdivision – At a recent neighborhood meeting, a homeowner reported fears that the reclaimed areas seeded with grasses present a fire hazard as the dry summer months approach, and that there is a present danger to homes existing next to these dry grassy areas. Species should be planted that don’t tend to dry out so much where homes are present, or irrigation should be considered as a fire preventative in those areas. In addition, attendees at neighborhood meetings representing citizens of BPSOU in Census Tract 1, mentioned health concerns related to "source areas" on the hill that are actually vacant lots scattered throughout residential neighborhoods, left unreclaimed through the Superfund period. Children use the lots as informal play areas, yet none are posted for toxics or heavy metals concerns, nor are they routinely fenced for safety of children. Children playing on the areas have reported getting sores on their legs, asthma, severe allergies and stomach problems. To meet the community's vision, it is hoped that areas affecting children and residents will get utmost priority in action planning for the clean-up, including measurement and posting of all areas that are in proximity to residential areas throughout BPSOU.

Mountain Consolidated, Bell Diamond, Grayrock and sites to the north – These are areas that should be fully evaluated for potential impact on soil and water quality in the Operable Unit and beyond. The preferred remedy is for the dumps to be removed and the land contoured and seeded, rather than capped. Significant volumes of mine waste should not be left as interpretive features. However some smaller features could be used to enhance the landscape and focus attention (e.g., some of the large manganese boulders near the Moose dump).

Railroad Walking Trail – The Railroad Walking Trail brings citizens and animals into proximity with the caps along the trail including young adults, children, and domestic animals disturbing the integrity of the caps. Steeply sloping embankments are being traversed year-round, causing the death of grasses and increased erosion. This situation needs to be corrected. The whole idea of using caps and their accompanying institutional controls is to remove people from the toxic wastes. Given that the trails are bringing people to the capped areas, the integrity of the caps is threatened. These wastes should either be removed or the caps should be fortified to an extent that will allow intensive use of the grounds. Removal of capped waste from the steeply sloping embankments would best protect these extremely vulnerable sites and their neighboring yards.

The Parrot Tailings/Upper Silver Bow Creek and Metro Storm Drain (MSD) – The contaminated soils are literally at the headwaters of the Columbia River and the MSD focused Feasibility Study (appearing as an appendix to the main study) is thoroughly unconvincing in its dismissal of the groundwater and surface water contamination problems. Groundwater quality is being severely degraded by interaction of these highly contaminated, metal-laden, acidic sediments with percolating rain water and laterally migrating groundwater. Soil and water samples shows that the Parrot Tailings area is one of the areas of the worst contamination in the Butte area. These mine, mill, and smelter wastes have been positively identified as the primary source of contamination to groundwater under the Butte Valley. The large majority of mill tailings, mine waste rock, smelter slag and other contaminants are readily accessible for removal, and should be removed. We strongly recommend removal of the tailings, slag, and waste rock in the: (a) Butte Shops and neighboring areas, up to the railgrade, so as to remove the contaminants outside of the Berkeley Pit cone of depression, and (b) in the areas between Harrison and Kaw Avenues (Diggings areas and others) where additional volumes of mine, mill and smelter waste materials have been deposited. Based upon valid and scientifically defensible data recently collected by the Montana Bureau of Mines and Geology (MBMG), it is projected that the aquifer beneath the MSD channel will reach beneficial use standards within several decades, providing that the maximum volumes of source contaminant materials (i.e., the Parrot Tailings and others) are removed from the MSD channel. There is zero chance for restoration of the aquifer if the contaminated sediments are left in place. The anticipated conventional water treatment plant for treating MSD groundwaters could conceivably cease operations within 20-50 years, as opposed to the anticipated perpetual operations which will be required if the mine, mill and smelter wastes are left in place.

Removal of the contaminated mine, mill and smelter wastes can be attained by excavating the floodplain areas (Diggings east and west, etc.) and the part of Parrot Tailings proper that is west and south of the railroad grade. Most of these areas have little infrastructure, other than the City–County Shop complex. Stipulations and funding need to be in place to fund the inventory and removal of contaminated wastes from beneath buildings when those buildings are torn down, replaced, or when the areas are excavated for any reason. EPA's projected costs for removal of the MSD wastes can be significantly reduced by requiring haul trucks to use a route to the proposed repository that proceeds around the east side of the Berkeley Pit. This solution also completely eliminates all traffic safety concerns and damage to the County streets. Significant additional cost savings can be realized by siting a new repository at a lower elevation, which is closer to the MSD channel. We are aware there may be scientific discrepancies in the interpretation of hydro-geochemical data from the MSD. In the event the EPA recognizes the validity of these interpretive discrepancies, this Working Group strongly recommends the EPA take the most environmentally protective course of action and require removal of mine, mill and smelter wastes from the MSD channel. If the wastes are left in place, the aquifer will be perpetually contaminated and mechanical water treatment will be required in perpetuity. If, however, the wastes are removed from the channel, we believe, based on scientific data from the MBMG, that the aquifer will eventually attain maximum beneficial use in a relatively short time frame. In that case, conventional water treatment could be terminated in as little as 20 or 30 years and the citizens of Butte can then enjoy the use of the MSD aquifer resources. In the event of scientific, technical discrepancies and/or uncertainties, the EPA should mandate the course of action that is most protective of human health and the environment in the context of perpetuity. Remove the mine wastes, mill tailings and smelter slags from the MSD channel.

Butte Reduction Works / Lower Area One (LAO) – A significant quantity of material was left behind, is not covered by infrastructure or the historic slag walls, and to the maximum practicable extent, should be removed to a repository. This area has not been significantly reclaimed and is being used as a sediment pond in the lower portion of Missoula Gulch. Sparse vegetation in the area, possibly due to contamination, allows significant dust production when the area dries out. The significant quantity of contaminated sediments left in this area should be removed. For some unexplained reason, removal of mill tailings was stopped arbitrarily in this area. Allowing water to percolate through the sediment contributes to contamination of the shallow aquifer and ultimately to Silver Bow Creek. This area is part of the BPSOU and removal of tailings at the areas where waste material is accessible should take place. The fact that there is little infrastructure in the area makes completion of the cleanup an obvious next step. Maximum practicable removal of mine, mill and smelter wastes in this area will accelerate recovery of the groundwater aquifer and allow this current wasteland to re-vegetate and improve wildlife habitats, while continuing to temporarily act as a storm water runoff pond.

The fact, however, is that the treatment ponds remain an eyesore on the doorstep to Butte. The function, capacity, aesthetics, longevity and impact to downstream receptors will remain a concern as long as the ponds are present. Proposed actions suggesting that the ponds can be aesthetically enhanced through the introduction of wetlands plant species is insufficient, as it is feared that the ponds will remain an eyesore as long as they are present. This provides no guaranteed solution to the concerns of function, capacity, longevity and impact to downstream receptors. We suggest that the ultimate solution for the treatment ponds at LAO is to remove the storm water/groundwater treatment aspects of the ponds and develop the area into a natural looking wetlands habitat. A conventional plant to be located near LAO would replace the treatment ponds or water could be pumped or piped to the existing Horseshoe Bend treatment plant.

Granite Mountain Memorial Site and area along Alexander Street between Main Street and the Memorial (Atlantic, Josephine and Sister dumps) – The aforementioned mine dumps are an aesthetic negative when it comes to tourism to the Granite Mountain Memorial Site, an important area for tourism-related economic development. As exposed mine dumps, they also pose a potential health threat related to leaching, erosion, and dust. Other mine dumps inside the Granite Mountain Memorial area itself may pose the same health risk, though they are part of an agreement to leave them exposed in exchange for land and funds. Alternatives approaches include:

- Clean up these dumps (Atlantic, Josephine, and Sister), contour them, vegetate so the aesthetics of the road to the GMM are conducive to heavy tourism traffic (this is especially valid since there are extensive opportunities to view dumps from the Memorial itself).
- Remediate the dump sites within the GMM area itself if air monitoring shows health dangers from leaving them exposed.
- Pave Alexander Street from Main St. to the GMM and back as a cap on exposed soil, facilitating the tourism potential of the GMM.

All Mine Yards – All mine yards throughout the BPSOU need to be reclaimed to insure community and human health, while retaining their historical value as a secondary goal. Mine dumps and tailings must be remediated for the benefit of health, safety and the environment as the primary focus.

General Comments on Caps – The capped sites that are vegetated with only a few species of grasses do not meet the communities' clear preference for a mixed grass/shrub/forest landscape. Additionally, these sites do not meet the State of Montana's ARAR for sustainable, native biodiversity. Although erosion problems may not be evident over the short term, intensive maintenance actions have already been required to repair damage from runoff events that have had less than 2-year recurrence intervals.

Unreclaimed sites with contaminated soils (generally referred to as "source areas" in the Butte–Silver Bow plan) should be cleaned up. These sites may include soils that are below the lead and arsenic thresholds that have been used by EPA to direct previous stabilization actions. However, these sites may have elevated levels of copper and zinc, among other metals, that severely impact aquatic life when runoff enters stream systems. It is unprotective of human health and the environment for the Agency to take the position that large volumes of exposed mine, mill and smelter wastes are acceptable as long as the discharges to the Creek are "within standards". These unreclaimed sites must be addressed and remediated. Local removal of significant amounts of waste rock may be necessary so development and re-vegetation can take place. Localized areas of deep-rooted vegetation would help to stabilize slopes over the long term and tend to reduce infiltration and discharge of highly contaminated shallow groundwater to the storm water system. Success of the capping of waste rock piles and other contaminants on the hill requires that vegetation be continually maintained so sediment is not allowed to leave capped areas. The caps must be continually maintained and improved. Additionally, a rigorous system that will provide maintenance, if not partial reconstruction, of the caps in perpetuity must be in place. This system must be funded so that unforeseen contingencies can be dealt with if needed. Because of the lack of significant runoff events in the time that the caps have been in place, maintenance and improvements in the caps may require significant expenditures in the future.

Quantitative measurements of erosion rates, periodic geo-chemical sampling of sediment and water leaving the caps, and rethinking of hillslope geometry's and vegetation mixes should be expected in the next 5-50 years. Significant local removal may be necessary in order to stabilize the caps. Areas that have not been capped and have soils that cannot support self-regenerating native vegetative covers should be inventoried, stabilized, and monitored. Either removal of acid generating sediments or capping of the sites may be required.

Indoor/Attic Dust – Indoor/attic dust related to mining activities is widespread and remains untreated; little is know about the true nature and extent of the dust. The dust may also be a significant cause of the distinct health issues (and numbers of cases involving these health issues) recently documented in Butte. Currently, insufficient data are available to appropriately select remedies for this material. The human health risk assessment that was prepared in response to the indoor/attic dust is also inadequate. A reexamination of available data and a detailed on-the-ground assessment to determine the nature and extent of the indoor/attic dust is critical. A detailed evaluation of this data will either contradict or support the proposed cleanup actions, allowing for preparation of a proper human health risk assessment and a consistent application of appropriate cleanup remedies.

The following people participated as members of the BPSOU Citizens' Working Group during the past six months:

Mark W. Ahlborn
Evan Barrett
Chris Brick
Bob Corbett
Kriss Douglass
George Everett
Jim Griffin
Carl Hafer
Ristene Hall
Bernard Harrington
Jerry Harrington
Jill Larson
Tom Madrazo
Tom Malloy
Barbara Miller
John W. Ray
Colleen Schulte
Larry Smith
Matt Vincent

Appendix B GIS Data

The development of a project GIS was critical to collect, manage, analyze, and report on the vast amount of available data. The Montana Natural Resource Information System (NRIS), Montana NRDP, Butte-Silver Bow GIS Department, Montana FWP, Montana DEQ, Montana DNRC, Montana Department of Transportation, Montana Tech, U.S. Forest Service, NRCS, USGS, Pioneer Technical Services, and others provided data for this effort. The table below lists many of the data sources, which are also catalogued in the reference library database described in Section 4.2.

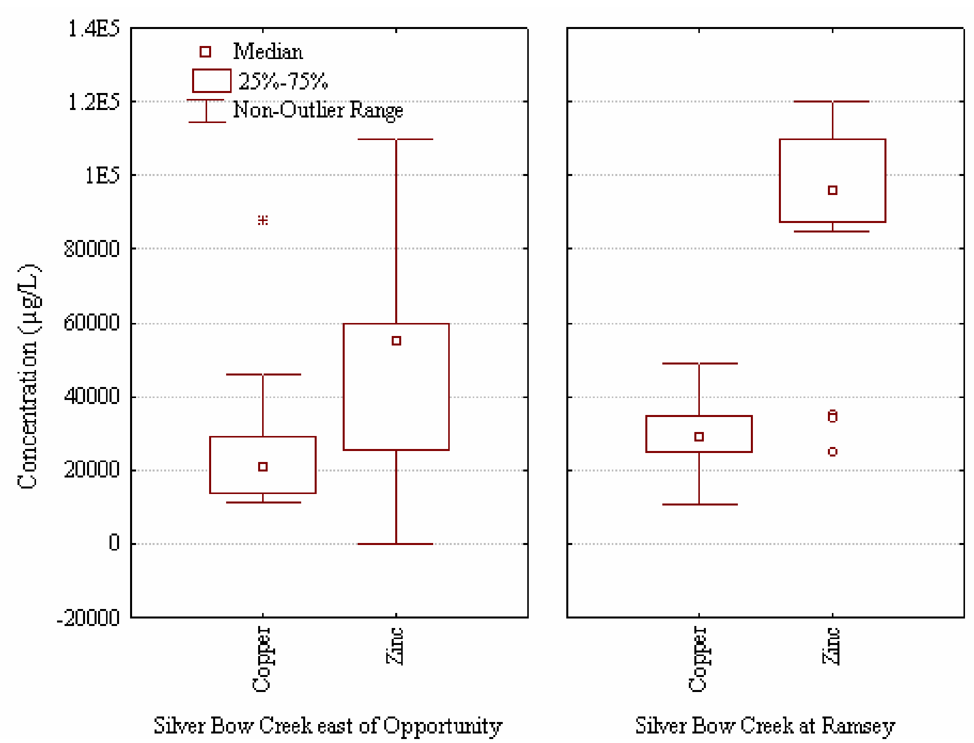
Category	***Data***
Anaconda Municipal	Contours
Anaconda Municipal	Buildings
Anaconda Municipal	Fence
Anaconda Municipal	Water
Anaconda Municipal	Trees
Anaconda Municipal	Roads
Anaconda Municipal	Trails
Base Map	Digital orthophoto quarter quadrangles
Base Map	Digital USGS 24 K topos
Base Map	Digital Elevation Model
Base Map	Low resolution (30m) Landsat color satellite imagery
Boundaries	Counties
Boundaries	Townships
Boundaries	Sections
Butte Municipal	Water
Butte Municipal	Trails
Butte Municipal	Roads
Butte Municipal	Buildings
Butte Municipal	Contours
Butte Municipal	Fence
Butte Municipal	Poles
Butte Municipal	Trees
Climate	PRISM climatic data
Fish	Montana FWP statewide fish distribution data
Fish	Montana FWP angler use data
Fish	FWP fisheries inventory
Geology	MBMG and USGS geologic mapping,
Geology	Geology: 250K, detailed Butte, faults and veins
Hydrology	USGS hydrologic data
Infrastructure	Roads
Infrastructure	Railroads
Infrastructure	Power lines
Land Ownership	Montana Natural Resource Information System (NRIS) land ownership
Land Ownership	Montana Dept. of Revenue parcels data
People	Population density
People	Tax roll data
People	Geographic Names Information System
People	Census data

Category	***Data***
Pollution	Operable Unit Boundaries
Pollution	Active Mine features
Pollution	Mine Flooding Study
Pollution	Mine Tailings
Pollution	Storm Sewers
Pollution	Drainage Basins
Pollution	Groundwater
Pollution	Mill sites
Pollution	Reclaimed Areas
Recreation	Hunting districts: Antelope, deer, elk, moose, sheep, goat
Soils	NRCS soils database (Deerlodge County only)
Soils	USFS R1 Land type associations
Topography	USGS digital elevation data (NED and SRTM)
Vegetation	USGS GAP vegetation data
Vegetation	USGS National Land Cover Database (NLCD)
Vegetation	Montana Noxious Weed Trust Fund weed distribution data
Vegetation	USFS and Butte-Silver Bow Weed District noxious weed mapping
Water	Water wells
Water	Streams
Water	USGS Gaging Stations and Gage Data
Water	4th, 5th, and 6th level HUC watershed boundaries
Water	Lakes
Water Quality	Ground Water Information Center (GWIC) well and water quality data
Water Quality	STORET Water Quality
Water Quality	USGS Water Quality
Water Quality	Tri-State Water Council Summary Data
Water Rights	Water Rights (DNRC database)
Wildlife	Montana FWP statewide wildlife habitat and winter range
Wildlife	Montana FWP aerial wildlife assessment
Wildlife	Miscellaneous data layers from NRIS
Wildlife	Miscellaneous data layers from the Butte-Silver Bow GIS Department
Wildlife	Water quality information from STORET, MBMG, and Tri-State Water Quality Council
Wildlife	Predicted Wildlife Habitats: Elk, deer, moose, antelope, sheep, goat, otter, mink
Wildlife	Wildlife winter ranges (Dan Hook)
Wildlife	Elk sightings (Dan Hook)

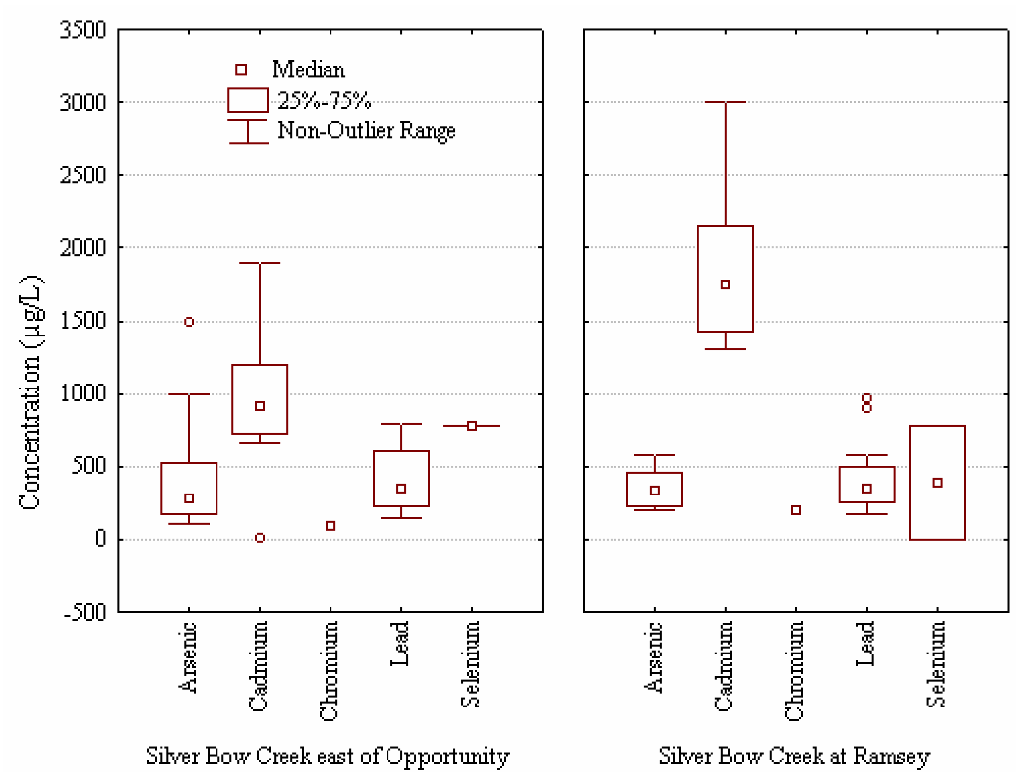
Appendix C Water Quality Sampling

Water quality data for the Silver Bow Creek watershed are available in the STORET database maintained by the EPA and a database developed by the Tri-State Water Quality Council. The following graphics present distributional statistics for these data in the box and whisker graph format, a standard representation of water quality data. The boxes provide values withi the 25th and 75th percentiles while the median value is the smaller box within this range. The non-outlier range represents values that fall within the upper and lower outlier limits, which are statistically derived values. Outliers and extremes are atypical, infrequent observations; data points which do not appear to follow the characteristic distribution of the rest of the data. These graphs include these atypical observations because despite their relative rarity among the available data, they may represent conditions with considerable ecological significance. Sample locations are on Figure 7-2.

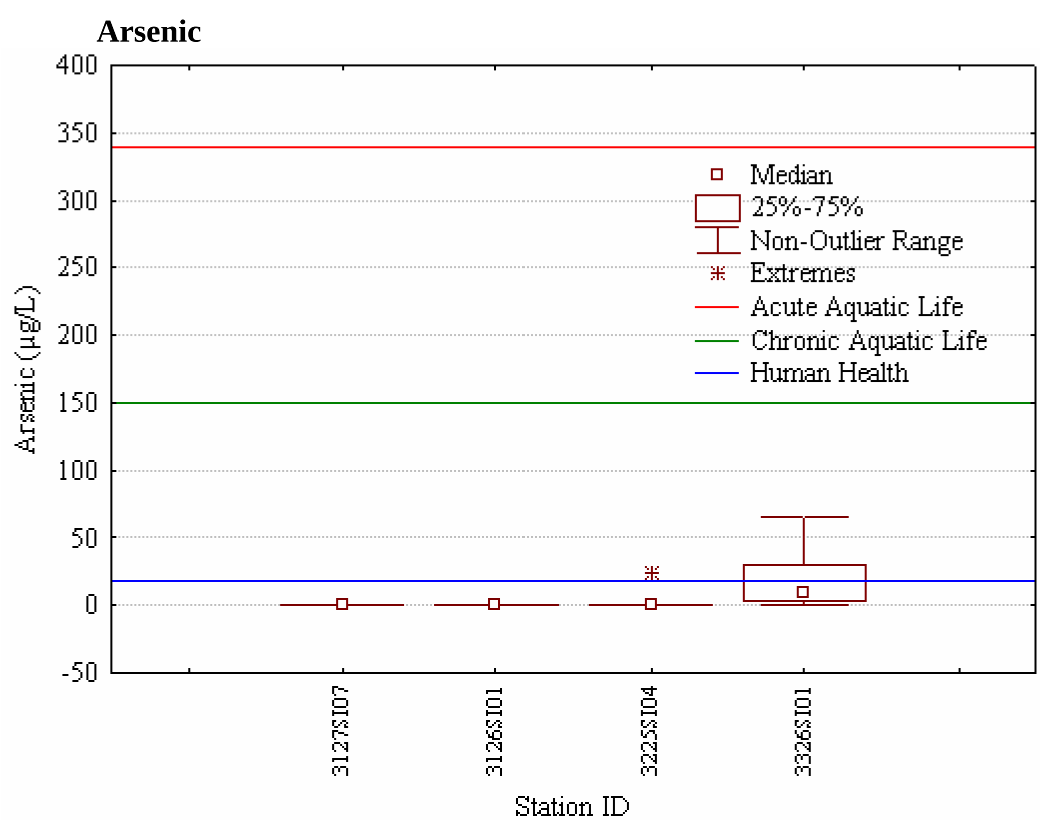
Metals and Arsenic Sampling, Silver Bow Creek



Copper and zinc concentrations, Silver Bow Creek (Stations 293028 and 293035) 1970-1971.

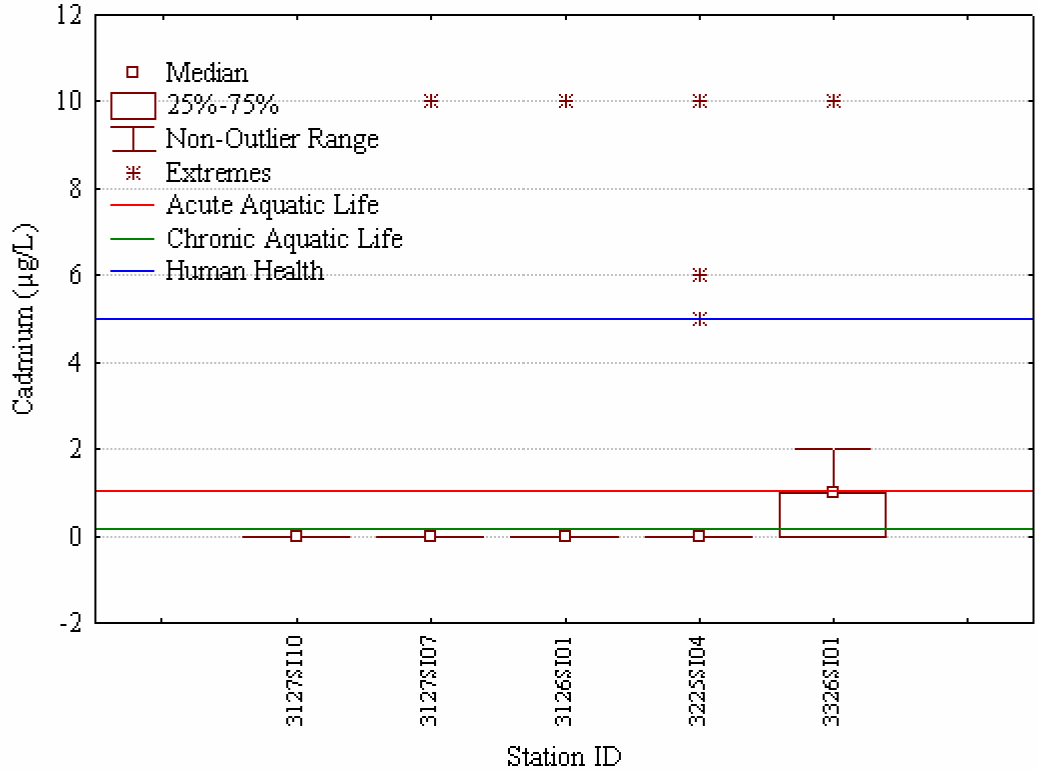


Metals and arsenic concentrations, Silver Bow Creek (Stations 293027 and 293035), 1970-1971.



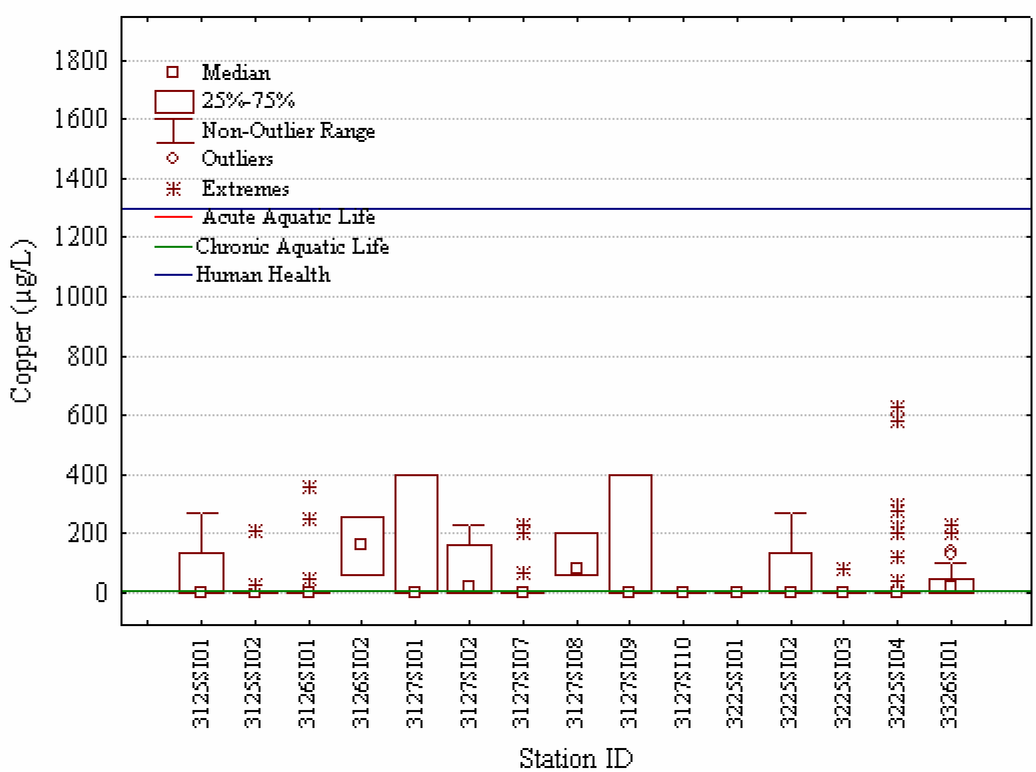
Arsenic concentrations measured on Silver Bow Creek (STORET database, 1970s through 1990s).

Cadmium

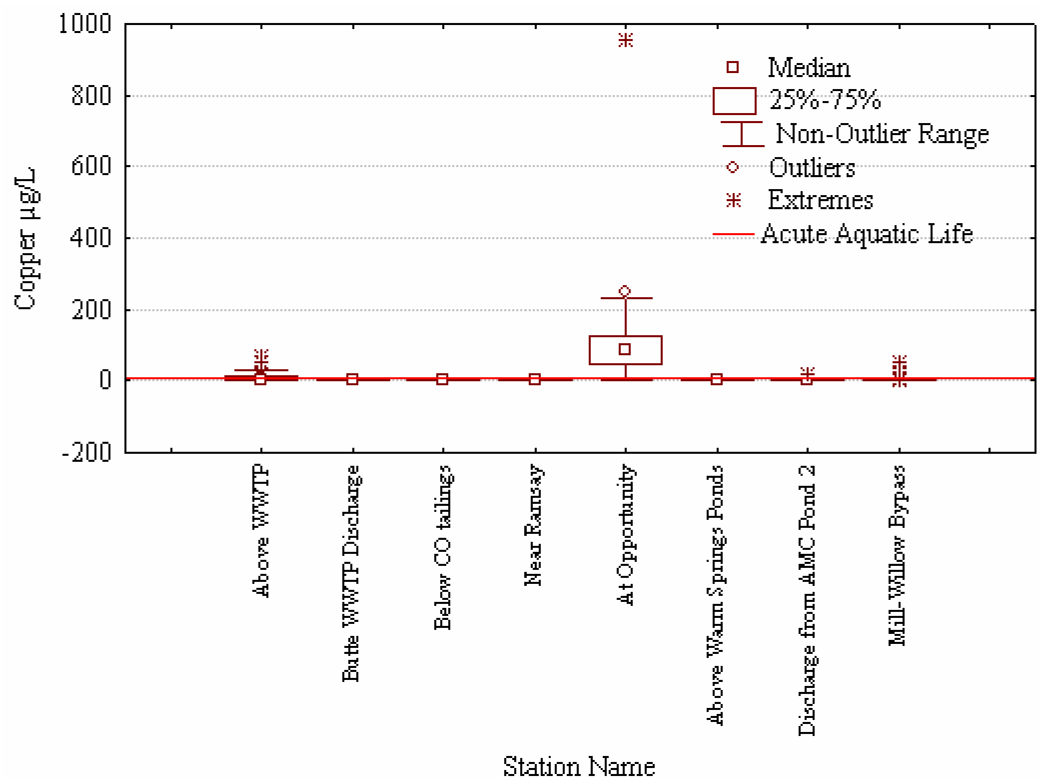


Cadmium concentrations measured on Silver Bow Creek (STORET database 1970s through 1990s).

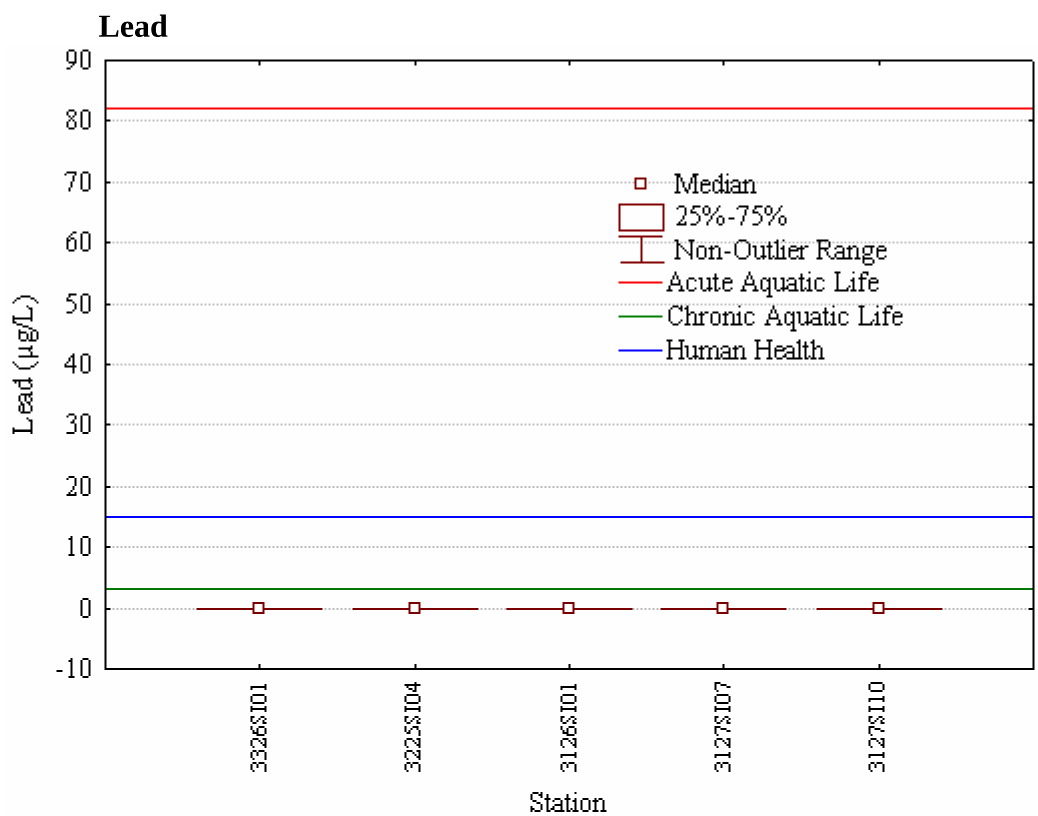
Copper



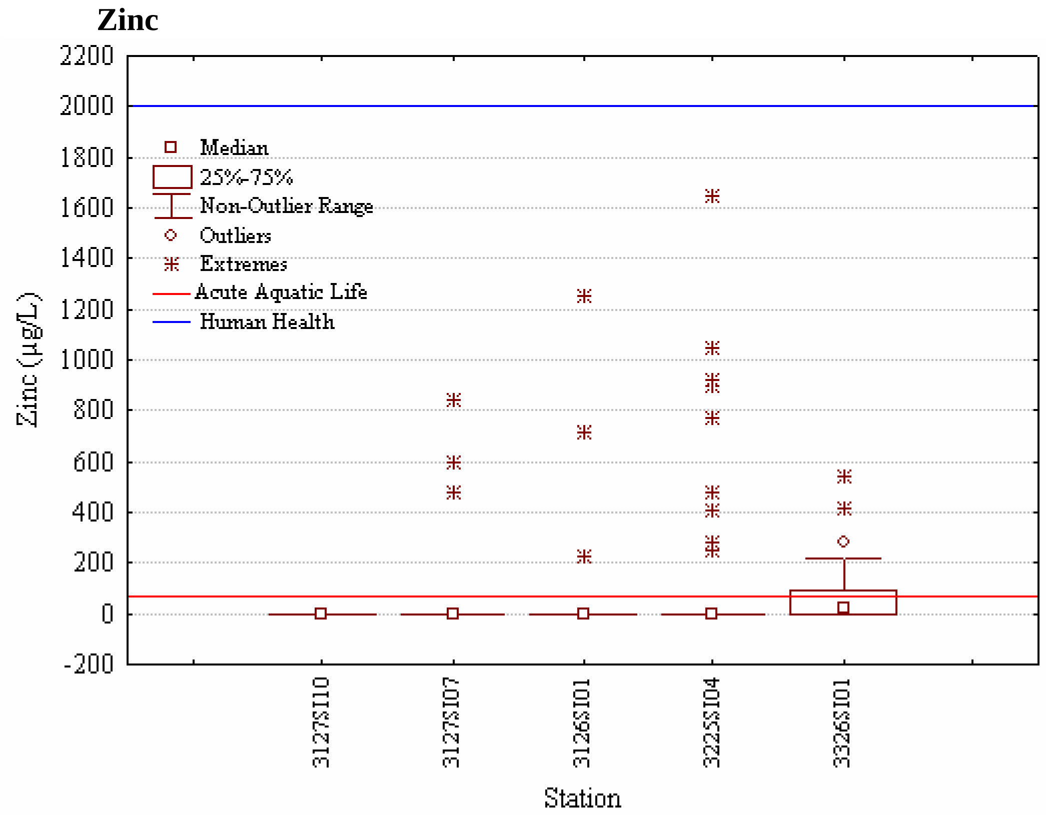
Copper concentrations measured on Silver Bow Creek (STORET database, 1970s through 1990s).



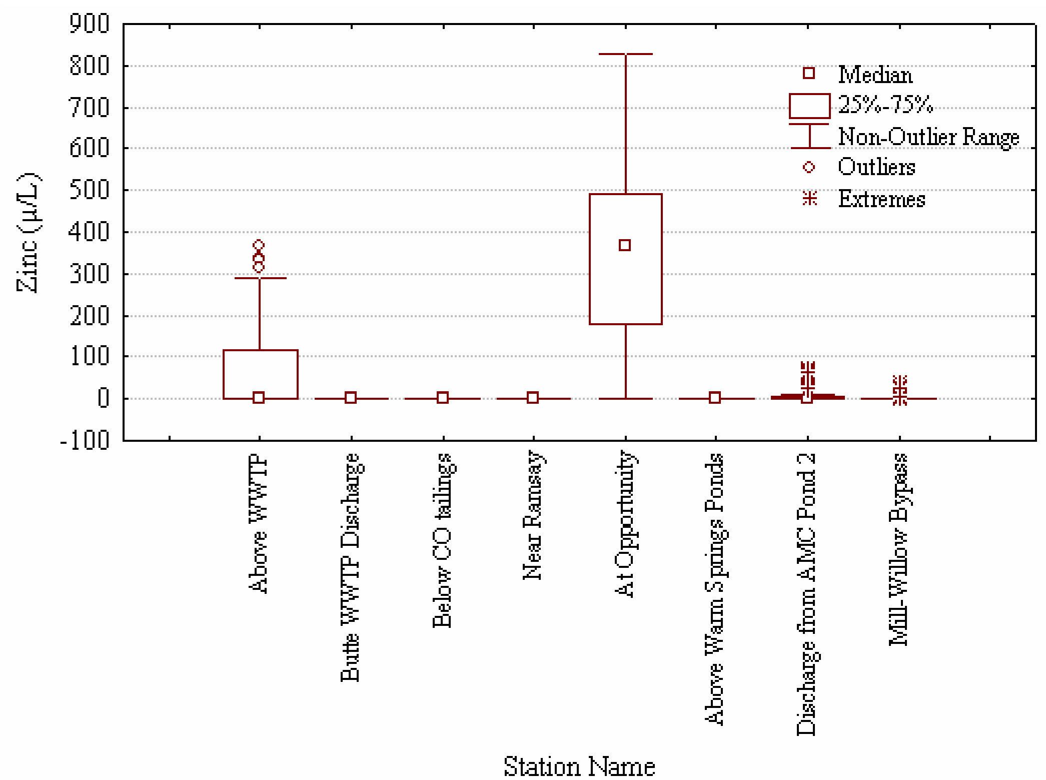
Copper concentrations measured on Silver Bow Creek, Tri-State Water Quality Council (1986-2002).



Lead concentrations measured on Silver Bow Creek (STORET database, 1974-1992).

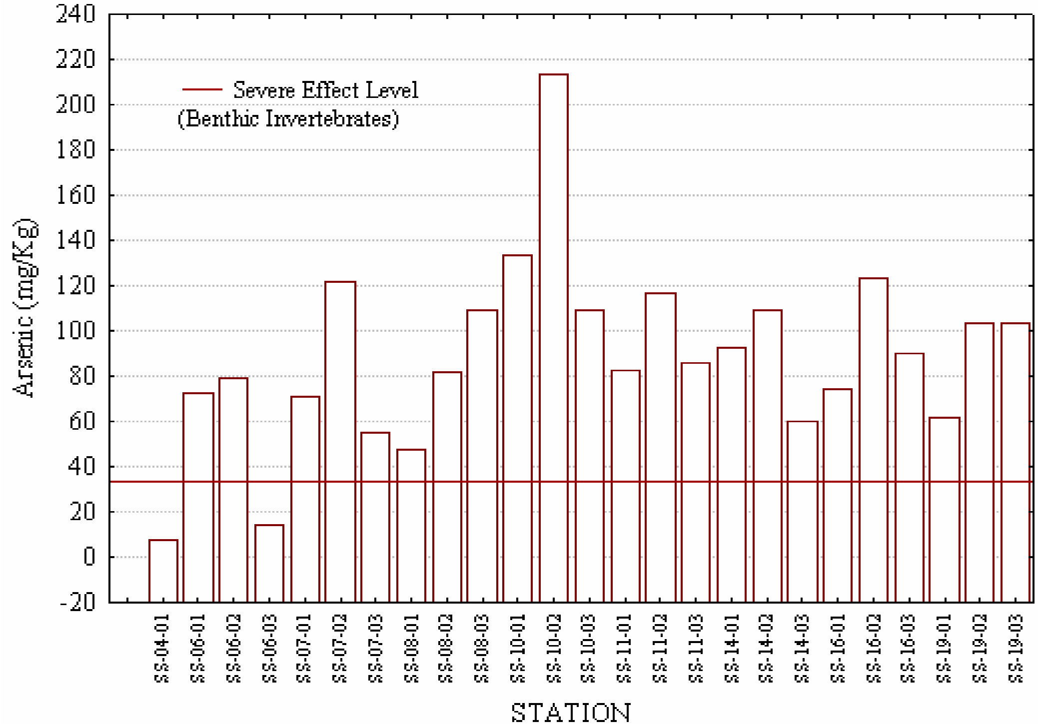


Zinc concentrations measured Silver Bow Creek (STORET database, 1970s through 1990s).

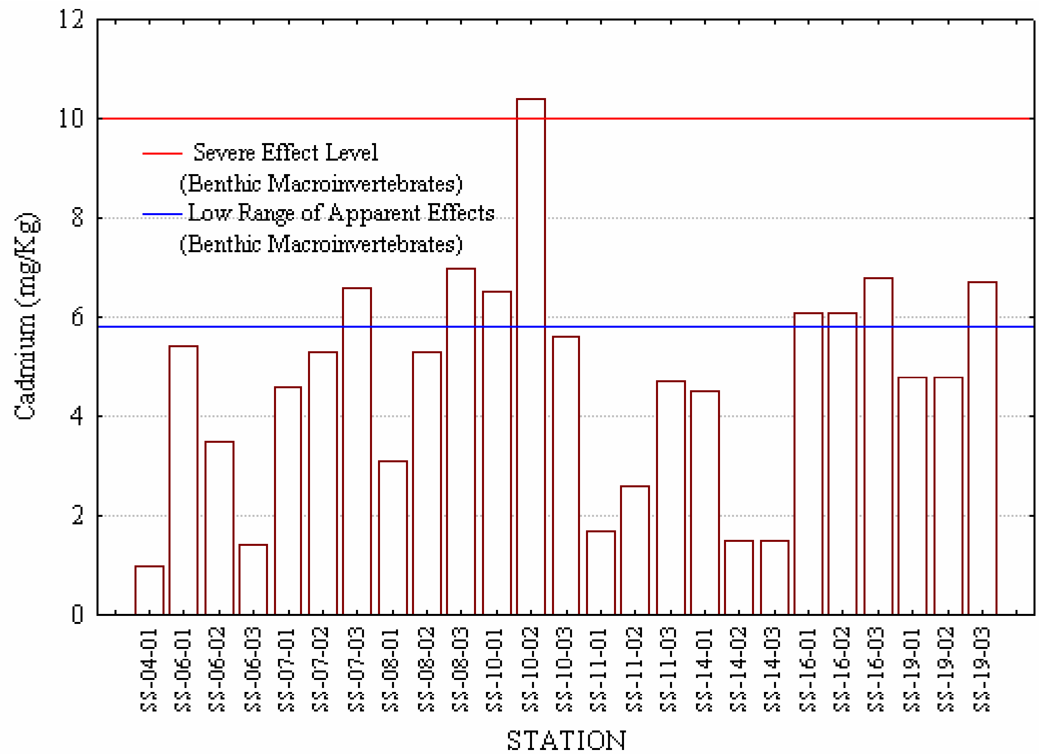


Zinc concentrations measured on Silver Bow Creek by the Tri-State Water Quality Council (1986-2002).

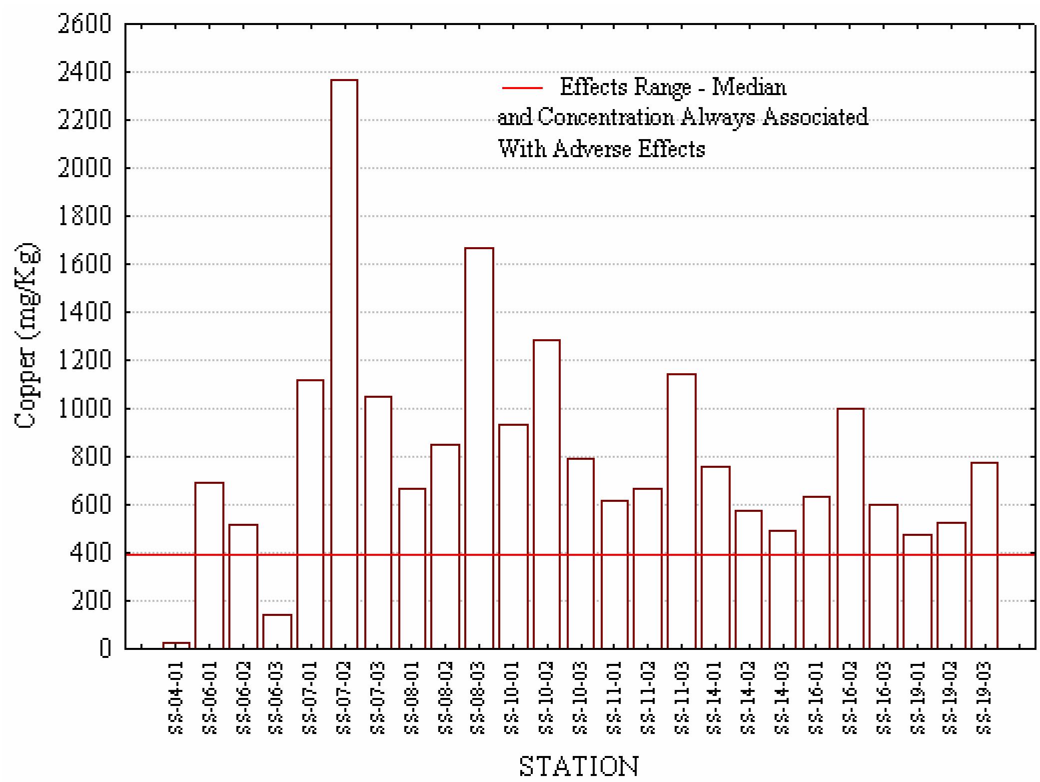
Benthic Sediment Sampling on Silver Bow Creek



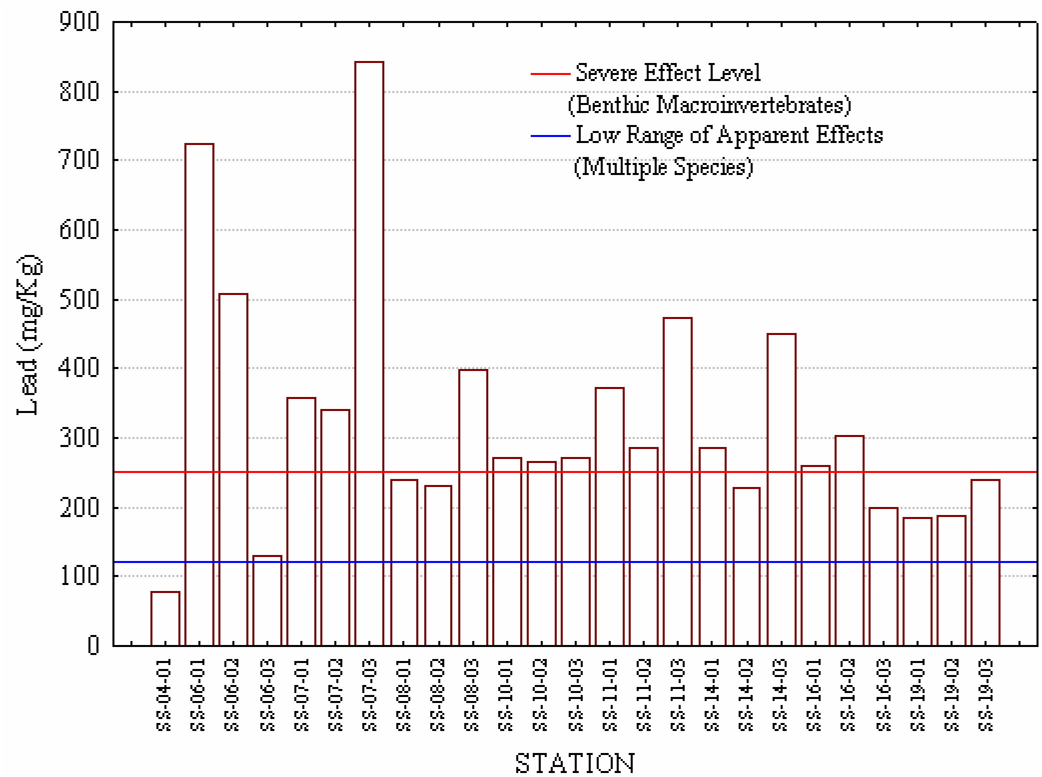
Arsenic concentrations in benthic sediments in Silver Bow Creek (1985).



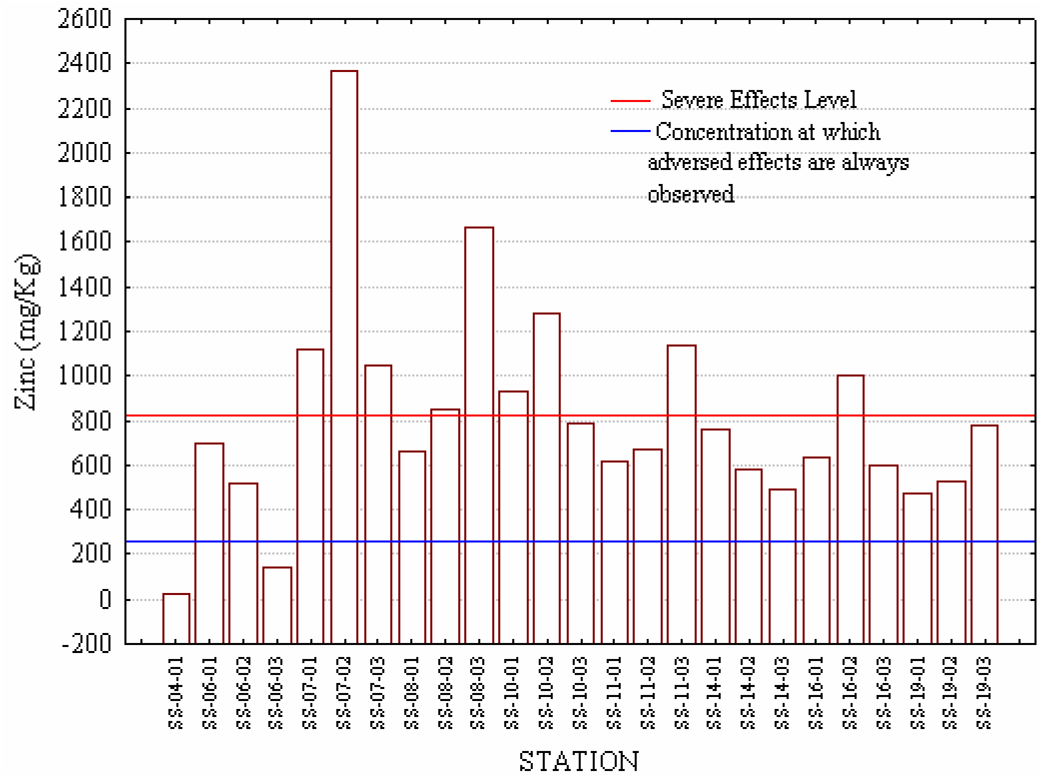
Cadmium concentrations measured in benthic sediments in Silver Bow Creek (1985).



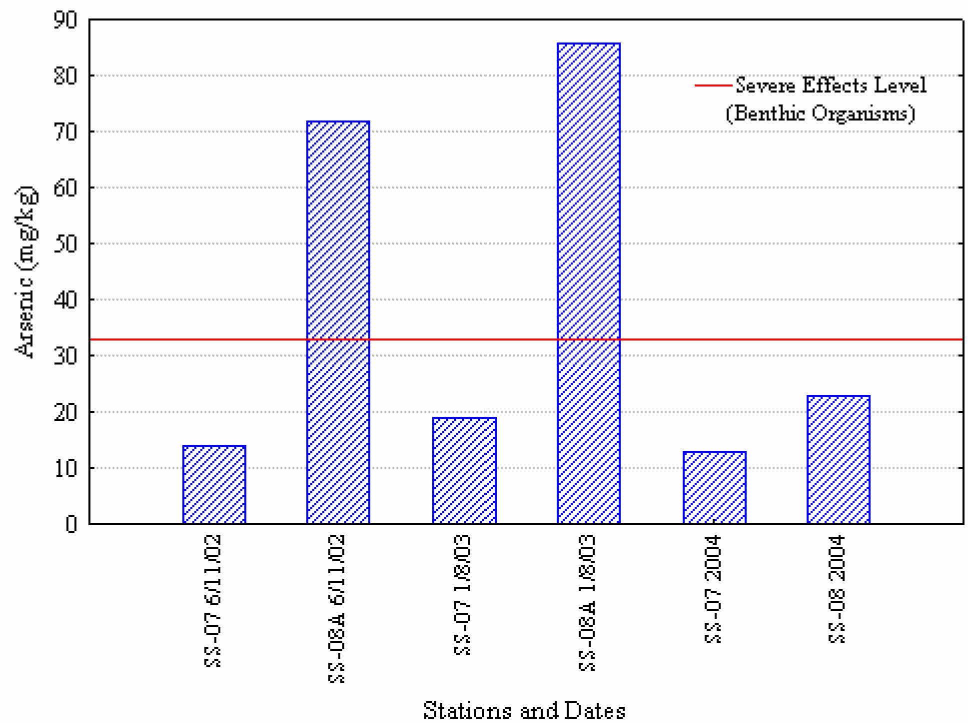
Copper concentrations measured in benthic sediments in Silver Bow Creek (1988).



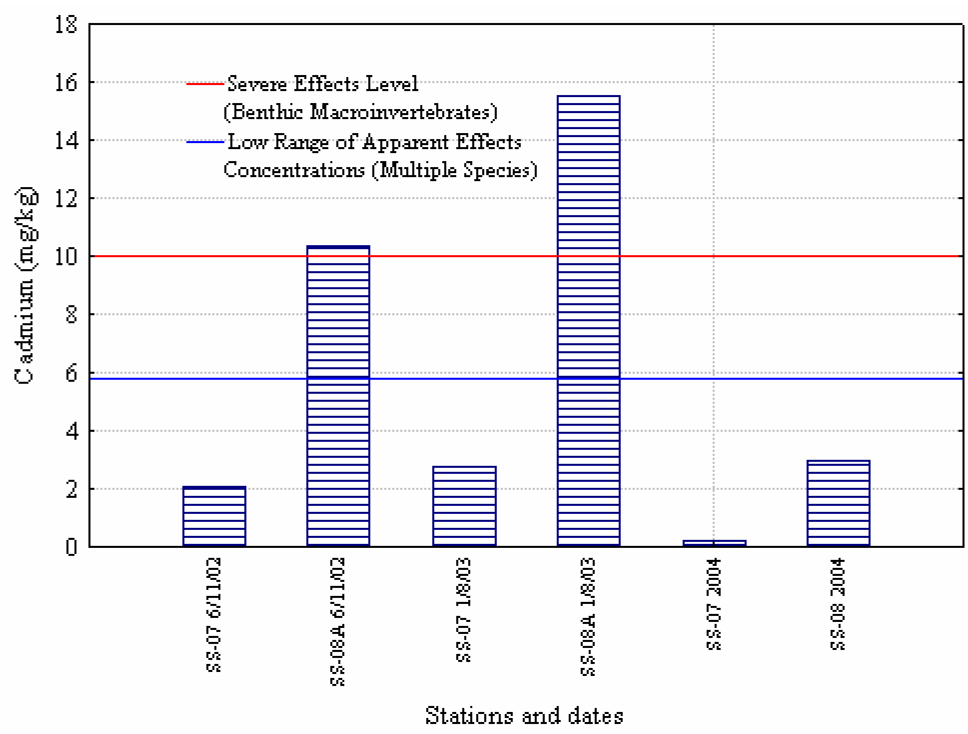
Lead concentrations measured in benthic sediments in Silver Bow Creek (1988).



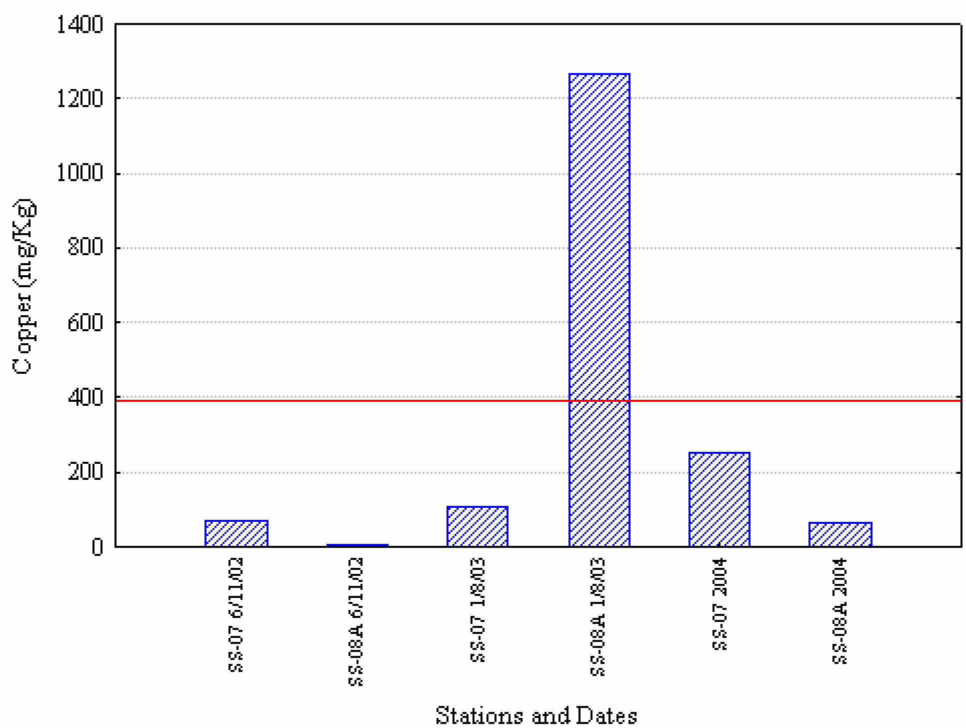
Zinc concentrations measured in benthic sediments in Silver Bow Creek (1989).



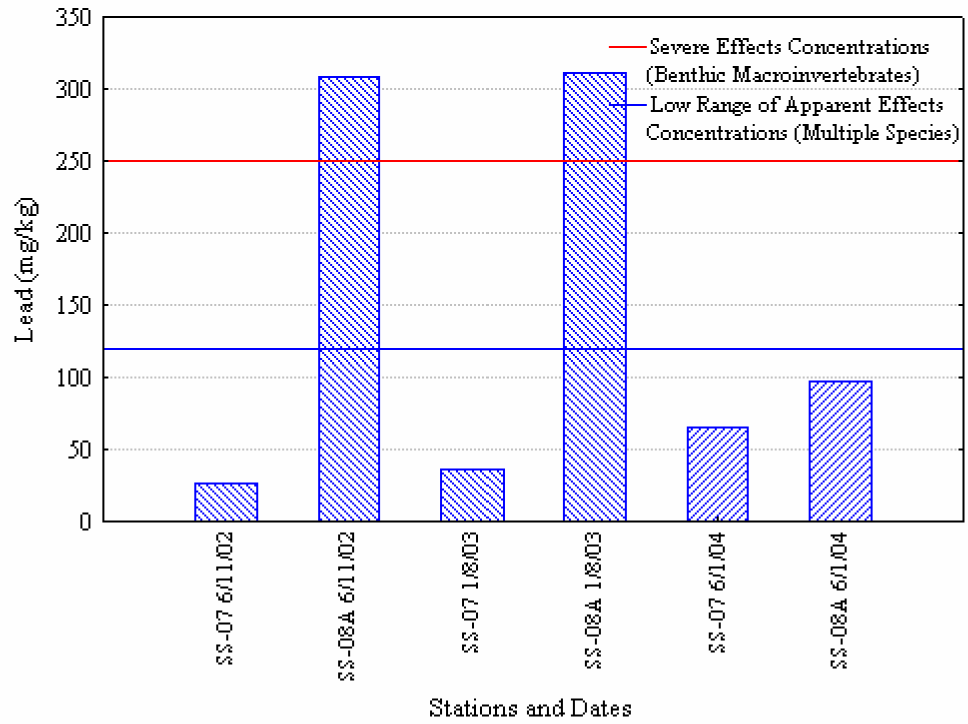
Arsenic concentrations in benthic sediments measured after remediation activities in Silver Bow Creek (2002).



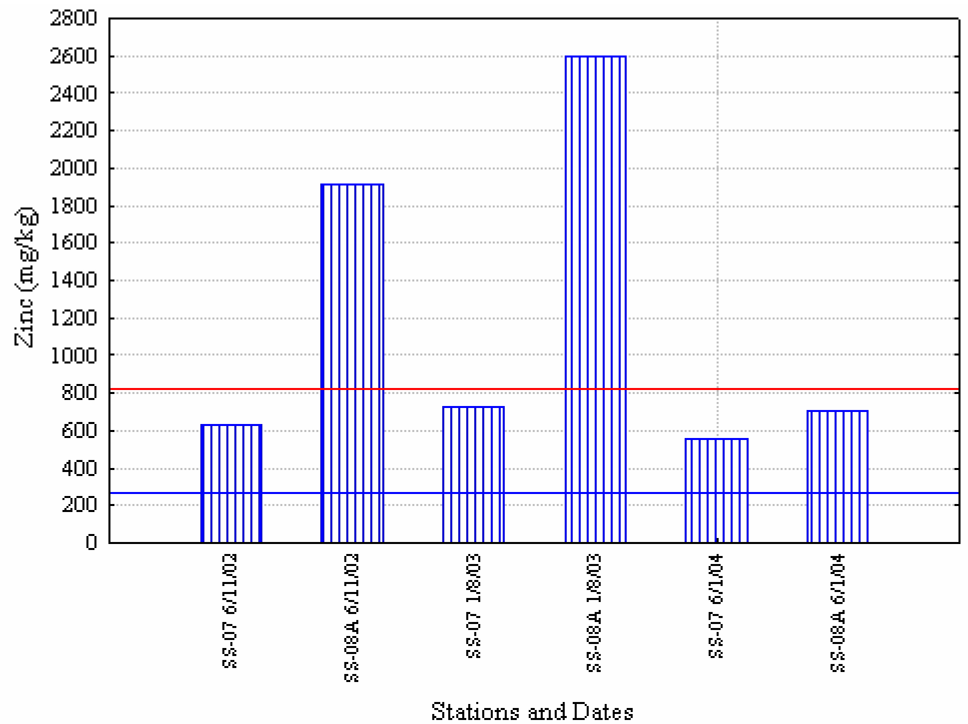
Cadmium concentrations measured in benthic sediments after remediation activities, Silver Bow Creek (2002).



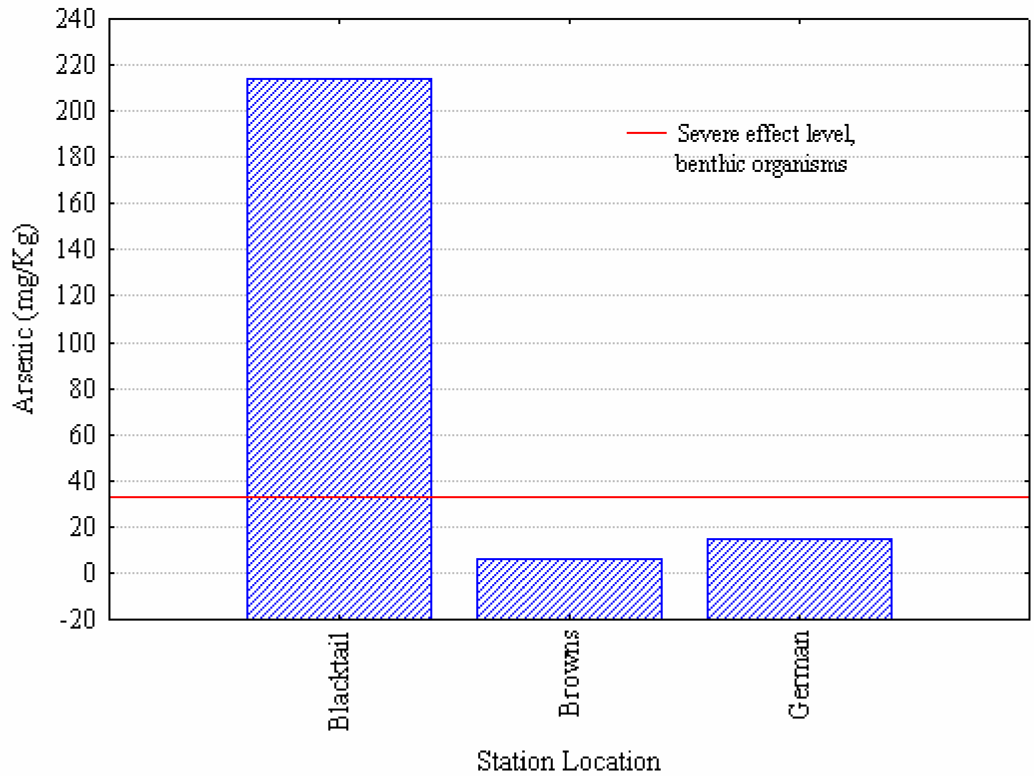
Copper concentrations measured in benthic sediments on Silver Bow Creek after remediation activities (2002).



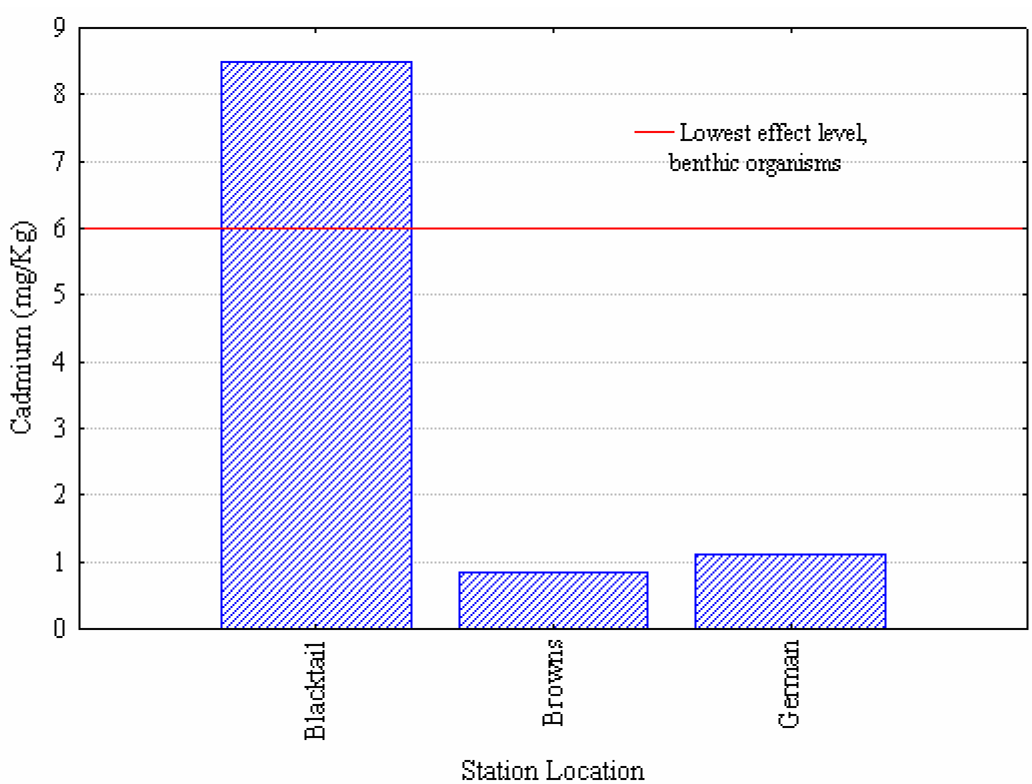
Lead concentrations measured in benthic sediments on Silver Bow Creek after remediation activities (2002).



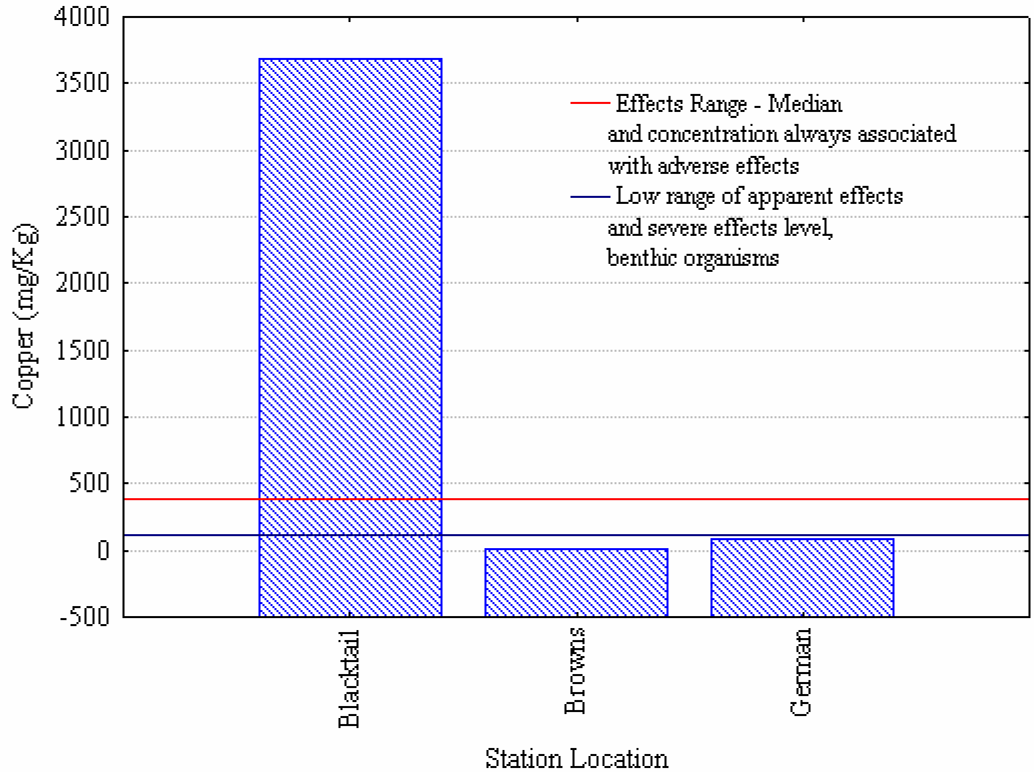
Zinc concentrations measured in benthic sediments on Silver Bow Creek after remediation activities (2002).



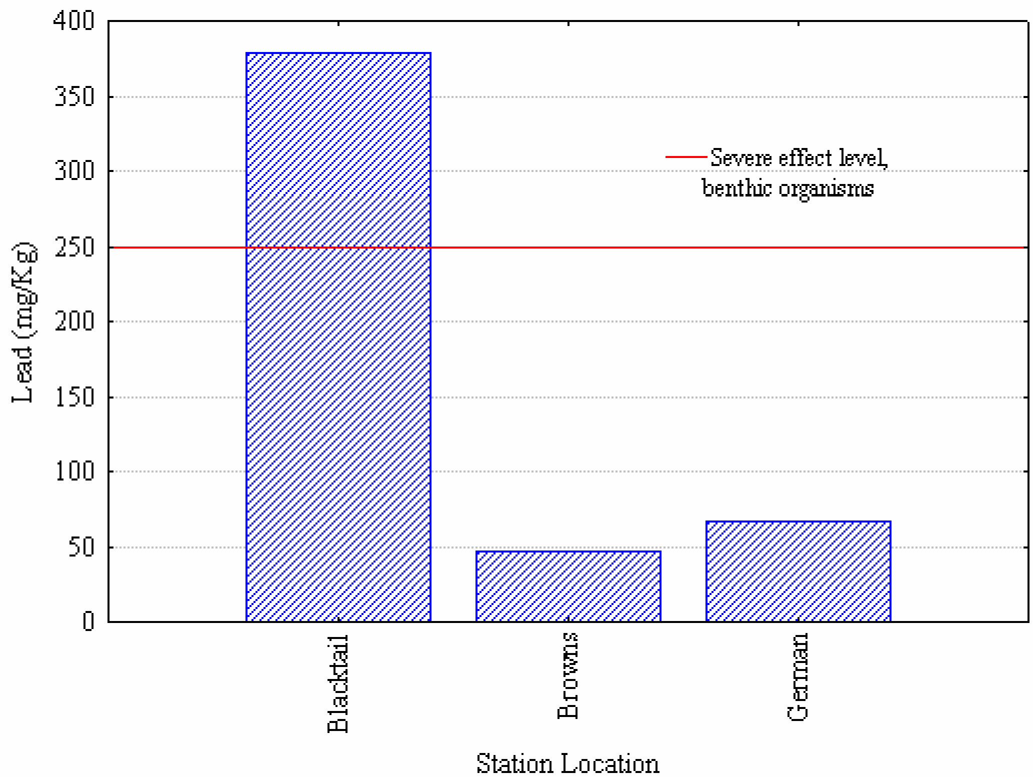
Arsenic concentrations in benthic sediments sampled on major tributaries to Silver Bow Creek (1987).



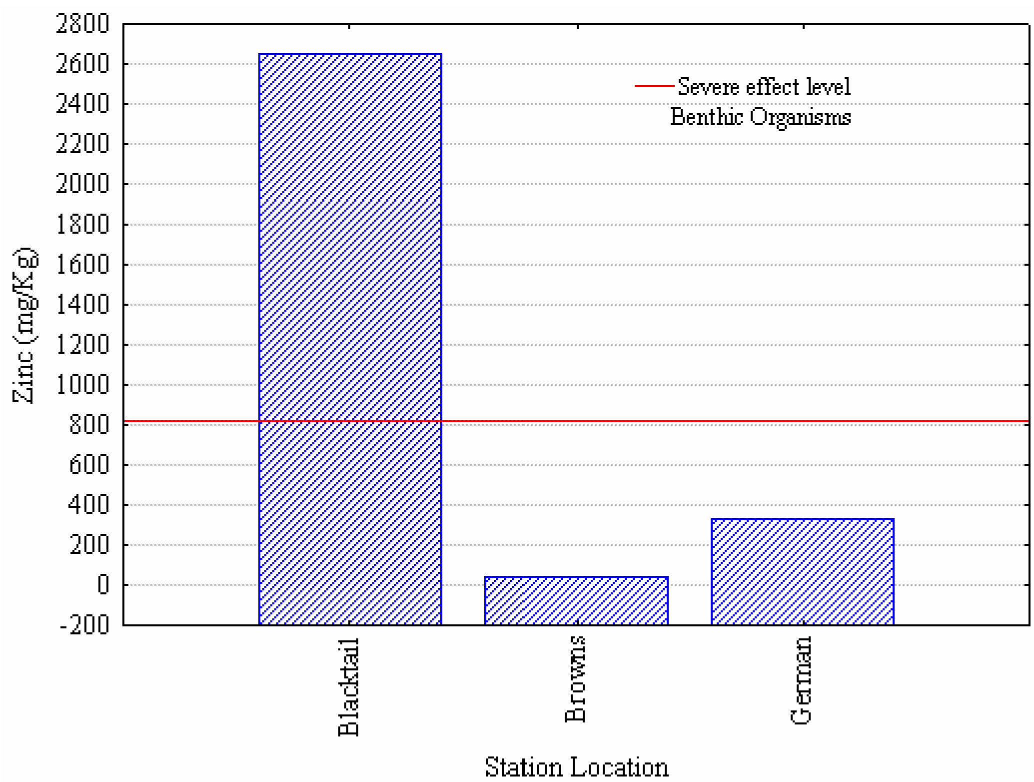
Cadmium concentrations in benthic sediments sampled on major tributaries to Silver Bow Creek (1987).



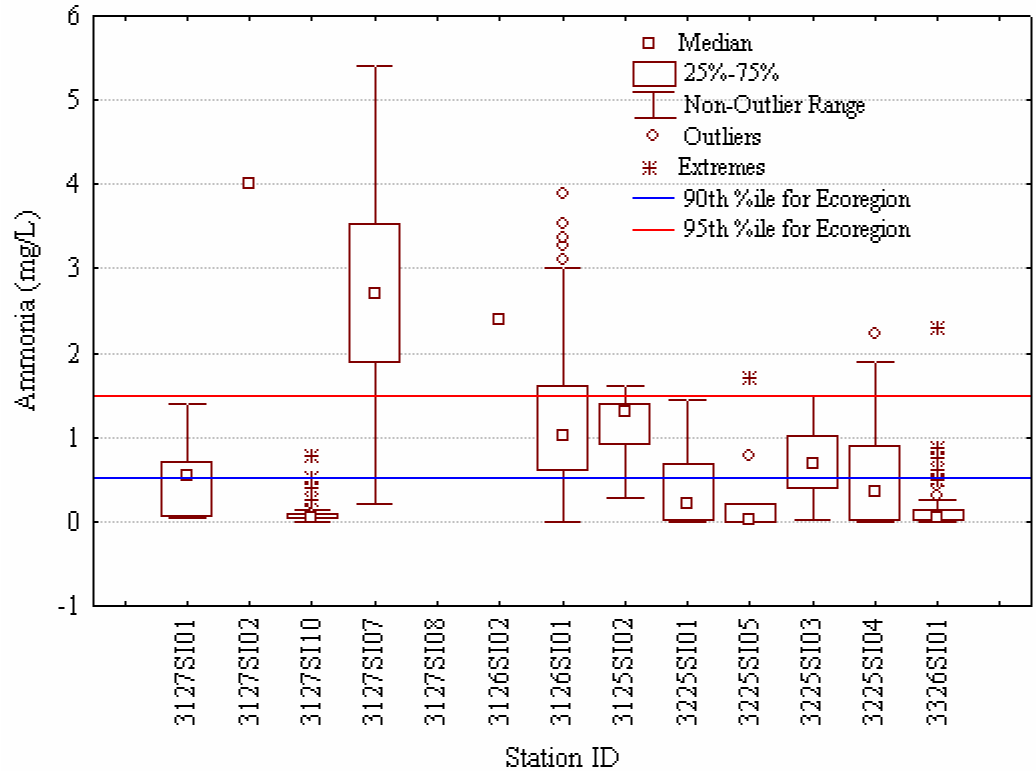
Copper concentrations in benthic sediments sampled on major tributaries to Silver Bow Creek (1987).



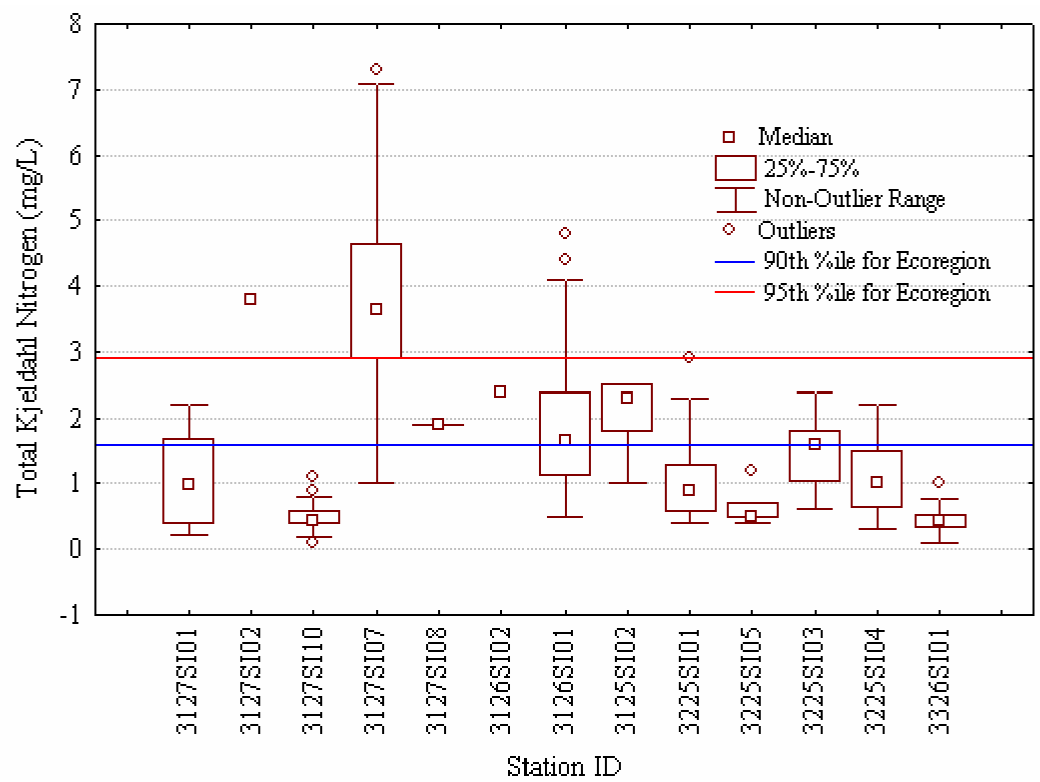
Lead concentrations in benthic sediments sampled on major tributaries to Silver Bow Creek (1987).



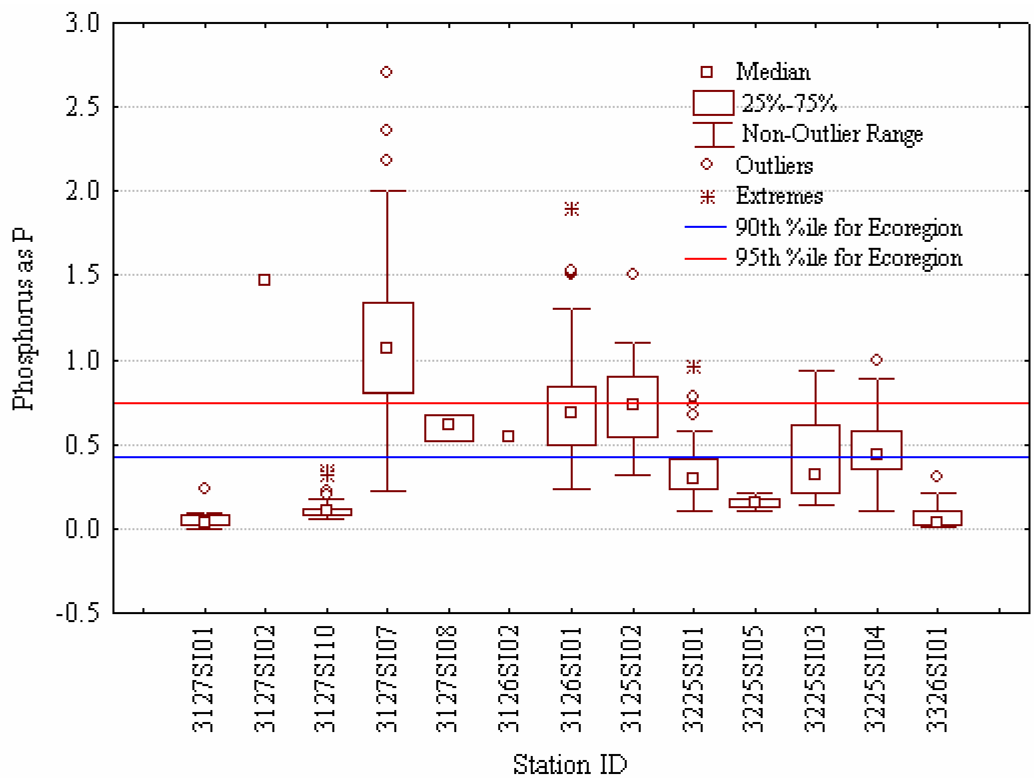
Zinc concentrations in benthic sediments sampled on major tributaries to Silver Bow Creek (1987).



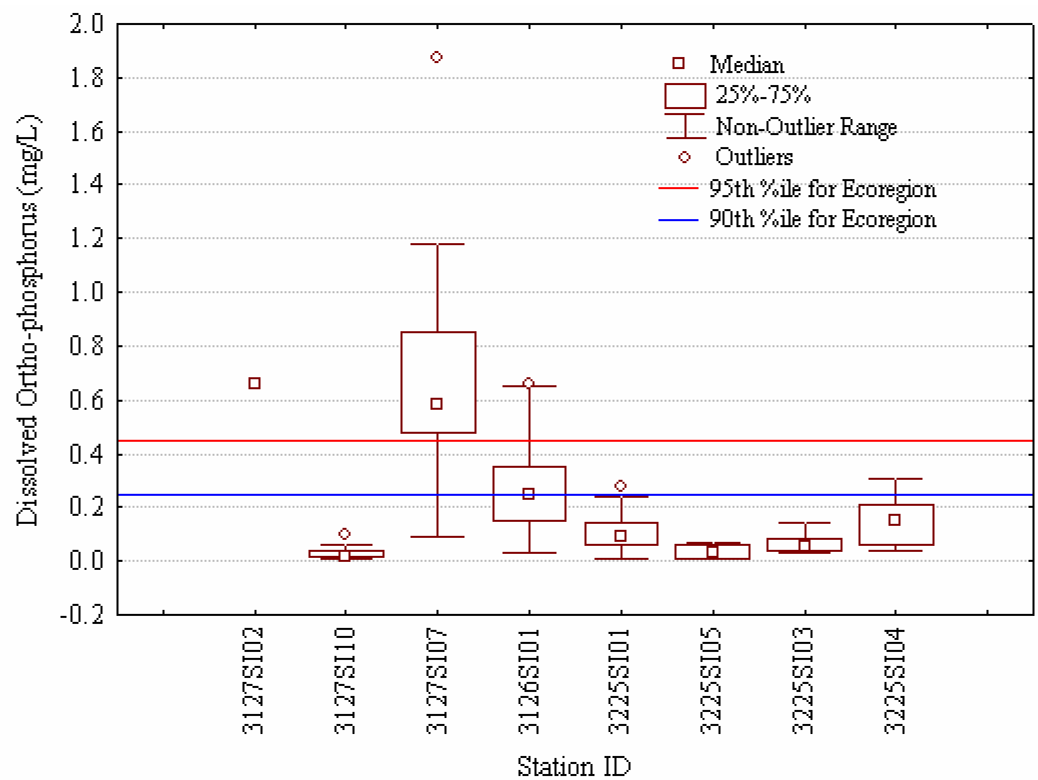
Ammonia concentrations measured at sampling stations on Silver Bow Creek (1970s through 1990s).



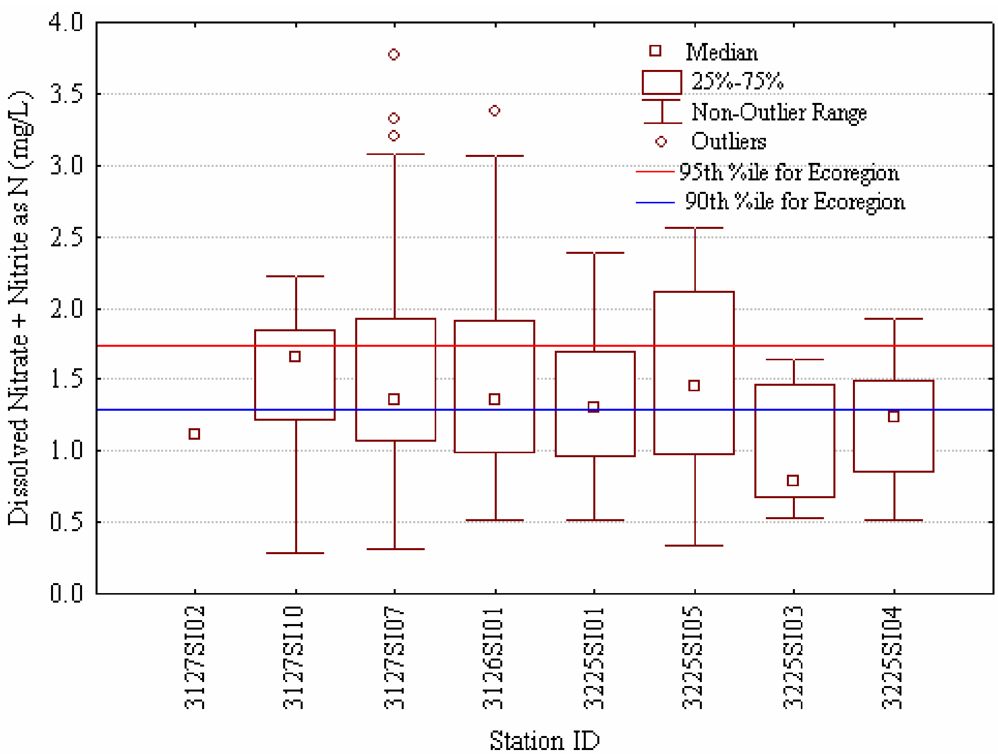
Total Kjeldahl nitrogen concentrations measured on Silver Bow Creek (1970s through 1990s).



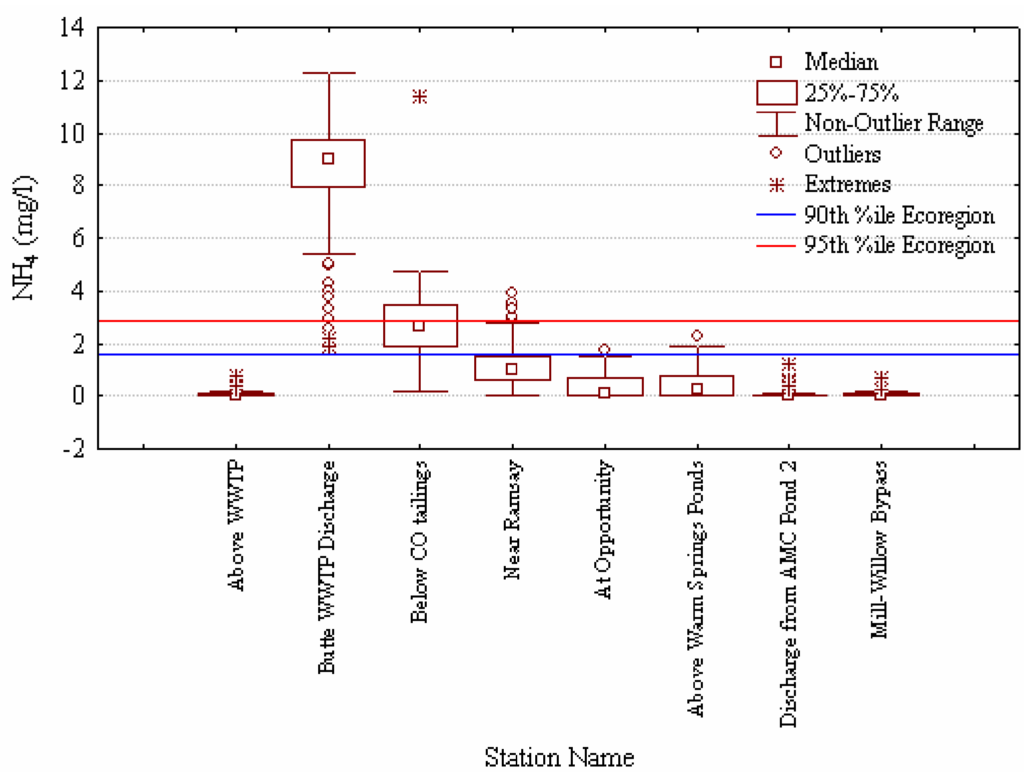
Total phosphorus concentrations measured on Silver Bow Creek (1970s through 1990s).



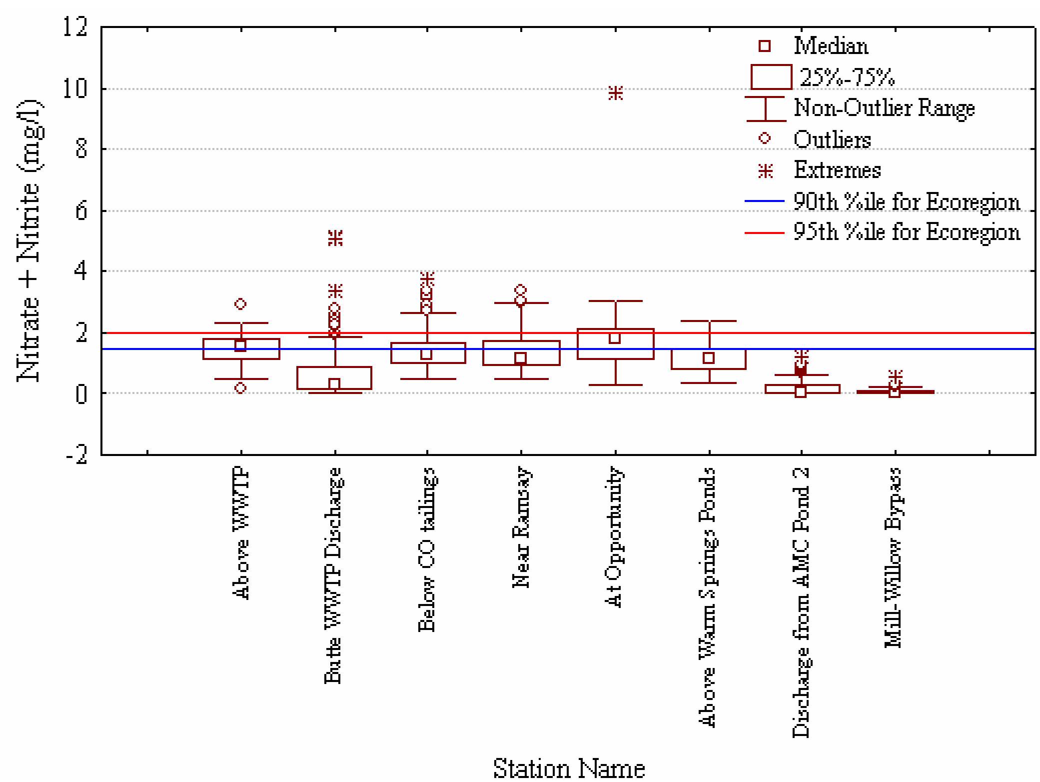
Dissolved ortho-phosphorus concentrations measured on Silver Bow Creek (1970s through 1990s).



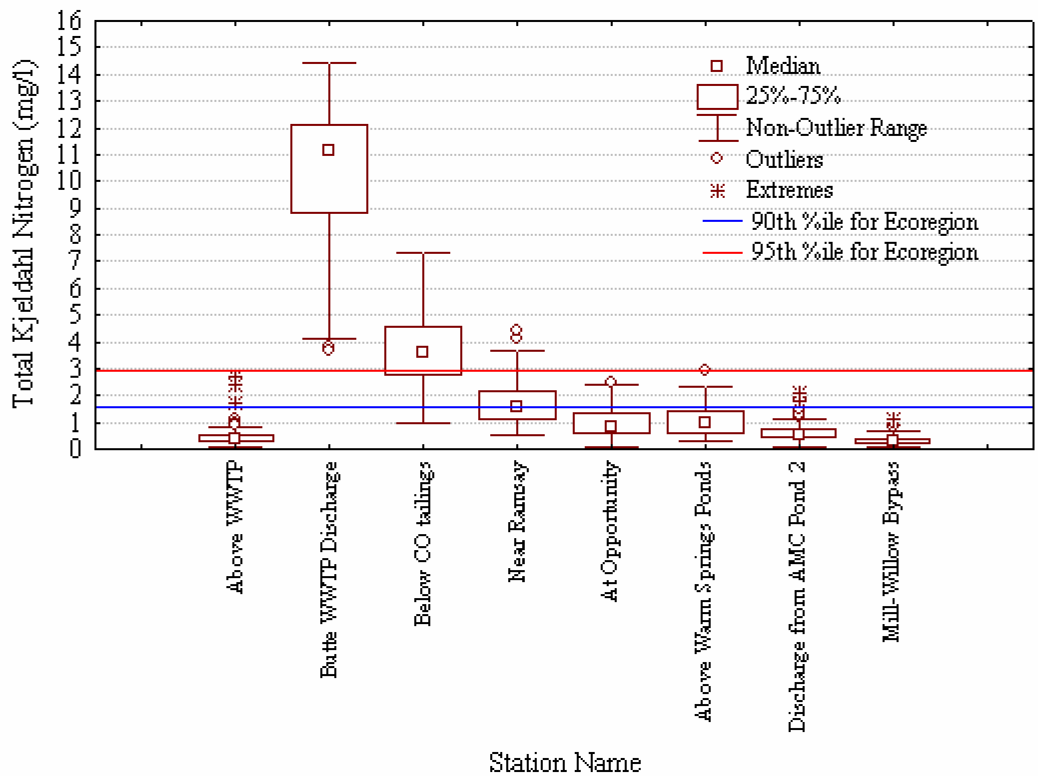
Dissolved nitrate + nitrite as N concentrations measured on Silver Bow Creek (STORET database, 1970s through 1990s).



Ammonium concentrations measured on Silver Bow Creek (Tri-State Water Quality Council monitoring data, 1985 through 2002).

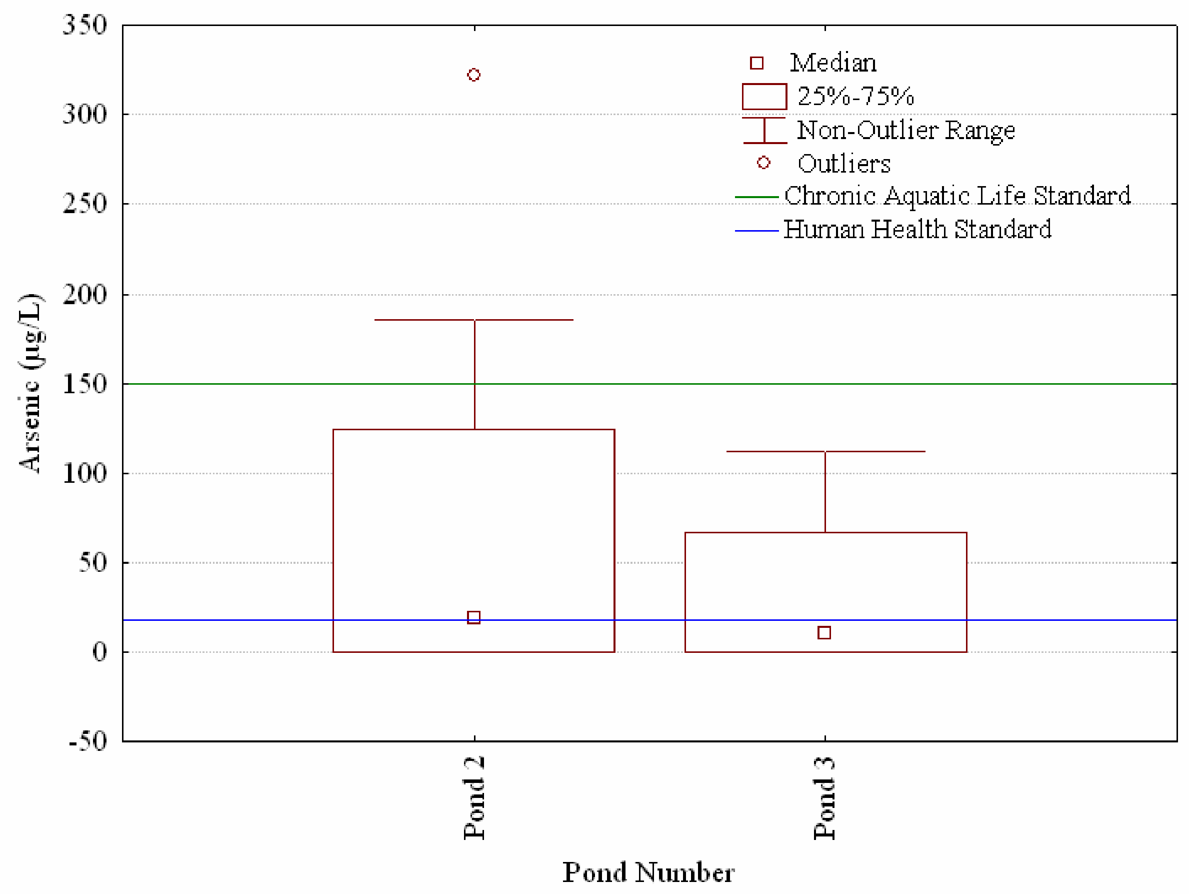


Nitrate + nitrite concentrations measured at sampling stations on Silver Bow Creek (Tri-State Water Quality Council data, 1980s through 2002).

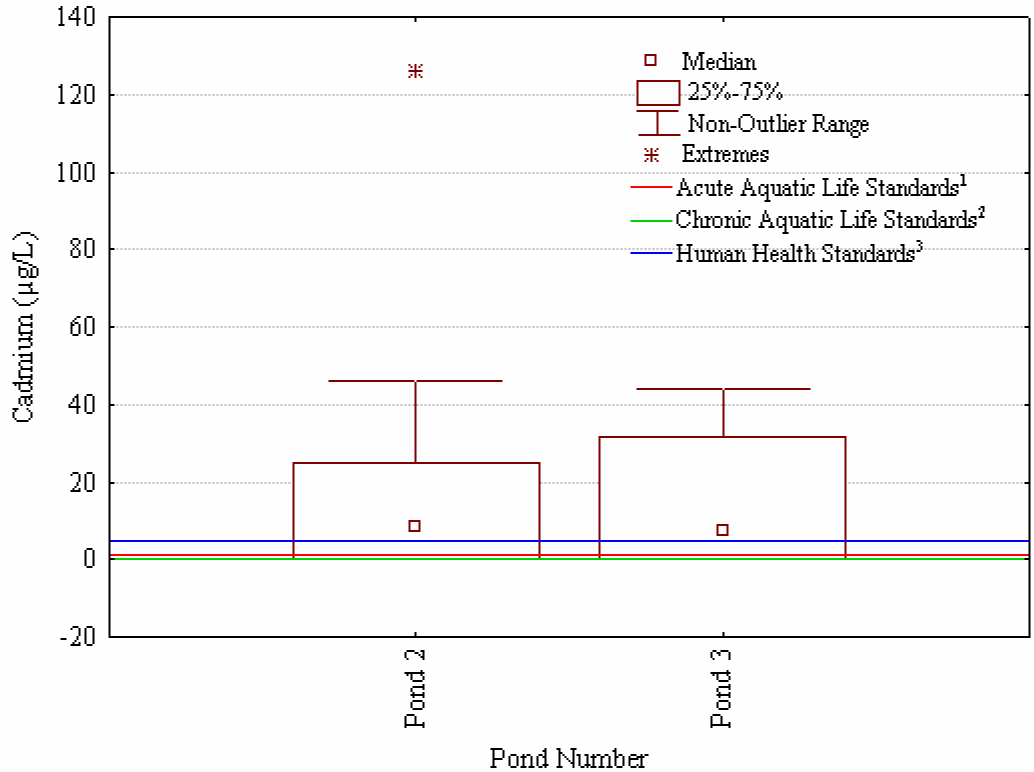


Total Kjeldahl nitrogen concentrations measured at sampling stations on Silver Bow Creek (Tri-State Water Quality Council data, 1985 though 2002).

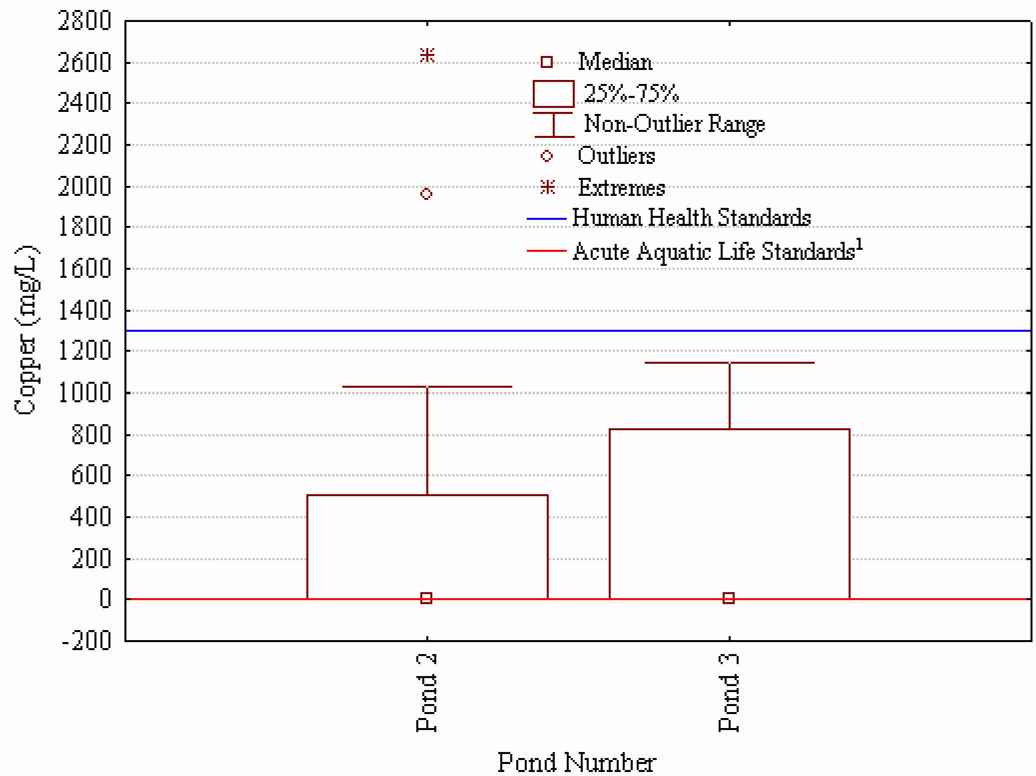
Water Quality Sampling, Warm Springs Ponds



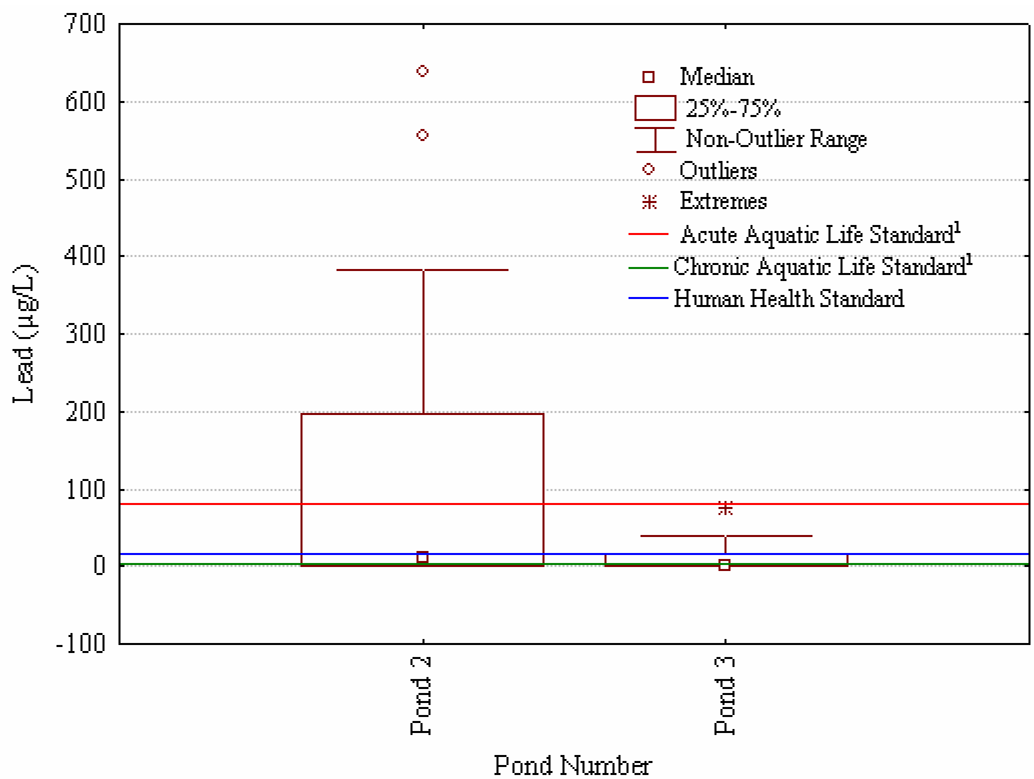
Arsenic concentrations measured in surface water in Warm Springs Ponds (1985-1987).



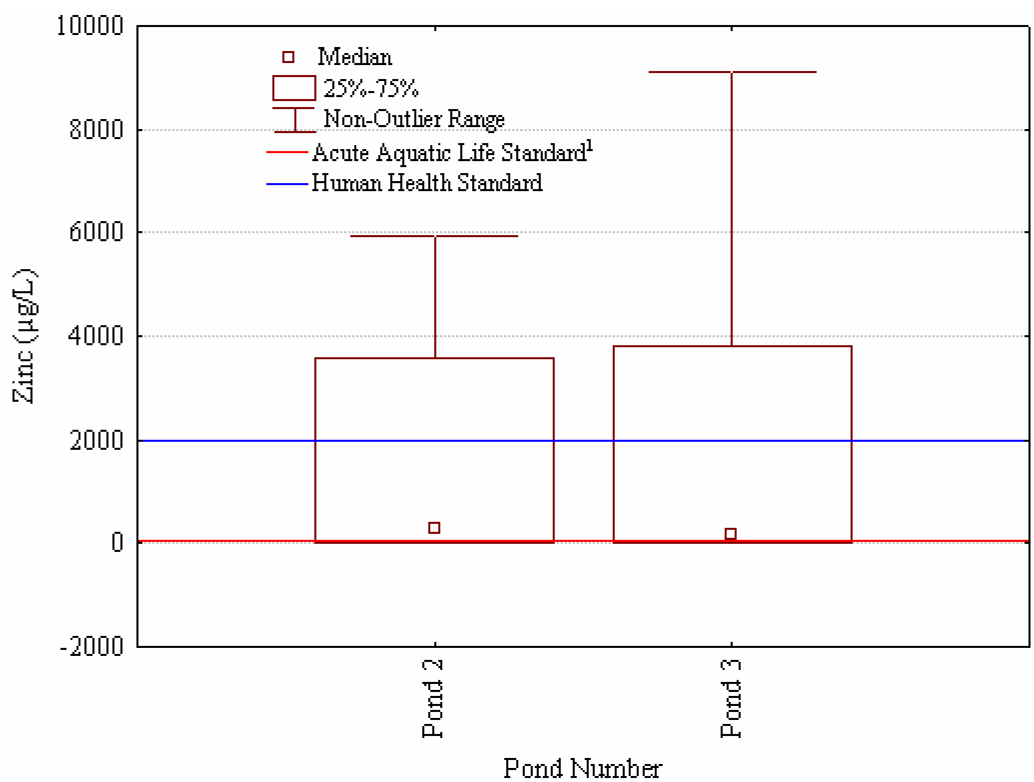
Cadmium concentrations measured in surface water in Warm Springs Ponds (1985-1987).



Copper concentrations measured in surface water in Warm Springs Ponds (1985-1987).

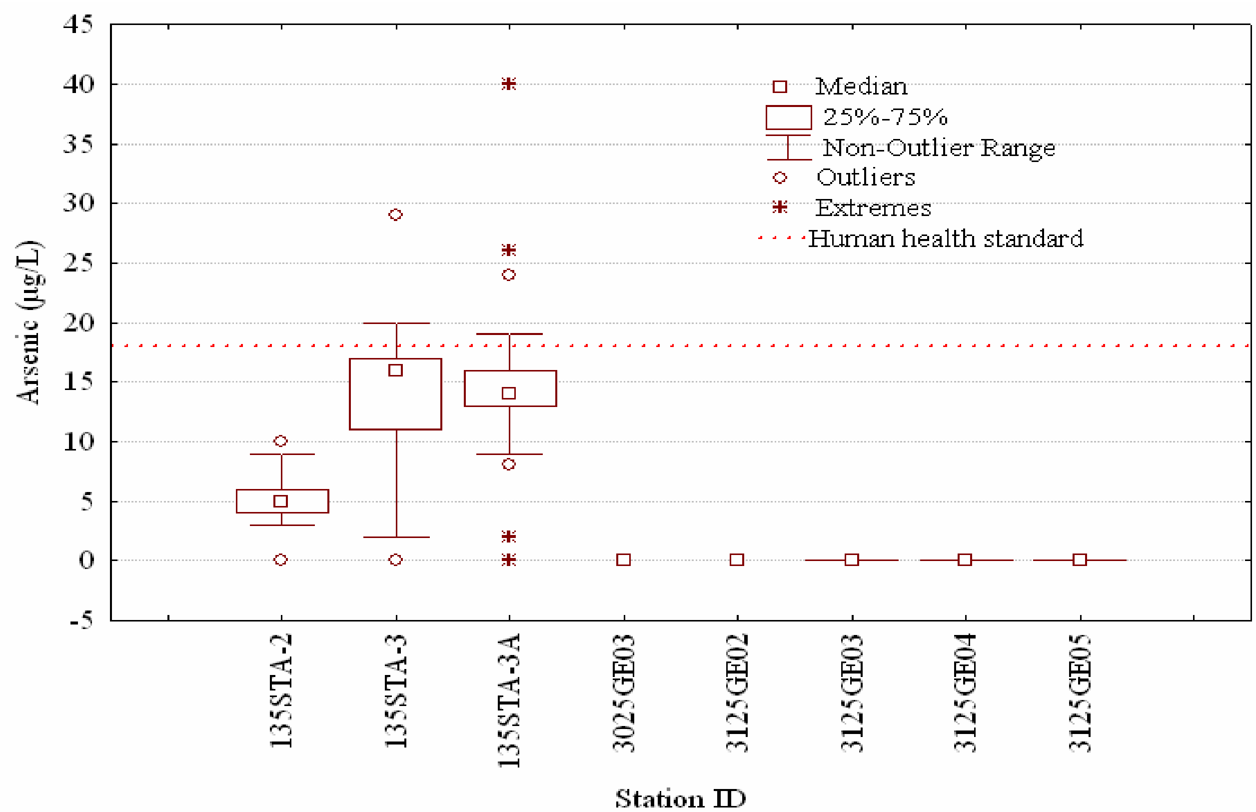


Lead concentrations measured in surface water in Warm Springs Ponds (1985-1987).

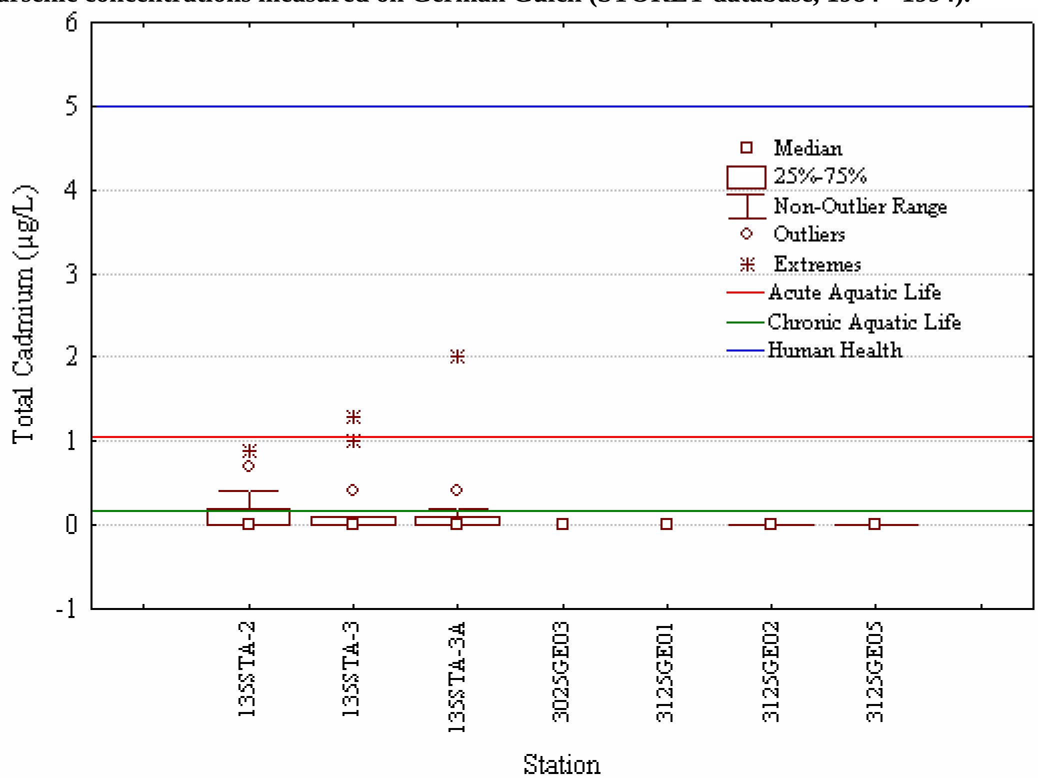


Zinc concentrations measured in surface water in Warm Springs Ponds (1985-1987).

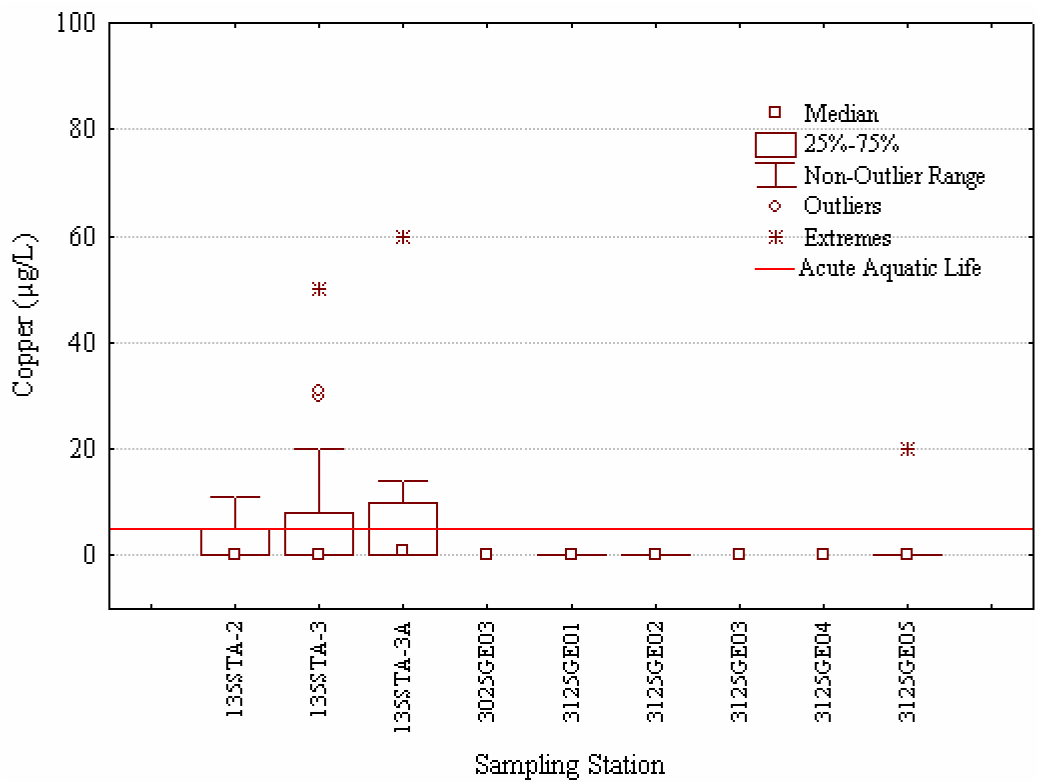
Water Quality Sampling, German Gulch



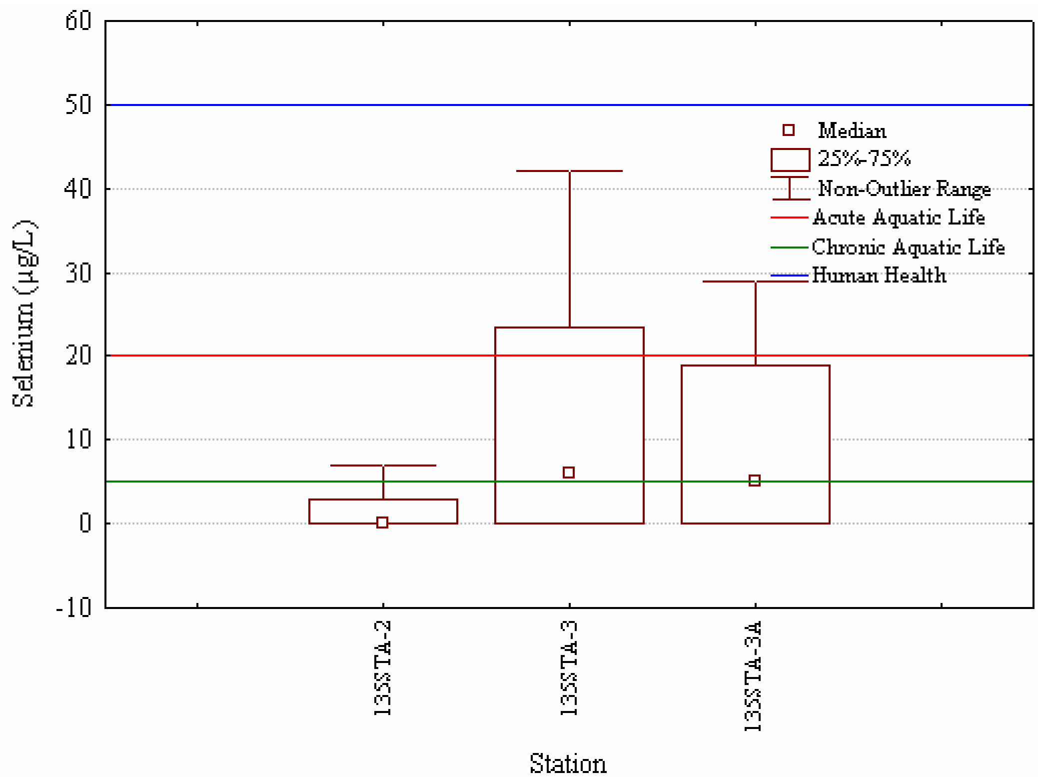
Total arsenic concentrations measured on German Gulch (STORET database, 1984 - 1994).



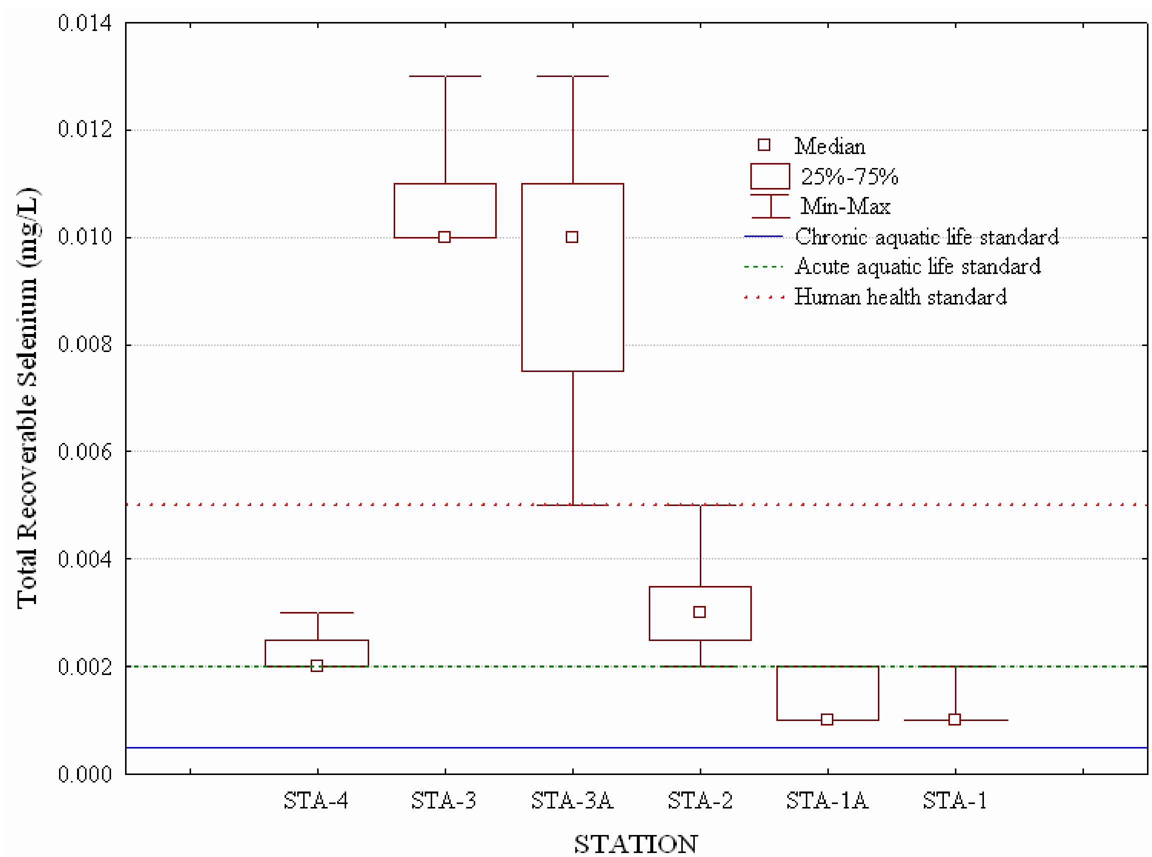
Cadmium concentrations measured on German Gulch (STORET database, 1976-1994).



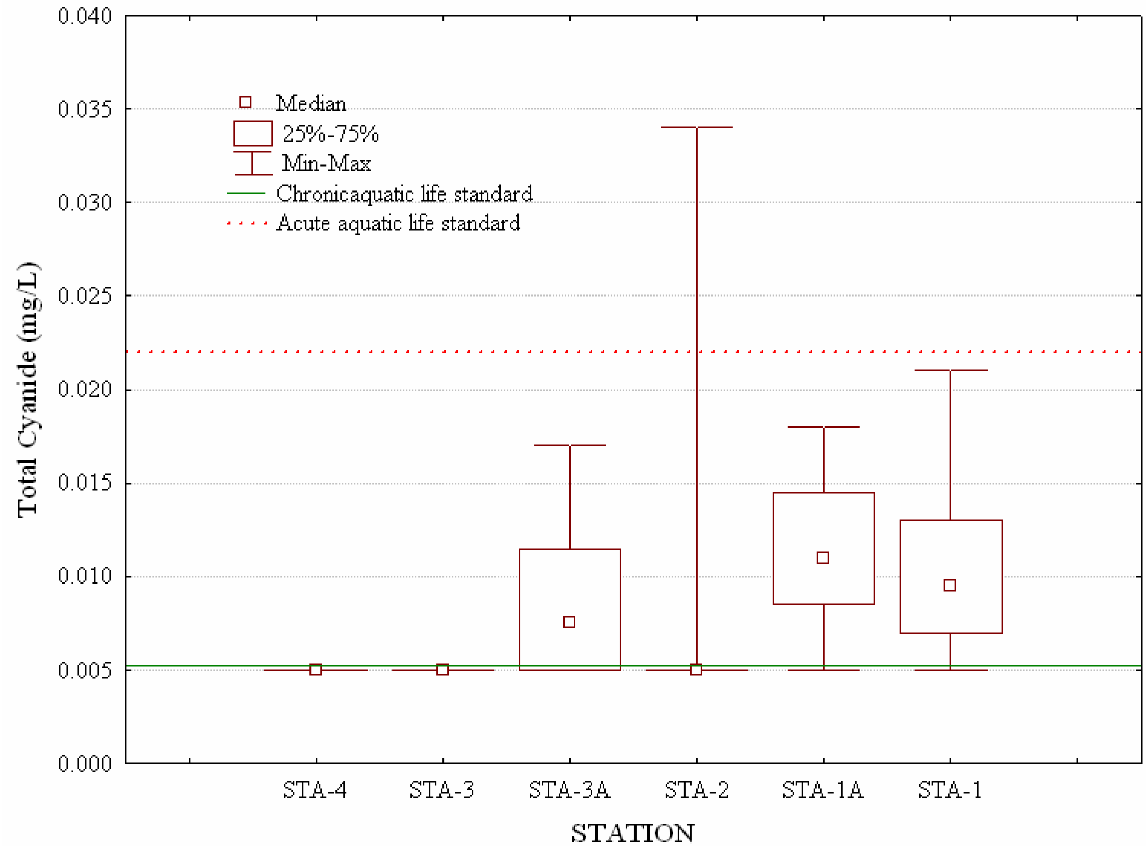
Total copper measured at sampling stations on German Gulch (STORET database, 1976-1994).



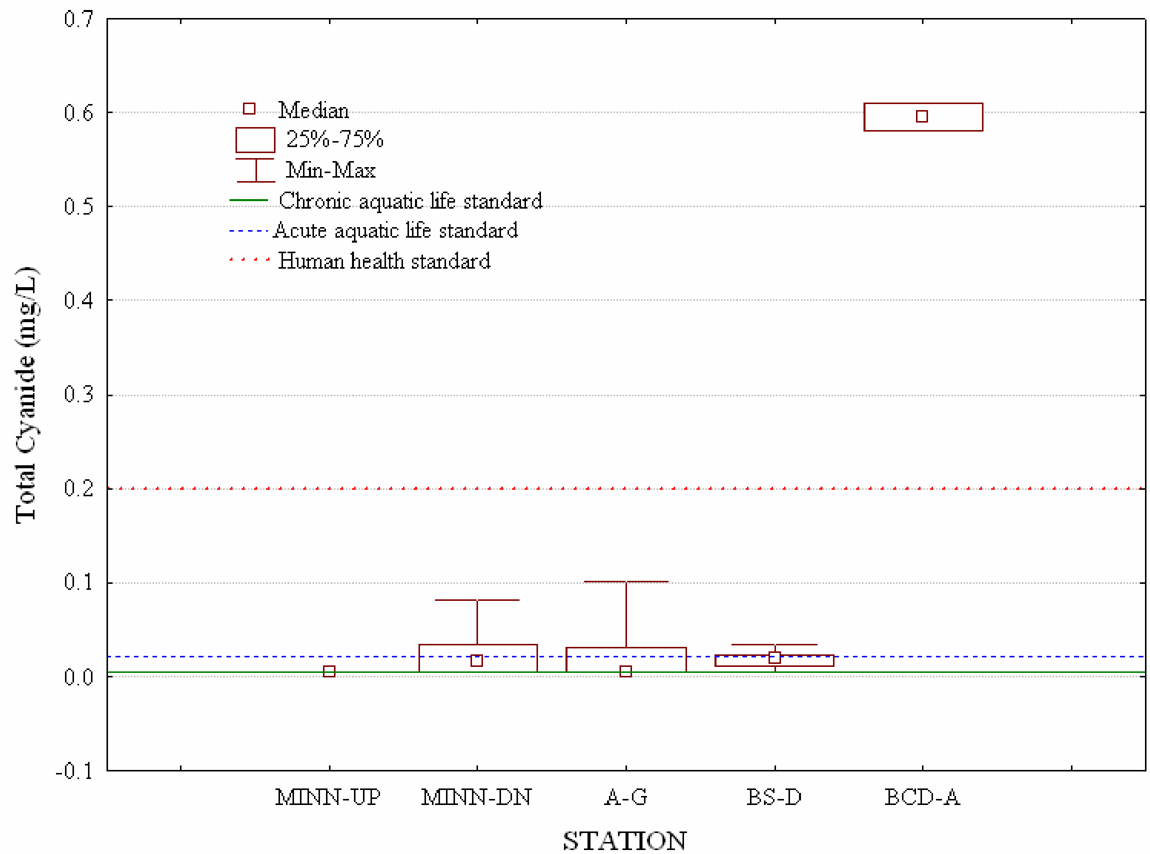
Selenium measured at sampling stations on German Gulch (STORET database, 1987-1994).



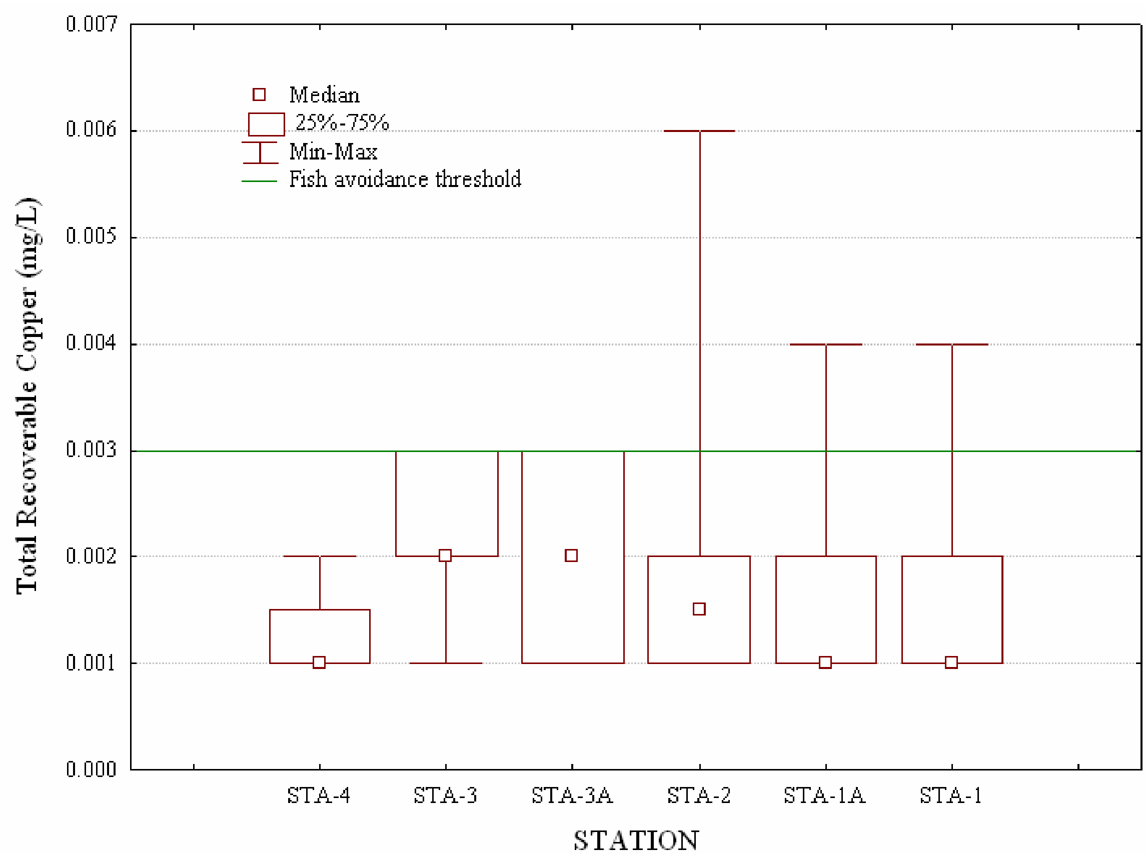
Selenium concentrations measured at sampling stations on German Gulch in 2003 (N = 12 for all sites except STA4 [N = 4] and STA-3 [N = 5]).



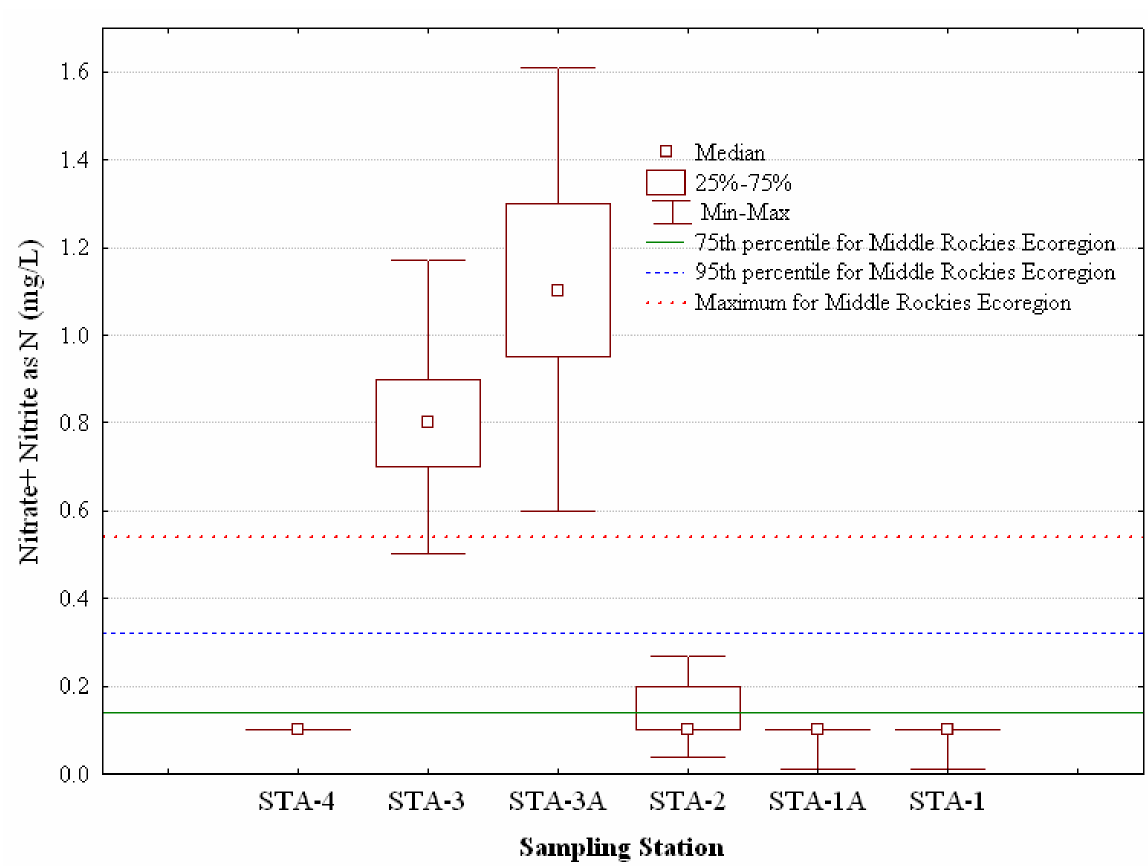
Cyanide concentrations measured at sampling stations on German Gulch in 2003 (N = 12 for all sites except STA-4 [N=4] and STA-3 [N=5]).



Cyanide concentrations measured in tributary streams in the German Gulch watershed in 2003 (N = 12 except MIN –UP [N=6] and BCD=A [N=2]).

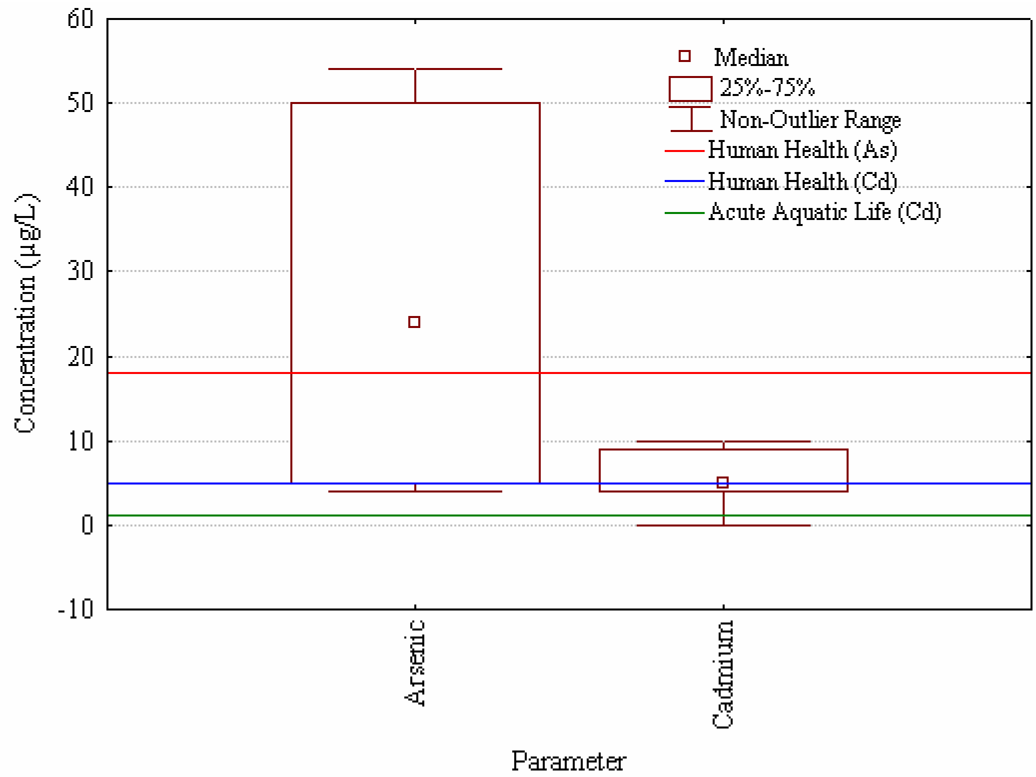


Copper concentrations measured on German Gulch in 2003 (N = 12 for all sites except STA-4 [N=4] and STA-3 [N=5]).

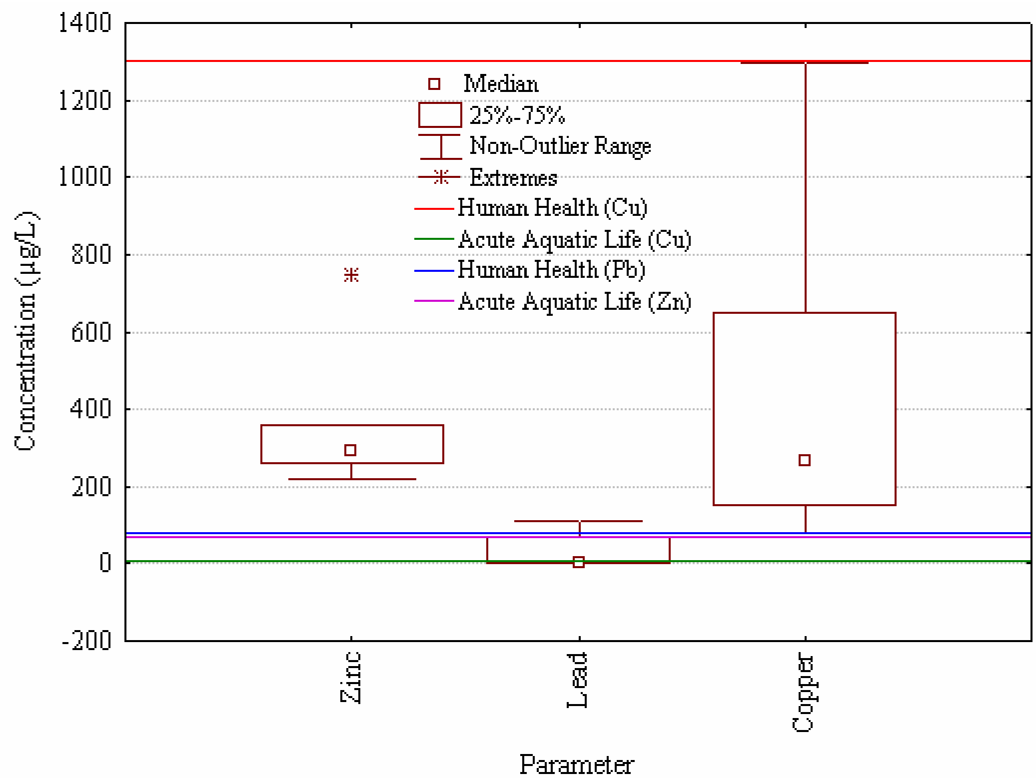


Nitrate + nitrate as N concentrations measured for stations on German Gulch in 2003 (N = 12 for all sites except STA-4 [N=4] and STA-3 [N=5]).

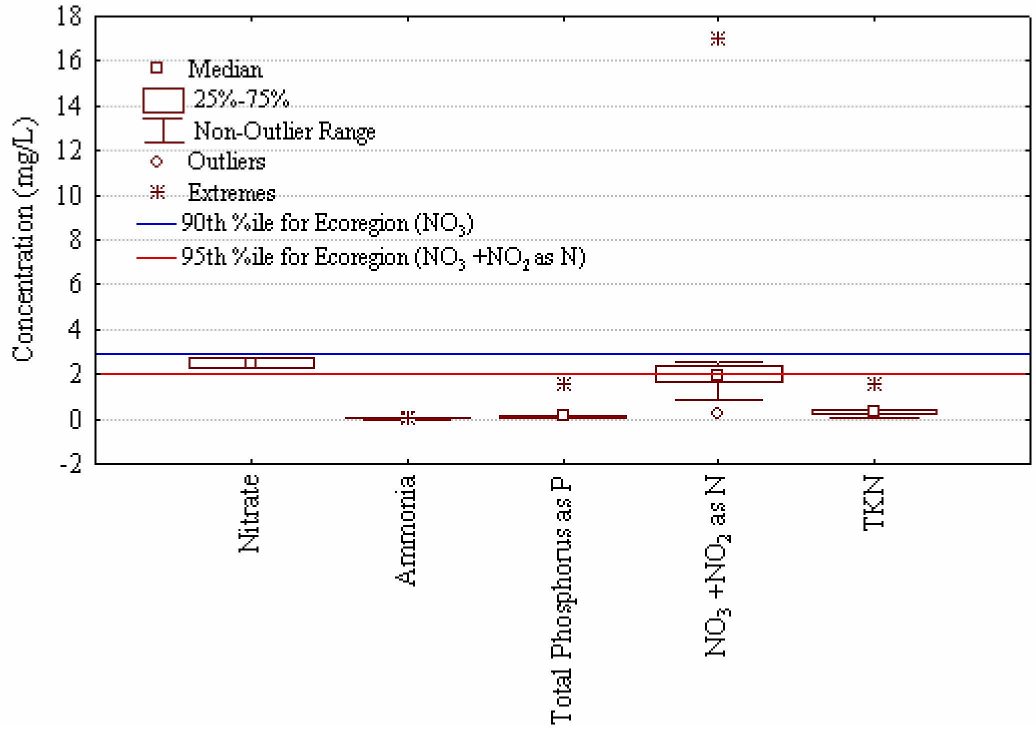
Water Quality Sampling, Basin and Blacktail Creek



Arsenic and cadmium concentrations measured on Basin Creek in 1975 (Station 3028SI01). N = 6.



Zinc, lead, and copper concentrations measured on Basin Creek in 1975 (Station 3028SI01). N = 6.



Nutrient concentrations measured in Blacktail Creek (STORET database, 1974 and 1977).

Appendix D Aerial Photo Assessment

The aerial assessment utilized several types of information, including both digital and non-digital data. The GIS environment provided a means to access most of this information using available digital datasets, and aerial photography and satellite imagery. The base layer utilized for the assessment consists of digital black and white aerial photography (Digital Orthophoto Quarter Quadrangles, or DOQQ's). These air photos were taken in 1995 and 1996, and are available for the entire watershed. Visual interpretation of the air photos helped assess general stream and riparian condition, identified infrastructure elements and general land use.

Reach breaks were visually determined based on a combination of changes in channel form, slope, riparian vegetation cover, valley configuration, drainage area, and location of major structures (bridges, diversions, etc.). A summary of data entry fields used to delineate and describe each reach is included below.

Parameters used to describe individual reaches in aerial assessment.

Parameter	***Purpose***
Reach names	Stream reaches were uniquely identified to allow easy correlation of results to site location. Furthermore, it will allow a GIS user to click on a specific stream reach to access an attribute table containing all relevant information and known data sources.
General Stream Type	Approximate channel lengths were based on available digital stream layers. The reach length identifies the spatial extent of a given condition and facilitates the determination of data needs. Reach length can also be utilized to estimate slope and sinuosity in a specific area.
Rosgen channel Type	General, qualitative classification of Rosgen channel type was performed based on observable conditions of regional valley slope, valley configuration and confinement, channel pattern, sediment storage patterns, and channel migration trends. Although parameters such as entrenchment, substrate gradations, and width/depth ratios cannot be accurately determined from aerial photography, patterns in sinuosity, gradient and geomorphic indicators allow fairly accurate determination of general Rosgen channel types that can be refined with field verification. Defining channel types will facilitate the identification of data collection needs, and provide a basis for communication among technical reviewers who may not have visited that specific reach.
Land Use	Observable land use within both the stream corridor and adjacent upland areas were recorded for each reach. Examples of land use descriptors include irrigated crops, timber harvest, hay production, mining, and grazing. Land use is an important descriptive parameter in regional assessment of human impacts, as well as the development of management strategies with respect to overall habitat and water quality.
Geology	Available published geologic maps were utilized to identify geologic units that comprise the main drainage area, or locally abut or underly the river corridor. Geologic controls can have a strong influence on soil erosion rates, stream sediment caliber, inherent channel resilience, runoff patterns, and groundwater-surface water interactions. Unfortunately, the only detailed geologic maps available are for the southern portion of the basin, hence the evaluation of geologic influences in the aerial assessment was spatially limited.

Parameter	Purpose
Potential Impairment	Observable indicators of potential degradation within each reach were documented. Examples of identifiable indicators of geomorphic degradation on aerial imagery include channelization, loss of channel form, excessive sediment storage, floodplain encroachment and riparian degradation. These factors are recognized in stream and watershed planning as potential sources of impairment.
Restoration Opportunity	Often from aerial photography we can estimate the type of restoration may be needed to address the identifiable impairment. These can be BMPs revegetation, stream restoration, water management, pollution mitigation, etc.
Other Opportunity	Other opportunities identified include land acquisition, trails, and fresh water sources.
Benefits	Benefits refer to those resources or services that may benefit from addressing the identified impairment such as riparian or fish habitata, water quality, or public access.
Limitations to Restoration	Potential factors that may limit restoration such as cost, active industrial operations, or pollution sources.
Reference Reach	If a reach shows the potential for reference conditions, it was noted along with its associated channel type. This information was used as an initial screening of potential reference data collection points.
Comments	Additional comments that may play a role in watershed restoration planning efforts were recorded. Examples include geographic features, geologic controls, impoundments, specific sediment sources and definitions of reach boundaries.

We then developed Rosgen Level 1 classifications (Rosgen, 1996) for each of the defined reaches, based on parameters observable in the aerial photography. Due to data limitations, slope was not calculated for each reach. A brief description of the suite of Rosgen channel types utilized in the assessment is included below.

Channel types (Rosgen, 1996).

Stream Type	*Fundamental Characteristics*
A	*A-Type Channels* are relatively steep channels that form in headwater areas as well as within bedrock canyons. These channels are entrenched and confined by steep valley margins such that little to no floodplain occurs on their border. As the boundaries of A-type channels are commonly highly resistant to erosion, these stream types are generally quite resilient with respect to human impacts. The most common cause of geomorphic change within A-type channels is due to large scale sediment transport events, (landslides, debris flows, debris jam failure) that may result in blockage or deflection of channel flow.
B	*B-Type Channels* tend to form downstream of headwater channels, in areas of moderate slope where the watershed transitions from headwater environments to valley bottoms. Moderate slopes, moderate entrenchment, and stable channel boundaries characterize B-channels. Due to the relatively steep channel slopes and stable channel boundaries, B-channels are moderately resistant to human impacts, although, their reduced slopes relative to headwater areas can make them prone to sediment deposition and subsequent adjustment in the event of a large sediment transport event such as an upstream landslide, debris flow, or flood.
C	*C-Type Channels* are typically characterized by relatively low slopes, meandering plan forms, and pool/riffle sequences. The channels tend to occur in broad alluvial valleys, and they are typically associated with broad floodplain areas. C-channels tend to be relatively sinuous, as they follow a meandering course within a single channel thread. In stream systems in which the boundaries of C-type channels are composed of alluvial sediments, channels tend to dynamic in nature, and susceptible to rapid adjustment in response to disturbance.
D	*D-Type Channels* are braided channels that have open bar deposits between multiple active channel threads. They tend to occur where sediment supply is abundant. They can commonly result from disturbances that increase sediment loads. D-channels are commonly aggradational, and are typically characterized by rapid rates of lateral adjustment.

DA	*DA-Type Channels* have multiple active channel threads that are relatively narrow and deep, separated by extensive, vegetated floodplains and wetlands. DA channels tend to form in areas of relatively low slope, with low bedload sediment volumes. Bank lines are typically very stable.
E	*E-Type Channels* are somewhat similar to C channels, as they form as single threads with defined, accessible floodplain areas. However, E channels are different in that they tend to have fine-grained channel margins, which provide cohesion and support dense bank line vegetation. The fine-grained, vegetation-reinforced bank lines allow for the development of steep banks, very sinuous plan forms, and relatively deep, U-shaped channel cross sections. E-type channels commonly form in low gradient areas with fine-grained source areas, mountain meadows, and in beaver-dominated environments. E-channels tend to have very stable plan forms, and efficient sediment transport capacities due to low width/depth ratios.
F	*F-Type Channels* typically have relatively low slopes (<2%), similar to C and E channel types. The primary difference between C/E channels and F channels is with respect to entrenchment. F channels are entrenched, which means that the floodplain is quite narrow relative to the channel width. The entrenchment of alluvial F-type channels typically is an indicator of an historic down cutting event. F-type channels may form in resistant boundary materials (e.g. U-shaped bedrock canyons), and relatively erodible alluvial materials (e.g. arroyos). When the boundary materials are erodible, the steep valley walls are prone to instability, and channel widening commonly occurs within the entrenched channel cross section.
G	*G-Type Channels* are entrenched, gully type channels with moderate slopes, and low width/depth ratios. These channels commonly have step/pool morphologies, and form as deeply incised streams in alluvial or colluvial materials. Commonly, G channels are unstable, and prone to accelerated sediment production due to active downcutting and bank erosion.

The following table contains the results of the aerial assessment. Reach breaks correspond to those on maps found in Chapter 7.0.

Appendix D Table 1: Aerial photography assessment results.

Stream	***Reach***	***General Stream Type***	***Rosgen Channel Type***	***Land Use/Cause***	***Geology***	***Potential Impairment***	***Restoration Need***	***Other Need***	***Benefits***	***Limitations to restoration***	***Reference Reach***	***Comments***
Blacktail Creek	BTC01	Montane	A	Natural	KTi	None	None					Headwaters above logging
Blacktail Creek	BTC02	Montane	A/B	Logging	KTi	Sediment, riparian	BMP, buffers, reveg		Fish, riparian habitat	None		Some streamside logging
Blacktail Creek	BTC03	Montane	E	Residential	KTi	Development, septic	BMP, septic regs.		Water quality		E Channel reference	Residential development; low gradient beaver ponde meadows
Blacktail Creek	BTC04	Montane	B	Road	KTi	Sediment, riparian	BMP, buffers, reveg		Fish, riparian habitat	Confinement		Narrow valley bottom, gravel road
Blacktail Creek	BTC05	Montane	B/E	Highway	KTi	Riparian, sediment	BMP		Fish, riparian habitat	Confinement	Downstream 1/4 mile	Long confined (by Hwy) reach, forced B channel (from E)
Blacktail Creek	BTC06	Montane	E/F	Ag, culverts	KTi	Riparian, sediment, fish habitat	BMP, channel restoration, reveg		Fish, riparian habitat	Ag operations		Channelized on margin of pasture/hay meadow
Blacktail Creek	BTC07	Valley Foothill	E/F	Ag	KTi	Channelization, riparian, fish habitat	BMP, channel restoration, reveg		Fish, riparian habitat	Ag operations	Upstream end reach	Channelized on margin of pasture/hay meadow
Blacktail Creek	BTC08	Valley Foothill	E	Ag	KTi	Riparian clearing	BMP, reveg		Fish, riparian habitat	Ag operations		Sinuous E channel in cleared valley bottom
Blacktail Creek	BTC09	Valley Foothill	E/F	Ag	KTi	Channelization, riparian, fish habitat	BMP, channel restoration, reveg		Fish, riparian habitat	Ag operations		Channelized within pasture/hay meadow; corridor management opportunity
Blacktail Creek	BTC10	Valley Foothill	C	Residential, golf course	KTi	Development, septic, nutrient runoff	BMP, septic regs., improved fertilizer management at golf course		Water quality	Residential Encroachment	C	Fairly wide corridor/riparian zone within residential area
Blacktail Creek	BTC11	Valley Foothill	F	Residential	KTi	Riparian, fish habitat	Channel restoration, reveg		Fish, riparian habitat	Residential Encroachment		Entrenched, historically channelized through residential area
Blacktail Creek	BTC12	Valley Foothill	F	Residential/Urban	KTi	Riparian, fish habitat	Channel restoration, reveg		Fish, riparian habitat	Residential, Roadway Encroachment		To Silver Bow Creek; entrenched, historically channelized through Butte
Basin Creek	BC01	Montane	A/E	Road	KTi	Sediment	BMP		Fish Habitat			Very small area of disturbance
Basin Creek	BC02	Montane	A	None	KTi	None					Yes	No visible impairments

Stream	***Reach***	***General Stream Type***	***Rosgen Channel Type***	***Land Use/Cause***	***Geology***	***Potential Impairment***	***Restoration Need***	***Other Need***	***Benefits***	***Limitations to restoration***	***Reference Reach***	***Comments***
Basin Creek	BC03	Montane	A	Reservoirs	KTi	None	BMP, source water protection		Water Quality			Basin Creek Reservoir(s) reach. Protect water quality
Basin Creek	BC04	Montane	B	Roads, grazing	KTi	Sediment, riparian	BMP, reveg	Trails	Fish, riparian habitat, recreation	Water quantity		Road impacts, reduced riparian cover
Basin Creek	BC05	Montane	E	Riparian degradation, grazing?	KTi	Riparian	BMP, reveg	Trails	Fish, riparian habitat, recreation	Water quantity		Improves toward downstream end of reach
Basin Creek	BC06	Valley Foothill	E	Riparian degradation, grazing?	Qa	Riparian, fish habitat	BMP, reveg	Trails	Fish, riparian habitat, recreation	Water quantity		Reduced riparian, development impacts
Basin Creek	BC07	Valley Foothill	E	Riparian degradation, grazing?	Qa	Riparian, fish habitat	BMP, reveg	Trails	Fish, riparian habitat, recreation	Water quantity		Reduced riparian cover, may be partially due to dewatering
Basin Creek	BC08	Valley Foothill	E/F	Riparian degradation, development, grazing?	Qa	Channelization, riparian, fish habitat	Channel restoration, reveg	Trails	Fish, riparian habitat, recreation	Water quantity		Channelized before airport. Trail corridor?
Basin Creek	BC09	Valley Foothill	E/F	Riparian degradation, urban impacts	Qa	Channelization, riparian, fish habitat, culverts, storm water impacts	BMP, reveg	Trails	Fish, riparian habitat, recreation	Water quality, water quantity		Culverts under runways, storm water runoff, urban impacts. Trail corridor?
Browns Gulch	BG01	Montane	B	Logging, roads	KTv	Siltation, riparian	BMP		Fish, riparian habitat			Several clearcuts nearby, thin riparian in places
Browns Gulch	BG02	Montane	E	Road, cattle grazing?	KTv	Siltation?, riparian degradation?	BMP		Fish, riparian habitat			Road close to stream, no logging nearby, some cattle grazing
Browns Gulch	BG03	Montane	E	Riparian degradation, grazing, bank erosion	Qs	Riparian degradation, siltation, habitat alteration, bank erosion	BMP, buffers, reveg		Fish, riparian habitat	Water quantity		Relatively confined, grazing, not much irrigation
Browns Gulch	BG04	Montane	E	Riparian degradation, dewatering, grazing	KTv, Qs	Riparian degradation, siltation, habitat alteration, bank erosion, flow alt	BMP, buffers, reveg		Fish, riparian habitat	Water quantity		Long widening valley from above. Abt flood irrigated pasture, heavily grazed riparian

Stream	***Reach***	***General Stream Type***	***Rosgen Channel Type***	***Land Use/Cause***	***Geology***	***Potential Impairment***	***Restoration Need***	***Other Need***	***Benefits***	***Limitations to restoration***	***Reference Reach***	***Comments***
Browns Gulch	BG05	Montane	E, occasional B	Riparian degradation, dewatering, grazing	KTv, Qs	Riparian degradation, siltation, habitat alteration, bank erosion, flow alt	BMP, buffers, reveg		Fish, riparian habitat	Water quantity		Canyon stretch, could be significant habitat. Canyon ranges from 100-800 ft wide
Browns Gulch	BG06	Valley Foothill	E	Riparian degradation, dewatering, grazing	KTv, Qs	Riparian degradation, loss of channel definition, siltation, habitat alteration, bank erosion, flow alt	BMP, buffers, reveg		Fish, riparian habitat	Water quantity		Intermittent canyon. Lack of channel definition from dewatering.
Browns Gulch	BG07	Valley Foothill	E	Riparian degradation, channelization, dewatering, grazing	KTv, Qs	Riparian degradation, channelization, siltation, habitat alteration, bank erosion, flow alt	BMP, channel restoration, buffers, reveg		Fish, riparian habitat	Water quantity, water quality (DuPont)		Open reach from canyons to I-90. Locally channelized. Historic DuPont explosives site has unknown risk.
Browns Gulch	BG08	Valley Foothill	E	Highway, railroad	KTv, Qs	Riparian degradation, siltation, culvert	Reveg, channel restoration, BMP		Fish, riparian habitat	Water quantity, water quality, fish passage barrier?		Short reach between I-90 and RR. Trail connection with Greenway?
Browns Gulch	BG09	Valley Foothill	E	Mining, RR.	KTv, Qs	Mine tailings, Riparian degradation, siltation, culvert	Remove tailings, Reveg, channel restoration, BMP		Fish, riparian habitat	Water quantity, water quality, fish passage barrier?		Short reach between RR and Silver Bow Creek. Floodplain tailings.
German Gulch	GG01	Montane	A	Natural	Ks	None	None					Headwaters above Beal Mine
German Gulch	GG02	Montane	A	Mining	Ks	Sediment, riparian, mining impacts, metals	Stream restoration, reveg, BMP		Fish, riparian habitat	Legal		Within active mine area. Stream diverted through culverts, riparian cover removed.
German Gulch	GG03	Montane	A	Placer Mining, roads	Ks, KTi, KTv	Riparian, sediment, metals, channel modifications	Stream restoration, reveg, BMP	Trails	Fish, riparian habitat			Extensive placer mining, good habitat locally

Stream	***Reach***	***General Stream Type***	***Rosgen Channel Type***	***Land Use/Cause***	***Geology***	***Potential Impairment***	***Restoration Need***	***Other Need***	***Benefits***	***Limitations to restoration***	***Reference Reach***	***Comments***
German Gulch	GG04	Montane	A	Placer Mining, roads	Ks, KTi, KTv	Riparian, sediment, channel modifications	Stream restoration, reveg, BMP	Trails	Fish, riparian habitat			Some placer mining, good habitat locally, canyon section
German Gulch	GG05	Montane	A	Grazing	KTv	Riparian, sediment, weeds	BMP, weed management	Trails	Fish, riparian habitat, recreation			Protect existing resources, BMPs for grazing, weed management
Willow Creek	WC01	Montane	A	Natural	KTi, KTv	Smelter Impacts?	BMP, soil amendment(?), reveg		Fish, riparian habitat	Cost of soil amendments		Short reach above logging impacts. Are soils impacted?
Willow Creek	WC02	Montane	A	Logging, roads, minimal buffers	KJs, KTv	Siltation, channel alteration, headcutting, riparian degradation	BMP, reveg, road removal, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		Abundant logging, reported headcutting, siltation, embeddedness, exacerbated by smelter impacts. Minimal buffers between logging and streams.
Willow Creek	WC03	Montane	A	Logging, roads, moderate buffers	KTv	Siltation, channel alteration, headcutting, riparian degradation	BMP, reveg, road removal, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		Abundant logging, reported headcutting, siltation, embeddedness, exacerbated by smelter impacts. Moderate buffers between logging and streams.
Willow Creek	WC04	Montane	A	Logging, roads, minimal buffers	KTv	Siltation, channel alteration, headcutting, riparian degradation	BMP, reveg, road removal, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		Smelter impacts to upland veg very visible, tribs impacted, abundant logging.
Willow Creek	WC05	Montane	A/B	Roads, upland logging and smetler impacts	KTv	Siltation, riparian, smelter impacts	BMP, reveg, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		Transition to B channel. Upland logging and smelter impacts still impacting stream.
Willow Creek	WC06	Montane	B/E	Roads, upland logging and smetler impacts	KTv	Siltation, riparian, smelter impacts	BMP, reveg, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		B channel with local E portions. Uplands impacts still important
Willow Creek	WC07	Valley Foothill	B	Grazing, upland logging and smetler impacts	Qs, KTv	Riparian degradation, siltation, smelter impacts	BMP, reveg, soil amendment(?)		Fish, riparian habitat	Cost of soil amendments		Narrow riparian zone, uplands show reduced vegetation. Above RR crossing.
Willow Creek	WC08	Valley Foothill	B/E	Grazing, upland impacts, dewatering	Qs	Riparian degradation, siltation, loss of channel definition	BMP, reveg, water management		Fish, riparian habitat			Degrading riparian zone moving downstream. Losing stream definition (dewatering)

Stream	***Reach***	***General Stream Type***	***Rosgen Channel Type***	***Land Use/Cause***	***Geology***	***Potential Impairment***	***Restoration Need***	***Other Need***	***Benefits***	***Limitations to restoration***	***Reference Reach***	***Comments***
Willow Creek	WC09	Valley Foothill	B/E	Grazing, upland impacts, dewatering	Qs	Riparian degradation, siltation, loss of channel definition, water quality from Yellow Ditch	Pollution mitigation, BMP, reveg, water management		Fish, riparian habitat	Legal		Dewatering impacts, riparian degradation, water quality concerns from Yellow Ditch.
Willow Creek	WC10	Valley Foothill	B/E	Grazing, upland impacts, dewatering. Residential development	Qs	Riparian degradation, siltation, loss of channel definition, water quality (nutrients from septic systems and metals	Pollution mitigation, BMP, reveg, water management	Trails, fishing access	Fish, riparian habitat			Abundant algae reported by Montana DEQ as well as metals exceedences. Visible dewatering impacts, riparian degradation,
Mill Creek	MC01	Montane	A		Kti, Ys	None		Land Acquisition	Access, recreation	Ownership, cost of acquisition		Privately owned area, Miller Lake and headwaters.
Mill Creek	MC02	Montane	B	Natural sand/silt substrate, smelter impacts	Qs	Upland and riparian degradation vegetation	BMP, reveg	Land Acquisition	Access, recreation, fish habitat	Ownership, cost of acquisition		Appears to be sediment choked from Kti and Qs and smelter impacts.
Mill Creek	MC03	Montane	B/E	Smelter Impacts, riparian and upland degradation	Qs, KTi	Riparian and upland vegetation degradation	BMP, reveg	Land Acquisition	Access, recreation, fish habitat	Ownership, cost of acquisition		Riparian and upland vegetation degradation from smelter impacts. May be causing siltation.
Mill Creek	MC04	Montane	B	Smelter Impacts, riparian and upland degradation	Qs, KTi	Riparian and upland vegetation degradation	BMP, reveg		Riparian, fish habitat			Riparian and upland vegetation degradation from smelter impacts. May be causing siltation. Metals from Cabbage Gulch runoff
Mill Creek	MC05	Valley Foothill	B	Mining and smelting, dewatering	Qs	Metals, riparian degradation	Pollution mitigation, BMP, reveg, water management		Fish, riparian habitat	Pending litigation		Metals from smelting activities, dewatering.
Mill Creek	MC06	Valley Foothill	B	Mining and smelting, dewatering	Qs	Metals, riparian degradation, dewatering	Pollution mitigation, BMP, reveg, water management	Trails	Fish, riparian habitat	Pollution sources		Yellow ditch and smelter impacts, dewatering

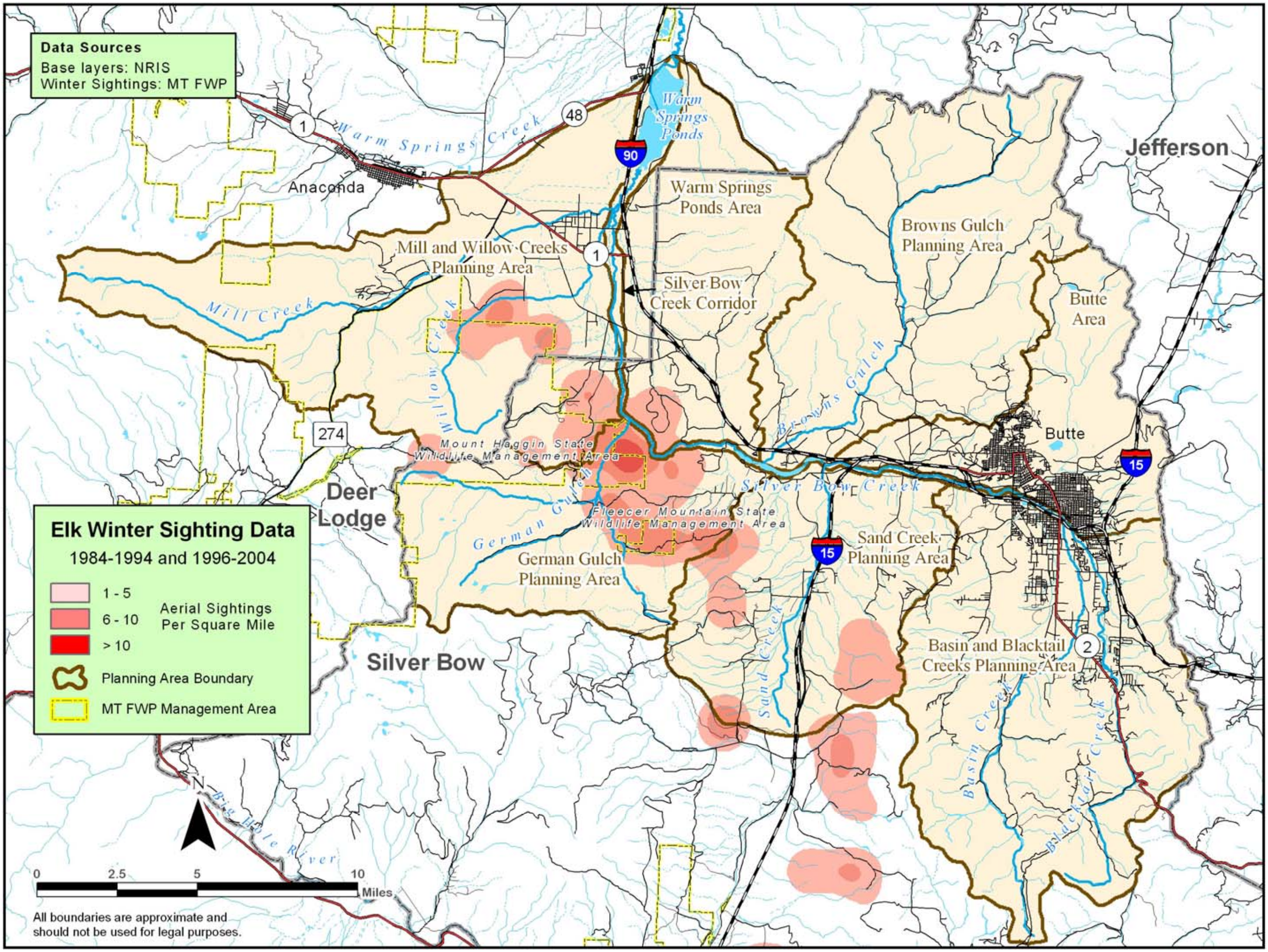
Stream	*Reach*	*General Stream Type*	*Rosgen Channel Type*	*Land Use/Cause*	*Geology*	*Potential Impairment*	*Restoration Need*	*Other Need*	*Benefits*	*Limitations to restoration*	*Reference Reach*	*Comments*
Mill Creek	MC07	Valley Foothill	B	Mining and smelting, dewatering, urban	Qs	Metals, riparian degradation, dewatering, nutrients from Opportunity septic systems	Pollution mitigation, BMP, reveg, water management	Trails	Fish, riparian habitat	Pollution sources		Opportunity wastewater, metals, dewatering impacts. Trails opportunity.
Sand Creek	SC01	Valley Foothill	B	Minor highway, RR	Tb							Headwaters reach
Sand Creek	SC02	Valley Foothill	B	RR, highway, channel modofications	Tb	Metals, riparian degradation	Pollution mitigation?		Water quality, riparian			Possible metals contamination from RR, could impact groundwater or Silver Bow Creek (during runoff). Riparian veg/wetlands would help mitigate pollution.
Sand Creek	SC03	Valley Foothill	B	RR, highway, industrial sites, channel modofications	Tb							Possible metals contamination from RR and industrial sites, could impact groundwater or Silver Bow Creek (during runoff). Riparian veg/wetlands would help mitigate pollution.
Silver Bow Creek	Silver Bow Creek01	Montane	A	None	KTi	None		Clean water source	Water quality, vegetation	Active mining operation	Yes, classic beaver ponded channel	Water currently flowing into Yankee Doodle tailings could be used for better purposes (Greening of Butte, dilution)
Yankee Doodle Creek	YDC01	Montane	A	None	KTi	None	Protect water supply			Active mining operation		
Yankee Doodle Creek	YDC02	Montane	B	None	KTi, KTv	None		Clean water source	Water quality, vegetation	Active mining operation		Water currently flowing into Yankee Doodle tailings could be used for better purposes (Greening of Butte, dilution)

Appendix E Montana FWP Wildlife Aerial Sighting Data

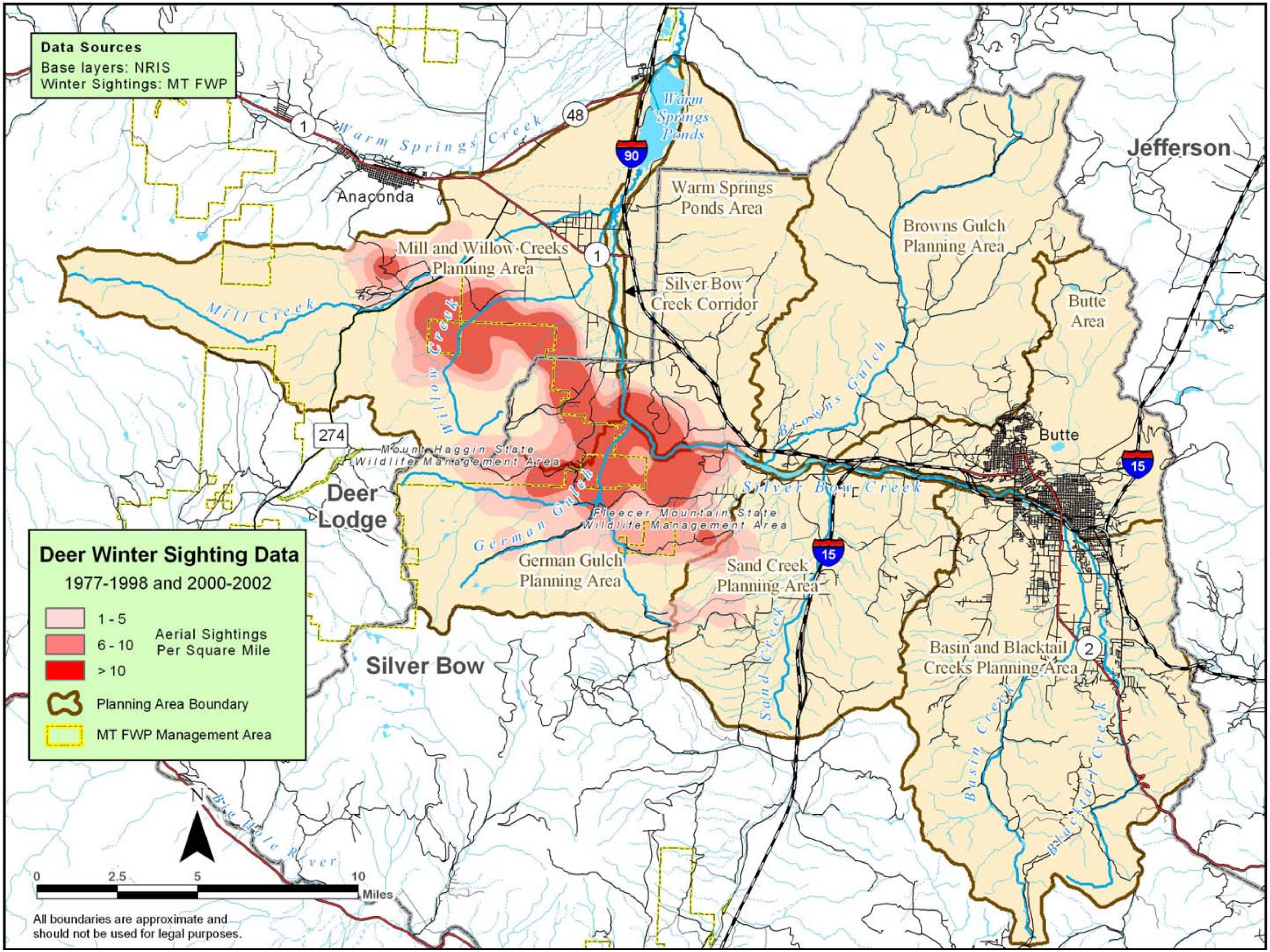
From 1977 through 2004, Montana FWP personnel conducted aerial sighting surveys of elk, deer, and antelope over the southern and western portions of the Silver Bow Creek watershed. Dan Hook, a retired biologist for Montana FWP, compiled and converted the data to GIS format for this plan as a contracted service to the NRDP. Data collected are intermittent for each species throughout the years. The maps below present the distribution of sightings through the years and do not represent population densities. In addition, each data set covers differing years. The table below lists the differences between the data sets.

Species	***Years Data Collected***	***Number of Years***	***Data points***
Elk	1984-1994 and 1996-2004	20	200
Deer	1977-1998 and 2000-2002	23	656
Antelope	1998-2000 and 2002	4	21

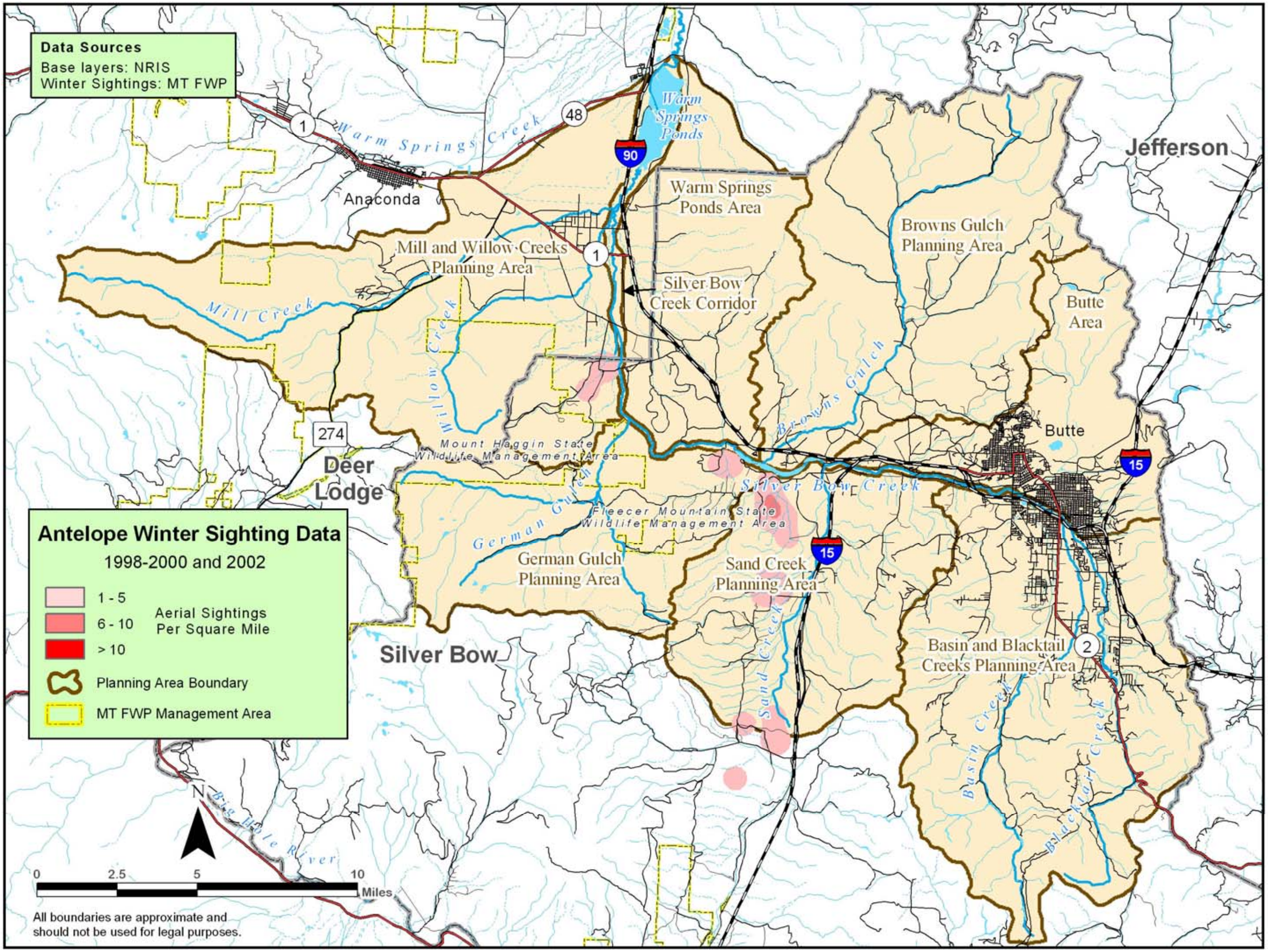
This distribution of data indicate why each data set should be examined separately from the others and should not be compared to each other. For example, the winter sighting data set for deer contains 656 sightings distributed over 23 years of surveys. These data should not be compared with those for antelope, with 21 sightings in four years of surveys. It is possible, however, to examine the general extent of the density of data points to get an overview of the extent of winter ranges for each species. Both elk and deer winter range occur in the public/private land boundary in the German Gulch and Mill and Willow creeks planning areas. These areas are noted in sections 7.2 and 7.3 of this document as important winter range threatened by potential future development.



Data Sources
Base layers: NRIS
Winter Sightings: MT FWP
Elk Winter Sighting Data
1984-1994 and 1996-2004
1 - 5
6 - 10
> 10
Aerial Sightings Per Square Mile
Planning Area Boundary
MT FWP Management Area
0
2.5
5
10
Miles
All boundaries are approximate and should not be used for legal purposes.
Warm Springs Creek
Warm Springs Ponds
Anaconda
Jefferson
Warm Springs Ponds Area
Browns Gulch Planning Area
Mill and Willow Creeks Planning Area
Silver Bow Creek Corridor
Butte Area
Mill Creek
Willow Creek
Browns Gulch
Butte
Mount Haggin State Wildlife Management Area
Deer Lodge
Silver Bow Creek
Fleecer Mountain State Wildlife Management Area
German Gulch
German Gulch Planning Area
Sand Creek Planning Area
Sand Creek
Basin and Blacktail Creeks Planning Area
Silver Bow
Basin Creek
Blacktail Creek
Big Hole River
N
1
48
90
274
15
2



Data Sources
Base layers: NRIS
Winter Sightings: MT FWP
Deer Winter Sighting Data
1977-1998 and 2000-2002
1 - 5
6 - 10
> 10
Aerial Sightings Per Square Mile
Planning Area Boundary
MT FWP Management Area
Anaconda
Jefferson
Deer Lodge
Silver Bow
Butte
Warm Springs Ponds
Warm Springs Ponds Area
Warm Springs Creek
Mill and Willow Creeks Planning Area
Mill Creek
Willow Creek
Silver Bow Creek Corridor
Browns Gulch Planning Area
Browns Gulch
Butte Area
Mount Haggin State Wildlife Management Area
Fleecer Mountain State Wildlife Management Area
German Gulch
German Gulch Planning Area
Silver Bow Creek
Sand Creek Planning Area
Sand Creek
Basin and Blacktail Creeks Planning Area
Basin Creek
Blacktail Creek
Big Hole River
1
48
90
274
15
2
N
0
2.5
5
10
Miles
All boundaries are approximate and should not be used for legal purposes.



Data Sources
Base layers: NRIS
Winter Sightings: MT FWP
Antelope Winter Sighting Data
1998-2000 and 2002
1 - 5
6 - 10
> 10
Aerial Sightings
Per Square Mile
Planning Area Boundary
MT FWP Management Area
All boundaries are approximate and
should not be used for legal purposes.
0
2.5
5
10
Miles
Warm Springs Ponds
Warm Springs Creek
Anaconda
Jefferson
Warm Springs Ponds Area
Browns Gulch Planning Area
Mill and Willow Creeks Planning Area
Silver Bow Creek Corridor
Butte Area
Mill Creek
Willow Creek
Browns Gulch
Butte
Mount Haggin State Wildlife Management Area
Deer Lodge
Silver Bow Creek
Fleecer Mountain State Wildlife Management Area
German Gulch
German Gulch Planning Area
Sand Creek Planning Area
Sand Creek
Silver Bow
Basin and Blacktail Creeks Planning Area
Basin Creek
Blacktail Creek
Big Hole River
N
90
15
1
48
274
2