Big Spring Creek Watershed Water Quality Restoration Plan and Total Maximum Daily Loads

Montana Department of Environmental Quality

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BIG SPRING CREEK TMDL
EXECUTIVE SUMMARY

E.1 Introduction

This document presents Total Maximum Daily Loads (TMDLs) for the Big Spring Creek TMDL Planning Area (TPA), located in Fergus County, Montana. A TMDL is a pollutant budget identifying the maximum amount of a particular pollutant (sediment, nutrients, PCBs) that a waterbody can receive without causing applicable water quality standards to be exceeded. Section 303(d) of the Clean Water Act requires states to assess its waterbodies (streams, rivers, lakes and reservoirs) and identify waters that are not meeting water quality standards. Section 303 of the Federal Clean Water Act and section 75-5-703 of the Montana Water Quality Act requires development of TMDLs for waterbodies that are not meeting State water quality standards (impaired waters).

Four streams within the Big Spring Creek TPA were listed as impaired on the state's 2004 303(d) list. These streams are: Big Spring Creek, Beaver Creek, Cottonwood Creek and Casino Creek. Table E-1 summarizes the present impairment status for these streams and lists the pollutants of concern that require the development of Total Maximum Daily Loads.

Table E-1. Present Impairment Status for Streams in the Big Spring Creek TMDL Planning Area.

Waterbody	Year Listed	Listed Probable Causes	Current Status
Big Spring Creek (MT41S004_010) headwaters to confluence with E. Fork	1996	Nutrients Other habitat alterations Suspended solids	Impaired for PCBs **PCB TMDL required**
	2004	PCBs	
Big Spring Creek (MT41S004_020) confluence of E. Fork to mouth	1996	Noxious aquatic plants Nutrients Other habitat alterations Siltation	Impaired for sediment, nutrients, PCBs **Sediment TMDL required** **Nutrient TMDL required** **PCB TMDL required**
	2004	PCB Nutrients Siltation Other habitat alterations Riparian degradation Fish habitat degradation	
Beaver Creek (MT41S004_030)	1996	Nutrients Suspended solids	Not Impaired No TMDL required
	2004	Bank erosion Riparian degradation Other habitat alterations Nutrients Siltation Fish habitat alteration Dewatering	
Casino Creek (MT41S004_040)	1996	Nutrients Suspended solids	Impaired for nutrients

Table E-1. Present Impairment Status for Streams in the Big Spring Creek TMDL Planning Area.

Waterbody	Year Listed	Listed Probable Causes	Current Status
	2004	Nutrients Other habitat alterations Riparian degradation	**Nutrient TMDL required**
Upper Cottonwood Creek (MT41S004_051)	1996	Nutrients Organic enrichment/DO Suspended solids	Not Impaired No TMDL required
	2004	Fully supporting beneficial uses	
Lower Cottonwood Creek (MT41S004_052)	1996	Nutrients Organic enrichment/DO Suspended solids	Impaired for nutrients, dissolved oxygen **Nutrient/Dissolved Oxygen TMDL required**
	2004	Nutrients Siltation Organic enrichment/low DO Flow alteration Dewatering Other habitat alterations Riparian degradation Fish habitat degradation	

A summary of pollutant-related issues follows. Table E-3 provides a summary of all required TMDL elements for the Big Spring TMDL Planning Area.

E.2 Big Spring Creek

Big Spring Creek is presently impaired due to PCBs, sediment and nutrients. Verification and justification for these impairment determinations are given in Sections 4.0, 6.0, and 7.0. Required TMDL elements for each of these pollutants have been prepared and are given in Sections 5.0, 6.0 and 8.0. A summary of each pollutant-related issues follows.

E.2.1 PCBs

In 2003, paint used on the raceways of the Big Springs Trout Hatchery was identified as the source of PCBs in Big Spring Creek. Decades of maintenance operations at the Big Springs Trout Hatchery resulted in the flushing of PCB-containing paint chips into Big Spring Creek. Recent sampling of stream sediments in Upper Big Spring Creek, from the trout hatchery to its confluence with East Fork Big Spring Creek, show elevated levels of PCBs in the stream substrate. Tissue samples from trout in Big Spring Creek contain levels of PCB well above ‘do not eat’ guidelines issued by the Montana Department of Health & Human Service. In response to this new information the Montana Department of Fish, Wildlife & Parks (FWP) has placed ‘Catch and Release Only’ restrictions on upper Big Spring Creek as a precaution.

Water quality targets have been developed that, when achieved, will reflect attainment of water quality standards and a non-impaired condition for PCBs. Targets include:

- Fish tissue PCB concentrations <0.025 ppm
- Stream sediment PCB concentrations <0.187 ppm

The **Total Maximum Daily Load of PCB** is expressed as a percent reduction. Based on existing data, a 79% reduction in average PCB concentration in stream sediments will result in achieving stream sediment PCB concentrations of <0.187 ppm. Identification and remediation of sources of PCB at the Big Springs Trout Hatchery will ensure that no additional inputs of PCBs from the hatchery will reach Big Spring Creek; hence a 100% reduction in loading from the trout hatchery is expected. In order to meet water quality targets and attain water quality standards, considerable cleanup of in-stream PCB-contaminated sediments must be conducted. Presently, FWP is investigating possible remediation strategies and feasibility studies to accomplish this goal. **Restoration actions, effectiveness monitoring of implementation activity** will be developed, based on the outcomes of FWP-led investigations.

E.2.2 Sediment

Significant sources of sediment impairment in Big Spring Creek include: bank erosion, urban nonpoint source inputs, and tributary inputs. Flow is a major influence on the ability of Big Spring Creek to transport sediment loads. Low flows and the lack of seasonal flushing flows due to upstream reservoirs may inhibit Big Spring Creek from gaining the competency to flush fine sediment accumulation from stream substrates.

Water quality targets for sediment include:

- Periphyton siltation index <25
- Percent macroinvertebrate clinger taxa >50%
- Percent surface fine particles less that 2mm diameter <20%

The **Total Maximum Daily Load of sediment** is expressed in terms of performance-based measures, and calls for:

- <20% unstable and eroding stream banks for middle and lower Big Spring Creek
- 60% reduction in total suspended solids loads from urban stormwater and runoff
- Maintaining seasonal flushing flows. Specific flushing flow recommendations are not given. Rather, investigation into flushing flow methodologies and implementation actions should be conducted to ensure that flow objectives are met

Restoration strategies include working collectively with local city officials, landowners and natural resource agencies (FWP, NRCS, DNRC, DEQ) to enhance riparian health through establishing stable streambanks through implementation of BMPs, revegetation, and other means to reduce sediment inputs from eroding banks, and urban inputs. Establishing flushing flow recommendations will require the effort of a multidisciplinary team to establish objectives and appropriate methodologies to reach flushing flow objectives.

E.2.3 Nutrients

Nutrient source assessments identify phosphorous loads coming from the Lewistown wastewater treatment plant (WWTP) as the major source of nutrients affecting impairment conditions on Big Spring Creek. In the segment immediately downstream from Lewistown the WWTP is estimated to contribute over 75% of the phosphorous load to Big Spring Creek during typical summertime flows. Lesser inputs are received from tributaries, urban sources, land-use related sources, and natural background sources (Table 8-6).

Water quality targets for nutrients include:

- Total Nitrogen concentrations <0.500 mg/L
- Total Phosphorous concentrations <0.035 mg/L
- Chlorophyll-a densities <100 mg/m^2 summer mean, <150 mg/m^2 summer max

Total Nitrogen targets are presently being met in Big Spring Creek. Total phosphorous targets are exceeded; therefore a TMDL of phosphorous is calculated. Because allowable phosphorous concentrations are a function of flow, the **TMDL is dependent on flow conditions**. Table E-2 presents the TMDL of phosphorous under different flow conditions, and shows the necessary load reduction required to meet the TMDL.

Table E-2. Phosphorous TMDLs, Existing Loads, and Load Reductions for Big Spring Creek.

Flow (cfs)	TMDL (lbs/day)	Existing Load (lbs/day)	Load Reduction (lbs/day)
80	15.1	28.2	13.1
88	16.6	29.1	12.5
110	20.8	30.4	9.6
150	28.3	37.3	9.0
200	37.8	45.0	7.2
250	47.2	53.9	6.8

As the Lewistown WWTP contributes over 75% of the phosphorous load to Big Spring Creek during typical summer flows, load reductions are allocated to the Lewistown WWTP. Presently, the WWTP is undergoing a substantial upgrade and will be capable of meeting necessary phosphorous reductions once upgrades are complete. Future effluent discharge permits issued by the Montana Department of Environmental Quality (DEQ) shall incorporate existing loading estimates given in Table E-2 and any new data that will allow refinement of loading estimates. It is assumed that, once plant upgrades are in place and permitted phosphorous discharges are reduced, Big Spring Creek will meet water quality targets.

E.3 Beaver Creek

No TMDLs are required for Beaver Creek. Recent water quality assessments and analysis conducted by the DEQ have determined that present conditions do not violate water quality standards for sediment or nutrients and therefore no TMDL is required.

E.4 Casino Creek

Casino Creek is presently impaired due to nutrients. Verification and justification for these impairment determinations are given in Section 7.0. Required TMDL elements for have been prepared and are given in Section 8.0. A summary of the nutrient-related issues follows.

E.4.1 Nutrients

Source assessments in Casino Creek are limited to field reconnaissance and information from aerial assessments. Water quality data does not have the spatial coverage to adequately characterize contributions from different natural and anthropogenic sources. However, nitrogen and phosphorous concentrations in Casino Creek are elevated above target conditions, necessitating the development of a nutrient TMDL. In the absence of numeric source assessment information that allows nutrient loads to be allocated to specific sources, a qualitative approach that identifies source categories and utilizes performance-based approaches to reduce loads for these categories is employed.

Water quality targets for nutrients include:

- Total Nitrogen concentrations <0.500 mg/L
- Total Phosphorous concentrations <0.035 mg/L
- Chlorophyll-a densities <100 mg/m^2 summer mean, <150 mg/m^2 summer max

Because specific nutrient sources have not been adequately assessed, allocation of loads to specific sources cannot be conducted at this time. Rather, attention should be focused on developing land use practices that protect and maintain water quality. Building and maintaining relationships between landowners and local natural resource agencies (FWP, NRCS) is integral to efforts to restore Casino Creek to an unimpaired condition. To date, local agencies and organizations such as NRCS, FWP, Fergus County Conservation District, and the Big Spring Creek Watershed Partnership have succeeded in developing and implementing a variety of projects (Table 4-3 and 5-6) that have enhanced riparian health through BMP implementation and fisheries improvement projects. The success of the public/private partnership is realized through these efforts, and the continuation of these efforts is crucial and should be the major mechanism for implementing projects aimed at restoring beneficial uses in Casino Creek and meeting water quality targets.

E.5 Cottonwood Creek

Cottonwood Creek is presently impaired due to nutrients/low dissolved oxygen. Verification and justification for these impairment determinations are given in Section 7.0. Required TMDL elements for have been prepared and are given in Section 8.0. A summary of pollutant-related issues follows.

E.5.1 Nutrients/Low Dissolved Oxygen

A detailed source assessment that identifies natural and anthropogenic sources contributing to nutrient impairment conditions in Cottonwood Creek is lacking. In the absence to information that allows identification, quantification and allocation to specific sources and contributing factors, it would be premature to speculate on the causes of impairment in Cottonwood Creek. It is likely that a suite of interrelated factors, natural and non-natural are responsible for wide dissolved oxygen fluctuations, algal growth, high water temperature and low flows. It is expected that, as additional data and information becomes available, contributing sources will be identified and over time, inferences and assumptions will be revisited and reevaluated.

Water quality targets for nutrients/dissolved oxygen:

- The target value for dissolved oxygen is to maintain minima above the Montana water quality standard for B-1 waters of 4 mg/l.
- The target value for summertime streambed coverage by filamentous algae is $\leq$ 30%.
- The target for chlorophyll-a concentration in Big Spring Creek is 100 mg/m^2 mean summer (June 1^{st} – Nov 1^{st}) concentration and 150 mg/m^2 maximum summer concentration.

Lack of adequate source assessment information precludes the development of total maximum daily loads, and therefore load allocations at this time. Monitoring and assessment activities given in Section 8.2.5 are proposed to gather information in order to properly assess source contributions.

Table E-3 provides a summary of all required TMDL components for impaired streams in the Big Springs TMDL Planning Area.

Table E-3. Water Quality Restoration Plan and TMDL Summary Information.

<table>
<tr>
<td>Waterbodies, Pollutants of Concern, and Current Impairment Status</td>
<td>The following four (6) individual waterbodies were addressed by either demonstrating that they are currently not impaired, or by preparing all necessary TMDLs:
<table>
<tr><th>Waterbody</th><th>Year Listed</th><th>Listed Probable Causes</th><th>Current Status</th></tr>
<tr><td rowspan="2">Big Spring Creek (MT41S004_010) headwaters to confluence with E. Fork</td><td>1996</td><td>Nutrients
Other habitat alterations
Suspended solids</td><td rowspan="2">Impaired for PCBs

PCB TMDL required</td></tr>
<tr><td>2004</td><td>PCBs</td></tr>
</table>
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</tr>
</table>

Table E-3. Water Quality Restoration Plan and TMDL Summary Information.

		2004	PCB Nutrients Siltation Other habitat alterations Riparian degradation Fish habitat degradation	
	Beaver Creek (MT41S004_030)	1996	Nutrients Suspended solids	No TMDL required
		2004	Bank erosion Riparian degradation Other habitat alterations Nutrients Siltation Fish habitat alteration Dewatering	
	Casino Creek (MT41S004_040)	1996	Nutrients Suspended solids	Impaired for nutrients **Nutrient TMDL required**
		2004	Nutrients Other habitat alterations Riparian degradation	
	Upper Cottonwood Creek (MT41S004_051)	1996	Nutrients Organic enrichment/DO Suspended solids	No TMDL required
		2004	Fully supporting beneficial uses	
	Lower Cottonwood Creek (MT41S004_052)	1996	Nutrients Organic enrichment/DO Suspended solids	Impaired for nutrients, dissolved oxygen **Nutrient/Dissolved Oxygen TMDL required**
		2004	Nutrients Siltation Organic enrichment/low DO Flow alteration Dewatering Other habitat alterations Riparian degradation Fish habitat degradation	

Table E-3. Water Quality Restoration Plan and TMDL Summary Information.

Section 303(d)(a) or 303(d)(3) TMDL	303(d) TMDLs to address: PCB in Big Spring Creek (MT41S004_010) PCB in Big Spring Creek (MT41S004_020) Sediment in Big Spring Creek (MT41S004_020) Nutrients in Big Spring Creek (MT41S004_020) Nutrients in Casino Creek (MT41S004_040) Nutrients in Cottonwood Creek (MT41S004_052) Dissolved Oxygen in Cottonwood Creek (MT41S004_052)	
Impaired Beneficial Uses	Waters appeared on the 1996 and/or 2002 303(d) lists for partial support, or threatened status, for beneficial uses: cold water fishery, aquatic life, recreation, drinking water, and industry.	
Pollutant Sources	Sediment:	Bank erosion, agriculture, silviculture, urban runoff, riparian degradation, grazing-related, habitat modification, hydromodification
	Nutrients:	Land development, wastewater lagoons, municipal point sources, urban runoff, septic, agriculture, grazing related
	PCBs:	Land disposal, unknown
Target Development Strategy	The current water quality impairment status of all waters originally listed in 1996 303(d) list were evaluated using a weight of evidence approach with a suite of water quality indicators. Sediment target include: periphyton siltation index <25, percent clinger taxa >50%, % surface fines <20% Nutrient targets include: TN <0.500 mg/L, TP<0.035 mg/L, chl-a <100 mg/m2 summer mean and <150 mg/m2 summer maximum, percent filamentous algae cover <30%, minimum dissolve oxygen >4 mg/L daily minima. PCB targets include: fish tissue PCB concentration <0.025 ppm, instream sediment PCB concentrations <0.187 ppm.	
TMDL	Sediment:	Performance-based allocations, reductions in urban TSS load, flushing flow recommendation.
	Nutrients:	Flow based TMDL. Refer to Table E-2
	PCB:	Load reductions of known sources and in-stream sediments
Allocations	Sediment:	Bank erosion – reduction in bank erosion to <20% Tributaries –phased - 85% compliance with BMPs Urban sources – 60% reduction in TSS loads from urban NPS/storm Flow – flushing flow allocation – to be decided.
	Nutrients:	Lewistown WWTP – reduction is a function of streamflow
	PCBs:	100% reduction in load from fish hatchery 79% reduction in average PCB concentration in stream sediments
Primary Restoration Strategies and Other Recommended Measures	Sediment:	Establishment of grazing, agriculture, and stormwater BMPs Increased spring runoff peak flows through flushing flow implementation
	Nutrients:	Reduction in P discharges through WWTP upgrade and NPDES permit limits
	PCBs:	Hatchery remediation In-stream sediment cleanup to be decided
Margin of Safety	Margins of safety are included through a cumulative suite of conservative assumptions and are implicit in BMP compliance. A MOS of 10% of the TMDL is given for Big Spring Creek nutrients.	
Seasonal Considerations	Seasonal considerations are addressed in the nutrient TMDL by using summertime low flows to compute TMDLs. Sediment and PCB TMDLs do not require seasonal considerations, as BMPs will reduce sediment loads year-round.	

Table E-3. Water Quality Restoration Plan and TMDL Summary Information.

Impairments No Longer Existing on the Information Presented in this Document	Impairments that were not warranted based on data and analysis included in the document include: Beaver Creek – sediment, nutrients Cottonwood Creek – sediment Casino Creek – suspended solids

SECTION 1.0
INTRODUCTION

This document describes a water quality restoration plan for the Big Spring Creek Total Maximum Daily Load Planning Area (TPA). Four streams within the Big Spring Creek TPA appear on Montana's 303(d) list of impaired waterbodies and are the subject of this report (Figure 1-1). These streams include:

- Big Spring Creek
- Beaver Creek
- Cottonwood Creek
- Casino Creek

The primary pollutants of concern in these four streams are sediment, nutrients, and PCBs. For the purposes of this document, sediment is used to refer to a group of sediment-related pollutants including sediment, siltation, suspended solids, and/or habitat alteration. Nutrient-related pollutants include the chemical constituents, nitrogen and phosphorous. PCBs are polychlorinated biphenyls, and include congener mixtures known commonly as aroclors. For all four streams, total maximum daily loads are proposed for the pollutants of concern as required by Section 303 of the federal Clean Water Act. The exceptions to this, as described in Section 4.0 and Section 7.0, are instances where the available data indicate TMDLs are not required

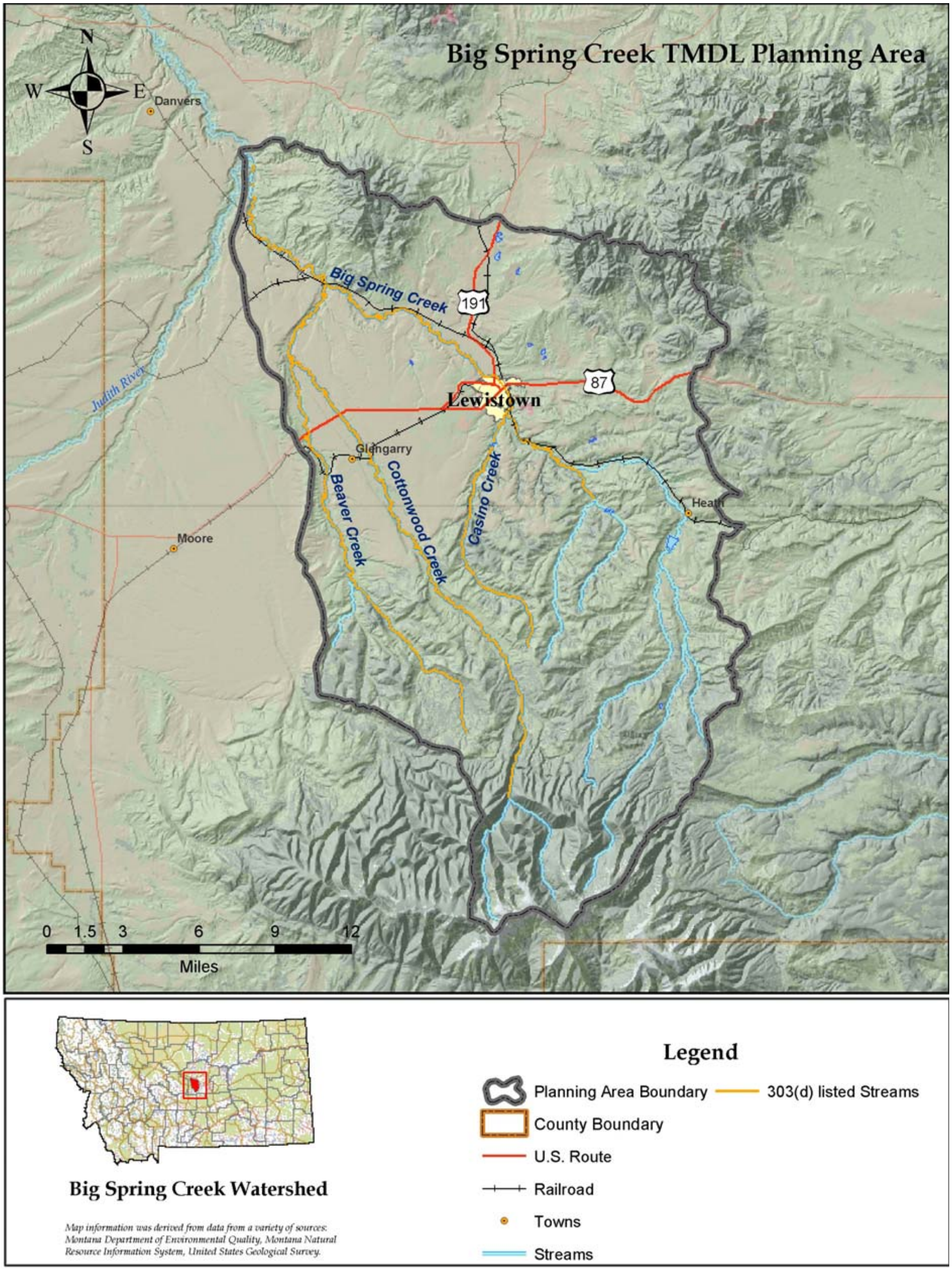

Figure 1-1. Big Spring TMDL Planning Area.

SECTION 2.0
WATERSHED CHARACTERIZATION

The following section describes the physical, chemical, biological and cultural condition of the environment within the Big Spring TMDL Planning Area. Applicable landscape influences, climate, hydrology, aquatic resources and cultural characteristics are addressed.

2.1 Physical Setting

2.1.1 Location and Ecoregion

The Big Springs Creek Watershed is located in the geographic center of Montana in Fergus County and encompasses an area of approximately 400 square miles. The Watershed is comprised of two 5th-field Hydrologic Unit Code sub basins: Big Springs Creek (10040103050) and Cottonwood Creek (10040103060). Bounded to the south by the east-west trending Big Snowy Mountains, and the domal uplifts of the Judith and South Moccasin Mountains to the northeast and northwest, respectively, the headwaters of Big Spring Creek originate south of Lewistown in the Big Snowy Mountains and flow northwest to their confluence with the Judith River at the northwestern-most point in the watershed (Map 1). Major tributaries to Big Spring Creek include Cottonwood Creek, Casino Creek, Castle Creek, Hansen Creek, and East Fork Big Spring Creek.

Lands within the Big Springs Watershed lie within three distinct ecoregions: ***Northern Rockies*** (Scattered Eastern Igneous-Core Mountains ecoregion and Big Snowy-Little Belt Carbonate Mountains ecoregion), ***Mountain Valley and Foothill Prairie*** (Non-calcareous Foothill Grassland ecoregion and Limy Foothill Savanna ecoregion) and the ***Northwestern Great Plains*** (Judith Basin Grassland) (Woods et al., 1999). Map 2 shows the distribution of ecoregions within the Big Spring Creek watershed.

2.1.2 Topography and Elevation

Elevations in the Big Spring Creek watershed range from 3,400 to 8,730 feet above sea level. The lowest elevation (3,400') is at the northernmost point of the planning area at the confluence of Big Spring Creek and the Judith River. The highest elevation in the watershed is Greathouse Peak (8,730') in the Big Snowy Mountains.

The southern border of the watershed is bounded by the Big Snowy Mountains, the crest of which trends east west, formed by a long narrow ridge of resistant limestone. Steep narrow canyons are etched into the massive ridge-forming limestone and extend northward. At lower foothill elevations (~5,500'), topographic slope lessens from the rugged mountain core before reaching the relative flat of the Judith Basin floor at 4,500'.

The northeast-trending Judith Mountains bound the northeast portion of the Big Springs watershed. The Judiths are a series of several domes, the highest of which is Judith Peak at 6,428 feet. Several smaller peaks rise above 6,000 feet. Similar in character and topography to the

Judiths but slightly smaller in size (~5,800 feet) are the South Moccasin Mountains along the northern boundary of the watershed. Both the Judiths and the South Moccasins rise abruptly from the surrounding plains and are flanked by foothill slopes generally steeper than those abutting the Big Snowy Mountains.

The low grasslands of the Judith Basin comprise the central and westernmost portions of the watershed. Elevation ranges from 4,500 feet in the south to the lowest elevation in the watershed at 3,400 feet.

2.1.3 Geology and Soils

The Big Spring TMDL Planning Area can be divided into three distinct regions based on geologic genesis and character: ***Big Snowy Mountains and Foothills, Judith and South Moccasin Mountains and Foothills, Judith Basin lowlands.*** Mining activity for precious metals is associated with the emplacement of igneous intrusions and is confined to these zones in the Judith and South Moccasin Mountains. Sedimentary rocks yield coal and gypsum deposits and are also mined for sand, gravel and building stone. A geologic map and stratigraphic column illustrates the distribution of rock types in the region (Map 3, Figure 2-1).

Big Snowy Mountains and Foothills

The Big Snowy Mountains are the result of the Big Snowy uplift, a Laramide (69-47ma) asymmetrical west-northwesterly trending anticline composed entirely of sedimentary rocks. The exposed core of the Big Snowy uplift consists of the massive resistant Madison Group limestone. Younger limestone, dolomite, sandstone, and shale of Paleozoic and Mesozoic age form the Big Snowy foothills flanking the Madison core and dip gently (8 – 10 degrees) into the Judith Basin to the south.

Mountain soils (Map 4) consist mainly of Helmville Series soils: well-drained strongly calcareous loams, silt loams, and gravelly clays over bedrock. Helmville soils exist mainly above 4,600 feet and support a variety of alpine and subalpine trees shrubs and grasses. Foothill soils are of the Hughesville-Whitecow Series. They consist of calcareous, well-drained, deep loams and stony loams formed in alluvium and colluvium derived mainly from limestone, but with lesser sandstone and shale components. The Hughesville-Whitecow series supports both forest and rangeland habitats.

System	Group	Unit	Thickness feet (m)	Lithology
Cretaceous		Eagle Sandstone	141 ft (43 m)	Light-gray sandstone and sandy shale
		Telegraph Creek Formation	285 ft (87 m)	Light-gray sandy shale
		Colorado Shale	1525 ft (465 m)	Dark-gray to black shale with subordinate interbedded siltstone, sandstone, bentonite, and calcareous shale
		Kootenai Formation	328-492 ft (100-150 m)	Red, maroon, gray, and black mudstone with interbedded brown to tan sandstone
Jurassic		Morrison Formation	220 ft (67 m)	Pastel pink to gray mudstone; minor coal near top; gray limestone near base
	Ellis Group	Swift Formation	56 ft (17 m)	Brown, glauconitic sandstone
		Rierdon Formation	89 ft (27 m)	Gray shale and limestone; brown sandstone
		Piper Formation	121-230 ft (37-70 m)	Variegated shale, gray limestone, and gypsum
Mississippian	Big Snowy Group	Heath Formation	0-492 ft (0-150 m)	Gray to black shale and limestone
		Otter Formation	144 ft (44 m)	Gray limestone and tan to black shale
		Kibbey Formation	112 ft (34 m)	Red to brown sandstone and siltstone
	Madison Group	Mission Canyon Limestone	1345 ft (410 m)	Massive gray limestone with solution breccia at top
		Lodgepole Limestone		Thin-bedded gray limestone
Devonian		Jefferson Dolomite	151 ft (46 m)	Gray, brown, and black dolomite
Cambrian		Limestone and shale undivided	1280 ft (390 m)	Gray limestone and intraformational limestone conglomerate; gray-green to black shale
		Flathead Sandstone	165 ft (50 m)	Tan to pink quartzite

Figure 2-1. Stratigraphic Units in the Big Springs TMDL Planning Area. (Feltis, 1973)

South Moccasin and Judith Mountains and Foothills

The South Moccasin and Judith Mountains bound the Big Spring Watershed to the north and northeast. These mountains are structurally and lithologically distinct from the Big Snowy Mountains to the south, and were formed in Tertiary time when igneous intrusions domed existing sedimentary strata, forming a suite of gumdrop-shaped 'blisters' on the plains of central Montana. Subsequent erosion has exposed the porphyritic igneous cores of many of these domes. The intrusive igneous cores of the South Moccasin and Judith Mountains are flanked by

Paleozoic and Mesozoic strata that dip, generally, from 20 to 60 degrees, yet some areas exhibit nearly vertical to overturned bedding (Figure 2-2). The dip of these units gradually decreases away from the mountains until, after a few miles, they are nearly horizontal (Feltis, 1973).

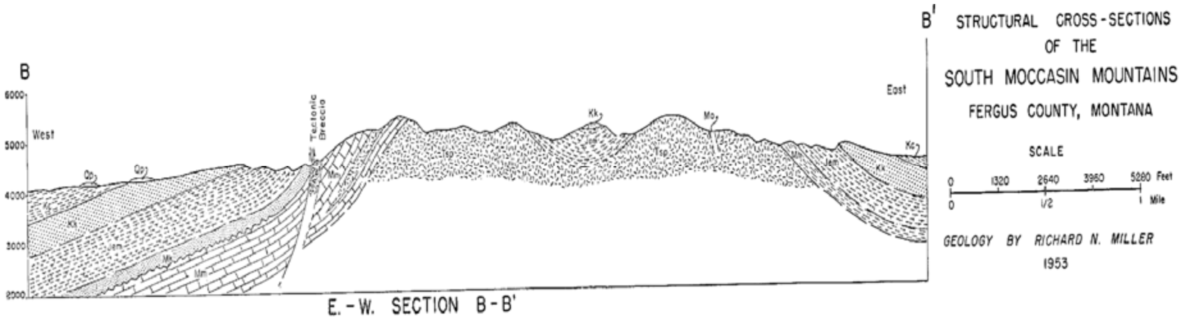

Figure 2-2. Structural Cross-Section of the South Moccasin Mountains (Miller, 1959).

Gold-bearing ores are associated with these intrusions and occur as veins, contact deposits and replacement deposits. The Madison limestone was responsible for significant ore deposits where it occurred in contact with igneous masses.

These lands to the north and northeast of Lewistown are lithologically distinct from the Big Snowy Mountains to the south in that igneous rocks, which are absent in the Big Snowy Mountains, dominate the geology and have a subsequent influence on soil types. Foothill soils consist predominantly of soils of the Norbert Series. Norbert soils are shallow, well-drained soils derived mainly from the Cretaceous shales of the Kootenai, Colorado and Telegraph Creek formations. They contain significant amounts of clay and therefore have high runoff potential depending on slope angle. Norbert soils are most suitable for range and support a suite of native grasses, forbs and shrubs.

The foothill areas between the Big Snowy Mountains and the Judith Mountains consist primarily of Castner Series soils. These soils reflect the difference in geology of the northern mountains and are composed of shallow, well-drained, non-calcareous mixed skeletal loams formed from the sandstones and argillites of the area mountains' flanking beds mixed with the fine-grained igneous rocks of the Judith Mountains. Primarily used as rangelands, Castner soils may locally support an overstory of Douglas fir and ponderosa pine.

Extensive terrace deposits drape the foothills to the south and east of Lewistown and range in thickness up to 65 feet thick (Feltis, 1973). Terraces are thought to be ancient alluvial deposits that were once much more widespread before exhumation of the Judith Basin (Feltis, 1973). While terrace deposits to the south of Lewistown consist mainly of sandstone and limestone gravels from the Snowy Mountains, deposits to the north and east of Lewistown contain significant amounts of igneous rock fragments from the Judith and South Moccasin Mountains. These terrace gravels yield water for a number of wells as well as numerous seeps and springs within the watershed (Feltis, 1973).

Judith Basin

Basin deposits and soils are derived from the remnants of a suite of coalescing alluvial fans that extend outward from the Big Snowy, Judith and South Moccasin Mountains. The alluvial and floodplain deposits that make up the Judith Basin vary in thickness from quite shallow to over 50 feet thick in places. Alluvial soils vary in texture and depth and are characterized by Doughty and Tamaneen Series soils on alluvial fans and stream terraces and Marcott Series soils within the floodplains.

Doughty Series soils are very deep, calcareous, fine loamy and well drained. They occupy the higher alluvial terraces to the south and west of Lewistown and are used mainly for rangeland. Tamaneen Series soils cover the bulk of the lowlands to the north and west of Lewistown. They are very deep, well-drained fine smectitic soils and are used predominantly for dryland crops and rangeland. Marcott Series soils are found in floodplain and low terrace areas along Big Spring Creek. They are very deep, somewhat poorly drained smectitic soils that formed from clayey alluvium derived from shale, limestone and sandstone, and are used for pasture, hay production, and rangeland.

Mining History

In May of 1880, prospectors in the Judith Basin discovered placer gold in the Judith Mountains. This led to the influx of settlers, miners, stockmen and entrepreneurs and the establishment of numerous mining towns, the largest of which were Maiden, in the Judith Mountains, and Kendall, in the North Moccasin Mountains. The Gilt Edge/Maiden Mining District grew around the town of Maiden, and while a majority of the mining activity occurred north of the Big Springs Watershed planning area, significant deposits of gold, silver, and copper were mined within the planning area in the Judith Mountains. The South Moccasin Mountains yielded gold, lead, zinc, silver calcium and fluorine in appreciable amounts at several locations. In 1903 and 1904, Fergus County led Montana in gold production, predominantly from ores of the Kendall Mining District, and by 1920 most of the mining claims in the Judith and Moccasin Mountains had been played out.

In addition to the historic placer and hard-rock mining in the Judith and South Moccasin mountains, gypsum, coal, stone, sand, gravel and clay continue to be mined from sedimentary deposits at lower elevations in the watershed. Mining activity in the Big Springs TMDL Planning Area is concentrated in the northern portion of the watershed and is absent from the Big Snowy Mountains (Map 3).

2.1.4 Vegetation and Land Cover

Vegetation in the Big Springs Creek watershed is characterized by alpine tundra at the highest elevations, conifer forests above 5,500 feet, and mixed conifer/deciduous forests and grasslands at the lower elevations. Forested areas of the watershed are dominated by subalpine fir at the highest elevation (6,500-7,000 ft), and Douglas fir, ponderosa pine, lodgepole pine, Engelmann spruce, and quaking aspen at lower elevations. Depending on soil type and aspect, the lower grasslands support a variety of native and non-native grasses including but not limited to:

bluebunch wheatgrass, western wheatgrass, green needlegrass, rough fescue, blue grama, basin wildrye, redtop bentgrass, common timothy. Riparian species composition includes: water birch, hawthorne, willow, wild rose, cottonwoods, aspen, dogwood, chokecherry, serviceberry, and a variety of grasses, forbs, sedges and rushes.

Land cover in the Big Springs watershed is dominated by pasture and croplands, a variety of rangelands, and forests (Figure. 2-3, Table 2-1). Map5 shows the distribution of landcover in the watershed.

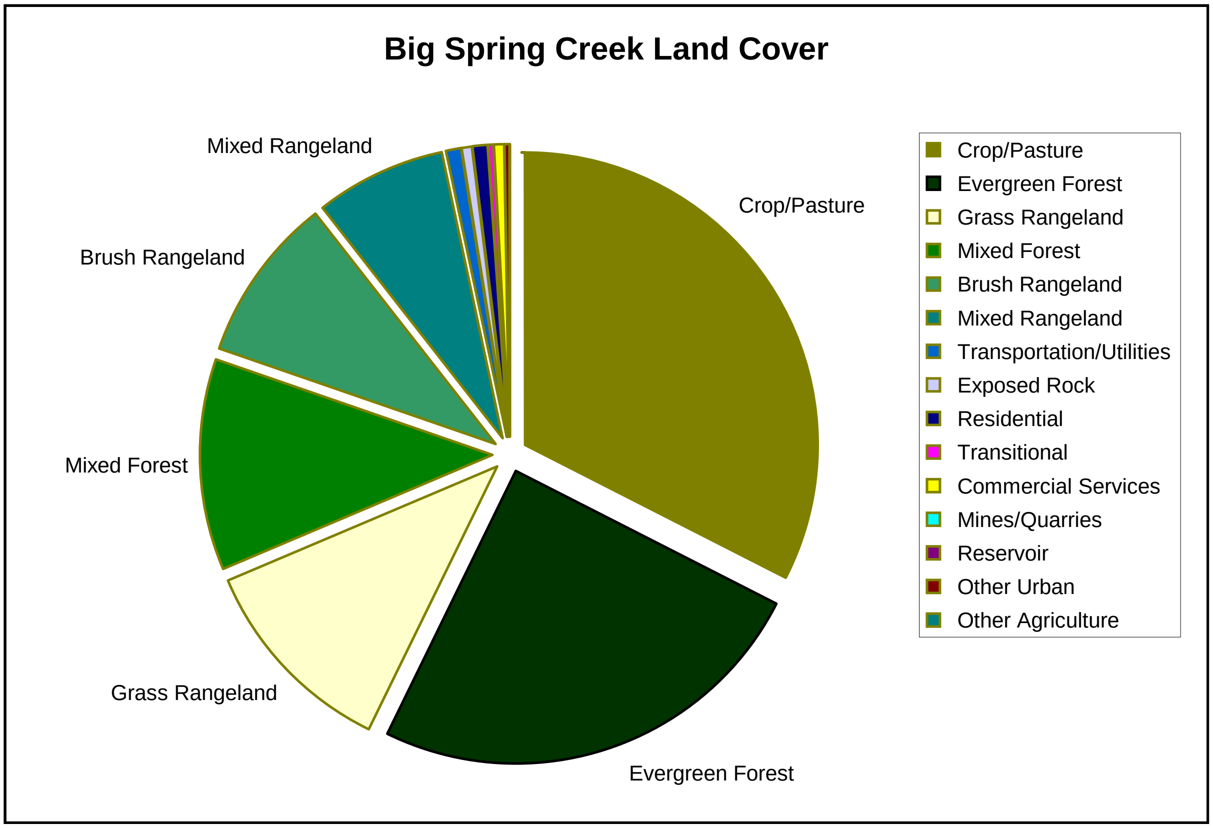

Figure 2-3. Land Cover (NRIS data) for Big Springs Creek TMDL Planning Area.

Table 2-1. Land Cover (NRIS data) for Big Springs TMDL Planning Area.

Percent	Acres	Classification
32.5%	83,000	Crop/Pasture
24.6%	62,940	Evergreen Forest
11.6%	29,708	Grass Rangeland
11.4%	29,242	Mixed Forest
9.3%	23,675	Brush Rangeland
7.3%	18,602	Mixed Rangelend
0.7%	1,895	Transportation/Utilities
0.7%	1,727	Exposed Rock
0.6%	1,647	Residential
0.5%	1,304	Transitional

Table 2-1. Land Cover (NRIS data) for Big Springs TMDL Planning Area.

Percent	Acres	Classification
0.3%	894	Commercial Services
0.1%	380	Mines/Quarries
0.1%	203	Reservoir
0.1%	195	Other Urban
0.1%	176	Other Agriculture
100%	255,588	

2.2 Meteorological Setting

Although located in the center of Montana, the climate in the Big Springs Creek Watershed is wetter than is expected from normal continental type climate. Lewistown, near the center of the watershed, lies 150 miles east of the continental divide, yet mountains to the south and east are close enough to influence local climate.

2.2.1 Precipitation

Precipitation ranges from 17 inches per year at the lowest elevations in the watershed to over 40 inches per year in the highest elevations of the Big Snowy Mountains (Map 6). Precipitation at the Lewistown airport (elevation 4,140 ft) averaged 18.5 inches/yr for the period from 1896-2001 (Figure 2-4), nearly half of it falling during the months May, June and July.

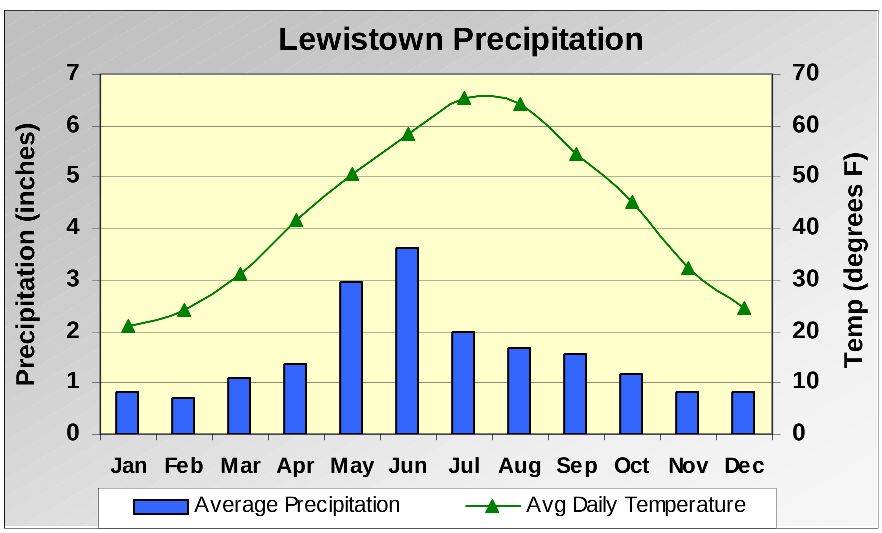

Figure 2-4. Monthly Precipitation Averages at the Lewistown Airport.

Precipitation in the Big Snowy Mountains approaches 45 inches per year. At an NRCS SNOTEL site at Crystal Lake (elevation 6,050 ft) in the Big Snowy Mountains just to the SW of the planning area, annual precipitation averages over 38 inches per year for years 1988-2003 (Figure 2-5). Precipitation totals in the smaller Judith and South Moccasin Mountains is considerable less, ~26 inches/year. At higher elevations, precipitation is concentrated in the months of April, May and June.

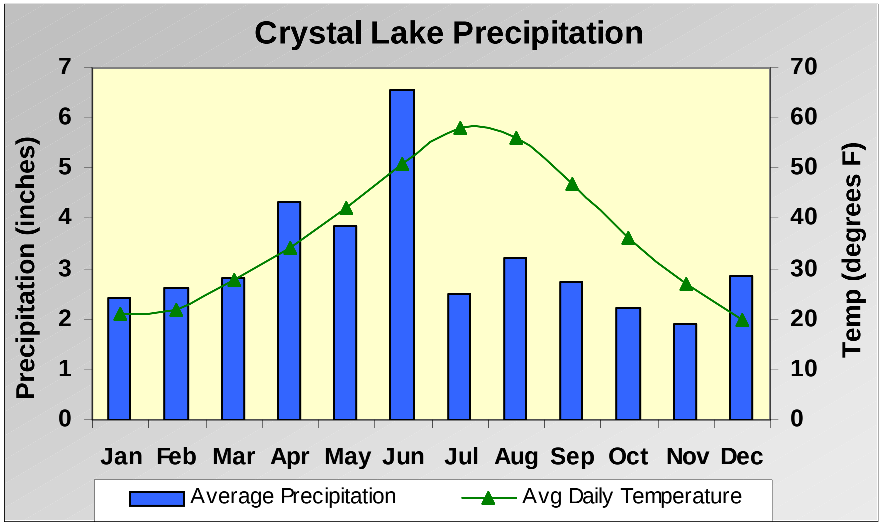

Figure 2-5. Monthly Precipitation Averages at Crystal Lake.

Snowfall is concentrated in the higher elevations and can be considerable at times. Snow can fall at any month of the year in the Big Snowy Mountains. Snowfall in the town of Lewistown typically occurs from November through May, however snow squalls in October and June are not uncommon.

2.2.2 Temperature

Temperatures in the Big Springs Watershed reflect season variations and extreme hot and cold spells that can occur in continental climates. Temperatures in Lewistown range from daily averages in the low 20's in January to the mid 60's in July. Daily average temperatures in the higher elevations are slightly cooler in the summer and slightly warmer in the winter. Temperatures in the basin near Lewistown may reach extremes of -48°F in the coldest months of the winter to 105°F in the heat of the summer. Figures 2-6 and 2-7 illustrate the average temperatures at the Lewistown airport and Crystal Lake.

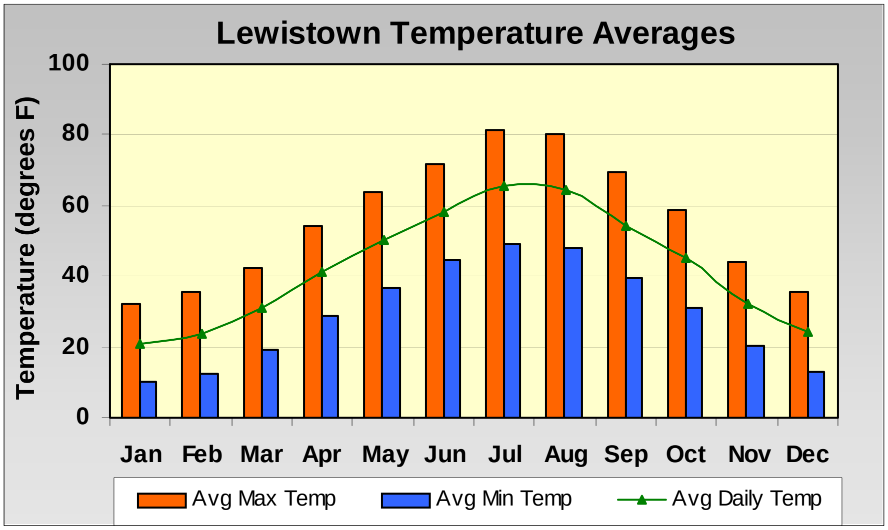

Figure 2-6. Average Temperatures at Lewistown Airport (1896-2001).

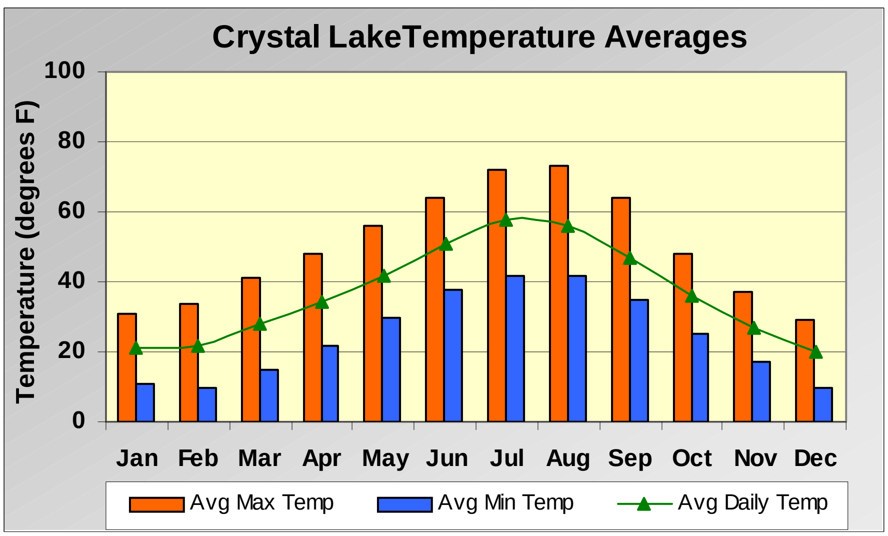

Figure 2-7. Average Temperatures at Crystal Lake (1988-2003).

2.3 Drainage Basin Characteristics

2.3.1 Hydrography

Most perennial streams in the Big Springs watershed originate in the Big Snowy Mountains and flow generally northward. Exceptions include a few smaller tributaries to Big Springs creek (Pike Creek, Burnette Creek) that drain the southeastern flank of the Judith Mountains. Streams exhibit a dendritic pattern consistent with low angle sedimentary strata, yet areas of structural control do exist locally. Table 2-2 illustrates the length of significant streams in the watershed.

Table 2-2. Selected Stream Lengths in the Big Springs TMDL Planning Area.

Stream Name	Tributary to	Miles
Cottonwood Creek	Big Spring Creek	32.0
Big Spring Creek	Judith River	30.1
East Fork Big Spring Creek	Big Spring Creek	24.8
Beaver Creek	Cottonwood Creek	21.3
Casino Creek	Big Spring Creek	11.8
Middle Fork Big Spring Creek	Big Spring Creek	11.3
Boyd Creek	Big Spring Creek	10.4
Burnette Creek	Big Spring Creek	8.8
Pike Creek	Big Spring Creek	7.3
Castle Creek	Big Spring Creek	7.3
Breed Creek	Big Spring Creek	6.7
Hansen Creek	Big Spring Creek	5.7
Coyote Creek	Cottonwood Creek	5.2
Little Casino Creek	Big Spring Creek	4.5

A series of four reservoirs (Table 2-3, Map 7) were constructed upstream of Lewistown in the mid 1970's as a community response to repeated flooding in the residential and downtown areas. In addition to the four flood control reservoirs, a diversion channel was constructed that channeled a portion of the flow of Big Spring Creek around the east side of Lewistown. Big Spring Creek itself flows under the downtown area. Just before it enters downtown, the main channel of Big Spring Creek is diverted underground, flows under streets and businesses, and reemerges four blocks to the north where it merges with the diversion channel to form a single channel once again (Figure 2-8).

East Fork and Hansen Creek Reservoirs are owned and operated by the city of Lewistown. Pike Creek and Big Casino Creek Reservoirs sit on private land but are maintained and operated by the city of Lewistown. The reservoirs were constructed with the main purpose of flood control and sediment catchement. East Fork and Hansen Creek reservoirs also provide recreational opportunities. In 1993, the Montana Department of Fish Wildlife and Parks, the City of Lewistown and Fergus County entered into an agreement with landowners adjacent to Big Casino Creek Reservoir, to provide public access and recreational fishing opportunities via a Recreational Site Easement acquired by the Department of Fish Wildlife and Parks. Presently, all three (East Fork, Hansen, Casino Creek reservoirs) see winter and summer recreational use.

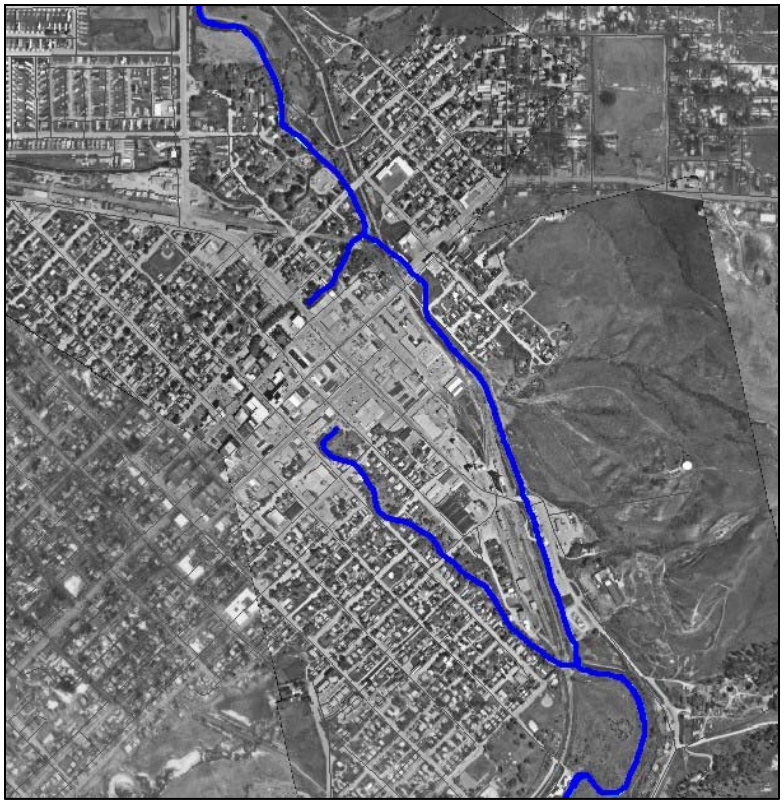

Figure 2-8. Big Spring Creek and Diversion Channel Through Lewistown.

Table 2-3. Reservoirs in the Big Spring TMDL Planning Area.

Reservoir	Drainage Area (sq miles)	Max Capacity (AF)	Year Built
East Fork Reservoir	61.8	7150	1974
Pike Creek Reservoir	7.7	780	1977
Big Casino Creek Reservoir	18.9	2063	1976
Hansen Creek Reservoir	7.8	860	1974

Several smaller tributaries and ephemeral drainages contain less substantial dams and earthen impoundments, mainly for irrigation, stock water and recreational use. Some of the larger impoundments include: Upper and Lower Carter's Pond on Burnette Creek and Butcher Dam on Wolverine Creek. Maximum storage capacity on each is less than 150 acre-feet of water.

2.3.2 Hydrology

Surface Water

There have been four USGS Gauging stations operating in the Big Spring Creek watershed. Stations 6111500, 6112000, and 6112100 reported daily mean streamflow, while station 6111850-reported instantaneous streamflow once per month. In addition to these established stations, flow data has been recorded at a variety of other locations in the planning area (Table 2-4, Map 7).

Table 2-4. Stream Flow Records in the Big Springs TMDL Planning Area.

	Description	USGS ID	Years	N	Years	N	Years	N	Years	N
1	Big Spring Creek below Hatchery	6111500	1932-57	9252			1967-71	56	1988	7
2	East Fork Big Spring Creek near Heath						1968	2		
3	East Fork Big Spring Creek								1988	7
4	Big Spring Creek above Casino Creek		1953	1						
5	Big Spring Creek at Boulevard Bridge		1911-75	4						
6	Artesian Well		1937	1						
7	Big Spring Creek at Hanover	6111850					1967-71	62	1988	7
8	Cottonwood Creek ab Nat'l Forest Bdry						1967	1		
9	Cottonwood Creek at Nat'l Forest Bdry						1967-68	2		
10	Cottonwood Creek bl Nat'l Forest Bdry						1968	1		
11	Cottonwood Creek at Heller Ranch				1960-63	35				
12	Cottonwood Creek near Lewistown	6112000	1945-51	1825	1959-63	42				
13	Cottonwood Creek near Moore	6112100			1957-63	2220	1969-71	22	1988	7
14	Cottonwood Creek near Glengarry				1960-63	35				
15	Cottonwood Creek bl Hiway 200								1988	7
16	Beaver Creek bl Hiway 200								1988	7
17	Big Spring Creek at Spring Cr Colony								1988	7
18	Cottonwood Creek at Hanover						1967-71	60		
19	Big Spring Creek near Danvers						1966	1		

Big Spring Creek

Big Spring Creek has the distinction of originating from a first magnitude spring (average discharge >100 cfs) at Big Springs. Originating about six miles south of Lewistown above the mouth of Castle Creek and below Hansen Creek Dam, Big Springs discharges at a relatively constant rate year round. A USGS gauging station on Big Spring Creek, below Castle Creek and approximately 0.5 miles below Big Spring, recorded daily discharge from 1932 through 1957. Regular daily discharge measurements were discontinued on 9/30/1957, however discharge readings were taken sporadically from 1967 through 1971, and again for a portion of 1988. The average discharge of Big Springs Creek at USGS gauging station 06111500 for water years 1932-1957 is 107 cfs (Figure 2-9). The highest recorded flow at station 06111500 was 250 cfs on 6/14/1967. Additional high flows of over 220 cfs occurred in the spring of 1951 and 1953. These flows reflect substantial short-lived increases resulting from runoff inputs from Hansen and Castle Creek rather than increases in spring discharge. The discharge from Big Springs does appear, however, to fluctuate with changes in annual precipitation.

Feltis (1973) noted that, “discharge from the spring has gradually increased from about 109 cfs in February 1967 to 132 cfs in January 1969. This increase probably reflects the above-average precipitation during 1967 and 1968 following below-average precipitation in 1966.”

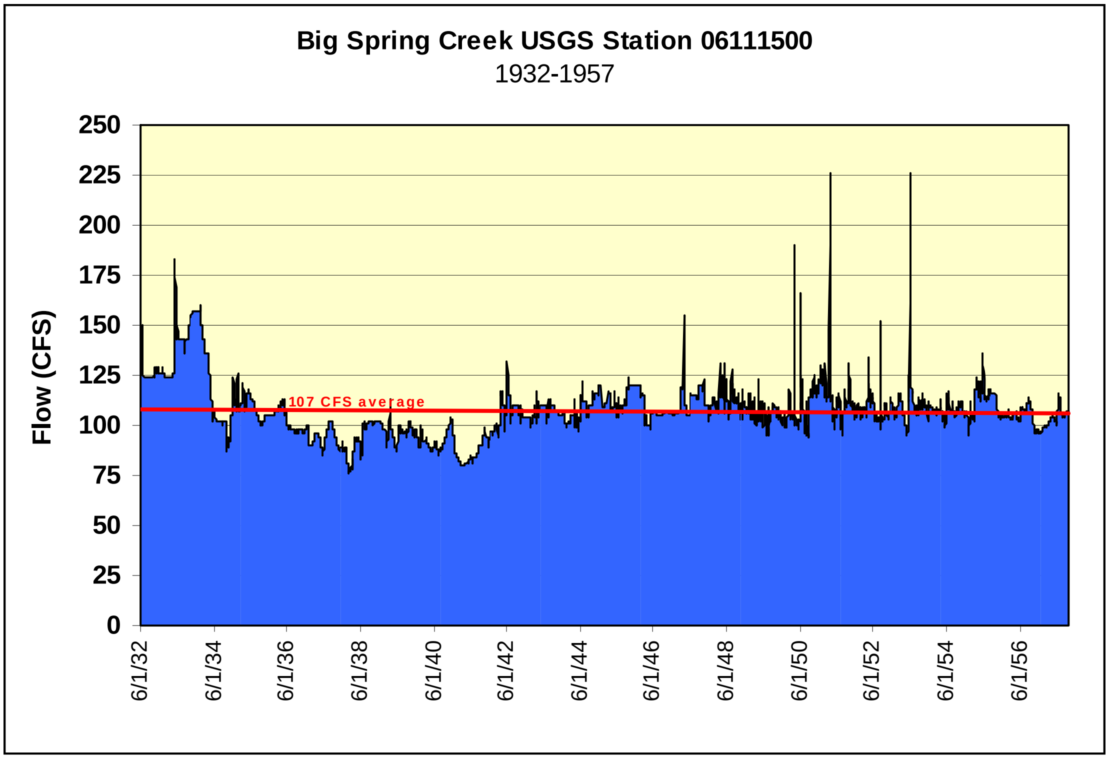

Figure 2-9. Daily Mean Stream Flow for USGS Station 06111500 from 6/1/1932 to 9/30/1957.

Before the construction of the four flood-control reservoirs upstream from Lewistown, upper Big Spring Creek saw substantial spring runoff inputs from tributaries: Hansen Creek, Castle Creek, East Fork Big Spring Creek, Pike Creek, Casino Creek. Unpublished USGS flow data reports flows of 1,200 CFS for Big Spring Creek above Casino Creek and 1,230 CFS at Highway 87 bridge on 5/29/1953 and 5/8/1975, respectively. Spring flooding through town was not uncommon and eventually necessitated the construction of Hansen Creek, Pike Creek, East Fork and Casino Creek reservoirs in the early to mid 1970s. Since their construction, flooding has become a rare occurrence. More recent high flows are the result of short events associated with rapid snowmelt or precipitation rather than the seasonal snowmelt and runoff period.

Below Lewistown, lower Big Spring Creek receives significant spring runoff input from Cottonwood Creek. While recorded discharge measurements on lower Big Spring Creek are limited, discharge at stations on Big Spring Creek recorded monthly from 1967-1971 (Figure 2-10) characterize the range of flow conditions typical of the lower watershed. Maximum and minimum recorded flows on Big Spring Creek at Hanover above Cottonwood Creek are 1,080 cfs on 6/8/1967 and 106 cfs on 8/25/1988, however, given the paucity of flow data on the lower watershed, these values should not be taken as true max and min values.

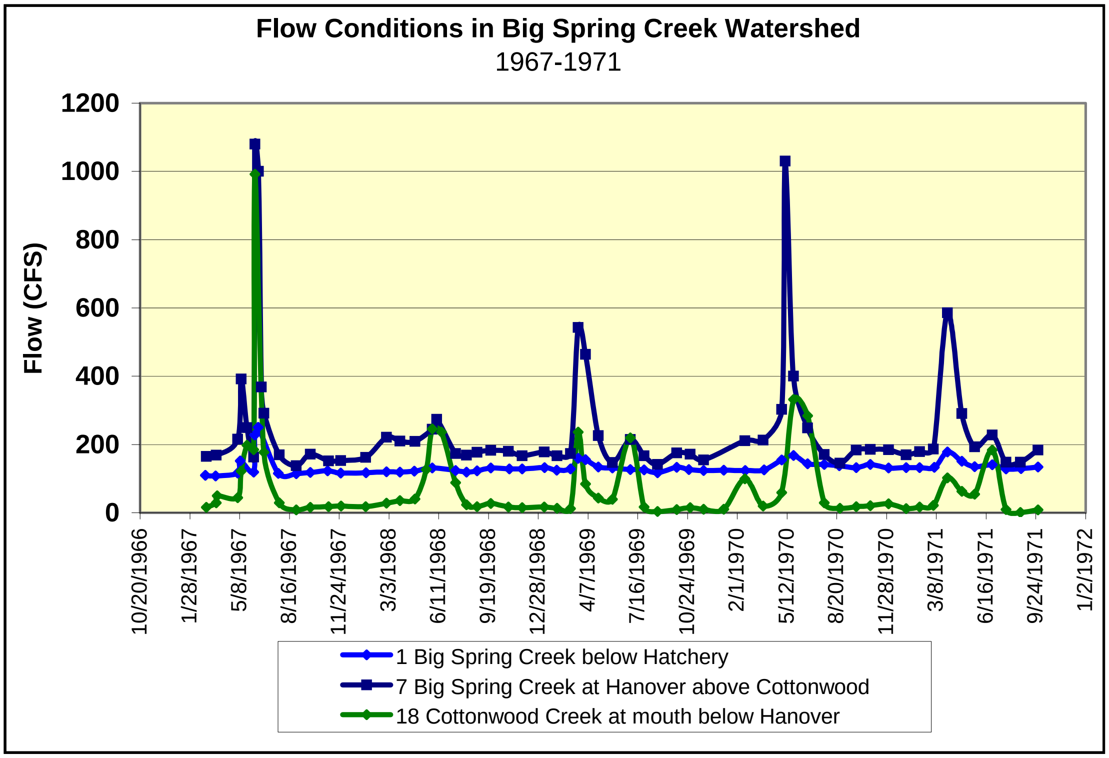

Figure 2-10. Big Spring Creek Monthly Flow, 1967-1971.

With the exception of upper Big Spring Creek, stream flows in the Big Spring Creek watershed generally adhere to a pattern of increasingly high flows in late winter and spring, followed by gradual declines through the summer and fall. Cottonwood Creek hydrographs reflect this progressively increasing contribution from low to higher elevation snowmelt from March through early summer. Peak flows in June are characteristic of the watershed and represent contributions from rainfall and mountain snowmelt.

Cottonwood Creek and Beaver Creek

Cottonwood Creek originates in the Big Snowy Mountains and flows through bedrock, and terrace alluvium before entering Big Spring Creek. Two long-term USUS gauging stations have recorded daily mean flows from 1945 to 1951 (Figure 2-11) and from 1957 to 1963. In addition, flow data has been recorded on a limited basis at seven other locations on Cottonwood Creek. Flow data was collected on a monthly basis from 1960 through 1963 at four locations on Cottonwood Creek (Figure 2-10), and at selected locations from 1967-1971 (Figure 2-12) and again in 1988 (Table 2-4).

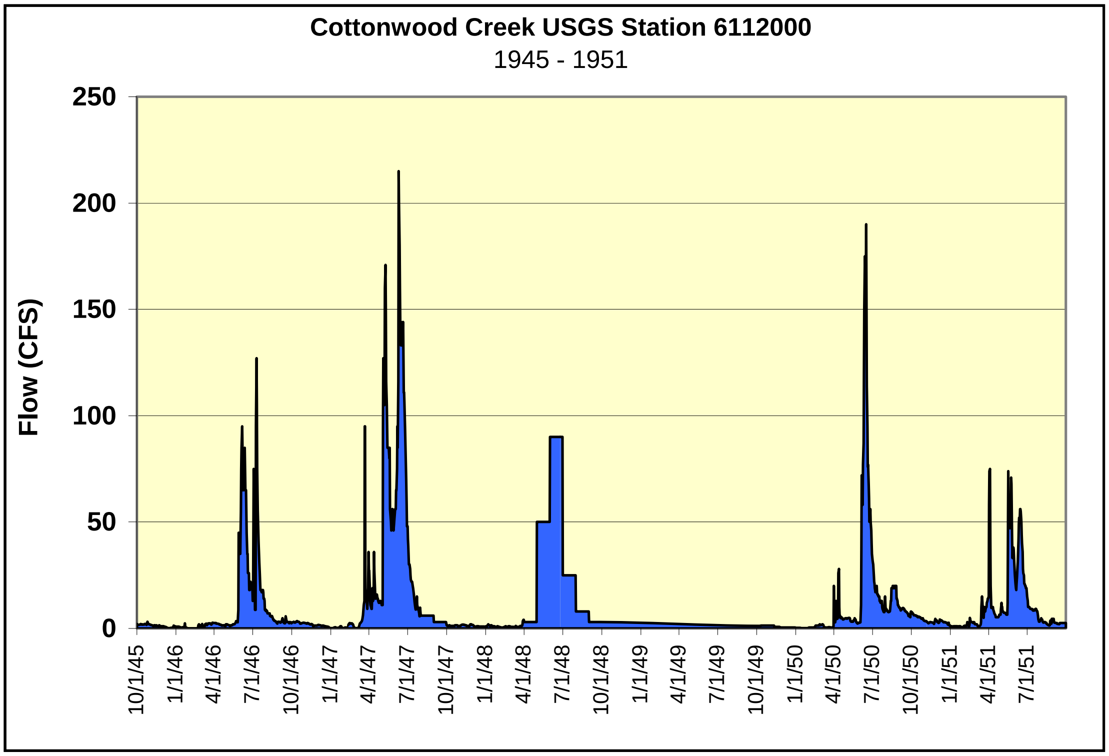

Figure 2-11. Daily Mean Stream Flow for USGS Station 06112000 from 10/1/1945 to 9/30/1951.

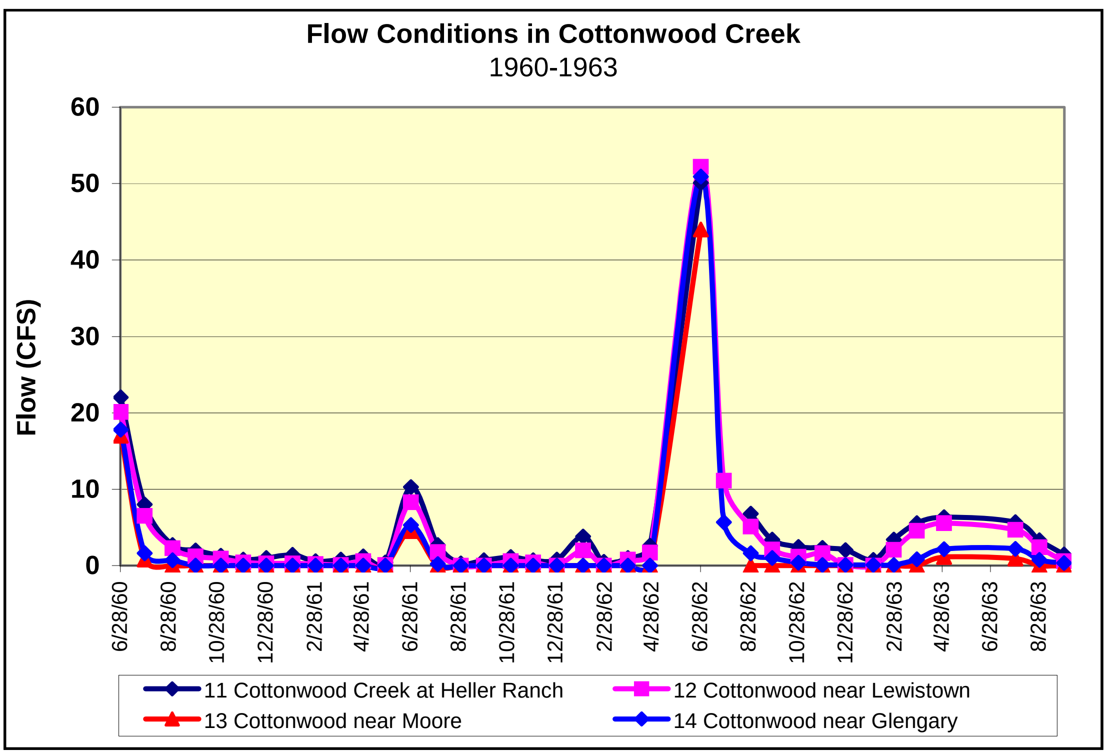

Figure 2-12. Monthly Flow Data for Four Locations on Cottonwood Creek.

Available data, as well as personal accounts from residents and landowners, demonstrate that middle Cottonwood, from above the foothill/basin boundary to near Glengary, is susceptible to regular dewatering and severe low flows in all times but snowmelt runoff and storm events. This is likely due to a combination of factors including: natural geology (infiltration into terrace gravels, loss of streamflow to the cavernous Madison limestone), drought, and irrigation withdrawals.

Beaver Creek drains the lower foothill elevations to the west of Cottonwood Creek. Flow data for Beaver Creek is very limited and consists of seven recordings in 1988. Flow data collected monthly from April 1988 through Sept 1988 for Beaver and Cottonwood Creek shows that smaller Beaver Creek maintained a higher flow that Cottonwood Creek for the same period. Extensive beaver ponds along the length of Beaver Creek may provide water storage both in ponds and floodplain deposits, thereby supporting and prolonging baseflow throughout dry periods. Numerous spring and seep inputs in the Beaver Creek drainage may also assist in maintaining flow condition. Differences in irrigation practices and withdrawals between Beaver and Cottonwood Creeks may also contribute to differences in flow conditions in these two streams

Groundwater

Groundwater conditions in the watershed can be described as under either artesian or water table conditions. Water present in the terrace deposits that drape the foothills and extend into the Judith Basin, as well as water in floodplain and surficial deposits, is generally unconfined and thereby under water table conditions. Recharge of these deposits occurs primarily from infiltration of rainwater and from streams. Recharge may also occur from upward movement of water from permeable units of the Colorado shale, which underlies many of the gravelly terrace deposits. The bulk of annual recharge to these deposits occurs in the spring during the significant rain and snowmelt period. As the terrace deposits are underlain by the Colorado shale, water entrained therein moves laterally along this impervious boundary and emerges as seeps and springs where the boundary between terrace gravels and cretaceous shale is exposed. Numerous springs and seeps in the Beaver Creek drainage illustrate this phenomenon.

Artesian conditions exist where water in the subsurface is confined above by impermeable layers, and is best characterized by the bedrock aquifers that dip away from the Big Snowy Mountains and are overlain by impermeable shale’s. By far, the most significant of these aquifers in the Big Springs Creek watershed is the Madison limestone. The Madison dips gently (8-10 degrees) away from the core of the Big Snowy Mountains and is topped by younger sandstones and shales, making it an ideal confined aquifer (Figure 2-13).

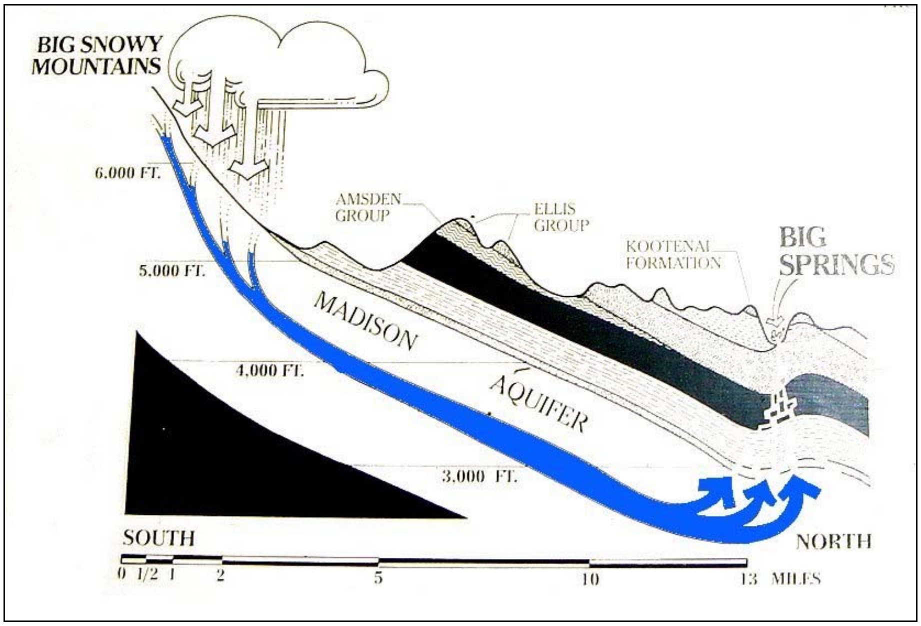

Figure 2-13. Generalized Cross Section of Water Flow Through the Madison Aquifer.

Extensive fractures and solution channels in the Mission Canyon formation of the Madison limestone makes this unit a significant recharge area for springs lower in the watershed. With the exception of the spring runoff period, very few streams in the higher mountains cross this unit without losing all of their flow to the fractures and solution cavities of the Mission Canyon (Feltis, 1973). USGS unpublished flow data records a loss of over 30 cfs (78 cfs to 45 cfs) over a 1.5-mile stretch of Upper Cottonwood Creek on July 1968 where the creek flows over outcroppings of the Madison Limestone. Water that enters the limestone at mountain elevations above travels through the cavernous rock to emerge at artesian springs lower in the watershed. The most significant of these discharge areas is the suite of springs (Upper Big Spring, Lower Big Spring, BS, Lehmann Spring) located at the site of the Big Springs Trout Hatchery. Infiltration into the Madison Limestone, particularly on Upper Cottonwood Creek, severely dewaters upper Cottonwood Creek and prevents mountain stream flows from reaching the lower reaches of the creek in all but the most vigorous of flows.

Groundwater inputs from both artesian and seep sources provide baseflow to lower sections of both Beaver and Cottonwood Creeks during periods of low flow.

2.4 Aquatic Resources

2.4.1 Fisheries

Montana Department of Fish, Wildlife & Parks conducts fish surveys on selected streams in the Big Spring Creek watershed. As of the date of this report, fish survey data is available for Big Spring Creek, Cottonwood Creek, Beaver Creek, East Fork Big Spring Creek, Burnette Creek, Casino Creek, Castle Creek and East Fork Reservoir.

Known fish species in Big Spring Creek and surveyed tributaries is shown in Tables 2-5 through 2-12.

Table 2-5. Big Spring Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Lower Big Spring Creek	Brown Trout
	Common Carp
	Fathead Minnow
	Goldeye
	Lake Chub
	Longnose Dace
	Longnose Sucker
	Mountain Sucker
	Mountain Whitefish
	Northern Pike
	Rainbow Trout
	Sauger
	Sculpin
	Shorthead Redhorse
	Walleye
	White Sucker
	Yellow Perch
Upper Big Spring Creek	Brown Trout
	Common Carp
	Fathead Minnow
	Lake Chub
	Longnose Dace
	Longnose Sucker
	Mountain Sucker
	Mountain Whitefish
	Northern Redbelly Dace
	Rainbow Trout
	Sculpin
	White Sucker

Table 2-6. Beaver Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Beaver Creek	Brook Trout
	Lake Chub
	Longnose Dace
	Longnose Sucker
	Mottled Sculpin
	Mountain Sucker
	Rainbow Trout
	White Sucker

Table 2-7. Burnette Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Burnette Creek	Brook Stickleback
	Brown Trout
	Mottled Sculpin
	Northern Redbelly Dace
	White Sucker

Table 2-8. Casino Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Casino Creek	Brook Trout
	Mottled Sculpin
	White Sucker
Little Casino Creek	Brook trout
	Brown trout
	Fathead minnow
	Longnose dace
	Longnose sucker
	Mottled sculpin
	Rainbow trout
	Northern Redbelly dace
	White sucker

Table 2-9. Castle Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Castle Creek	Brook Trout
	Fathead Minnow
	Longnose Dace
	Longnose Sucker
	Mottled Sculpin
	Rainbow Trout
	White Sucker

Table 2-10. Cottonwood Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
Cottonwood Creek	Brook Trout
	Brown Trout
	Longnose Sucker
	Mountain Sucker
	Rainbow Trout
Upper Cottonwood Creek	Westslope Cutthroat Trout
West Fork Cottonwood Creek	Westslope Cutthroat Trout
East Fork Cottonwood Creek	Westslope Cutthroat Trout

Table 2-11. East Fork Big Spring Creek Fisheries Data (NRIS, 2003).

Waterbody	Species
East Fork Big Spring Creek	Brook Trout
	Brown Trout
	Brown Trout
	Fathead Minnow
	Longnose Dace
	Longnose Sucker
	Mottled Sculpin
	Mountain Sucker
	Rainbow Trout
	White Sucker
Upper East Fork Big Spring Creek	Westslope Cutthroat Trout

Table 2-12. East Fork Reservoir Fisheries Data (NRIS, 2003).

Waterbody	Species
East Fork Reservoir	Longnose Sucker
	Northern Pike
	White Sucker
	Yellow Perch

Sauger (*Stizostedian canadense)* and Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi)* have been designated by the Montana Department of Fish, Wildlife & Parks, and the Montana Natural Heritage Program as Montana Species of Special Concern. Species of Special Concern are native Montana fish with limited habitat and/or limited numbers in the state. The Species of Special Concern list acts as a 'watch list' to increase awareness of the status of these fish. In addition to being designated a Species of Special Concern, westslope cutthroat trout have been listed as 'sensitive'[1] by the US Forest Service and has been given 'special status'[2] designation by the Bureau of Land Management.

Westslope cutthroat trout have been found in the headwaters of Cottonwood Creek and East Fork Big Spring Creek. Sauger, a cool-water fish, has been found in the lower reaches of Big Spring Creek (Map 9).

The Montana Department of Fish, Wildlife and Parks operates the Big Spring Trout Hatchery 6.5 miles south of Lewistown at the site of the Big Spring. The first raceways and original hatchery building were constructed in 1939, and the hatchery has since been used for rearing a variety of trout species for stocking in Montana's streams, lakes and reservoirs. Big Spring Creek, itself, is a viable fishery and hatchery trout have not been stocked in the creek since the 1970's. Recently, concerns over the potential of whirling disease infecting hatchery trout have resulted in upgrades

[1] "Animal species…for which population viability is a concern as evidenced by significant downward trend in population or a significant downward trend in habitat capacity."
[2] "Federally-listed Endangered, Threatened, or Candidate species or other rare or endemic species that occur on BLM lands" (Carlson, 2001).

to the hatchery in order to protect the hatchery water supply from the disease. Additional upgrades are planned to manage hatchery effluent and reduce effluent discharge to Big Spring Creek. In 2003, PCBs were detected in hatchery raceway paints, prompting the *Montana Department of Fish, Wildlife and Parks* to initiate investigation into remediation options (see Section 6.0).

2.4.2 Aquatic Insects

The assemblage of aquatic insects, or benthic macroinvertebrates, present in a stream can be an excellent indicator of water quality. Macroinvertebrate data have been used by the DEQ to assess the water quality of Big Spring Creek, and have been collected and analyzed at a variety of locations along Big Spring Creek from 1990 to 2001 (Map 10).

Taxa Richness (the number of unique taxa present in a sample) for five sites along Big Spring Creek is shown in Figure 2-14. Taxa Richness generally decreases with increasing degradation of riparian areas and water quality. However, slight increases in taxa richness can be observes where mild nutrient enrichment of previously nutrient-limited waters occurs. As waters become more enriched in nutrients downstream, more tolerant forms appear, elevating taxa richness. Wisseman (1992a) documented an increase in chironomid midge richness (tolerant form) from 4 taxa near the hatchery to 20 taxa at the Hruska fishing access north of town, indicating diminished water quality. Since 1990, however, downstream taxa richness has decreased substantially from 1990 levels, perhaps suggesting an improving trend in water quality.

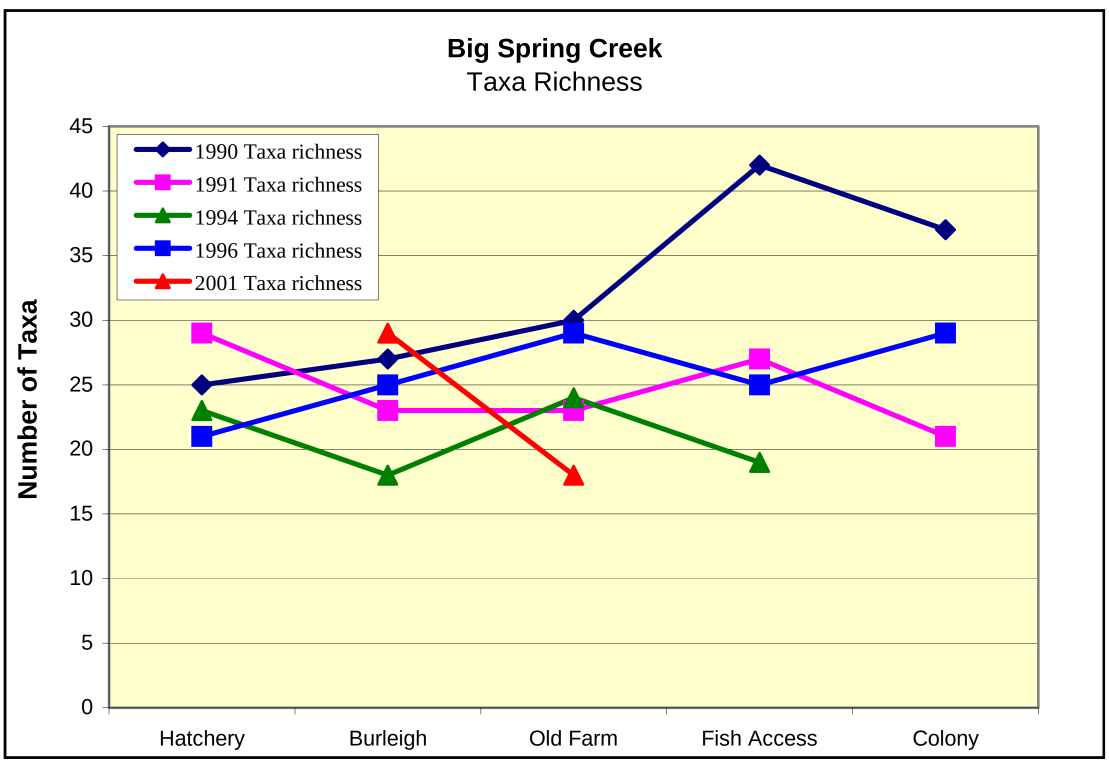

Figure 2-14. Big Spring Creek Taxa Richness Trends Since 1990.

Biotic Index is an indicator of nutrient enrichment, and is a modification of the Hilsenhoff Biotic Index. The lower the Biotic Index value, the less impacted the biologic assemblage. Analysis of Macroinvertebrates from Montana foothill prairie streams by Bollman (1998) showed correlation between biotic index and water temperature, substrate embeddedness and fine sediment. Generally, taxa tolerant to nutrient-enriched conditions are also tolerant to the aforementioned habitat conditions as well. Figure 2-15 shows Biotic Index values for sites along Big Spring Creek from 1990 to 2001. With the exception of the most recent sampling event (2001), data shows a marked increase in biotic index value downstream of Lewistown, indicating a change in substrate habitat and/or water quality conditions.

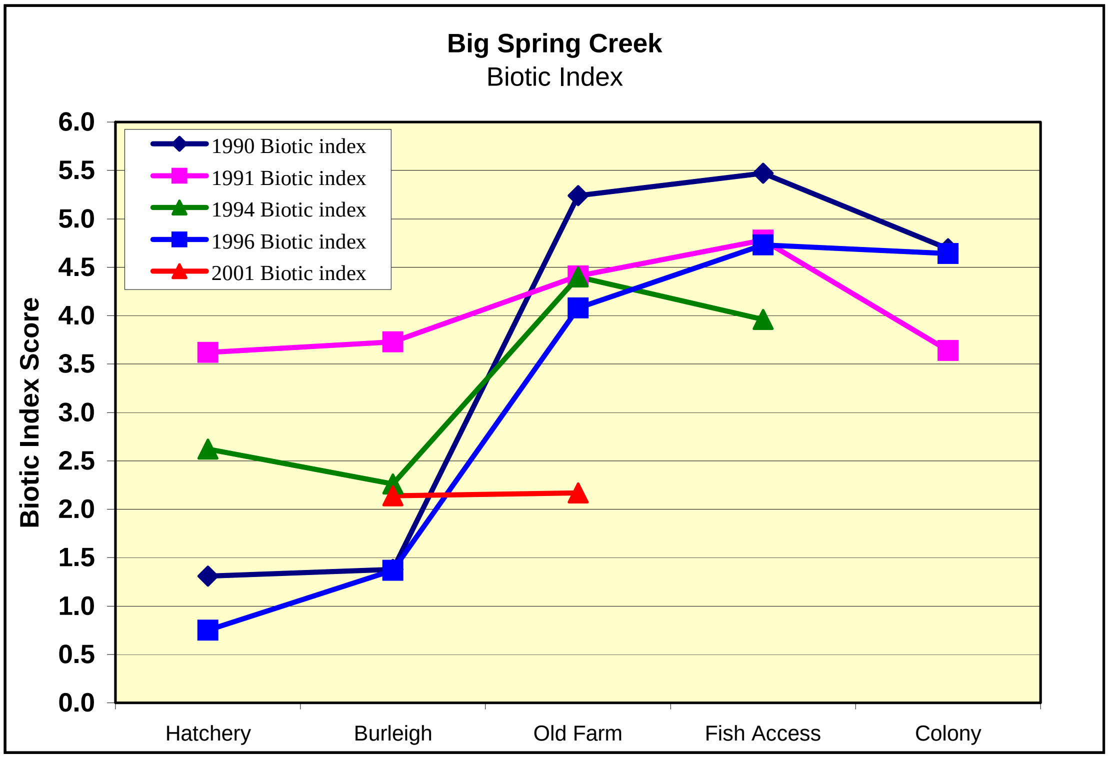

Figure 2-15. Big Spring Creek Biotic Index Trend Since 1990.

More detailed information regarding macroinvertebrate data and water quality assessments on Big Spring Creek and selected tributaries is given in following sections**.**

2.4.3 Periphyton

Periphytons are algae that are attached to rocks and plants in the stream, and include soft algae such as green, blue-green, and red algae, and hard-bodied algae (diatoms). Periphytons are primary producers and sensitive to environmental change, making them useful indicators of water quality.

Periphytons have been sampled by the Montana Department of Environmental Quality at various sites on Big Spring Creek and its tributaries. As conditions change from headwaters to mouth as a result of variations in flow, temperature, and point and nonpoint source influences, the periphyton community responds, likewise. The constant flow and temperature that the discharge from the Big Springs provides greatly influences the makeup of the biologic community below the spring. Periphyton flora on upper Big Springs Creek below the Big Spring is dominated by *Diatoma hyemalis*, an organism that requires constant cold-waters (Bahls, 2001a). Further downstream, biologic character changes in response to increasing variability of flow, temperature and nonpoint source inputs. Downstream of Pike Creek, only 12% of the flora was shared with the sampling site immediately downstream of Big Spring, “indicating that the flora of Big Spring Creek had changed from a *spring* flora to more of a *stream* flora at this point” (Bahls, 2001a). Further downstream, additional changes in periphyton community reflect increasing inputs of nutrients and deposition of fine sediment.

2.5 Cultural Characteristics

2.5.1 Historical Overview

Fergus County was established in 1885 by an act of the Fourteenth Legislative Assembly, Montana Territory. Sponsored by and named after James Fergus, miner, cattleman and territorial legislator, Fergus County originally spanned over 7,500 mi^2. It was later divided into the present Fergus County boundaries, Petroleum County and parts of Judith Basin, Wheatland, and Golden Valley Counties. Lewistown, the county seat, was named for Major William H Lewis who established Fort Lewis in 1874. Lewistown grew as a trading post on the Carroll Trail, a shipping route from near the mouth of the Musselshell River to Helena, and was incorporated in 1899.

1885 Montana county maps mark present Big Spring Creek as Big Trout Creek. As Lewistown grew and downtown buildings and businesses were constructed, sections of Big Spring Creek through town were covered over by the growing downtown area.

2.5.2 Population and Demographics

The population in the Big Springs Creek watershed was 8,772 people according to 2000 census data (Figure 2-16), 5,813 of which reside in the town of Lewistown. Average population density outside city limits is less than 8 people per square mile, with many large tracks of land being uninhabited.

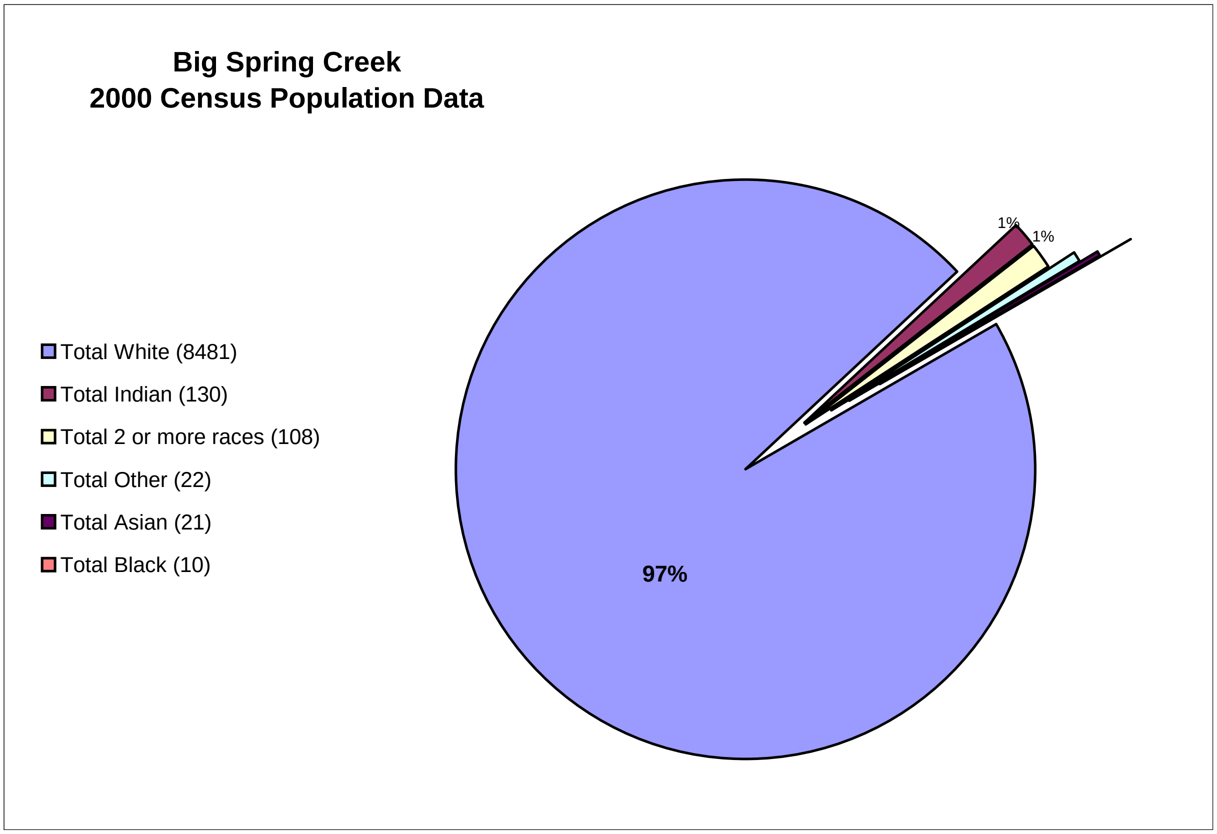

Figure 2-16. Population Data (NRIS) for the Big Spring Creek TMDL Planning Area.

2.5.3 Land Use and Ownership

The Big Springs Creek watershed is predominantly an agricultural watershed. Land use is a mosaic of irrigated and dryland agriculture, rangeland, and forested lands. Much of the undissected flatlands of the basin floor are very fertile and devoted to grain production. A summary breakdown of major land use categories and associated acreages is given in Table 2-13.

Table 2-13. Land Use Summary for Big Springs TMDL Planning Area (NRIS Data).

Percent	Acres	Land Use Summary
32.5%	83,175	Agriculture
28.2%	71,985	Rangeland
24.6%	62,940	Evergreen Forest
11.4%	29,242	Mixed Forest
1.8%	4,631	Urban
1.3%	3,412	Bare Ground
0.1%	203	Open Water
100%	255,588	

Land ownership is largely private (82%), with other large landowners being the U.S. Forest Service, Bureau of Land Management and the State of Montana. Lesser landowners (1% or less) include: local county and city government, Montana Department of Fish, Wildlife and Parks, and the U.S. Department of Defense. Figure 2-17 shows the distribution of land ownership in the Big Springs Creek watershed.

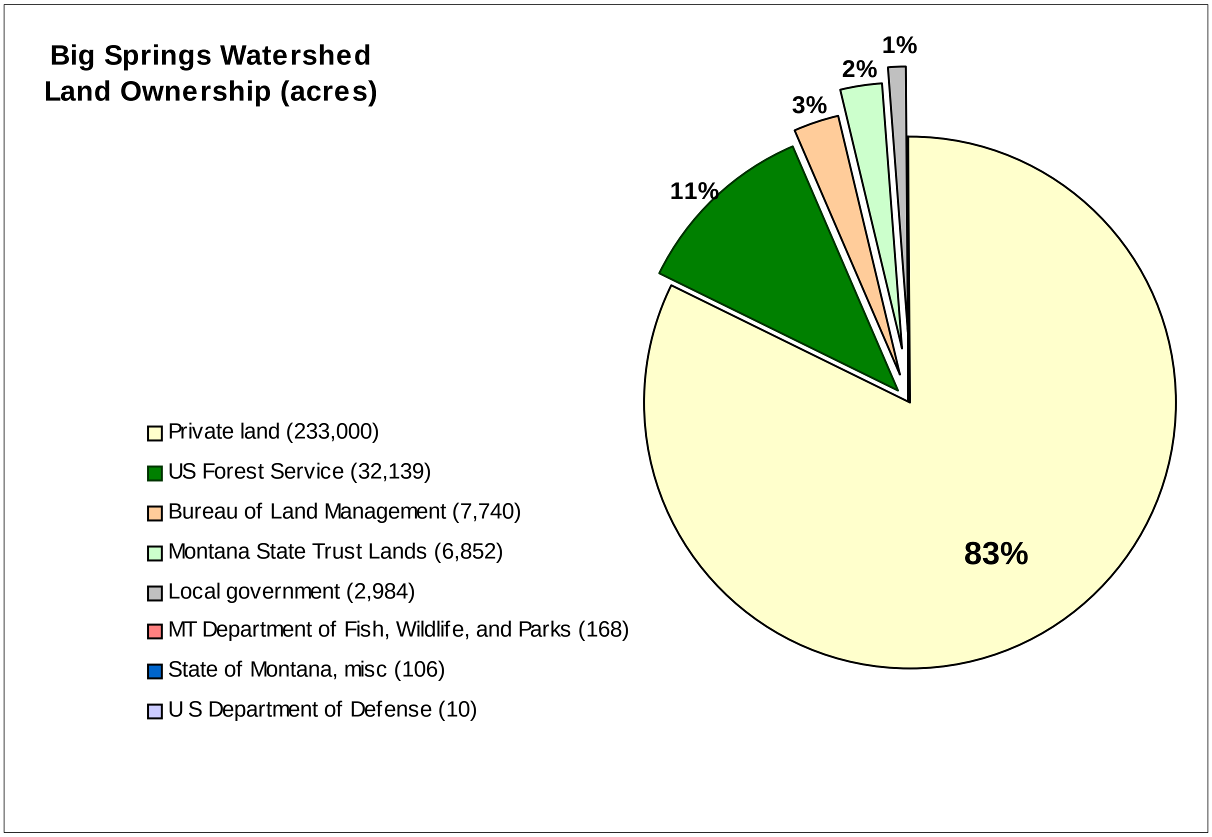

Figure 2-17. Land Ownership Data for the Big Springs TMDL Planning Area.

SECTION 3.0
WATER QUALITY IMPAIRMENT STATUS

This section of the document first presents the status of all 303 (d) listed waterbodies in the TPA (i.e., which waterbodies are listed as impaired or threatened and for which pollutant). This is followed by a summary of the applicable water quality standards. Section 4.0 Sediment Impairment Status, Section 6.0 PCB, and Section 7.0 Nutrient Impairment Status are devoted to a review of available water quality data and an updated water quality impairment status determination for each listed waterbody. A summary of the updated impairment status for each waterbody is given in Table 3-4.

3.1 303(d) List Status

The assessment of streams, lakes and wetlands to identify impaired waters for inclusion on the 303(d) list is an important step in a process intended to ensure that all waterbodies in the state will have water quality adequate to support all of their classified beneficial uses. The process has been developed and shaped by legal mandates, water quality standards, the tools and techniques of water quality monitoring, the availability of information, and the funds and administrative resources that can be devoted to assessment efforts.

The impairment causes and sources determination included on the 1996 303(d) list was based on data that showed impairments, however many determinations were based on professional judgment and involved limited data. Since the development of the 1996 303(d) list, the Montana Department of Environmental Quality has instituted procedures that more fully assess and identify impaired waters. This procedure, the *Sufficient Credible Data Assessment & Beneficial Use-Support Determination* (SCD/BUD) *Process,* conducted by the Montana Department of Environmental Quality in response to legal requirements stipulated in 75-5-702, MCA, resulted in updates to the 1996 303(d) listing. Consequently, impaired uses, causes, and sources on the 2004 303(d) list may differ from the original 1996 listings as a result of the data review and associated list revisions.

While the 2004 303(d) list is now Montana's most current approved list, and is based on more thorough data review and analysis than the 1996 list, a ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000 required that the state of Montana must complete all necessary TMDLs for waters listed as impaired or threatened on the 1996 303(d) list. Where new data has resulted in changes to the 303(d) listing status for 1996-listed waters through the State's SCD/BUD process, the DEQ will complete TMDLs based on updated impairment status resulting from this new information.

Waterbodies reviewed by the State's SCD/BUD process fall into 5 categories. The level of beneficial use support for the listed waters can be as fully supporting all designated beneficial uses (F), threatened (T), partially supporting (P), not supporting (N) and lacking sufficient credible data (X). The Beneficial Use-Support Determination for 303(d) listed streams in the Big Spring TMDL Planning Area is given in Table 3-1.

Table 3-1. Impaired Uses from Both 1996 & 2004 303(d) Lists. Source: DEQ, 1996, 2004.

Stream Reach (MT Waterbody ID)	Use Classification	**1996 Use-Support**						**2004 Use-Support**					
		Aquatic Life	Fishery	Drinking water	Agriculture	Industry	Contact Recreation	Aquatic Life	Fishery	Drinking water	Agriculture	Industry	Contact Recreation
Big Spring Creek (MT41S004_010) headwaters to confluence with E. Fork	B-1	T	T					P	P	F	F	F	P
Big Spring Creek (MT41S004_020) confluence of E. Fork to mouth	B-1	P	P				P	P	P	F	F	F	P
Beaver Creek (MT41S004_030)	B-1	P	P					P	P	F	F	F	P
Casino Creek (MT41S004_040)	B-1		T					P	P	F	F	F	P
Lower Cottonwood Creek (MT41S004_052)	B-1		T					P	P	P	P	P	P
Upper Cottonwood Creek (MT41S004_051)	B-1							F	F	F	F	F	F

Five waterbodies in the Big Spring Creek TMDL Planning Area occur on the Montana's 1996 303(d) list: Big Spring Creek (headwaters to East Fork), Big Spring Creek (East Fork to mouth), Beaver Creek, Casino Creek, and Cottonwood Creek. The causes and sources of impairment for each 1996 listing are indicated in Table 3-2 and the locations of the waters are shown in Figure 3-1.

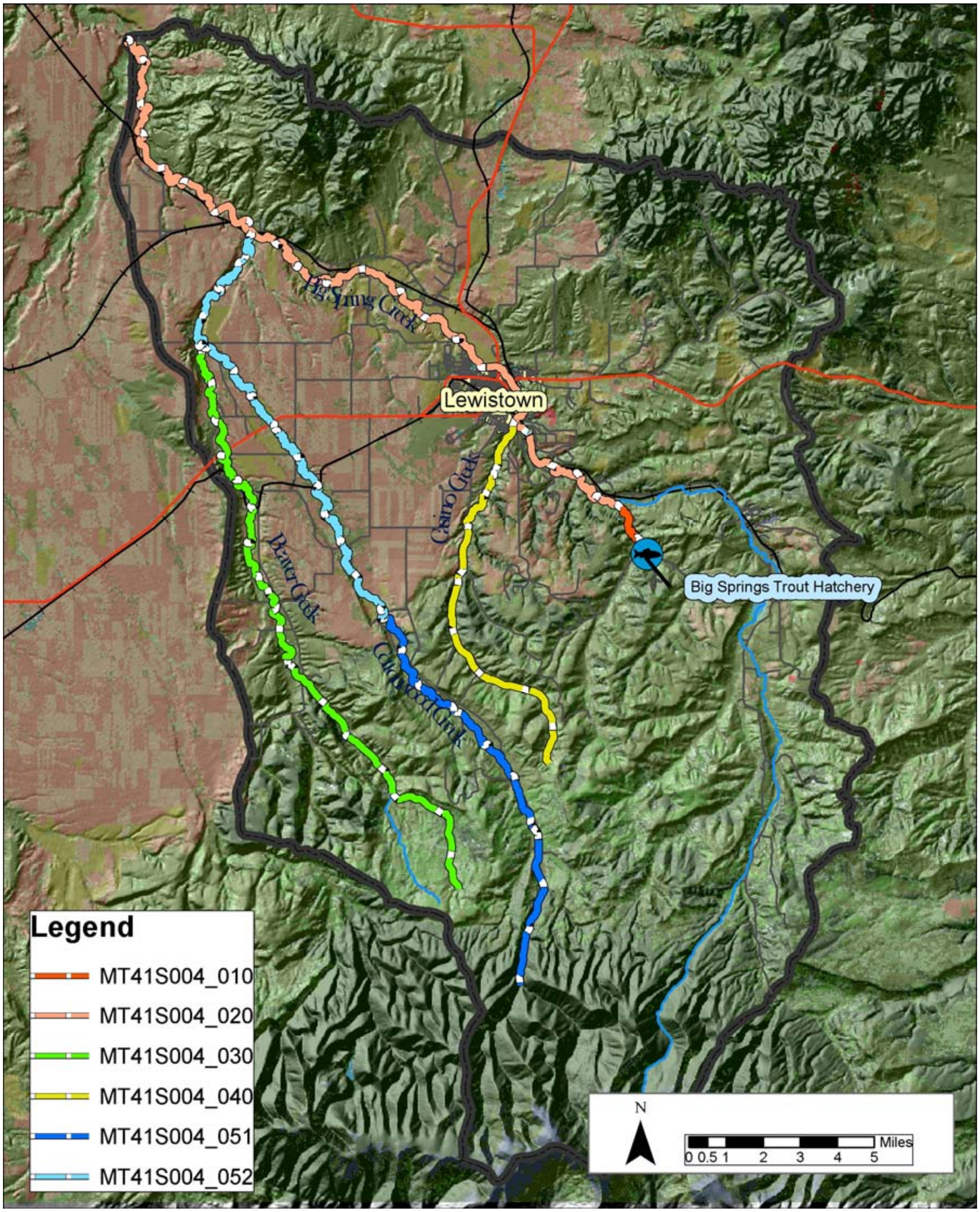

Figure 3-1. 303(d) Listed Waters in the Big Springs TMDL Planning Area.

Table 3-2. 1996 Listing Information for the Big Spring Creek TMDL Planning Area. Source: DEQ, 1996.

Segment Name (MT Waterbody ID)	**Est. Size (mi)**	**Probable Cause**	**Probable Source**
Big Spring Creek (MT41S004_010) headwaters to confluence w/ E. Fork	4	Nutrients Other habitat alterations Suspended solids	Aquaculture Land development
Big Spring Creek (MT41S004_020) confluence of E. Fork to mouth	28	Noxious aquatic plants Nutrients Other habitat alterations Siltation	Agriculture Channelization Domestic wastewater lagoon Municipal point source Off-farm animal hold/management area Silviculture Urban runoff/storm sewers
Beaver Creek (MT41S004_030)	23	Nutrients Suspended solids	Agriculture
Casino Creek (MT41S004_040)	12	Nutrients Suspended solids	Domestic waste water lagoon
Cottonwood Creek (MT41S004_052)	28	Nutrients Organic enrichment/DO Suspended solids	Domestic waste water lagoon

Since 1996, DEQ has collected additional data and information on streams in the Big Springs TPA, and has reviewed all available data and information in accordance with the state's SCD/BUD process. This has resulted in changes to impairment status for several waterbodies in the Big Springs TPA. In instances where probable causes of impairment were removed from the 1996 303(d) list, sufficient credible data did not exist to confirm 1996 determinations. Changes to the 1996 303(d) list were the result of additional information and data analysis. Consequent changes in impairment status from the 1996 303(d) list include:

Big Spring Creek (MT41S004_010):
Nutrients, habitat alterations and suspended solids were removed as probable causes of impairment. PCBs were added as a cause of impairment.
Big Spring Creek (MT41S004_020):
Noxious aquatic plants were removed as a probable cause of impairment and PCBs, riparian degradation and fish habitat degradation were added as probable causes of impairment.
Beaver Creek (MT41S004_030):
Suspended solids were removed as a probable cause of impairment and bank erosion, siltation, dewatering, riparian degradation and habitat alterations were added as probable causes of impairment.
Cottonwood Creek:
Cottonwood Creek was segmented into two separate reaches, based on topography and elevation: an upstream reach (MT41S004_051) and a downstream reach (MT41S004_052). The upstream reach was determined to be fully supporting its

beneficial uses, while probable causes of impairment for the downstream reach were listed as nutrients, siltation, organic enrichment/low dissolved oxygen, flow alteration/dewatering, habitat alteration and riparian and fish habitat degradation.
Casino Creek (MT41S004_040):
Suspended solids were removed as a probable cause of impairment and riparian degradation and habitat alteration were added as probable causes of impairment.

A full summary of all probable causes and sources of impairment on the 2004 303(d) list is given in Table 3-3.

Table 3-3. 2004 Listing Information for the Big Spring Creek TMDL Planning Area. Source: DEQ, 2004.

Segment Name (MT Waterbody ID)	**Est. Size (mi)**	**Probable Cause**	**Probable Source**
Big Spring Creek (MT41S004_010) headwaters to confluence w/ E. Fork	4	PCBs	Agriculture Intensive Animal Feeding Operations Aquaculture Contaminated Sediments
Big Spring Creek (MT41S004_020) confluence of E. Fork to mouth	28	Fish habitat degradation Nutrients Other habitat alterations PCBs Riparian degradation Siltation	Agriculture Grazing related Sources Municipal Point Sources Land Disposal Onsite Wastewater Systems Septic Tanks Habitat Modification other than Hydromodification Removal of Riparian Vegetation
Beaver Creek (MT41S004_030) headwaters to mouth	22	Bank erosion Dewatering Fish habitat degradation Flow alteration Nutrients Other habitat alterations Riparian degradation Siltation	Agriculture Grazing related Sources Habitat Modification other than Hydromodification Removal of Riparian Vegetation
Casino Creek (MT41S004_040) headwaters to mouth	12	Nutrients Other habitat alterations Riparian degradation	Agriculture Grazing related sources Intensive animal feed operations Habitat modification (other than hydromodification) Removal of riparian vegetation
Cottonwood Creek (MT41S004_052) from county road x-ing at T14N R18E sec 18 to mouth	13	Dewatering Fish habitat degradation Flow alteration Nutrients Organic enrichment/Low DO Other habitat alterations Riparian degradation Siltation	Agriculture Grazing related Sources Hydromodification Flow Regulation/Modification Habitat Modification other than Hydromodification Removal of Riparian Vegetation

Table 3-3. 2004 Listing Information for the Big Spring Creek TMDL Planning Area. Source: DEQ, 2004.

Segment Name (MT Waterbody ID)	**Est. Size (mi)**	**Probable Cause**	**Probable Source**
Cottonwood Creek (MT41S004_051) headwaters to county road x-ing at T14N S18E sec 18		Fully Supporting Beneficial Uses	

TMDLs or Total Daily Maximum Loads are developed for pollutants; these are water quality impairments that can be quantified and a load can be calculated. Riparian degradation and habitat alteration are not *pollutants* but are considered *pollution*. Additionally, flow alteration and dewatering are impairment issues related to water quantity and when viewed alone is not subject to a TMDL. However, sediment-related impairments may be related to stream energy and flow conditions. Likewise, riparian degradation and habitat alteration, when considered alone, do not require a TMDL, yet are often linked to pollutant loading and may exacerbate and contribute to the loading and influence of a pollutant in a stream.

Pollutants of concern, i.e. those requiring TMDLs, include: nutrients, sediment, organic enrichment/dissolved oxygen, and PCBs. Specific information regarding the status of these pollutants is given in subsequent sections of this document. Following the conclusions drawn regarding pollutants of concern in Sections 4.0, 6.0, and 7.0, the present impairment status of Big Spring Creek, Beaver Creek, Cottonwood Creek and Casino Creek is given in Table 3-4.

Table 3-4. Present Impairment Status for Streams in the Big Spring Creek TMDL Planning Area.

Waterbody	Year Listed	Listed Probable Causes	Current Status
Big Spring Creek (MT41S004_010) headwaters to confluence with E. Fork	1996	Nutrients Other habitat alterations Suspended solids	Impaired for PCBs **PCB TMDL required**
	2004	PCBs	
Big Spring Creek (MT41S004_020) confluence of E. Fork to mouth	1996	Noxious aquatic plants Nutrients Other habitat alterations Siltation	Impaired for sediment, nutrients, PCBs **Sediment TMDL required** **Nutrient TMDL required** **PCB TMDL required**
	2004	PCB Nutrients Siltation Other habitat alterations Riparian degradation Fish habitat degradation	
Beaver Creek (MT41S004_030)	1996	Nutrients Suspended solids	Not Impaired

Table 3-4. Present Impairment Status for Streams in the Big Spring Creek TMDL Planning Area.

Waterbody	Year Listed	Listed Probable Causes	Current Status
	2004	Bank erosion Riparian degradation Other habitat alterations Nutrients Siltation Fish habitat alteration Dewatering	No TMDL required
Casino Creek (MT41S004_040)	1996	Nutrients Suspended solids	Impaired for nutrients **Nutrient TMDL required**
	2004	Nutrients Other habitat alterations Riparian degradation	
Upper Cottonwood Creek (MT41S004_051)	1996	Nutrients Organic enrichment/DO Suspended solids	Not Impaired No TMDL required
	2004	Fully supporting beneficial uses	
Lower Cottonwood Creek (MT41S004_052)	1996	Nutrients Organic enrichment/DO Suspended solids	Impaired for nutrients, dissolved oxygen **Nutrient/Dissolved Oxygen TMDL required**
	2004	Nutrients Siltation Organic enrichment/low DO Flow alteration Dewatering Other habitat alterations Riparian degradation Fish habitat degradation	

3.2 Applicable Water Quality Standards

Water quality standards include; the uses designated for a waterbody, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the high quality of a waterbody. The ultimate goal of this water quality restoration plan, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards are met. Water quality standards form the basis for the targets described in the Targets section for each pollutant. Pollutants addressed in this Water Quality Restoration Plan include: sediment, nutrients, PCBs and organic enrichment/dissolved oxygen. This section provides a summary of the applicable water quality standards for each of these pollutants.

3.2.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a waterbody based on the potential of the waterbody to support those uses. Designated Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of “uses” of state waters including: growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana Water Quality Act (WQA) directs the Board of Environmental Review (BER, i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana (ARM) 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply, however the quality of that waterbody must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or nonpoint source discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water's classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally miss-classified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed or made less stringent.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table 3-5. All waterbodies within the Big Springs TPA are classified as B-1 waters.

Table 3-5. Montana Surface Water Classifications and Designated Beneficial Uses.

Classification	Designated Uses
A-CLOSED CLASSIFICATION:	Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection.
A-1 CLASSIFICATION:	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities.
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-2 CLASSIFICATION:	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-3 CLASSIFICATION:	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-1 CLASSIFICATION:	Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-2 CLASSIFICATION:	Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated

Table 3-5. Montana Surface Water Classifications and Designated Beneficial Uses.

Classification	Designated Uses
	aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-3 CLASSIFICATION:	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply.
I CLASSIFICATION:	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.

3.2.2 Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

Numeric surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular WQB-7 (DEQ, January 2004). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant" or an authorization to degrade must be granted by the Department. However under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the waterbody.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a waterbody. Uses may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi and algae.

The standards applicable to the list of pollutants addressed in the Big Springs TPA are summarized, one-by-one, below.

3.2.2.1 Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in Table 3-2. The relevant narrative criteria do not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a reference condition that reflects a waterbody's greatest potential for water quality given current and historic land use activities where all reasonable land, soil, and water conservation practices have been applied and resulting conditions are not harmful, detrimental or injurious to beneficial uses (see definitions in Table 3-6).

Table 3-6. Applicable Rules for Sediment Related Pollutants.

Rule(s)	Standard
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
	The maximum allowable increase above naturally occurring turbidity is: 0 NTU for A-closed; 5 NTU for A-1, B-1, and C-1; 10 NTU for B-2, C-2, and C-3)
17.30.602(17)	"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.
17.30.602(21)	"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

3.2.2.2 Dissolved Oxygen

The freshwater aquatic life standards for dissolved oxygen are presented in Table 3-7. A table of fish spawning times and schedule for the presence of early life stages of fish are likely may be found at http://www.deq.state.mt.us/wqinfo/Standards/SpawningTimesFWP.pdf.

Table 3-7. Aquatic Life Standards for Dissolved Oxygen (mg/L).

Time Period	Use Class A-1, B-1, B-2, C-1, and C-2	
	Early Life Stages[a]	Other Life Stages
30-day average	NA	6.5
7-day average	9.5 (6.5)	NA
7-day average minimum	NA	5.0
1-day minimum	8.0 (5.0)	4.0

[a]These are water column concentrations recommended to achieve the required intergravel DO concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

3.2.2.3 Nutrients

Most waters of Montana are protected from excessive nutrient concentrations by narrative standards. The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/l) and total phosphorus (20 ug/l upstream of the confluence with the Blackfoot River and 39 ug/l downstream of the confluence) as well as algal biomass measured as chlorophyll *a* (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

The narrative standards applicable to nutrients elsewhere in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.,). The prohibition against the creation of "*conditions, which produce undesirable aquatic life*" is generally the most relevant to nutrients (Table 3-6).

3.2.2.4 Polychlorinated Biphenyls (PCBs)

Both narrative and numeric standards apply to PCBs in surface waters. The narrative standards applicable to PCBs are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637). Applicable prohibitions included in ARM 17.30.637 include substances that will:

> … c) produce odors, colors or other conditions as to which create a nuisance or render undesirable tastes to fish flesh or make fish inedible…
> d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life

Numeric standards for PCBs in surface water apply to both aquatic life and human health. For aquatic life, the chronic PCB standard is 0.014 µg/L. The drinking water standard for PCB in surface water is based on a priority pollutant concentration level of 0.0017 µg/L, and no sample shall be allowed to exceed this without violating the standard.

SECTION 4.0
SEDIMENT IMPAIRMENT STATUS

This section provides detailed information regarding sediment impairment conditions in the Big Spring TMDL Planning Area: data verifying impairment status, sources and processes affecting impairment and final determination of present impairment status for 303(d) listed streams. Because processes and practices affecting sediment –related impairments differ from waterbody to waterbody, each waterbody will be addressed individually in the following subsections. For each waterbody, all relevant data will be presented, and known and suspected/potential sources will be addressed. A summary of present water quality status for sediment is given in Table 3-4.

4.1 Causes of Sediment-Related Impairment

The 303(d) list status of waters in the Big Spring TMDL Planning Area is summarized in Section 3.1. Streams in the Big Spring Creek TMDL Planning Area listed for sediment-related impairments include (Figure 3-1):

- Big Spring Creek (MT41S004_010, MT41S004_020)
- Beaver Creek (MT41S004_030)
- Cottonwood Creek (MT41S004_051, MT41S004_052)
- Casino Creek (MT41S004_040)

Several probable causes identified on the 1996 and 2002 303(d) lists contribute to sediment-related impairment of beneficial use. These include siltation, suspended solids, habitat/riparian degradation, bank erosion and flow alteration, or dewatering.

4.1.1 Siltation

Siltation is a process by which fine sediment particles are deposited in excessive amounts in the streambed and occurs when the sediment load has exceeded the stream's transport capacity. Causes of sediment/siltation impairment may be due to reductions in stream flow and transport capacity or increases in sediment load to the stream, or both.

Build up of fine sediments has adverse effects on aquatic life. Siltation may fill interstitial spaces between spawning gravels, significantly inhibiting the spawning success and therefore propagation of salmonid fish species. Siltation also affects fisheries by reducing the habitat and productivity of aquatic insects, a primary food source for fish. Siltation may further affect fish habitat by decreasing pool volume. Pools are deeper areas in streams with slower velocities and cooler temperatures, and provide critical holding, hiding, and over-wintering areas for fish. Reduction and filling-in of pool habitat can lead to increased stress to fish due to overcrowding, loss of cold-water refugia, and increased competition.

4.1.2 Suspended Solids

Suspended solids are particles of clastic or organic material that remains suspended in the water column of the stream. While suspended solids are a naturally occurring constituent of water quality, excessive suspended solids are detrimental to salmonid fish species and associated aquatic life (Waters, 1995). Suspended solids can abrade and suffocate macrophytes and periphyton, disrupt respiration of fish and macroinvertebrates, and decrease primary production due to light reduction. Excessive suspended solids can also increase water temperatures and increase wear to irrigation pumps.

4.1.3 Riparian and Habitat Degradation

Riparian and *habitat degradation* refers to a variety of impacts to the stream channel and associated riparian zone. These may include: removal or alteration of streamside vegetation, removal of large woody debris, alteration of channel form or substrate, *bank erosion* or other alterations to terrestrial and aquatic habitat elements. While habitat alteration is not considered a 'pollutant' and therefore not subject to the development of total maximum daily loads, it can be a contributor or strong influence on the loading of a pollutant (sediment in this case). For instance, removal of riparian vegetation, especially trees and woody shrubs, may lead to bank instability and increased bank erosion and consequently increases in sediment loading to a stream. Likewise, vegetation removal may also reduce the ability of vegetated buffer zones to intercept sediment-laden runoff from uplands during storm events. So, while TMDLs are not developed for 'riparian degradation' or 'bank erosion', these types of pollution certainly contribute to sediment-related impairments and are addressed as factors that influence impairment. Restoration targets and implementation strategies commonly focus on these 'surrogate' indicators of impairment, and may call for enhancement and monitoring of habitat elements to assess attainment of beneficial uses.

4.1.4 Flow Alteration and Dewatering

Flow alteration and *dewatering* are commonly considered water quantity rather than water quality issues, however changes to stream flow can have a profound affect on the proper functioning of stream systems and can be a major factor influencing water quality impairments. Stream channel form evolves and stabilizes over long time periods based on the amount of stream flow (energy) and sediment supply (Leopold et al., 1964; Rosgen, 1996). When the balance between sediment supply and stream energy is disrupted, changes in channel form result. Decreases in stream energy may result in an inability of the stream to effectively transport sediments, thereby causing aggradation, or deposition of sediments in the stream channel, which further contributes to a decrease in stream energy by creating a wider and shallower channel. Consequently, appropriate duration and magnitude of peak flows (i.e. bank full or flood flows) and base flows are critical to a stream's ability to transport sediments. Sustained low flows, whether it be from flow regulation, channel alteration, drought or other natural conditions can lead to sediment-related impairments, and while TMDLs are not required for water quantity-related issues, low flows (like riparian or habitat degradation) contribute to sediment-related impairments and are addressed as a factor that influences impairment condition. Restoration targets and implementation strategies recognize the need for specific flow regimes, and may recommend flow-related recommendations and enhancements as a means to achieve full support of beneficial uses.

4.2 Existing Water Quality Conditions

This section of the document provides a summary and evaluation of all of the available data relative to potential sediment related impairments in Big Spring Creek, Beaver Creek, Cottonwood Creek, and Casino Creek. A summary of the available data types is presented first, followed by a waterbody-by-waterbody evaluation of the data.

Description of Available Data Types

A variety of data and information was assessed in order to make sediment-related impairment determinations. These include:

- Biological data
- Macroinvertebrate habitat assessments
- Physical measurements and observations
- Aerial surveys and nonpoint source assessments

4.2.1 Biological Data

Biological data consists of information on macroinvertebrate, periphyton, and fish assemblages. Biological data are a direct measure of the aquatic life beneficial use and provides an understanding of the cumulative and intermittent impacts that may have occurred over time in a stream. The Montana DEQ utilizes a variety of assessment methods and metrics to evaluate the response of biological systems to environmental stressors.

4.2.1.1 Macroinvertebrates

Mutimetric Index

Macroinvertebrate data are typically evaluated according to a multimetric index of biological integrity (IBI), or a “multimetric index.” A multimetric index integrates the values of several separate biological health indicators (metrics) into a single numeric score that describes the biological integrity of the macroinvertebrate assemblage sampled. DEQ uses a scoring procedure with the maximum possible score of 100 percent. Bioassessment scores *greater than 75 percent* are considered within the range of anticipated natural variability and represent full support of their beneficial use (aquatic life). Streams scoring between 25 and 75 are considered partially supporting their aquatic life uses and scores lower than 25 percent represent non-supported uses. While the multimetric approach is a tool that can assist in making impairment decisions, it does not distinguish between pollutant-specific impairments; individual metrics are interpreted to provide evaluation relevant to sediment-related impairment.

Individual Metrics

In addition to the multimetric approach, several individual metrics were used to evaluate sediment-related impairment conditions. These include: EPT taxa richness, percentage of clinger taxa, and trichoptera richness.

EPT taxa richness is a metric describing the number of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) taxa in a sample. Invertebrates that are members of these groups are generally understood to be sensitive to stressors in streams, whether physical, chemical, or biological. Consequently, they are less common in degraded streams. Metric values decrease in the presence of stressors.

The **percentage and number of clinger taxa** in a sample can be an indictor of sediment impairment. Clingers are aquatic insects that have morphological and behavioral adaptations that allow individuals to maintain position on an object in the substrate in the face of potentially shearing flows. These taxa are sensitive to fine sediments that fill interstitial spaces and therefore decreases in the presence of increased fine sedimentation. **A high percentage of clingers (>50%) suggest minor impact from sediment.** A minimum of 14 clinger taxa is expected in unimpaired mountain streams (Bollman 1998). Streams in the Big Spring TMDL Planning area fall on the cusp between the *Montana Valley & Foothill Prairie* and *Northwestern Great Plains* ecoregions, where higher levels of fine sediment are expected in relation to mountain streams. Consequently, the number of clinger taxa should be expected to be less than in mountain streams. **A criteria of greater than 8 clinger taxa and/or percent clingers >50% are chosen as indicators of conditions that represent minimal to minor impact from sediment for streams in the Big Spring TMDL planning area.**

Trichoptera taxa richness is a metric that describes the number of distinct caddisfly taxa in a sample. Trichopterans (caddisflies) are case-building insects that inhabit a variety of substrate habitats. Caddisfly taxa richness has been shown to decrease with increasing sedimentation (Bollman, 2003, personal communication). **A trichoptera taxa richness of greater than 4 is chosen as an indictor of conditions that represent minimal to minor impact from sediment for streams in the Big Spring TMDL planning area.**

4.2.1.2 Periphyton

Like macroinvertebrates, periphyton communities respond to changes in water quality conditions and can therefore be used as indicators of water quality. Diatoms, in particular, are considered useful water quality indicators because much is known about the relative pollution tolerances of different taxa and the water quality preferences of common species (Barbour et al., 1999).

Several different periphyton metrics are utilized to assess water quality. One such metric is the **siltation index.** The *periphyton siltation index* is a measure of the relative abundances of all diatoms adapted to living on sandy or silty substrates (Bahls, 2004). The motility of these diatom species enables them adjust to sedimentation/siltation, enabling their relative abundances to be used as indicators of sediment impacts. The siltation index is the sum of the percent abundances of all species in the silt-tolerant diatom genera Navicula, Nitzschia, and Surirella. **A high value**

(>20.0) for this index indicates potential sediment impacts for mountain streams (Bahls, 2004). For plains streams, a siltation index <50 indicates conditions with the range of what is considered 'natural.'

4.2.1.3 Fish

Fisheries are an important designated use in freshwater streams. Fish represent the higher trophic levels in streams and lakes. They serve as a surrogate for many physical and biological parameters such as adequate flow, spawning and rearing habitat, appropriate food sources, and proper environmental conditions.

Montana Fish, Wildlife and Parks have collected fish data on a variety of streams in the Big Springs TPA since the late 1960s. **Fish data may not provide a reliable measure of water quality and are used with caution herein due to a number of complicating factors affecting fish population and distribution.** Fish populations might change due to effects outside of management control such as temperature, peak runoff, primary productivity, competition from other fish species and invertebrate populations, or other factors unrelated to water quality. Data and trends in fishery production are presented herein for supporting purposes. Any future changes in fishery trends will be evaluated in combination with other water quality indicators.

4.2.2 Macroinvertebrate Habitat Assessments

Macroinvertebrate habitat assessments (Plafkin et al., 1989) yield a semi-quantitative measure of the character of the stream substrate and riparian habitat. Macroinvertebrate habitat assessments are designed to provide additional information with which to evaluate accompanying bioassessment scores, but are also useful in assessing site conditions. Many individual habitat parameters influence sediment delivery and deposition, and therefore low habitat scores reflect conditions that may contribute to sediment-related impairments.

Macroinvertebrate habitat assessments assign a numeric score to a variety of habitat categories: riffle development, benthic substrate, embeddedness, channel alteration, sediment deposition, channel flow status, bank stability, bank vegetation protection, vegetated zone width. Scores for individual parameters are totaled and compared to the best possible score to provide an overall macroinvertebrate habitat assessment value (Table 4-1).

Table 4-1. Habitat Condition Categories (Plafkin et al., 1989).

Habitat Condition	Macroinvertebrate Habitat Assessment Score
Optimal	≥80%
Sub-optimal	56%-75%
Marginal	29%-49%
Poor	<23%

4.2.3 Physical Measurements and Observations

Physical measurements and observations include a variety of data and information that includes but is not limited to: Wolman pebble counts, stream reach assessments, photographs, and field notes from a variety of sources.

4.2.3.1 Wolman Pebble Counts

Pebble counts provide an indication of the type and distribution of bed material in a stream. Streams naturally have a wide variety of bed material, however, too much fine material may degrade the habitat of fish, periphyton, and aquatic invertebrates, and can cause a shift in populations if conditions deviate from natural conditions. The state in which there is too much fine sediment in a streambed is often referred to as “embeddedness” or “siltation.”

The Wolman pebble count method is one method for determining the amount of fine sediment in a waterbody (Wolman, 1954). Pebble count data can be interpreted to compare median particle sizes between streams, evaluate the percent fines less than a specific size, and compare particle distributions between streams. Threshold pebble count values have not been fully developed by DEQ for Montana. Recent work completed in the Boise National Forest in Idaho showed a strong correlation between the health of macroinvertebrate communities and percent surface fines, where fine sediments are defined as all particles *less than 2 millimeters*. The most sensitive species were affected at 20 percent surface fines and a definite threshold was observed at 30 percent surface fines (USEPA, 2004). New Mexico Environmental Department has also established a percent surface fines target of less than 20 percent for TMDL development (New Mexico Environmental Department, 2002). **A criteria of <20% fines <2mm is chosen as an indictor of conditions that represent minimal to minor sediment impact to streams in the Big Spring TMDL planning area.**

4.2.3.2 Stream Reach Assessments

Stream reach assessments provide information on a variety of parameters related to stream and bank stability, riparian vegetation, aquatic habitat, and anthropogenic impacts. Like the macroinvertebrate habitat assessments DEQ stream reach assessments assign a numeric score to a variety of habitat categories: stream incisement, woody species establishment, habitat complexity, land use activities, etc. Scores for individual categories are totaled and compared to the best possible score to provide an overall stream reach assessment rating (Table 4-2).

Table 4-2. Stream Reach Assessment Rating (DEQ, Revised 2003).

Rating	Stream Reach Assessment Score
Sustainable	75% - 100%
At Risk	50% -75%
Not Sustainable	<50%

4.2.3.3 Photographs, Field Notes, Observations

Photographs, field notes and observations consist mainly of qualitative data regarding stream and riparian condition. Taken alone, the utility of these types of information is limited, however they supplement and provide supporting evidence for other more quantitative forms of information.

4.2.4 Aerial Surveys and Nonpoint Source Assessments

In 2003, DEQ contracted a stream assessment using aerial photography collected on Big Spring Creek (1989), Beaver Creek (1995) and Cottonwood Creek (1995). Parameters such as degraded riparian vegetation, riparian composition, eroding banks, channelization/channel alteration, channel riprap, buffer width and Rosgen Level I stream type were assessed for segmented reaches of Big Spring Creek, Beaver Creek, and Cottonwood Creek.

In addition to aerial photography assessments contracted by the Montana DEQ, NRCS conducted an aerial inventory survey of nonpoint sources on several tributaries of Big Spring Creek in 1995, and conducted a field stream inventory and assessment of physical features of Big Spring Creek in 1990. **Specific criteria with which to evaluate sediment impairment conditions from aerial and nonpoint source surveys are not employed. Rather information from these efforts is used to supplement other forms of information and data.**

4.3 Big Spring Creek

Big Spring Creek is a spring-fed stream that flows northwest from the foothills of the Big Snowy Mountains 32 miles to its confluence with the Judith River. Big Spring Creek is segmented into two distinct reaches (Figure 3-1). MT41S004_010 is a four-mile reach from Big Spring Creek's headwaters at Big Springs to its confluence with East Fork Big Spring Creek. This reach is dominated by the influence of Big Springs, a spring with an annual average discharge >100cfs. MT41S004_020 is ~28 miles long and extends from the confluence of East Fork Big Spring Creek to the confluence with the Judith River. As described in Section 2.3, dams in the headwaters of Big Spring Creek currently have a significant influence on the stream's hydrology. Also notable relative to potential sediment impairments, is the fact that roughly one mile of Big Spring Creek has been routed through a concrete and riprap lined channel through the City of Lewistown (see Section 2.3).

4.3.1 Existing Conditions for Big Spring Creek

Big Spring Creek (MT41S004_010) was listed on the 1996 303(d) list; cold-water fishery and aquatic life beneficial uses were listed as threatened due to nutrients, suspended solids, and habitat alterations. The basis for the 1996 listing is unknown. Big Spring Creek (MT41S004_010) was found to be fully supporting all its beneficial uses on the 2002 303(d) list.

Big Spring Creek (MT41S004_020) was listed on the 1996 303(d) list; cold-water fishery, aquatic life, and contact recreation beneficial uses were listed as partially supporting due to noxious aquatic plants, nutrients, siltation and other habitat alterations. The basis for the 1996 listing is unknown. On the 2002 303(d) list, cold-water fishery and aquatic life were listed as partially supporting due to nutrients, siltation, polychlorinated biphenyls (PCBs), riparian degradation, fish habitat and other habitat degradation.

Note that the data presented in the following evaluation considers data relevant to sediment-related impairments. An evaluation of nutrient conditions is presented in Section 7.0.

4.3.1.1 Biological Data

4.3.1.1.1 Macroinvertebrates & Macroinvertebrate Habitat Assessments

Macroinvertebrates have been collected at 13 sites on Big Spring Creek from 1983 to 2001. Several of these sites have been sampled multiple times over this 18-year period making for a thorough data set of macroinvertebrate assemblages from several locations along Big Spring Creek. Five of these sites, Below Fish Hatchery, Burleigh Easement, Carroll Trail Fishing Access Site (FAS), Hruska FAS and Spring Creek Colony, have been sampled for macroinvertebrates periodically since 1990, making an assessment of spatial and temporal trends in water quality possible (Figure 4-1).

Because Big Spring Creek is a spring fed system, its flow does not follow the common hydrologic pattern to which most western streams adhere. Low late summer flows are less of a concern on upper Big Spring Creek as they are on other streams in the area, and dams upstream of town have reduced spring run-off peaks. The result is a flow regime that does not exhibit the seasonal flow fluctuations that characterize other streams in the region. This flow regime, coupled with the influence of spring water temperature and chemistry, affects the biologic character of Big Spring Creek. For this reason, comparisons of Big Spring Creek's macroinvertebrate community to those of other streams in the region or to regional bioassessment criteria, for purpose of assessing aquatic life support, does not apply (Wease Bollman, personal communication, 2003). Multimetric index scores, therefore, should be used with caution when assessing beneficial use support for Big Spring Creek. Additional macroinvertebrate metrics (EPT richness, percent clinger taxa, trichoptera richness) can be useful in assessing biological response to stressors and are used herein to provide supplemental evidence for biological evaluations.

Macroinvertebrate surveys conducted for reach MT41S004_010 indicate a biologically diverse and unimpaired benthic community. At both the *Burleigh Easement* site and *Below Fish Hatchery* site, recent bioassessments indicate **unimpaired** benthic macroinvertebrate communities and **optimal** habitat conditions.

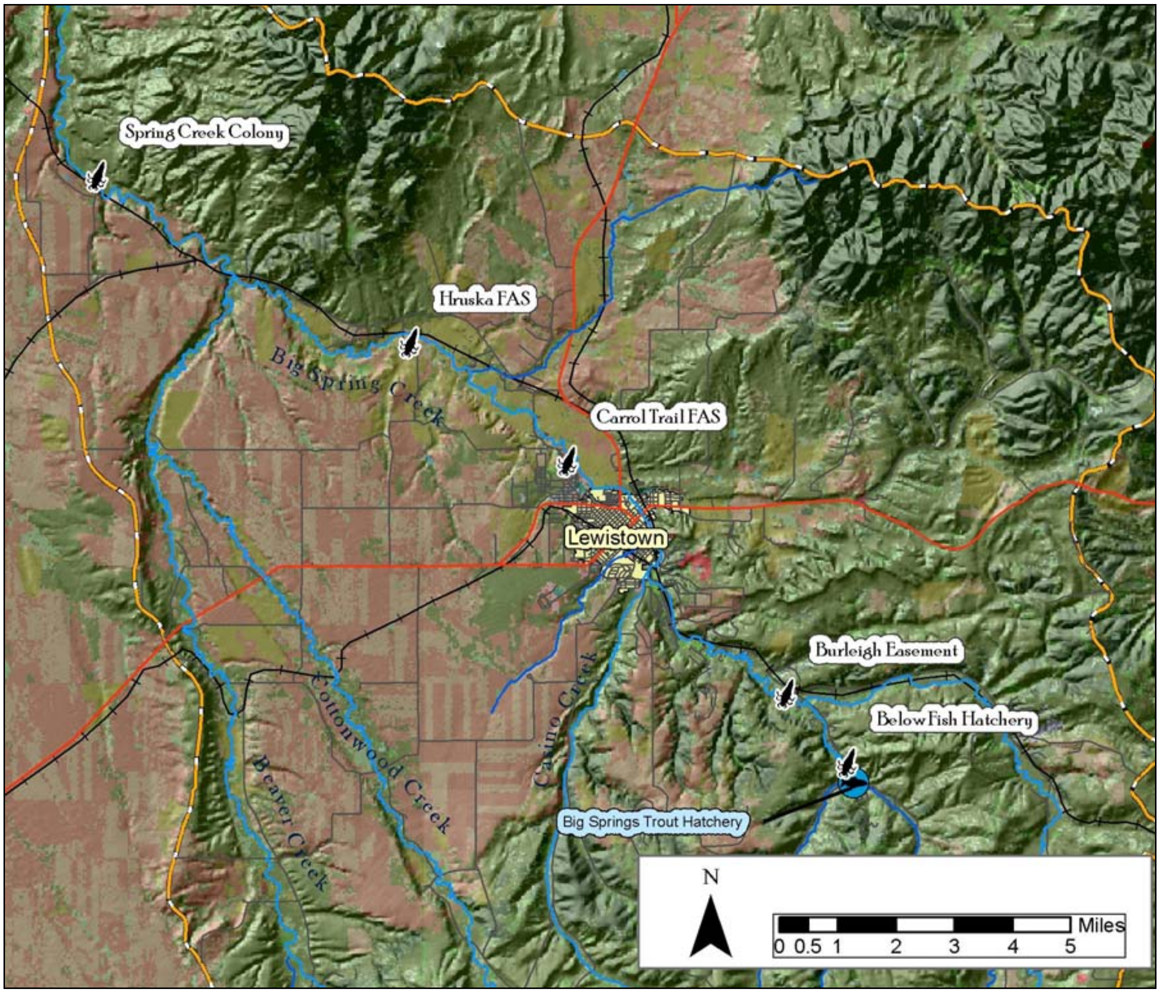

Figure 4-1. Selected Macroinvertebrate Sampling Locations on Big Spring Creek.

At the **Below Fish Hatchery** site, macroinvertebrate samples collected in 1996 indicate an assemblage influenced by spring and groundwater sources (McGuire, 1995). EPT richness was high (12), percent clinger taxa was very high (91%), and trichoptera taxa richness was high (5). Bioassessment scores based on a multimetric index developed by Wisseman (Wisseman, 1992b) scored 75% or greater in all years sampled (Figure 4-2), indicating unimpaired conditions. Macroinvertebrate Habitat Assessments, while not conducted in 1996, scored optimal in previous years (Figure 4-3).

At the **Burleigh Easement** site, the percentage of clinger taxa (49%) collected in 2001 "suggests that benthic substrates were clean and unimpaired by fine sediment deposition" (Bollman, 2001b). Likewise, "functional components of the benthic invertebrate community seem to be well balanced, with adequate representation of grazers, scrapers, predators, and shredders" (Bollman, 2001b). EPT taxa richness was high (13) as was trichoptera richness (5). Multimetric bioassessment scores (Wisseman, 1992b) indicated unimpaired conditions (Figure 4-2). Macroinvertebrate habitat assessments scored in the optimal range in five of six years (Figure 4-3).

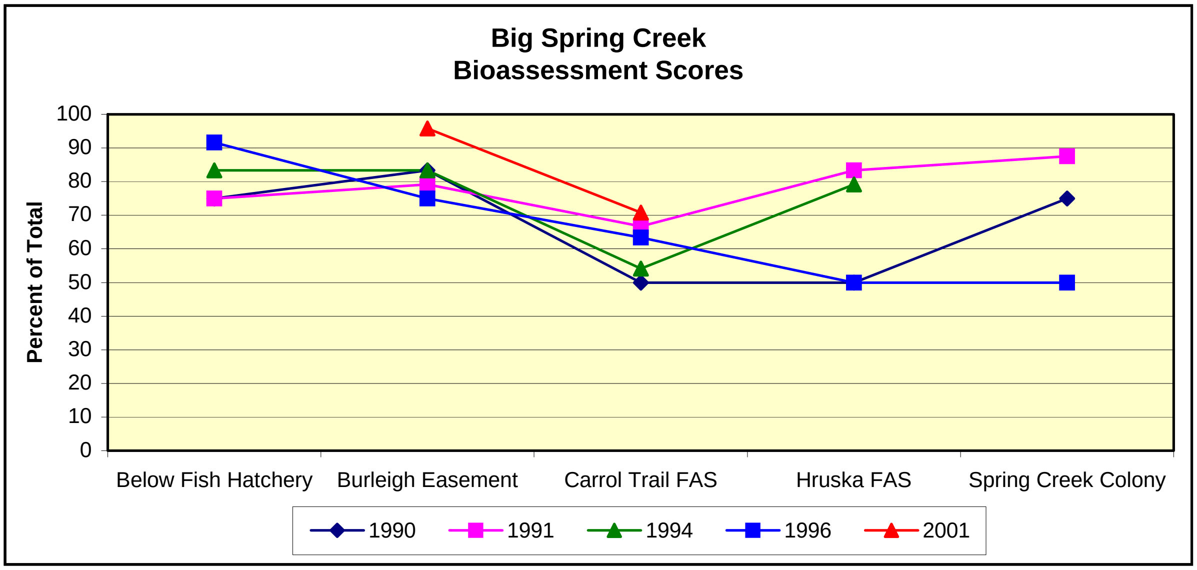

Figure 4-2. Big Spring Creek Macroinvertebrate Bioassessment Scores (1990-2001).

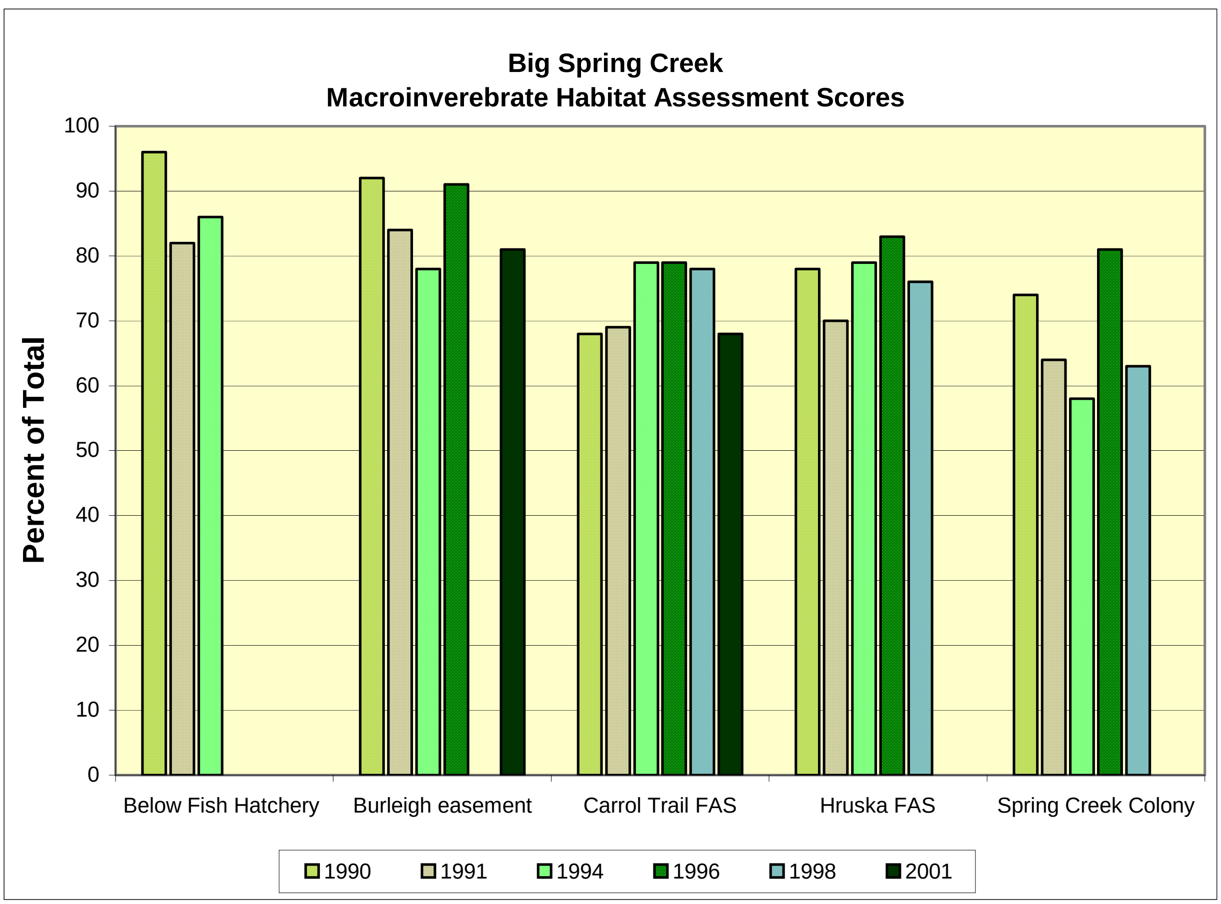

Figure 4-3. Big Spring Creek Macroinvertebrate Habitat Assessment Scores (1990-2001).

Bioassessment scores below Lewistown (Carroll Trail FAS, Hruska FAS) indicate a decrease in biological integrity. Further downstream at the Spring Creek Colony site, bioassessment scores improve slightly. Compared to upstream sites, EPT Richness, percent clinger taxa and trichoptera richness all decrease at downstream sites implying degradation of water quality at both the Carroll Trail FAS and the Hruska FAS (Figures 4-4 thru 4-6). Also, specific reductions in the number of mayfly and stonefly taxa from sites upstream of Lewistown to sites downstream of Lewistown suggest reach-scale disturbances affect both Carroll Trail FAS and Hruska FAS (Bollman, 2001b).

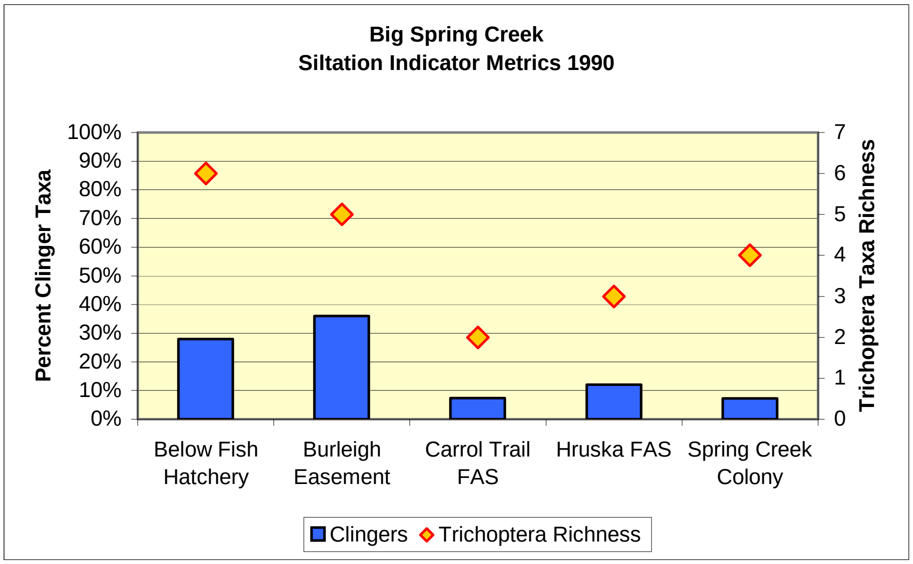

Figure 4-4. Big Spring Creek Siltation Indicators 1990.

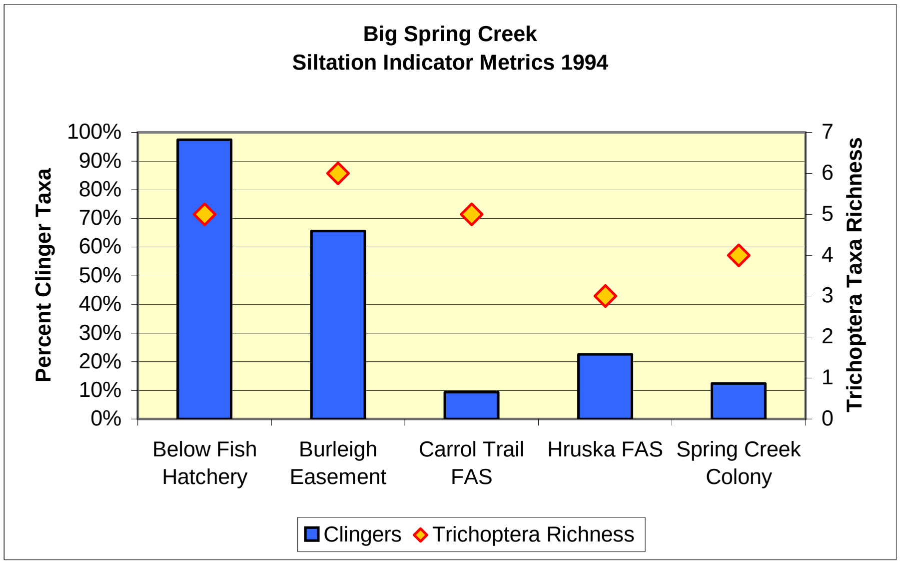

Figure 4-5. Big Spring Creek Siltation Indicators 1994.

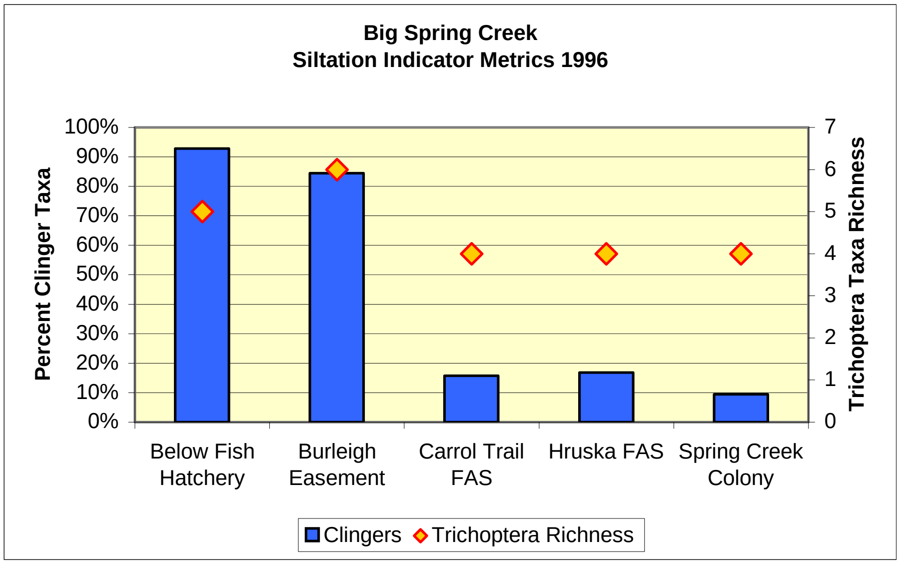

Figure 4-6. Big Spring Creek Siltation Indicators 1996.

Macroinvertebrate Habitat Assessment generally scores in the sub-optimal range (56%-75%) for sites Carroll Trail FAS, Hruska FAS and Spring Creek Colony (Figure 4-3). In addition, field observations at Carroll Trail FAS, Hruska FAS and Spring Creek Colony sites note that substrate gravels and cobbles are highly embedded with fine sediment and calcium carbonate material.

4.3.1.1.2 Periphyton

Periphyton have been collected at a total of 9 sites on Big Spring Creek in years 1998 and 2001. Of the nine sites on Big Spring Creek sampled for periphyton (Figure 4-8), four are upstream and five are downstream from Lewistown (Figure 4-7). Siltation indices for the four upstream sites are below 20, indicating conditions unimpacted by sedimentation, while siltation indices for four of the five downstream sites are above 30, indicating relatively higher level of sedimentation (Bahls, 2001a).

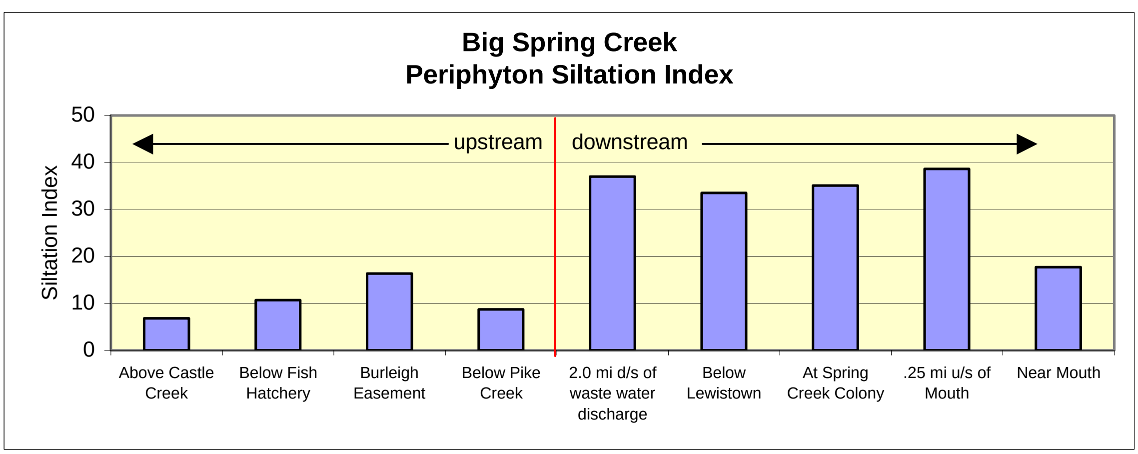

Figure 4-7. Big Spring Creek Siltation Indices at Selected Sites.

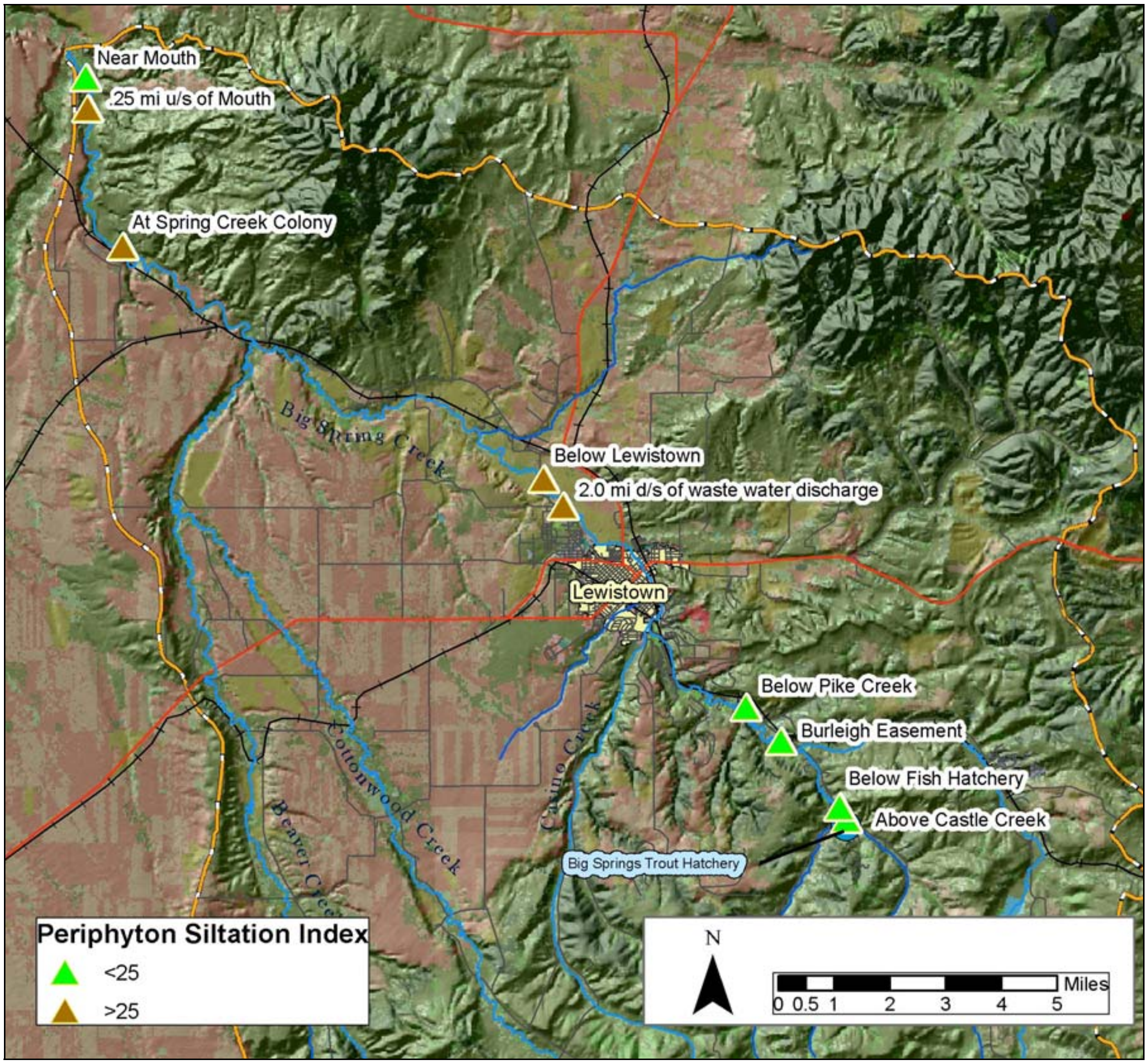

Figure 4-8. Periphyton Sampling Locations and Siltation Indices.

4.3.1.1.3 Fish

Data on fish numbers and size has been collected at sites upstream (Burleigh Easement) and downstream (Carroll Trail FAS) from Lewistown periodically since 1967. Long-term trends for rainbow trout (size and numbers) are given in Figures 4-9 and 4-10 (FWP unpublished reports). Factors governing fish populations are complex, making a determination of fisheries beneficial use support difficult to ascertain without additional detailed habitat and fisheries information.

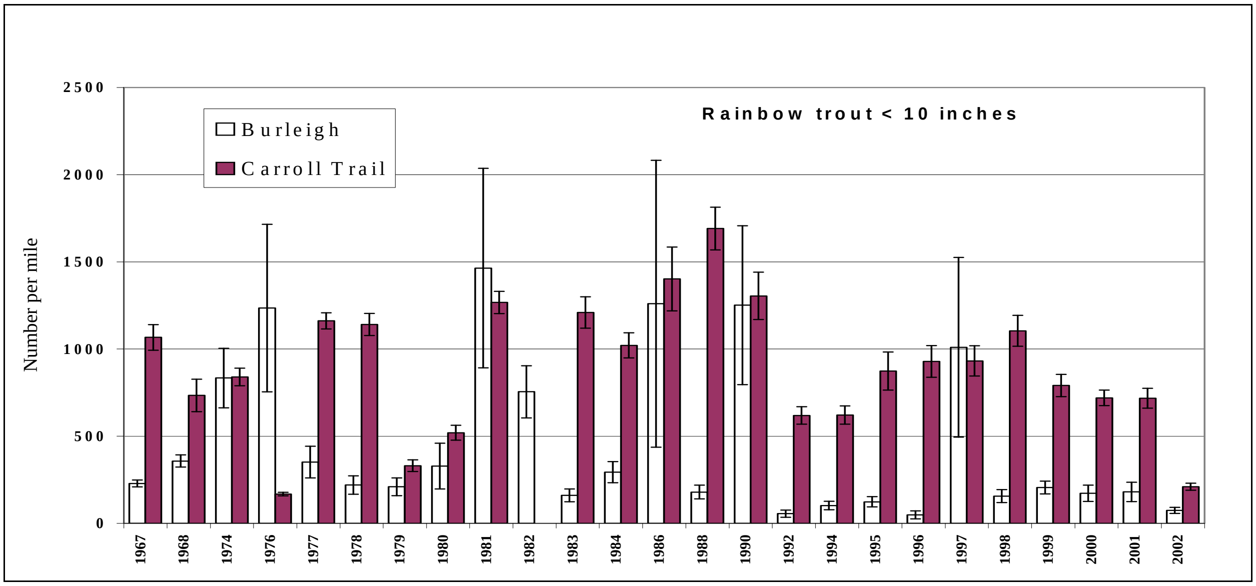

Figure 4-9. Rainbow Trout (<10”) Densities at Burleigh Easement and Carroll Trail (1967-2002).

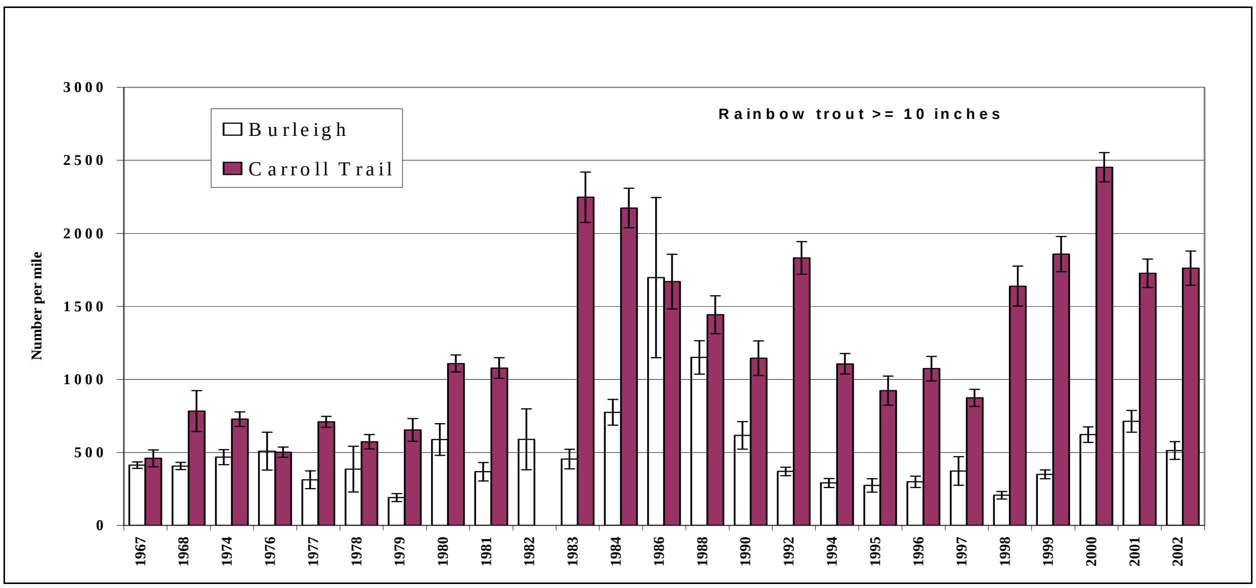

Figure 4-10. Rainbow Trout (>10”) Densities at Burleigh Easement and Carroll Trail (1967-2002).

Rainbow trout populations of both size classes below Lewistown at Carroll Trail are significantly higher than at the Burleigh Easement site. While siltation indicators (biological data and habitat assessments) at the Burleigh Easement site reflect less-impacted conditions, a variety of factors are likely influencing the difference in trout populations between the two sites. Among these may be: nutrient availability and biological production, flow, fish passage issues, additional habitat elements, and other factors. Relatively high numbers of trout at the Carroll Trail site may be a result of enhanced biologic productivity due to elevated nutrient levels coming from urban runoff and wastewater discharges.

4.3.1.2 Physical Measurements and Observations

4.3.1.2.1 Wolman Pebble Counts

Wolman pebble counts were conducted in the summers of 2001 and 2003 (Figures 4-11 and 4-12) at three sites on Big Spring Creek: Burleigh Easement, Carroll Trail FAS, and near the mouth. With the exception of one site, all pebble counts recorded percent surface fines at less that 20%. Notable in the pebble count from 2001 was a high amount of surface fines (36% <2mm) at the Carroll Trail site. A subsequent pebble count in the summer of 2003 did not record this fine sediment. However, in the spring of 2003, Big Spring Creek experienced a large flushing flow resulting from a short-lived snowmelt event that was estimated at over 600 cfs at the Ash Street bridge just north of Lewistown (Tews, personal communication 2003). Normal spring flows generally do not exceed 250 cfs (unpublished NRCS data). Local NRCS and FWP employees noted that this was the highest flow the Big Spring Creek had experienced in over six years, and resulted in newly formed gravel bars (Hawn & Tews, personal communication 2003).

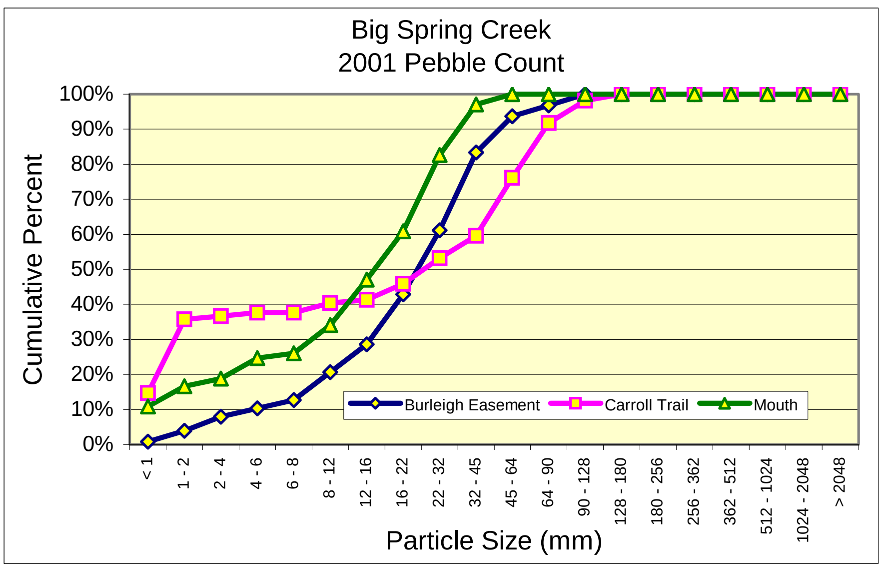

Figure 4-11. Big Spring Creek 2001 Pebble Count.

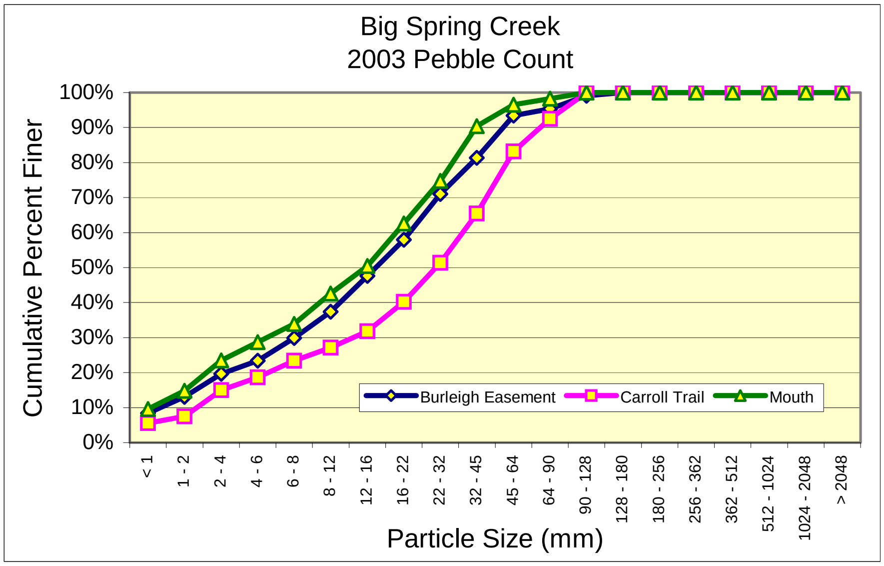

Figure 4-12. Big Spring Creek 2003 Pebble Count.

The bimodal distribution (peaks in amount of fines <2 mm and cobbles) seen in the 2001 Carroll Trail site reflects a stream that does not adequately transport its sediment load. Recent drought conditions, coupled with flow alteration from dams upstream of Lewistown may have contributed to hydrologic conditions that have allowed an excessive build-up of surface fines downstream from Lewistown. Upstream sediment inputs and urban storm water runoff enter Big Spring Creek and are transported under and through Lewistown in a serious of altered, channelized stream reaches. Downstream from Lewistown, Big Spring Creek regains its natural meandering character. As stream energy dissipates, sediment collected and held in suspension settles, thereby exacerbating fine sediment deposition downstream of Lewistown. The distribution of particle sizes in the 2001 Carroll Trail pebble count reflects this fine-sediment buildup. In the absence of flows with sufficient energy to move fine sediment, it is expected that siltation and sediment build-up will occur.

As the March 2003 flushing flow was the most significant flow in years, it appears that this event was competent enough to rework stream sediments to a more ‘normal’ distribution. This situation underscores the importance of spring scouring flows that act to transport fine sediment through the system.

4.3.1.2.2 Stream Reach Assessments

Stream reach assessments were conducted in 1990 by environmental consultant, *OEA Research*, on three reaches of Big Spring Creek: from one mile upstream of Lewistown to the Big Spring Trout Hatchery, from one mile above Lewistown to below Lewistown, and from below Lewistown to the mouth.

For the reach from Lewistown to the Big Springs Trout Hatchery, the assessment recorded little to no natural bank erosion and some moderate bank instability due to livestock utilization. Streamside vegetation provided good bank stability and the average width of the riparian buffer was greater than 50 feet. With the exception of some localized grazing impacts, the assessment did not identify any major sources of sediment or impacts from sediment.

For the middle reach through Lewistown, the assessment noted that nearly the entire channel was either riprapped or altered in some way and has destroyed the natural riparian corridor. The potential for nonpoint source pollution from a variety of sources (yard waste, road sediment and debris, industrial waste and debris, storm runoff, other foreign material) reaching the stream was rated as very high. Urban encroachment, channelization and removal of natural vegetation were identified as major influences throughout this reach.

For the reach from Lewistown to its confluence with the Judith River, the assessment noted that cattle grazing was evident throughout the reach and that fields were cultivated up to the stream banks in areas. Livestock grazing was causing some bank instability, but overall bank stability was given a moderate (10%-20% of banks eroding) rating. Water clarity was cloudy to opaque in areas, and moderate but no excessive riparian disturbance was noted.

4.3.1.3 Aerial Surveys and Nonpoint Source Assessments

In June of 1989, the Fergus County Conservation District commissioned an aerial assessment of Big Springs Creek. The objective of the stream survey and assessment was to assess physical condition, establishing present baseline conditions, identify general priority areas for restoration and preservation, and to gain a greater understanding of Big Spring Creek dynamics and morphology. Areas of significant impact to the channel were well documented. The assessment identified and cataloged physical features influencing stream stability: eroding banks, stream bank failure, bank mass wasting, blanket riprap. Observations of aforementioned parameters were made during the course of the flight and transcribed onto indexed aerial photographs. Ground-truthing and confirmation of aerial assessments and notable channel condition was then conducted and selected parameters were tabulated for the entire length of Big Spring Creek (Hawn, 1990). The resultant data is shown in Appendix A.

Overall, eroding banks and stream bank failure both increase in a downstream direction. While bank erosion and stream bank failure do not appear to be excessive on average, specific segments do exhibit erosion and failure levels much higher than the average (Figure 4-13). The majority of riprapped stream banks occur just above, through and below Lewistown (Figure 4-14). Mass Wasting occurs predominantly in the lower portion of Big Spring Creek (Figure 4-13).

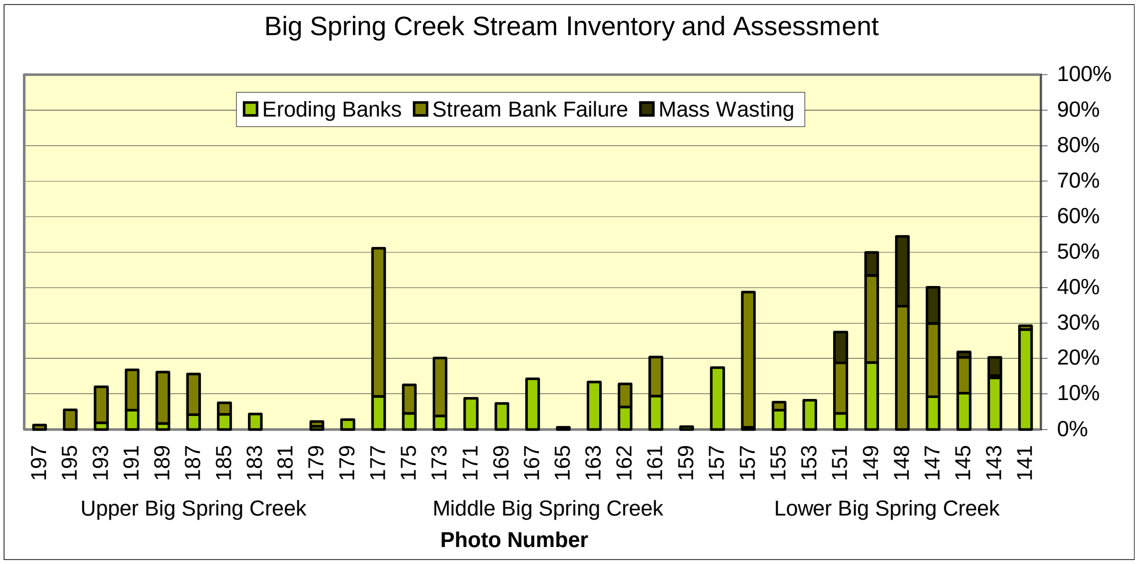

Figure 4-13. Stream Bank Condition by Reach (Modified from Hawn, 1990).

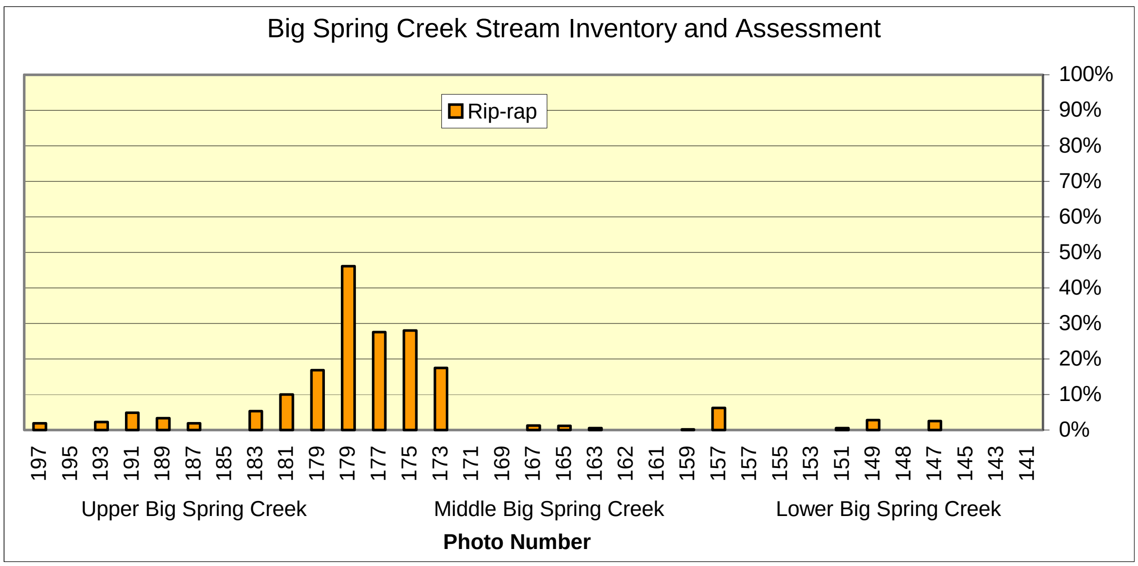

Figure 4-14. Riprap by Reach (Modified from Hawn, 1990).

The aerial survey and subsequent ground-truthing provided information predominantly on stream bank condition. Additional information, however, such as riparian composition and condition, Rosgen channel types, and geomorphic condition was needed to adequately assess sources and the relationships between vegetation, channel alteration and bank stability. In the fall of 2003, the Montana DEQ contracted with *Land & Water Consulting* to evaluate the June 1989 aerial photography for additional information on channel condition, riparian communities, vegetation condition, and other physical parameters.

For this second analysis, Big Spring Creek was divided into three major reaches (Upper, Middle and Lower Big Spring) and 35 subreaches. The objective of this analysis was to evaluate the extent to which riparian condition influences channel condition and potential sediment supply to

Big Spring Creek. For each subreach, information on channel condition and riparian vegetation condition was obtained from the aerial photographs. Channel condition information included: *stream bank length, Rosgen Level I channel type, riprap, channel alteration, unstable banks, and severely eroding banks*. Riparian vegetation condition included: *percent composition of trees, woody shrubs, grasses, bare/disturbed ground and impervious cover, feet of degraded riparian vegetation, and average buffer width per subreach*. In addition to channel and vegetation information, adjacent land use information was obtained from the aerial photography. No ground-truthing of the aerial assessment was conducted. The resultant data is shown in Appendix B. Methods utilized to derive these values are included in Appendix B.

In general, bank erosion and bank instability increase in the downstream direction (Figure 4-15). Big Spring Creek upstream from Lewistown (Big28-Big35) exhibits low levels of bank instability and bank erosion. Bank instability and erosion levels increase noticeably downstream from Big20, just upstream from the Hruska Fishing Access Site. Channel riprap levels (Figure 4-16) are similar to those identified by Hawn in the 1990 Stream Inventory and Assessment.

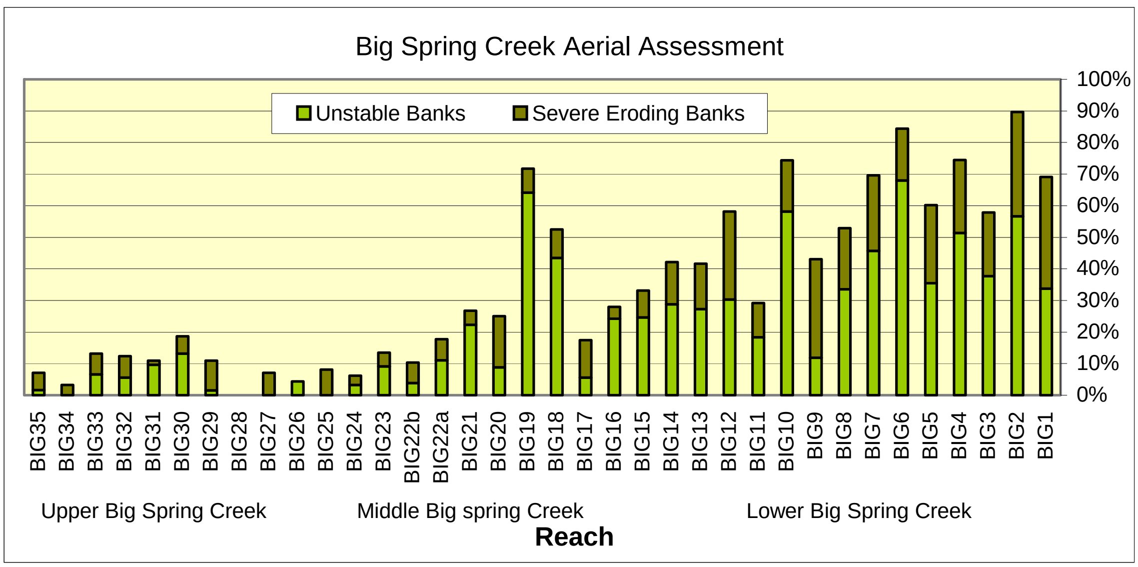

Figure 4-15. Big Spring Creek Channel Condition (Modified from Land & Water Consulting, 2003).

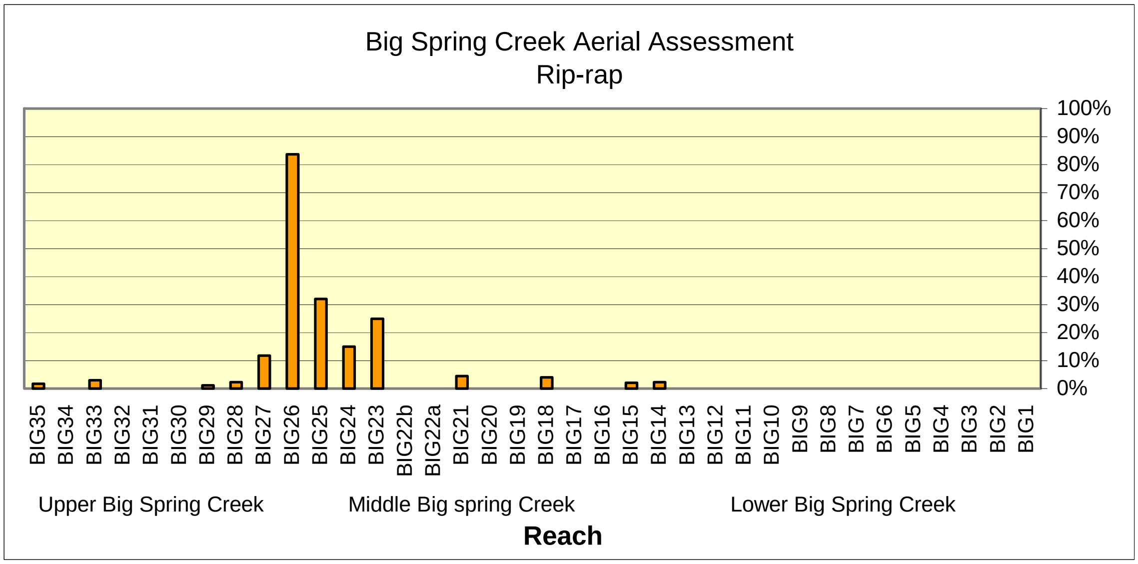

Figure 4-16. Big Spring Creek Channel Riprap (Modified from Land & Water Consulting, 2003).

Paralleling channel condition, riparian degradation generally increases in a downstream direction (Figure 4-17). Riparian composition along upper and middle Big Spring Creek is characterized by a higher percentage of trees and woody shrubs than lower Big Spring Creek. Riparian composition along lower Big Spring Creek is predominantly grass/sedge communities (Figure 4-18).

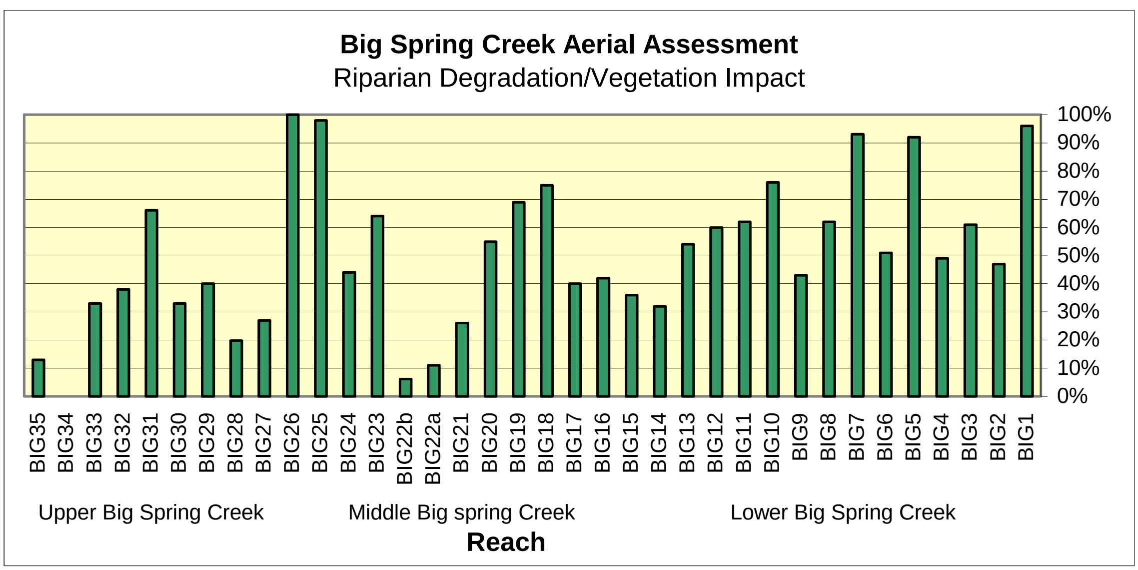

Figure 4-17. Big Spring Creek Degraded Riparian Vegetation (Modified from Land & Water Consulting, 2003).

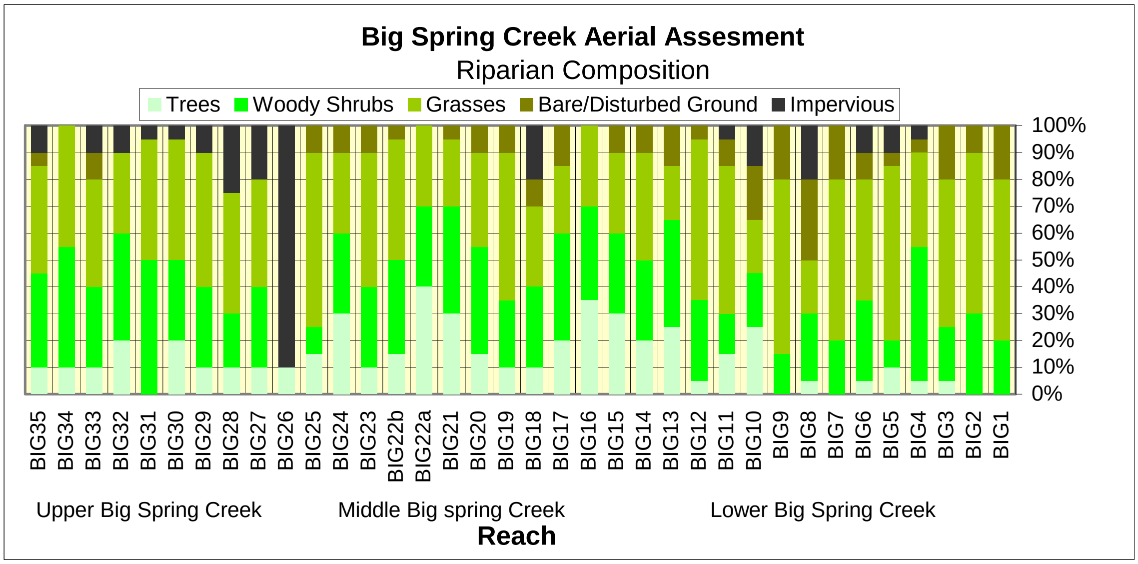

Figure 4-18. Big Spring Creek Riparian Composition (Modified from Land & Water Consulting, 2003).

Information obtained on vegetation condition and channel condition was used to develop overall ratings named *Vegetation Impact Category* and *Channel Impact Category* (Appendix B) Vegetation Impact Category is a rating of *lightly impacted*, *moderately impacted* or *highly impacted*, and relies on the amount of degraded riparian vegetation determined from aerial assessment. Channel Impact Category is a rating of lightly impacted, moderately impacted or highly impacted based on the cumulative score of the percentages of riprap, channelization, unstable banks and severely eroding banks. A general rating of anthropogenic impact level that sums both vegetation impact and channel impact scores is given in Figure 4-19. Impact levels are rather low (generally below 50) upstream from Lewistown (Big26), providing support for low levels of biological impacts (Section 4.1.1.1). Relatively high impact levels for reaches Big25 and Big26 are present immediately upstream from Carroll Trail FAS (Big 24) and likely influence water quality conditions at Carroll Trail (high siltation index, low percent clingers, high surface fines).

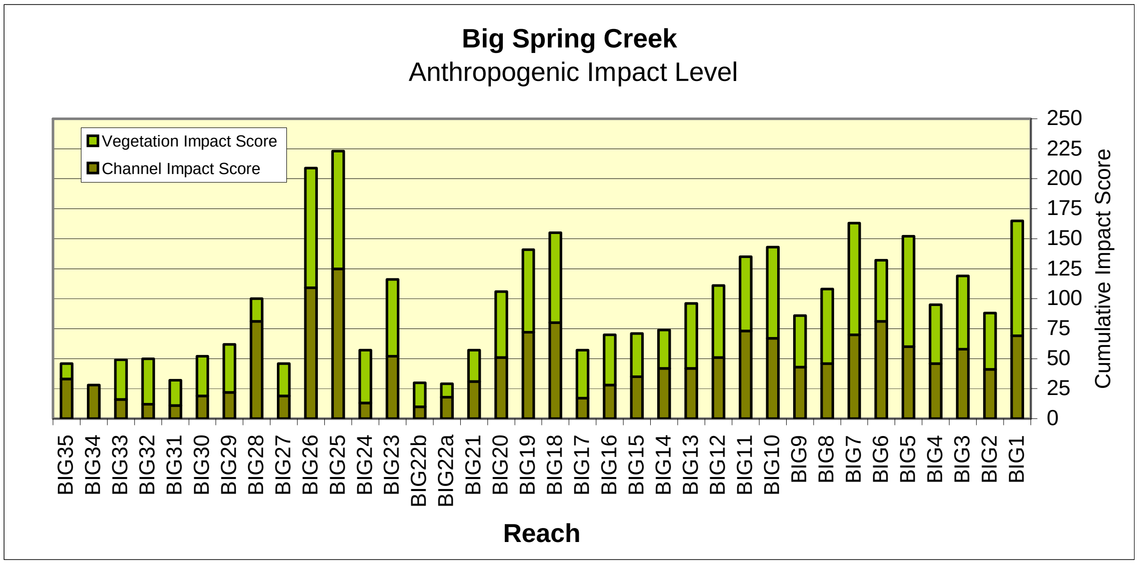

Figure 4-19. Big Spring Creek Anthropogenic Impact Level by Reach (Modified from Land & Water Consulting, 2003).

Perceived discrepancies between the two assessments reflect the differences in the objectives of each assessment and likewise affect the level of detail employed, methodologies used, and criteria used to define such parameters as eroding banks, severely eroding banks, unstable banks, etc. The assessment conducted by Hawn (1990) entailed significant ground-truthing and field observation of bank features, yet did not provide a comprehensive evaluation of riparian vegetation or composition. Likewise, the survey conducted by Land & Water Consulting attempted to characterize vegetation and channel/bank condition, yet did not incorporate a ground-truthing component to confirm measurements taken from the aerial photos. Consequently, comparisons between the two assessments should be considered with these thoughts in mind. Consistent between the two assessments, however, is the increasing trend in overall bank erosion and instability from the upper reaches to the mouth.

Due to lack of ground-truthing, it is likely that the values generated for riparian vegetation and channel condition in the Land & Water Consulting aerial assessment deviate from actual values. Based on the field-assessments conducted by Hawn, it appears that bank erosion and channel instability measures have been overestimated. However, relationships between riparian vegetation and channel condition can still be demonstrated. A discussion of these relationships is given in Section 5.1.2.

Since the date of the 1989 aerials, numerous BMPs, conservation easements, grazing management plans, and restoration projects have been enacted on Big Spring Creek. With assistance from the Lewistown NRCS office, landowners have made substantial improvement to a variety of reaches on Big Spring Creek. General locations of substantial projects and approximate lengths of improved stream banks are given in Table 4-3.

Table 4-3. Selected Big Spring Creek Riparian Improvement Projects (Source: NRCS Office, Lewistown).

Reach	Off-Stream Water Project	Channel Restoration or Revegetation Project	Stream Bank Protected (ft)
Big16	X	X	2,300
Big18	X	X	5,940
Big24	X	X	4,620
Big24	X		5,125
Big28		X	5,600
Big33		X	720
Big31		X	570
			26,375

Consequently, data presented on riparian vegetation or channel condition may not reflect current conditions for some reaches. While these projects to not capture the full extent of riparian improvement on Big Spring Creek since 1989, they do demonstrate a significant ongoing effort to improve riparian conditions on Big Spring Creek, and provide assurance that local efforts are underway to improve and enhance the riparian condition of Big Spring Creek.

4.3.1.4 Existing Conditions Summary

Big Spring Creek (MT41S004_010)

Based on macroinvertebrate siltation indicators, macroinvertebrate habitat assessments, and periphyton siltation indices, aquatic life uses in upper segment of Big Spring Creek (MT41S004_010) do not appear to be impaired due to sediment. Pebble counts did not indicate excessive surface fines, and stream reach assessments and surveys reported that bank erosion is minimal. Overall, data suggest that **Big Spring Creek (MT41S004_010) is not impaired due to sediment or suspended solids; therefore no sediment TMDL is required.**

Big Spring Creek (MT41S004_020)

Aquatic life uses for Big Spring Creek (MT41S004_020) do not appear to be fully supported. Macroinvertebrate siltation indictors (percent clinger taxa, trichoptera richness) demonstrate impacts from sedimentation, periphyton indices are above 30 are 4 of 5 sites downstream from Lewistown, and macroinvertebrate habitat assessments indicate sub-optimal conditions. Downstream from Lewistown, bank stability and erosion also increase, as does riparian degradation. Habitat alterations due to channelization, and riparian degradation are evident. Overall, data suggests that **Big Spring Creek (MT41S004_020) is impaired due to sediment; therefore a sediment TMDL is required.**

4.4 Beaver Creek

Beaver Creek (MT41S004_030) originates in the foothills of the Big Snowy Mountains and flows northeast 21 miles to its confluence with Cottonwood Creek, a tributary to Big Spring

Creek. Beaver Creek flows through both foothill and plains ecoregions (Map 2). In its upstream reaches, Beaver Creek has the characteristics of a foothill/valley stream. As it reaches lower elevations, Beaver Creek takes on the characteristics of a plains stream: water is warmer and slower, soft substrates are common, and bank vegetation consists of woody shrubs and grasses and less trees. With the exception of a small plot of state land in the upper watershed, nearly the entire Beaver Creek watershed is privately owned. Land uses in the watershed are predominantly agriculture and livestock grazing.

The riparian area of Beaver Creek is dominated by grasses and woody shrubs, and beaver activity is common. Beaver dams are responsible for slack-water areas on several segments of the creek, while other segments are comprised of riffle and pool sequences. A number of natural springs in the upper watershed provide inputs to Beaver Creek. The stream is classified as an E-type channel and is slightly entrenched in places, perhaps due to down cutting as a result of historic beaver dam removal. In general, the stream channel is rather stable and is comprised of fine-grained organic rich soil.

4.4.1 Existing Conditions for Beaver Creek

Beaver Creek was listed on the 1996-303(d) list; cold-water fishery and aquatic life beneficial uses were listed as partially supported due to nutrients and suspended solids. The basis for the 1996 listing is unknown. On the 2002 303(d) list, cold-water fishery, aquatic life, drinking water and contact recreation were listed as partially supporting due to nutrients, siltation, dewatering, bank erosion, riparian degradation, fish habitat and other habitat degradation.

Note that the data presented in the following evaluation considers data relevant to sediment-related impairments. An evaluation of nutrient conditions is presented in Section 6.0.

4.4.1.1 Biological Data

4.4.1.1.1 Macroinvertebrates & Macroinvertebrate Habitat Assessments

Macroinvertebrates have been collected at 3 sites on Beaver Creek: M22BEVRC01, M22BEVRC02, and M22BEVRC04 (Figure 4-20). The upper site, M22BEVRC01, falls within the Montana Valley and Foothill Prairie (MFVP) ecoregion, while M22BEVRC02 and M22BEVRC04 fall within the Northwestern Great Plains ecoregion. Due to differences in ecoregion, a variety of metrics were used to evaluate the data.

Since the uppermost site fell within the MFVP ecoregion, the MVFP metric index developed by Bollman (1998) was used to evaluate beneficial use support. M22BEVRC01 scored 44% indicating moderate impairment and partial support of beneficial uses. Percent clinger taxa was 55% and trichoptera taxa richness was 5, both indicators that clean substrates free of excessive siltation were present (Bollman, 2004).

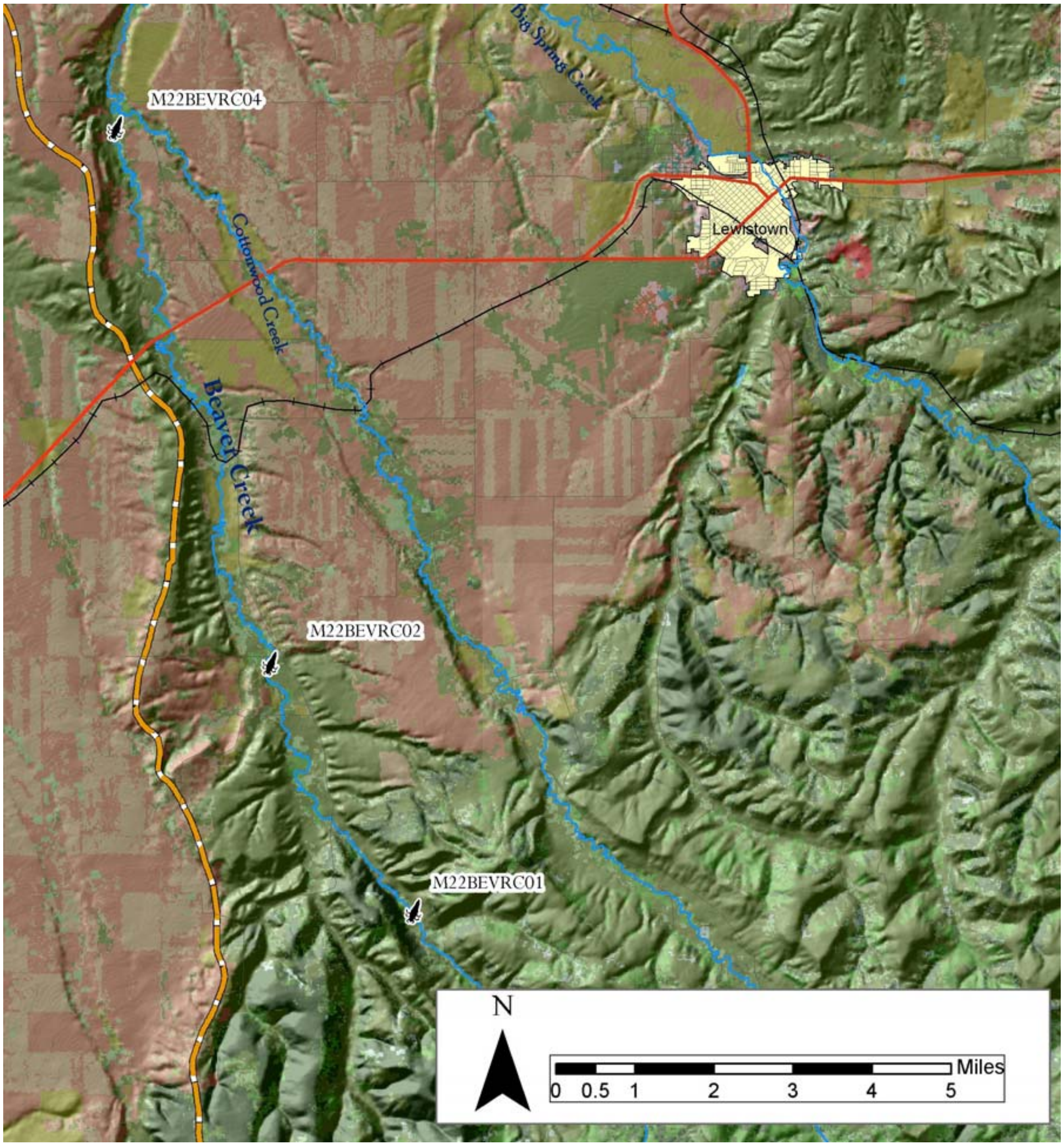

Figure 4-20. Biological Sampling Locations on Beaver Creek.

It is expected that sediment levels in plains streams are higher than in MVFP streams, and that macroinvertebrate assemblages reflect this natural change in substrate and habitat conditions. Consequently, it is expected that biotic assemblages downstream from M22BEVRC01 may reflect this environmental gradient. Beneficial use support at sites M22BEVRC02 and M22BEVRC04 was evaluated using both a Montana Plains ecoregion metric developed by Bukantis (1998), and another by Bramblett et al. (2004). Figure 4-21 shows Bioassessment scores based on these two metrics. While metric response varies, both metric scores are below 75%, indicating partial support of beneficial uses.

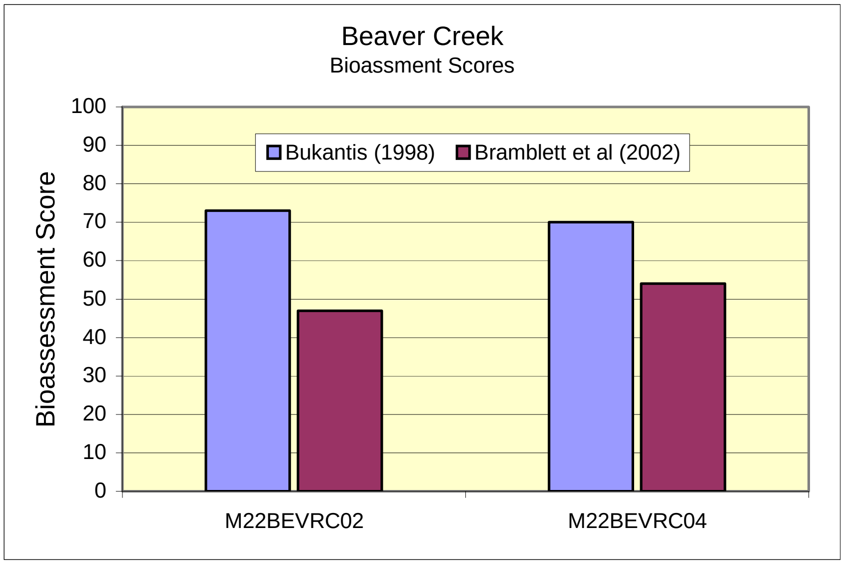

Figure 4-21. Plains Bioassessment Scores for Two Sites on Beaver Creek.

Percent clinger taxa and trichoptera richness at site M22BEVRC02 was 48% and 3, respectively. At M22BEVRC04 percent clinger taxa and trichoptera richness was 83% and 6, indicting that stony substrates free from sediment deposition were available and were an improvement from upstream conditions.

Macroinvertebrate habitat assessments were conducted at each sampling location on Beaver Creek (Figure 4-22).

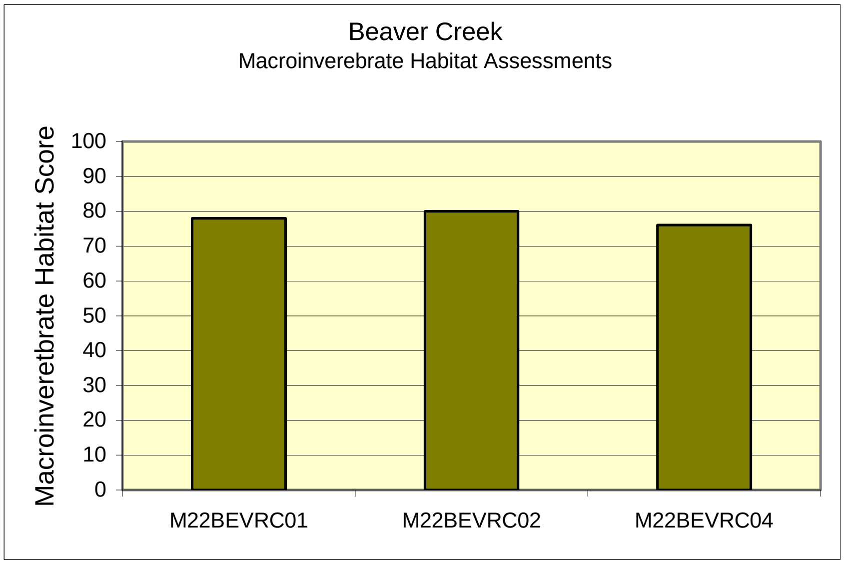

Figure 4-22. Beaver Creek Macroinvertebrate Habitat Assessment Scores (2003).

Macroinvertebrate habitat assessments scored optimal (>75%) at all three sites sampled, indicating that habitat integrity was not adversely affecting biotic assemblages.

4.4.1.1.2 Periphyton

Periphyton was collected in July of 2003 at sites, M22BEVRC01, M22BEVRC02, and M22BEVRC04 (Figure 4-23). Siltation indices at these sites are given in Figure 4-23.

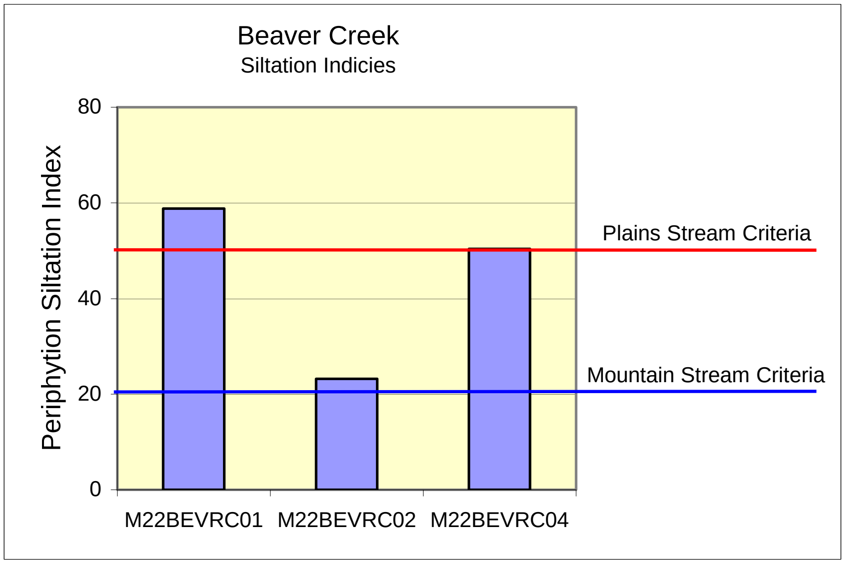

Figure 4-23. Beaver Creek Siltation Indices.

The siltation index at the uppermost site, M22BEVRC01, is considerably higher (59) than the criteria for mountain streams (20) indicating impacts from siltation. At downstream sites, M22BEVRC02 and M22BEVRC04, the siltation indices (23 and 50) fall within expected criteria for plains streams.

4.4.1.1.3 Fish

Data on fish population and distribution in Beaver Creek is limited. However, a preliminary report by FWP indicates that trout populations have increased since 1996 on a segment section of Beaver Creek that was restored through local landowner/agency efforts in 1997. FWP reports indicate that 1999 brook trout numbers increased substantially from 1996 and that size structure provided evidence of recent reproduction, an improvement from earlier data (FWP unpublished report).

While not assessed for their fishery improvements, recent restoration and riparian enhancement efforts on Beaver Creek (Table 4-5) point to an improving trend in fishery potential.

4.4.1.2 Physical Measurements and Observations

4.4.1.2.1 Wolman Pebble Counts

Wolman pebble counts were conducted in the summer 2003 at two sites on Beaver Creek: M22BEVRC01 and M22BEVRC04. Both pebble counts recorded percent surface fines at less than 20%. The percent surface fines <2mm at M22BEVRC01 and M22BEVRC04 were 9.3% and 15.3%, respectively, indicating substrates that are relatively free from excessive fine-sediment deposition.

4.4.1.2.2 Stream Reach Assessments

A stream reach assessment was conducted in 1994 by environmental consultant, *OEA Research*, on Beaver Creek. Although not detailed in scope, the assessment recorded mild bank erosion and some instability due to livestock utilization. Streamside vegetation provided good bank stability and the average width of the riparian buffer varied from 15 to 90 feet. Dewatering and cloudy water was noted along the length of Beaver Creek. Livestock grazing and dewatering were listed as the major influences affecting water quality.

4.4.1.3 Aerial Surveys and Nonpoint Source Assessments

In 1995 an aerial inventory by helicopter was conducted on the major tributary streams to Big Spring Creek (Hawn, 1997). The objective of the inventory was to characterize the condition of streams and riparian areas and to identify nonpoint pollution sources. Nonpoint pollutions sources identified included:

- **HU** - Heavy Livestock Use Areas
- **DA** - Disturbed/Active Erosion Sites
- **CS** -Channelized Areas
- **LA** - Recent Logged Areas (scour or gully erosion evident)
- **DS** - Degraded Streams (entrenched channel, stream bank erosion)
- **DR** - Degraded Riparian Areas (absence of or reduced shrub/tree community)
- **EA** - Other (housing development impact, car bodies, riprap)

Results of Beaver Creek and its tributaries are given in Table 4-4.

Table 4-4. Aerial Nonpoint Source Inventory Results for Beaver Creek (Hawn, 1997).

Stream	HU	DA	CS	LA	DS	DR	EA	Total
Beaver Creek	3,851	388	3,426	N/A	3,168	15,362	448	26,643
Middle Fork Beaver Creek	373	N/A	N/A	N/A	241	4,432	200	5,246
W Fork Beaver Creek	N/A	N/A	404	N/A	1,671	3,512	424	6,011
Total (ft)	**4,224**	**388**	**3,830**		**5,080**	**23,306**	**1,072**	**37,900**

In the fall of 2003, the Montana DEQ contracted with Land & Water Consulting to evaluate the 1995 aerial photography for additional information on channel condition, riparian communities, vegetation condition, and other physical parameters. The objective of this analysis was to evaluate the extent to which riparian condition influences channel condition and potential sediment supply to Beaver Creek. For purposes of comparative analysis, Beaver Creek was divided into 19 subreaches (Figure 4-24). For each subreach, information on channel condition and riparian vegetation condition was obtained from the aerial photographs. Channel condition information included: *stream bank length, Rosgen Level I channel type, riprap, channel* *alteration, unstable banks, and severely eroding banks*. Riparian vegetation condition included: *percent composition of trees, woody shrubs, grasses, bare/disturbed ground and impervious cover, feet of degraded riparian vegetation, and average buffer width per subreach*. In addition to channel and vegetation information, adjacent land use information was obtained from the aerial photography. No ground-truthing of the aerial assessment was conducted. The resultant data and methods utilized to derive these values are shown in Appendix C.

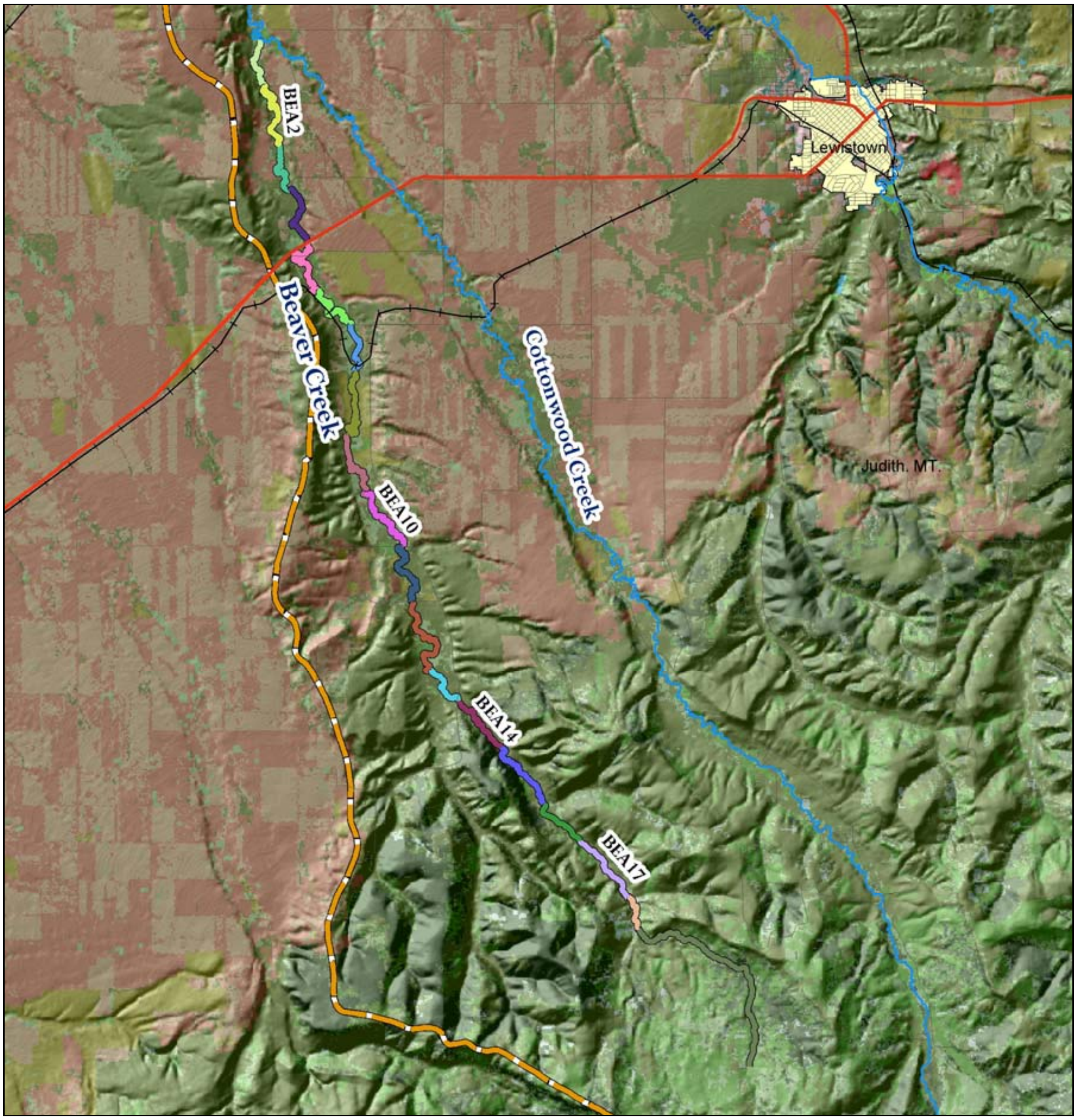

Figure 4-24. Beaver Creek Subreaches.

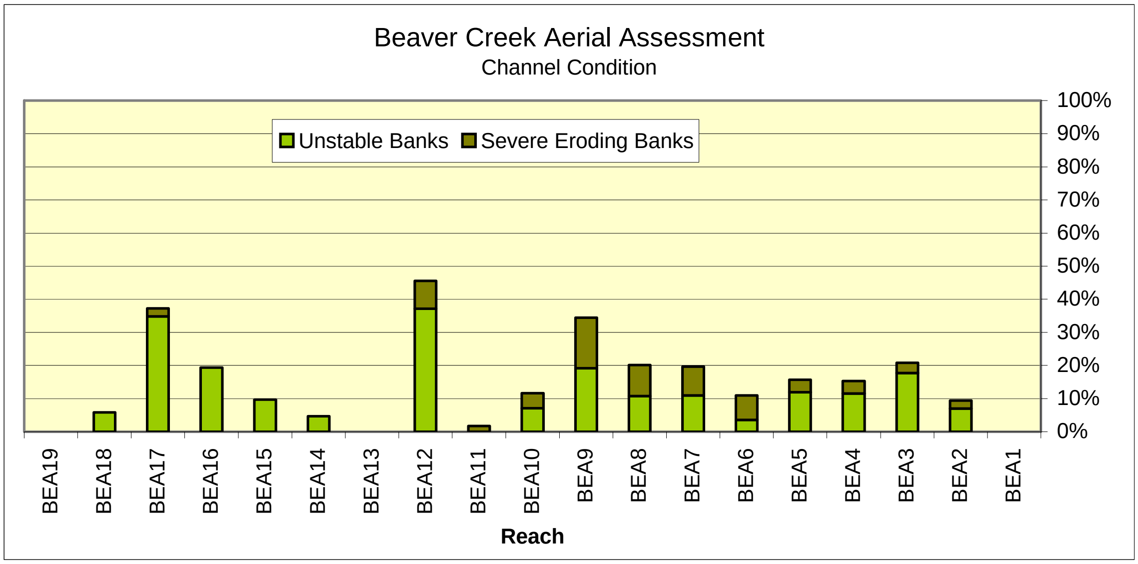

Figure 4-25. Beaver Creek Channel Condition (Modified from Land & Water Consulting, 2003).

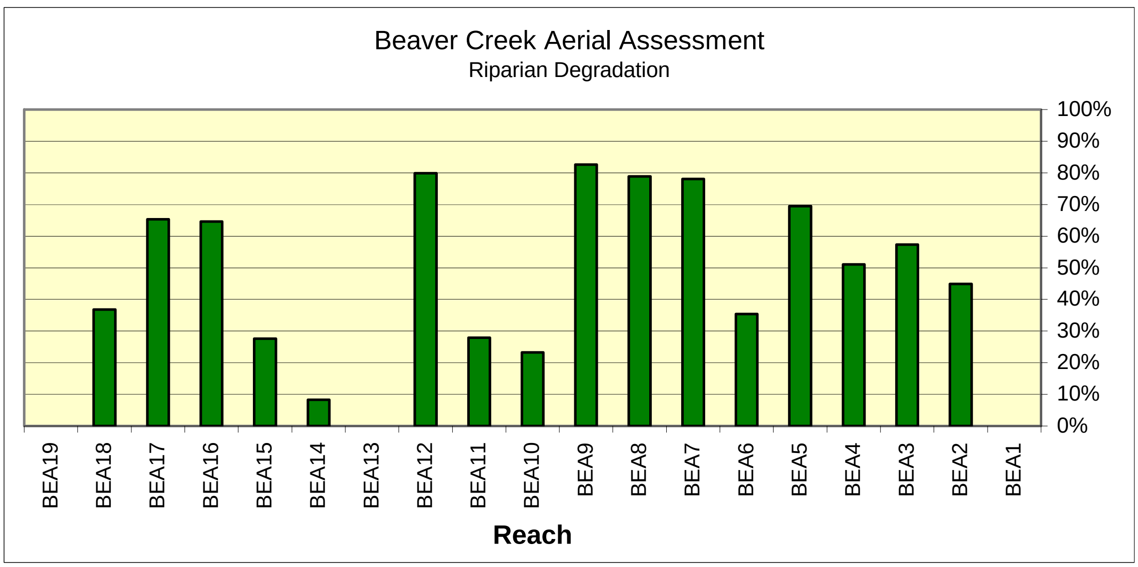

Figure 4-26. Beaver Creek Degraded Riparian Vegetation (Modified from Land & Water Consulting, 2003).

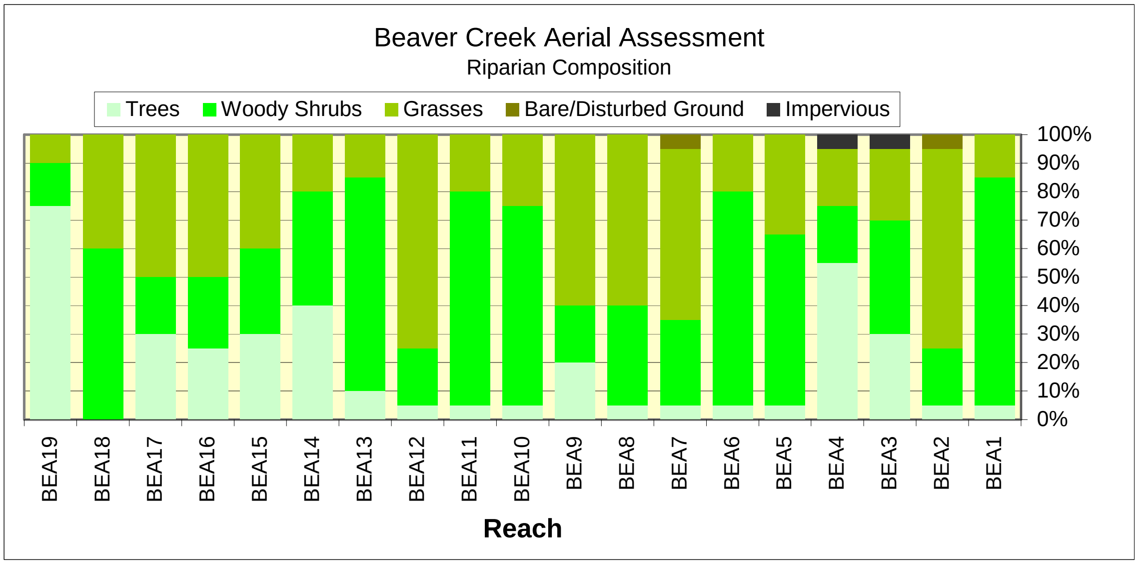

Figure 4-27. Beaver Creek Riparian Composition (Modified from Land & Water Consulting, 2003).

Based on this assessment, combined bank erosion and bank instability are below 20% in all but 3 of 19 reaches. Several reaches had very low to negligible amounts of bank erosion. Riparian degradation ranged from 0% to 83% per reach with an average value of 41% for all of Beaver Creek. Riparian degradation, however, is not considered a cause of impairment in itself, nor does it necessarily correspond to higher levels of sediment input, especially in more stable E-channel systems. For instance, in the case of Beaver Creek, many reaches with a high percentage of riparian degradation also had relatively low levels of bank erosion and instability. Riparian vegetation composition is dominated by trees and woody shrubs and make up over 63% of the riparian cover on Beaver Creek. In many reaches, streamside vegetation is very lush, even though buffer zones may be limited. Figure 4-28 illustrates a typical segment of Beaver Creek. Note that even though riparian degradation is evident, there is very little bank erosion.

Figure 4-28. Typical Riparian Condition of Beaver Creek (BEA5).

Data presented on riparian vegetation or channel condition may not reflect current conditions for some reaches. Since the date of the 1995 NRCS survey (Table 4-5), improvements have been made on over 3 miles of Beaver Creek, resulting in enhancements to riparian health and reductions in nonpoint sources of pollution. A summary of feet of improved stream and resultant reductions in degraded areas is given in Table 4-5. Riparian improvement projects include revegetation, channel stabilization, fencing, and off-stream watering.

Table 4-5. Beaver Creek Riparian and Channel Improvement Project Summary (NRCS Unpublished Data).

Stream	Cumulative Degradation (Table 4-4)	Improvement Projects Reduction	Total Degradation
Beaver Creek	26,643	12,220	**14,423**
Middle Fork Beaver Creek	5,246		**5,246**
W Fork Beaver Creek	6,011	3,000	**3,011**
Total (ft)	**37,900**	**15,220**	**22,680**

4.4.1.4 Existing Conditions Summary

Beaver Creek (MT41S004_030) appears to be a stable E-channel with a fairly robust riparian zone of grasses, sedges and woody shrubs. Evidence of present and historical beaver activity is common. It appears that in some areas, historic beaver dam removal has resulted in entrenched reaches of exposed fine-grained organic sediment. In other areas, active beaver complexes are responsible for slack water and sediment deposition. Beaver Creek maintains a base flow, in even the driest years. It is probable that the numerous springs that feed Beaver Creek, along with the storage capacity afforded by past and present beaver complexes, helps to maintain this base flow.

Areas of stream channel degradation and erosion may be contributing some anthropogenic sediment to the stream, however, these impacts are localized and do not represent the character of the stream as a whole. Periphyton siltation indices for the lower two sites are within expected criteria for plains streams, and pebble counts, macroinvertebrates, and habitat assessments all indicate that Beaver Creek’s in-stream habitat is minimally impacted by sediment. Overall, bank erosion levels are relatively low and, with the exception of a single elevated periphyton siltation index, data suggests that Beaver Creek is not impaired by sediment-related impacts.

Dewatering was listed as a possible cause for impairment on the 2002 303(d) list, and although a thorough investigation into possible impairments due to potential dewatering has not been conducted, biologic assessments indicate potential impacts due to periodic dewatering, nutrient enrichment and/or thermal stress (Bollman, 2004). The combination of spring inputs, warm slack-water environments and natural organic-rich bank material may result in bioassessment scores that reflect impacts to Beaver Creek. It appears that these impacts are a natural condition of Beaver Creek and not a function of anthropogenic influences.

Based on macroinvertebrate siltation indicators, macroinvertebrate habitat assessments, and periphyton siltation indices, aquatic life uses in Beaver Creek (MT41S004_030) do not appear to be limited due to unnatural siltation or suspended solids. Pebble counts did not indicate excessive surface fines, and stream reach assessments and surveys reported that bank erosion is minimal. Available data suggests that sediment and siltation conditions on Beaver Creek are not significantly elevated above naturally occurring conditions, hence **Beaver Creek is not impaired due to sediment or suspended solids. Therefore, no sediment TMDL is required.** However riparian enhancement efforts should continue, with focus on localized areas of stream bank instability and livestock impacts. BMP implementation through cooperative efforts between landowners, agencies and local technical experts can best address present and future management of Beaver Creek, and continuation of these efforts is encouraged.

4.5 Cottonwood Creek

Cottonwood Creek originates in the Big Snowy Mountains at an elevation of 8,000 feet and flows northeast 32 miles to its confluence with Big Spring Creek. Cottonwood Creek is segmented into two distinct reaches (Figure 3-1). MT41S004_051 is a 19-mile reach from Cottonwood Creek's headwaters to where it exits the foothills of the Big Snowy Mountains. MT41S004_052 is 13-mile reach and extends to Cottonwood Creek's confluence with Big Spring Creek about ½ mile west of the town of Hanover. Upper Cottonwood Creek is within the Montana Valley & Foothill Prairie (MVFP) ecoregion and exhibits characteristics of a mountain stream. Lower Cottonwood Creek, although lying within the Northwestern Glaciated Plains ecoregion, exhibits some characteristics of a valley & foothill prairie type stream: cobbled substrates are common and water temperature is, in general, colder.

4.5.1 Existing Conditions for Cottonwood Creek

Cottonwood Creek was listed on the 1996 303(d) list; cold-water fishery beneficial use was listed as threatened due to nutrients, organic enrichment/low dissolved oxygen, and suspended solids. The basis for the 1996 listing is unknown. Since the 1996 listing, Cottonwood Creek was segmented into two separate reaches. The upper reach, MT41S004_051, was found to be fully supporting its beneficial uses on the 2002 303(d) list. The lower reach of Cottonwood Creek, MT41S004_052, was listed as impaired on the 2002 303(d) list: aquatic life, cold water fishery, drinking water, industry and contact recreation were listed as partially supporting their beneficial use due to nutrients, organic enrichment/low dissolved oxygen, siltation, flow alteration/ dewatering, riparian degradation, fish habitat degradation and other habitat alterations.

Note that the data presented in the following evaluation considers data relevant to sediment-related impairments. An evaluation of nutrient conditions is presented in Section 7.0.

4.5.1.1 Biological Data

4.5.1.1.1 Macroinvertebrates & Macroinvertebrate Habitat Assessments

Macroinvertebrates have been collected at 3 sites on Cottonwood Creek: M22CTWDC01, M22CTWDC02, and M22CTWDC03 (Figure 4-29). The upper site, M22CTWDC01, falls within the Montana Valley and Foothill Prairie (MVFP) ecoregion, while M22CTWDC02and M22CTWDC03 fall within the Northwestern Great Plains (NWGP) ecoregion. Due to the differences in ecoregion and the close proximity of Cottonwood Creek to both the NWGP and MVFP ecoregions, a variety of metrics were used to evaluate the data.

Since the uppermost site fell within the MVFP ecoregion, the MVFP metric index developed by Bollman (1998) was used to evaluate beneficial use support. M22CTWDC01 scored 67% indicating slight impairment and partial support of beneficial uses. Nine clinger taxa and six trichoptera taxa were collected, indicating fine sediment deposition was not limiting or interfering with benthic aquatic habitats (Bollman, 2004). Also, high taxa richness (33) and the abundance of predator fauna indicate habitat complexity and richness (Bollman, 2004). Macroinvertebrate habitat assessments conducted at site M22CTWDC01 scored 76% indicating optimal to suboptimal habitat conditions.

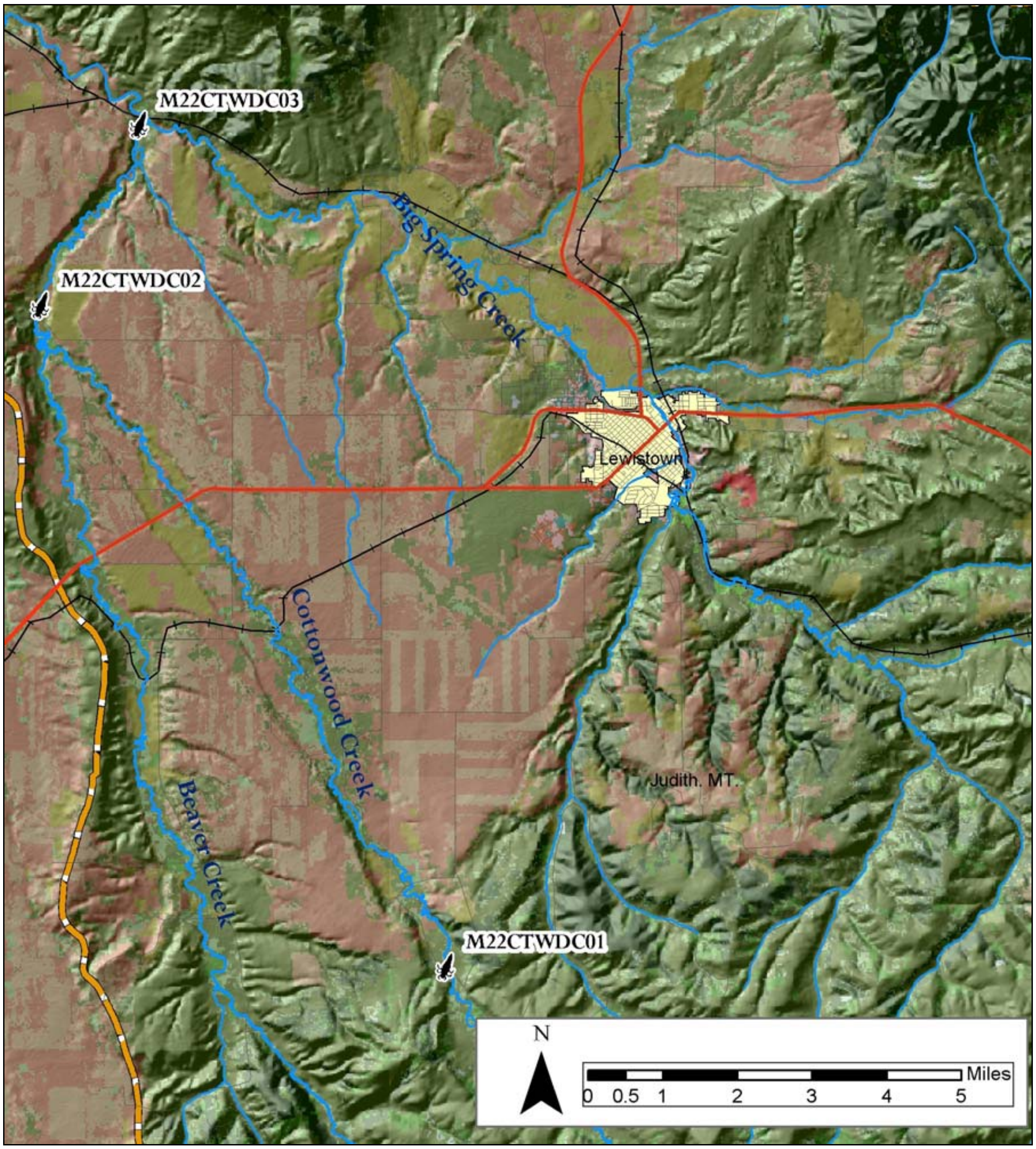

Figure 4.29. Sampling and Assessment Locations on Cottonwood Creek.

Beneficial use support at sites M22CTWDC02 and M22CTWDC03 was evaluated using both a Montana Plains ecoregion metric developed by Bukantis (1998), and the MVFP ecoregion metric developed by Bollman (1998). Figure 4-30 shows bioassessment scores based on these two metrics.

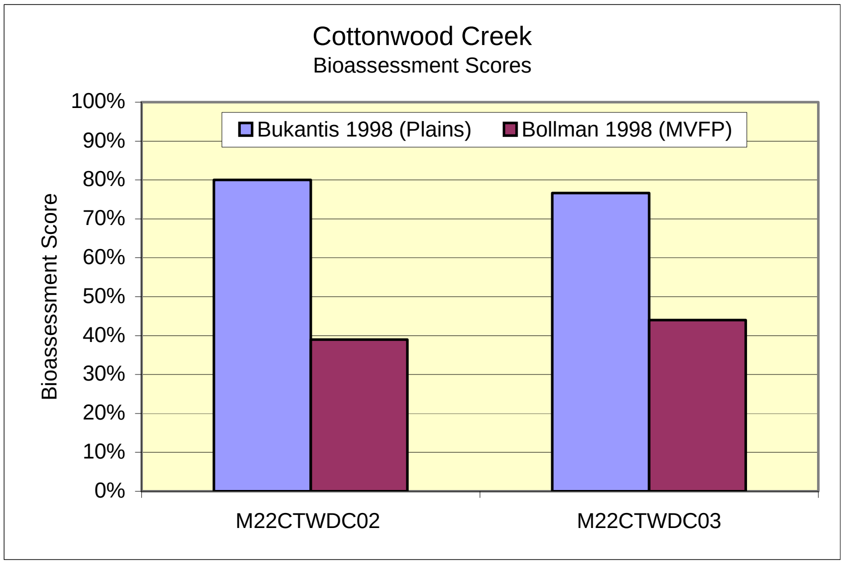

Figure 4-30. Bioassessment Score Comparisons for Two Sites on Cottonwood Creek.

Bioassessment scores (80% and 77%) using the Plains criteria indicate that both sites are within the natural range of conditions for plains streams and are fully supporting their beneficial uses. When the MVFP bioassessment criteria are considered, scores indicate moderate impairment and partial support of beneficial uses. At M22CTWDC02, nine clinger taxa and six trichoptera taxa were present indicating that substrates free from siltation were present, however Bollman states "the taxonomic composition of the sampled assemblage gives some evidence that fine sediments were present in some locations." At M22CTWDC03, eleven clinger taxa and five trichoptera taxa were present indicating clean benthic substrates. In all, benthic communities do not provide compelling evidence for sediment-related impacts. Some impact to aquatic communities was noted however (Bollman, 2001a). Bollman states that dewatering and warm water temperatures may explain impairments to biotic health at these sites.

Macroinvertebrate habitat assessments conducted in August 2001 at sites M22CTWDC02 and M22CTWDC03 scored 66% and 71.5%, indicating suboptimal conditions. Assessments at M22CTWDC02 noted silt-embedded cobbles, and moderate deposition of fine sediments. At M22CTWDC03, assessments noted pools heavily embedded with sands and silts, and moderate sediment accumulation. Bank erosion, stability and riparian vegetation were rated as sub-optimal to optimal at both sites. Based on macroinvertebrate metrics, sediment deposition at these sites does not appear to be adversely affecting biologic health, however, assessments at both sites also noted low-flow conditions, possible due to drought and/or water diversion upstream. Macroinvertebrate assemblages support this observation.

4.5.1.1.2 Periphyton

Periphyton was collected at sites M22CTWDC01, M22CTWDC02, and M22CTWDC03 in 2001. Siltation indices for the three sites are 26, 36 and 43, respectively. When compared to criteria for mountain streams, all three sites indicate impairment and partial support of beneficial uses. When compared to criteria for plains streams, the siltation index indicated no impairment and full support of beneficial uses (Figure 4-31). Site M22CTWDC01 falls within the MFVP ecoregion and maintains characteristics of a mountain stream, while the lower sites, M22CTWDC02, and M22CTWDC03, can reasonably be attributes to a transitional mountain/plains type stream.

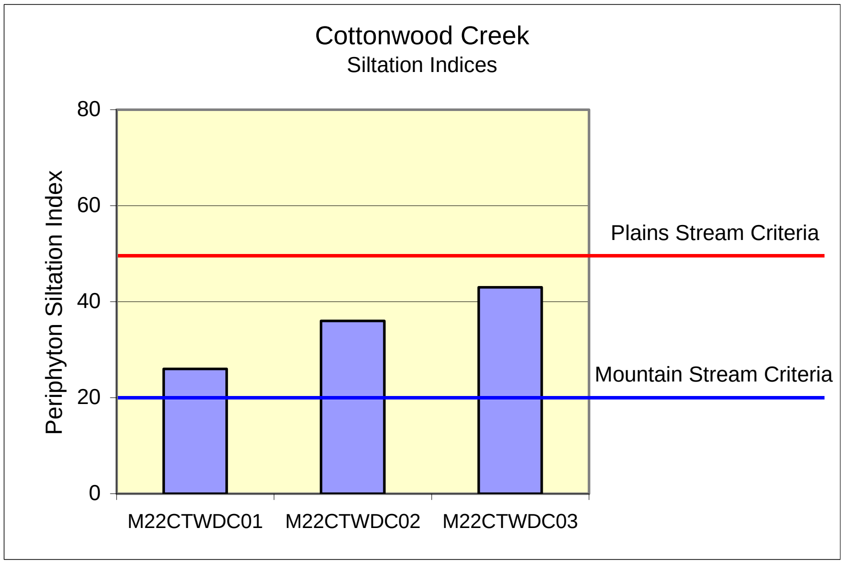

Figure 4-31. Cottonwood Creek Siltation Indices.

4.5.1.2 Physical Measurements and Observations

4.5.1.2.1 Wolman Pebble Counts

Wolman pebble counts were conducted in the summer 2003 at two sites on Cottonwood Creek: M22CTWDC01and M22CTWDC02. Both pebble counts recorded percent surface fines at less that 20%. The *percent surface fines <2 mm* at M22CTWDC01 and M22CTWDC02 were 4.9% and 9.8%, respectively, indicating substrates free from excessive fine-sediment deposition.

4.5.1.2.2 Stream Reach Assessments

Stream reach assessments were conducted in August 2001 by DEQ monitoring staff at three sites on Cottonwood Creek, M22CTWDC01, M22CTWDC02 and M22CTWDC03. Assessments at the uppermost reach centered at M22CTWDC01 noted robust and diverse riparian vegetation, little or no bank erosion and a stony substrate with little silt. Good stream shading and abundance of fish habitat was also noted. M22CTWDC01 scored 85%, indicating optimal conditions.

Assessments centered at reach M22CTWDC02 record conditions similar to reach M22CTWDC01 with respect to riparian vegetation, eroding banks and substrate condition, however evidence of sediment accumulation from upstream sources was noted. Low flows were responsible for limited fish and aquatic habitats, and continuous algae cover on stream substrate was noted. While sediment-related conditions did not appear to be limiting aquatic conditions, M22CTWDC02 scored 65%, indicating sub-optimal conditions. Low assessment scores were mainly due to excessive aquatic plant growth and reduction on instream habitats, most likely exacerbated by dewatered conditions.

Assessments centered at reach M22CTWDC03 indicate an intact riparian zone with approximately 60% of riparian climax species. The stream channel is classified as a slow-moving pool dominated stream with gavel/sand/silt point bars. Evidence of upstream sediment delivery is noted. Excessive plant growth is noted, and dewatering limits fish and aquatic habitats in this reach. M22CTWDC03 scored 71%, indicating sub-optimal conditions. Low assessment scores were mainly due to excessive aquatic plant growth and reduction of in-stream habitats, most likely exacerbated by dewatered conditions.

4.5.1.3 Aerial Surveys and Nonpoint Source Assessments

In 1995 an aerial inventory by helicopter was conducted on the major tributary streams to Big Spring Creek (Hawn, 1997). The objective of the inventory was to characterize the condition of streams and riparian areas and to identify nonpoint pollution sources. Nonpoint pollutions sources identified included:

- **HU** - Heavy Livestock Use Areas
- **DA** - Disturbed/Active Erosion Sites
- **CS** -Channelized Areas
- **LA** - Recent Logged Areas (scour or gully erosion evident)
- **DS** - Degraded Streams (entrenched channel, stream bank erosion)
- **DR** - Degraded Riparian Areas (absence of or reduced shrub/tree community)
- **EA** - Other (housing development impact, car bodies, riprap)

Results of Cottonwood Creek and its tributaries are given in Table 4-6.

Table 4-6. Aerial Nonpoint Source Inventory Results for Cottonwood Creek (Hawn, 1997).

Stream	HU	DA	CS	LA	DS	DR	EA	Total
Cottonwood Creek	20,060	3,684	2,977	14,800	19,119	31,282	422	92,344

In the fall of 2003, the Montana DEQ contracted with *Land & Water Consulting* to evaluate the 1995 aerial photography for additional information on channel condition, riparian communities, vegetation condition, and other physical parameters. The objective of this analysis was to evaluate the extent to which riparian condition influences channel condition and potential sediment supply to Cottonwood Creek. For purposes of comparative analysis, Cottonwood Creek was divided into 30 subreaches (Figure 4-32). For each subreach, information on channel condition and riparian vegetation condition was obtained from the aerial photographs. Channel condition information included: *stream bank length, Rosgen Level I channel type, riprap, channel alteration, unstable banks, and severely eroding banks*. Riparian vegetation condition included: *percent composition of trees, woody shrubs, grasses, bare/disturbed ground and impervious cover, feet of degraded riparian vegetation, and average buffer width per subreach*. In addition to channel and vegetation information, adjacent land use information was obtained from the aerial photography. No ground-truthing of the aerial assessment was conducted. The resultant data and methods utilized to derive these values are shown in Appendix D. A summary of channel and vegetation condition is given in Figures 4-33 thru 4-35.

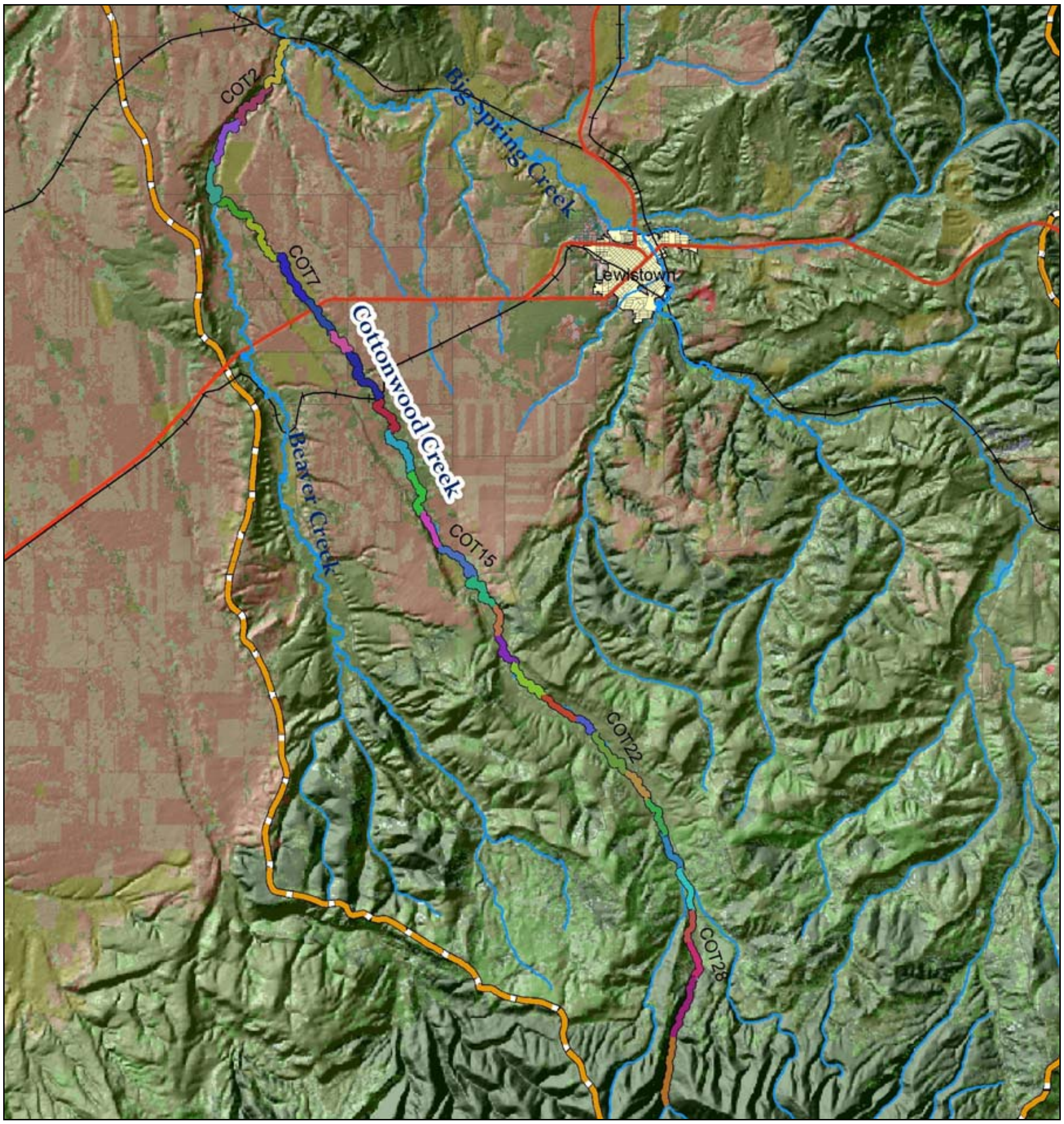

Figure 4-32. Cottonwood Creek Subreaches.

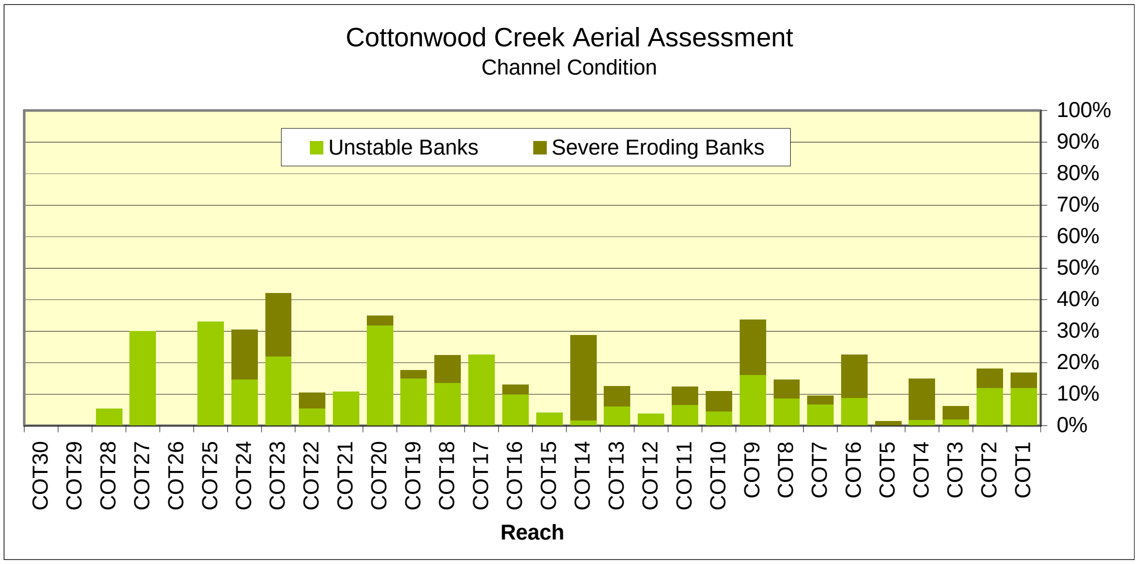

Figure 4-33. Cottonwood Creek Channel Condition (Modified from Land & Water Consulting, 2003).

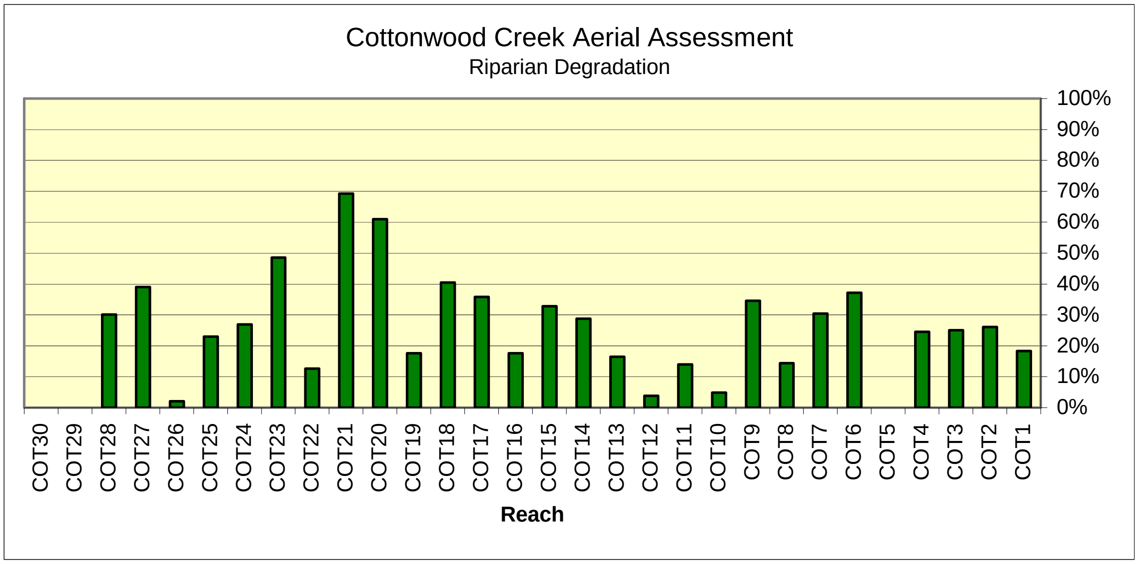

Figure 4-34. Cottonwood Creek Degraded Riparian Vegetation (Modified from Land & Water Consulting, 2003).

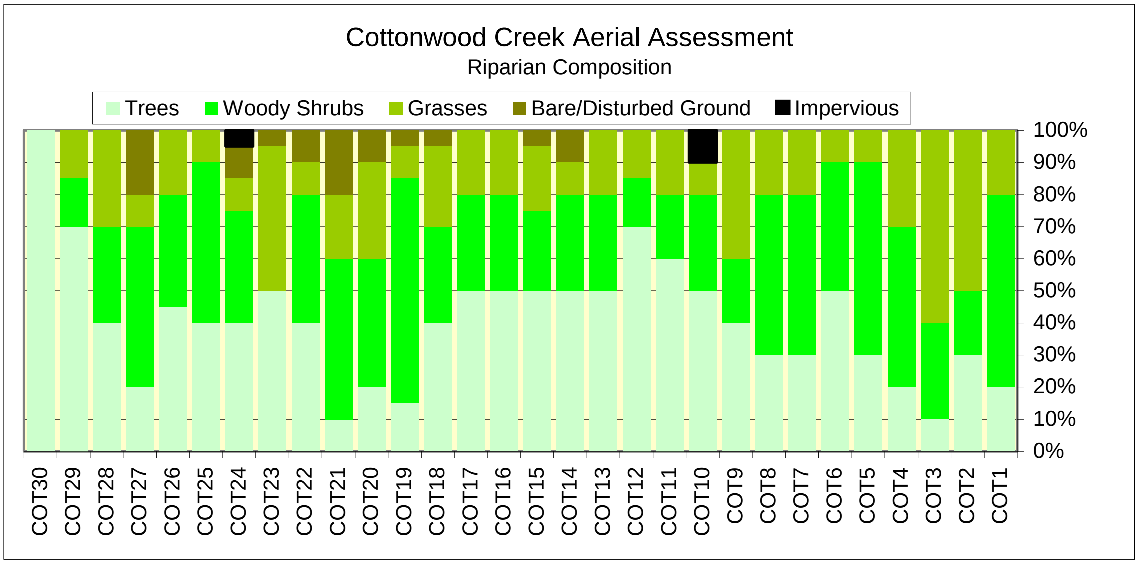

Figure 4-35. Cottonwood Creek Riparian Composition (Modified from Land & Water Consulting, 2003).

Based on this assessment, the percentage unstable banks and severe bank erosion on upper Cottonwood Creek, MT41S004_051, was 12.9% and 3.9%, respectively. Riparian degradation ranged from 0% to 69% per reach with an average value of 25% for segment MT41S004_051. Riparian vegetation composition is dominated by trees and woody shrubs and make up over 77% of the riparian cover on Upper Cottonwood Creek. Figure 4-36 illustrates a typical segment of Upper Cottonwood Creek, MT41S004_051.

Figure 4-36. Typical Riparian Condition of Upper Cottonwood Creek (COT18).

The percentage unstable banks and severe bank erosion on lower Cottonwood Creek, MT41S004_052, was 6.5% and 6.7%, respectively. Riparian degradation ranged from 0% to 37% per reach with an average value of 20% for segment MT41S004_052. Riparian vegetation composition is dominated by trees and woody shrubs and make up 75% of the riparian cover on lower Cottonwood Creek. Figure 4-37 illustrates a typical segment of lower Cottonwood Creek, MT41S004_052 during spring flow conditions (June21, 2003).

Figure 4-37. Condition of Lower Cottonwood Creek (COT4).

Note the naturally eroding stream banks in Figure 4-37. This condition was common on several reaches of lower Cottonwood Creek (COT9, COT7, COT6, COT4) and illustrates the potential for natural sediment delivery to lower Cottonwood Creek. This natural sediment source may explain sediment deposition observed during stream reach assessments at M22CTWDC02 and M22CTWDC03 (Section 4.5.1.2.2).

Data presented on riparian vegetation or channel condition may not reflect current conditions for some reaches. Since the date of the 1995 NRCS survey (Table 4-6), improvements have been made on over 2.5 miles of Cottonwood Creek, resulting in enhancements to riparian health and reductions in nonpoint sources of pollution.

4.5.1.4 Existing Conditions Summary

Cottonwood Creek (MT41S004_051)

Upper Cottonwood Creek exhibits characteristics of a foothill type stream and is evaluated using criteria designed to assess beneficial use support for streams that fall within the MVFP ecoregion. Based on macroinvertebrate indicators and macroinvertebrate habitat assessments, aquatic life uses in upper Cottonwood Creek (MT41S004_051) do not appear to be impaired due to sediment. Pebble counts did not indicate excessive surface fines, and stream reach assessments and surveys reported that bank erosion is minimal and riparian and instream habitats are optimal. The periphyton siltation index was 26, slightly elevated over reference conditions (20) for mountain streams, however, all other habitat and in-stream indictors suggest little to minor impact. Overall, data suggest that this reach is not impaired due to sediment or suspended solids. **Upper Cottonwood Creek is not impaired due to sediment; therefore no sediment TMDL is necessary.**

Cottonwood Creek (MT41S004_052)

Lower Cottonwood Creek, specifically with reference to sampling locations M22CTWDC02 and M22CTWDC03, exhibits characteristics of a transitional foothill/plains type stream. Hence, aquatic use support criteria designed to evaluate mountain and foothill type streams is not entirely appropriate for assessing beneficial use. Nor should established plains stream criteria be relied on entirely to assess beneficial use support. Rather, multiple considerations are taken into account when assessing whether lower Cottonwood Creek is impaired due to sediment.

Macroinvertebrate data (clinger and trichoptera taxa richness) suggests that benthic communities do not suffer from excessive siltation or fine sediment deposition. Periphyton siltation indices fall within acceptable levels for plains streams but above criteria for mountain streams (Figure 4-31). Pebble counts did not record excessive fine sediments and stream reach assessments did not implicate fine sediment as a factor limiting stream health. Information derived from aerial assessments and field observation provides supporting evidence. Excessive bank erosion is not noted, and in areas of severe bank erosion (COT9, COT7, COT6, COT4) causes are from natural conditions (Figure 4-37).

Based on the weight of evidence from multiple data sources, and in the absence of significant anthropogenic sediment sources, it appears that **lower Cottonwood Creek, (MT41S004_052), is not impaired due to sediment or siltation. No sediment TMDL is required.**

Riparian enhancement efforts should continue, with focus on localized areas of stream bank instability and livestock impacts. BMP implementation through cooperative efforts between landowners, agencies and local technical experts can best address present and future management of Cottonwood Creek, and continuation of these efforts is encouraged.

Figure 4-38. Natural Dewatering.

Figure 4-39. Diversion Dewatering.

Dewatering and flow alteration are listed as causes of impairment on Cottonwood Creek on the 2002 303(d) list. The lower 17 miles of Cottonwood Creek is include on the 2003 FWP Dewatered Stream list, and is listed as chronically dewatered. Chronic dewatering refers to streams where dewatering is a significant problem in virtually all years. Complete dewatering of reaches above Glengarry is common in most years, and is a natural phenomenon. Irrigation diversions, however, also withdraw significant amounts of water and at low flows, also contribute to dewatering of Cottonwood Creek (Figures 4-38 and 4-39). Total Maximum Daily Loads are not required due to dewatering, however dewatered conditions appear to limit both the aquatic macroinvertebrate community and the fishery. Increased flows will greatly benefit aquatic habitats and biotic communities and it is recommended that flow monitoring and investigation be conducted to provide the necessary information with which to develop and implement management activities that will result in enhancement of aquatic habitats and communities.

4.6 Casino Creek

Casino Creek (MT41S004_040) originates in the foothills of the Big Snowy Mountains and flows north 12 miles to its confluence with Big Spring Creek just south of the city of Lewistown. Casino Creek has the characteristics of a foothill/valley stream and falls within the Montana Valley & Foothill Prairie ecoregion. The Casino Creek watershed is almost entirely privately owned. Land uses in the watershed are predominantly agriculture and livestock grazing.

Grasses and woody shrubs dominate the riparian area of Casino Creek, and beaver activity is common. Beaver dams are responsible for slack-water areas on several segments of the creek, while other segments are comprised of riffle and pool sequences. A number of natural springs in the upper watershed provide inputs to Casino Creek. The stream is classified as an E-type channel and is highly entrenched in places, perhaps due to down cutting as a result of historic beaver dam removal. Deep organic-rich soils are common throughout the Casino Creek watershed. In general, the stream channel is rather stable and stream banks are comprised of fine-grained organic rich soil.

4.6.1 Existing Conditions for Casino Creek

Casino Creek was listed on the 1996-303(d) list; cold-water fishery beneficial use was listed as threatened due to nutrients and suspended solids. The 1996 listing was based on a nonpoint source assessment conducted in 1989. The 1989 assessment relied on existing data and reports, and acknowledged that limited data existed for Casino Creek. No field assessments or new data collection was used to make the listing determination. On the 2002 303(d) list, cold-water fishery, aquatic life, and contact recreation were listed as partially supporting due to nutrients, riparian degradation, and other habitat degradation. The following data review examines data and information to verify the 1996 303(d) listing for the water quality pollutant, suspended solids.

Note that the data presented in the following evaluation considers data relevant to sediment-related impairments. An evaluation of nutrient conditions is presented in Section 7.0.

4.6.1.1 Biological Data

4.6.1.1.1 Macroinvertebrates & Macroinvertebrate Habitat Assessments

Macroinvertebrates were collected in August 2000 at 2 sites on Casino Creek: C1 and C2 (Figure 4-40). For both sites, the MVFP metric index developed by Bollman (1998) was used to evaluate beneficial use support. Site C1 scored 33%, indicating moderate impairment and partial support of beneficial uses. Only three clinger taxa were collected at the site and trichoptera taxa richness was 1, both indicators of fine sediment deposition. The macroinvertebrate assemblage also showed strong evidence of warm water temperatures, and nutrient enrichment, possibly obscuring the effects of possible habitat degradation (Bollman, 2001c). Site C2 scored 39%, indicating moderate impairment and partial support of beneficial uses. Here, eight clinger taxa were collected and trichoptera taxa richness was 7, indicating that substrates were not significantly impacted by fine sediment. A low bioassessment score (39%) likely reflects impacts from nutrients and/or organic enrichment. Indictors of warm water temperatures were also present in the sample.

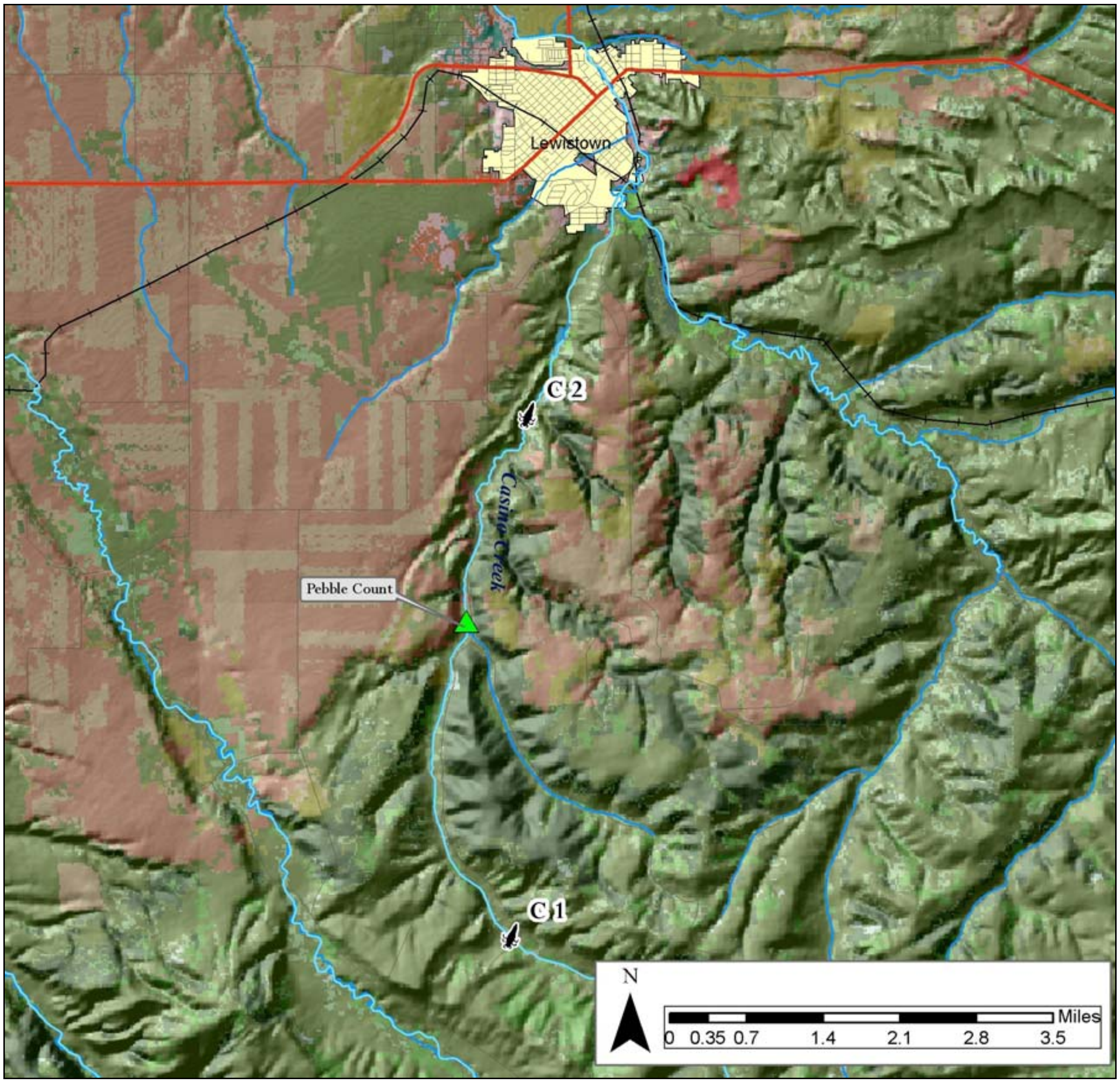

Figure 4-40. Biological Sampling Locations on Casino Creek.

Macroinvertebrate habitat assessments were conducted at sites C1 and C2 on Casino Creek. Macroinvertebrate habitat assessments scored 65% and 55%, respectively, indicating sub-optimal conditions at both sites. At C1 (Figure 4-41), the riparian zone was minimally impacted and stream banks were noted as stable. Marginal flow was noted at this site. At C2 (Figure 4-43), flow conditions were better than at C1, and riparian and stream bank condition was rated suboptimal. Excessive fine sediment deposition was noted, and was attributed to natural beaver activity throughout the reach.

Figure 4-41. Site C1 on Casino Creek (August, 2000).

Figure 4-42. Site C2 on Casino Creek (August, 2000).

4.6.1.1.2 Periphyton

Periphyton was collected in August of 2000 at sites C1 and C2. Siltation indices were 59 and 41, respectively, indicating impacts due to fine sediment deposition when compared to siltation reference criteria for mountain streams.

4.6.1.2 Physical Measurements and Observations

4.6.1.2.1 Wolman Pebble Counts

A Wolman pebble count was conducted in the summer 2003 at a site just downstream from the Mill Creek confluence (Figure 4-40). Percent surface fines <2mm at this site were 6.7% indicating low amounts of fine sediment in substrates.

4.6.1.2.2 Stream Reach Assessments

Stream reach assessments were conducted in August 2001 by DEQ staff at sites C1 and C2. Site C1 (Figure 4.43) scored 80%, indicating optimal conditions. Riparian growth consisted mainly of grasses, and lack of alder and willow regeneration was noted. Stream banks were rated as very stable and bank erosion was minor. Grazing was noted throughout the reach. Site C2 scored 71%, indicating sub-optimal conditions. Riparian growth consisted mainly of grasses, and alder and willow growth was vigorous in many places. Bank erosion was minor. Beaver activity was noted and attributed to slight turbidity of the water and the formation of mud and silt deposits.

Figure 4-43. Reach C1 on Casino Creek (June, 2003).

4.6.1.3 Aerial Surveys and Nonpoint Source Assessments

In 1995 an aerial inventory by helicopter was conducted on the major tributary streams to Big Spring Creek (Hawn, 1997). The objective of the inventory was to characterize the condition of streams and riparian areas and to identify nonpoint pollution sources. Nonpoint pollutions sources identified included:

- **HU** - Heavy Livestock Use Areas
- **DA** - Disturbed/Active Erosion Sites
- **CS** -Channelized Areas
- **LA** - Recent Logged Areas (scour or gully erosion evident)
- **DS** - Degraded Streams (entrenched channel, stream bank erosion)
- **DR** - Degraded Riparian Areas (absence of or reduced shrub/tree community)
- **EA** - Other (housing development impact, car bodies, riprap)

Results of Casino Creek and its tributaries are given in Table 4-7.

Table 4-7. Aerial Nonpoint Source Inventory Results for Casino Creek (Hawn, 1997).

Stream	HU	DA	CS	LA	DS	DR	EA	Total
Casino Creek	14,632	399	768	N/A	N/A	N/A	7000	22,800

Cursory aerial analysis reveals that areas of stream and riparian degradation were unidentifiable from aerial perspective. DEQ stream reach assessments and macroinvertebrate habitat assessments generally support this observation, as channel and riparian condition were rated as optimal to suboptimal.

Data presented on riparian vegetation or channel condition may not reflect current conditions for some reaches. Since the date of the 1995 NRCS survey (Table 4-7), improvements have been made on over 3,000 feet of Casino Creek (NRCS unpublished data), resulting in enhancements to riparian health and reductions in nonpoint sources of pollution. Riparian improvement projects include revegetation, fencing, and off-stream watering.

4.6.1.4 Water Quality Data

Total suspended solids (TSS) data was collected at four locations on Casino Creek in 2000 and 2003. TSS values ranges from 12 mg/l to 25 mg/l with a mean of 18 mg/l. Given that stream banks are predominantly comprised of fine-grained sediments, and that observations of turbid water have been attributed to Beaver activity (Figure 4-44), it is felt that TSS results are within the range of natural conditions for Casino Creek.

Figure 4-44. Turbid water associated with beaver complexes (Casino Creek, 2003).

4.6.1.5 Existing Conditions Summary

Casino Creek (MT41S004_030) is a stable E-channel with a fairly robust riparian zone of grasses, sedges and woody shrubs. Evidence of present and historical beaver activity is common. It appears that in some areas, historic beaver dam removal has resulted in entrenched riffle reaches of exposed fine-grained organic sediment. In other areas, active beaver complexes are responsible for ponded water, silty substrates, and fine sediment deposition. The natural fine-grained organic-rich sediment in the Casino Creek drainage, coupled with beaver activity appears to create conditions resulting in higher levels of fine sediment and areas of cloudy or turbid water. In the absence of significant sediment sources, conditions that result in indications of fine sediment accumulation (periphyton siltation indices, macroinvertebrate bioassessments) are considered natural. **Based on these findings, it is felt that the evidence does not support a suspended solids impairment listing (1996 303(d) list) for Casino Creek, and a TMDL for suspended solids is not required.**

Nutrient enrichment, organic pollution and warm water temperatures were noted as potential causes of impairment to aquatic communities (Bollman, 2001c), however. These potential causes of impairment will be addressed in Section 7.0.

Riparian enhancement efforts, however, should continue, with focus on localized areas of streambank instability and livestock impacts. BMP implementation through cooperative efforts between landowners, agencies and local technical experts can best address present and future management of Casino Creek, and continuation of these efforts is encouraged

SECTION 5.0
SEDIMENT – REQUIRED TMDL ELEMENTS

As described in Section 4.0, the sediment water quality standards do not currently appear to be met in Big Spring Creek. This section of the document presents the required TMDL elements (i.e., targets, source assessment, TMDLs & allocations, adaptive management, implementation and monitoring strategies, margin of safety) for Big Spring Creek.

5.1 Big Spring Creek

5.1.1 Sediment Targets

Sediment TMDL targets provide a means to assess whether water quality standards are being met, and act as water quality endpoints for sediment-impaired streams. Sediment targets are essentially a translation of the state's water quality standards for sediment, and achievement of water quality targets will, by definition, result in achievement of water quality standards for the specific pollutant of concern (sediment).

In accordance with the Montana Water Quality Act (MCA 75-5-703(7) and (9)), the DEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. This assessment will use the suite of targets specified in Section 5.1.1.2 to measure compliance with water quality standards. If all of the target values are met, it will be assumed that water quality standards for sediment have been achieved. Alternatively, if one or more of the target values are exceeded, it will be assumed that water quality standards have not been achieved. However, it will not be automatically assumed that implementation of a TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. As noted above, the circumstances around the exceedance will be investigated. For example, might the exceedance be a result of natural causes such as floods, drought, fire, or the physical character of the watershed? In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards; or
- Revisions to components of the TMDL are necessary.

Figure 5-1 illustrates the process by which target compliance is evaluated after control measures are implemented.

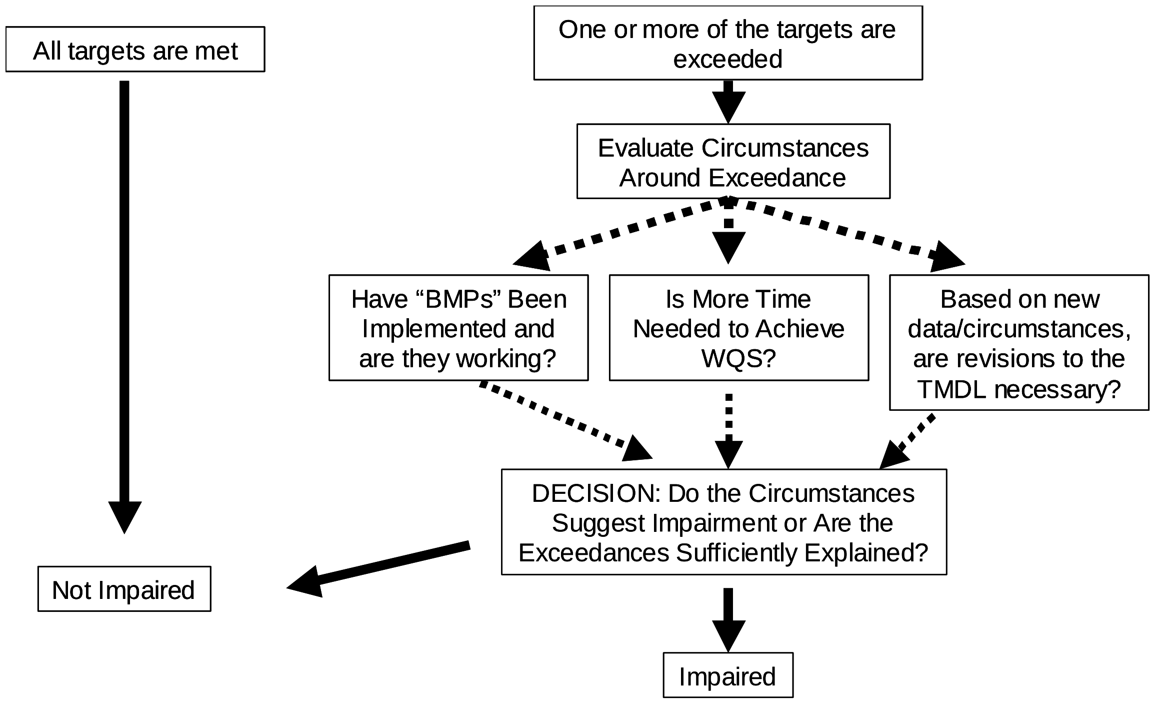

Figure 5-1. Methodology for Determining Compliance with Water Quality Standards.

Detailed discussions regarding each of the targets are presented below.

5.1.1.1 Basis for Targets

Montana water quality standards for B-classified waters relating to sediment state, *"no increases are allowed above naturally occurring concentrations of sediments or settleable solids… which will or are likely to …render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife."* (ARM 17.30.623-625[f]). Naturally occurring is further defined as *"…conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied"* (ARM 17.30.602[17]). A naturally evolving stream system develops and responds to events within the boundaries of "dynamic equilibrium" where the stability of the system fluctuates thru geologic time-scales (Leopold et al., 1964). Within dynamic equilibrium it is assumed that a percentage of a stream corridor may be in a disturbed or eroding state and still be deemed a natural condition.

There are no numeric standards for parameters associated with sediment. However, narrative standards do not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. Narrative standards translated into water quality goals should strive toward a condition that reflects a waterbody's greatest potential for water quality given current and historic land use activities, where *all reasonable land, soil, and water conservation practices* have been applied.

Water quality targets for Big Spring Creek (MT41S004_020) include parameters that reflect:

- Attainment of an aquatic macroinvertebrate and periphyton community that no significant impact from sediment above naturally occurring levels. Indicators include ***percent or number of macroinvertebrate clinger taxa*** and ***periphyton siltation index***.
- Attainment of substrate conditions (percent surface fines) that are not harmful or injurious to naturally occurring aquatic communities. The substrate condition indicator used is ***percent surface fines <2mm***.

Taken together, chosen biologic and substrate targets reflect conditions that are not "*harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife*" (ARM 17.30.623-625[f]), and are therefore a translation of Montana's narrative water quality standards for sediment.

5.1.1.2 Sediment Target Values

Percent Macroinvertebrate Clinger Taxa

The target value for percent *macroinvertebrate clinger taxa* is >50%. Upstream of Lewistown, percent clinger taxa values are greater than 60% at Burleigh Easement and greater than 90% below the fish hatchery. Neither site is impaired for sediment. As these reaches of Big Spring Creek are relatively stable E channel types (Rosgen, 1996) and sediment inputs are very low on upstream reaches, these values are not appropriate for the C type channels further downstream. A decrease in percent clinger taxa as natural sedimentation increases is expected. Based on present knowledge and assessments, it is felt that a target of >50% clingers is an appropriate criteria to evaluate sediment-related impairment conditions for sites downstream from Burleigh Easement.

Periphyton Siltation Index

The target value for *periphyton siltation index* is <25. As stated in Section 4.2.1.2, a siltation index of >20 indicates potential sediment impacts for mountain streams (Bahls, 2004). As Big Spring Creek is a spring fed system and may not entirely fit the criteria of a 'mountain stream', a siltation index of <20 is not deemed an appropriate value as a sediment target. Big Spring Creek does, however, experience flows capable of maintaining a dominant cobble/gravel substrate indicative of mountain-type streams. As natural sediment inputs increase from upper to lower Big Spring Creek, a siltation index that reflects this change should be chosen. Based on present knowledge, assessments and best professional judgment, a value of <25 for periphyton siltation index was chosen as an appropriate target.

Percent Surface Fines

The target value *for percent surface fines <2mm* is <20%. While the threshold for biological effects in response to increasing surface fines is still being investigated, studies suggest that this target value is appropriate (see Section 4.2.3.1).

Table 5-1. Water Quality Targets for Big Spring Creek (MT41S004_020).

Indicator	Target Value	Compliance Point	Measurement Method	Frequency
Percent macroinvertebrate clinger taxa	>50%	Burleigh Easement Carroll Trail FAS Hruska FAS Spring Creek Colony	Rapid Bioassessment Protocol II (Barbour, et al., 1999)	1/year
Periphyton siltation index	<25	Burleigh Easement Carroll Trail FAS Hruska FAS Spring Creek Colony	DEQ monitoring SOPs	1/year
Percent surface fines <2mm	<20%	Burleigh Easement Carroll Trail FAS Hruska FAS Spring Creek Colony	Wolman Pebble Count	1x/year

5.1.1.3 Comparison of Target Values to Existing Conditions

Percent Macroinvertebrate Clinger Taxa

Based on macroinvertebrate samples from 1996, all sampling sites upstream from the city of Lewistown currently meet target values. Downstream, percent clinger taxa values at Carroll Trail FAS, Hruska FAS, and the Spring Creek Colony site all were below 20% (Figure 4-6).

Periphyton Siltation Index

All periphyton siltation indices upstream from Lewistown currently meet target values. Below town, with the exception of a sampling site near the mouth of Big Spring Creek, all periphyton indices are not currently meeting target values (Figures 4-7 and 4-8).

Percent Surface Fines

Pebble counts conducted in 2003 at Burleigh Easement, Carroll Trail and Spring Creek Colony recorded percent surface fines as **13%, 8%,** and **15%,** respectively. Pebble counts conducted in 2001, recorded respective values of **4%, 36%** and **17%**. With the exception of the 2001 Carroll Trail value (36%) all percent fines values met the target value of <20% fines. 2003 counts were conducted soon after a large flow event and may reflect the results of flushing, scouring and sorting of fresh gravels.

5.1.1.4 Targets - Adaptive Management and Uncertainty

Water quality targets are established based on the best available information and the current understanding of the relationship between fine sediment and biologic health. Big Spring Creek is a unique system in that flows are largely dominated by relatively constant input from spring sources. Natural hydrologic regime, although altered significantly by flow modification, does not adhere to the 'normal' feast and famine character of the majority of western intermountain streams. This undoubtedly influences the biologic condition of Big Spring Creek. Hence, established biometrics used to assess and evaluate the biological condition of foothill and valley streams (Bollman, 1998) are not appropriate for such a system. In lieu of an established biological reference condition by which to evaluate the biological condition of Big Spring Creek, internal upstream to downstream trends and best professional judgment was employed when evaluating macroinvertebrate and periphyton data in order to develop biological targets appropriate for Big Spring Creek.

Because of the uncertainty inherent in individual biologic targets, a suite of targets is chosen. It is understood that target attainment will not simply be an endpoint, but a process by which targets are regularly evaluated. As additional data and information is gathered and evaluated, it is anticipated that these targets may be modified to better reflect attainment of water quality standards for sediment.

5.1.2 Source Assessment

Sediment source assessment includes identifying and assessing the contribution from all significant natural and human-caused sources of sediment, and factors affecting sediment impairment conditions in Big Spring Creek (MT41S004_020). Potential significant sources and factors include:

Nonpoint Sources

- Flow-related influences
- Bank erosion
- Overland flow
- Roads and road crossings
- Tributaries
- Urban sources

Point Sources

- Lewistown wastewater treatment plant

Based on preliminary source evaluation, the **major factors influencing sediment impairment conditions in Big Spring Creek appear to be flow modification, bank erosion and localized urban nonpoint source pollution**. A detailed discussion of source categories follows.

5.1.2.1 Flow-related Influences

Several stations have recorded flows on Big Spring Creek. Daily flows were recorded at USGS gauging station 06111500 just downstream from the Big Springs Trout Hatchery from 1932 through 1957. The average discharge of Big Springs Creek at station 06111500 for water years 1932-1957 is 107 cfs. The highest recorded flow at station 06111500 was 250 cfs on 6/14/1967. Additional high flows of over 220 cfs occurred in the spring of 1951 and 1953. The relatively flat hydrograph at this station results mainly from a constant year-round discharge from Big Springs, about 0.5 mi upstream.

As Big Spring Creek meanders north toward Lewistown, its flow is augmented by tributaries: Hansen Creek, Castle Creek, East Fork Big Spring Creek, Pike Creek, Casino Creek and Little Casino Creek. Until the mid 1970s these tributaries were free flowing and discharge through Lewistown reflected the cumulative input from all tributaries. In the early 1970s, reservoir construction began on Hansen Creek, East Fork, Pike Creek, and Casino Creek. By 1976, four on-channel reservoirs were in place upstream from Lewistown. While no long-term predam/postdam flow data exists, the construction of these reservoirs has likely resulted in a reduction of downstream peak flows during spring runoff. While flooding through town has largely been eliminated, flow alteration, specifically reduction in peak flows, has resulted in decreases in spring transport capacity and fine sediment deposition.

Unpublished USGS flow data records flows in excess of 1200 CFS through town during the spring of 1953 and 1975. While these flows may not have been typical of pre-dam years, they do demonstrate the flow potential of the system. NRCS collected daily flow data on Big Spring Creek at the Ash Street bridge (just above Casino Creek) from 1979 through 1993 (Figure 5-2). While flow data is absent for runoff years 1985, 1990, and 1992, sustained spring runoff flows above 250 CFS were observed only in years 1979, 1981, and 1982. Peak flows during each of these years topped 700 cfs, while peak flows above 250 cfs in other years was uncommon. As stated earlier, the estimated 600 cfs event captured in March 2003 was seen as an uncommon event among local resource managers.

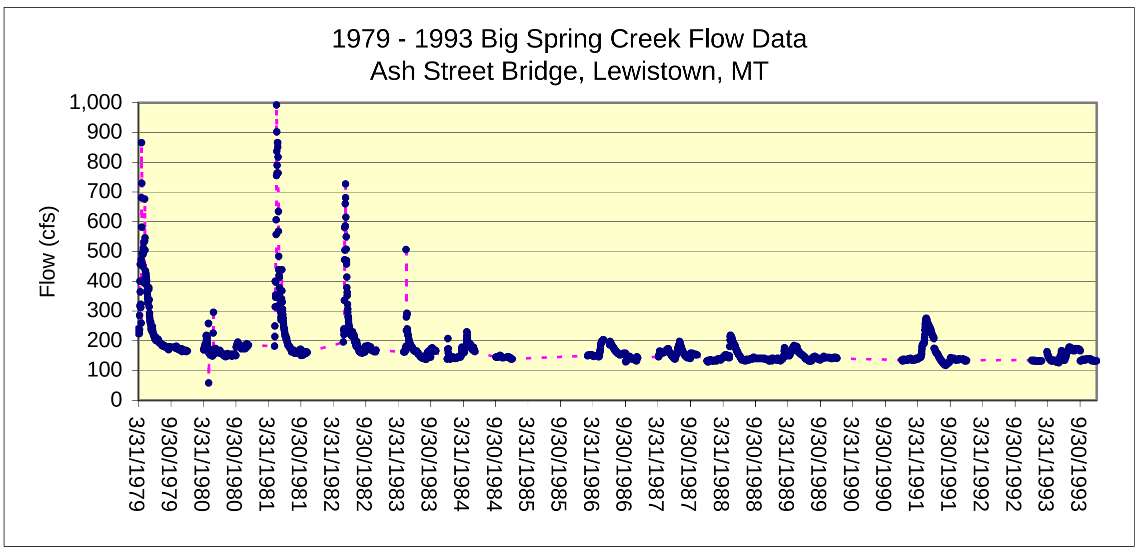

Figure 5-2. Big Spring Creek Flows at Ash Street Bridge (DNRC Unpublished Data).

The absence of pre-dam data precludes direct comparisons between pre and post dam flow conditions, however, lack of flooding events through the city of Lewistown since the construction of upstream reservoirs does provide compelling evidence on the effectiveness of these reservoirs in reducing peak flows through town.

While the reduction in peak flows itself does not provide rationale for a sediment impairment decision, observed habitat benefits resulting from the Spring 2003 flushing flow event provide evidence that high flows provide necessary energy to cleanse the system of fine sediment buildup. Pebble Counts conducted downstream from Lewistown after the 2003 flushing flow recorded a marked decrease in percent surface fines from 36% in August of 2001 to 8% in July 2003. Likewise biological data (macroinvertebrate and periphyton) collected below Lewistown (Carroll Trail) reflect impacts from siltation, presumably from accumulation of urban point and nonpoint sources, as well as residential and rural sediment inputs through Lewistown.

Under a natural flow regime, processes governing sediment transport and deposition may be expected to maintain a condition suitable for a naturally functioning biological community (Reiser et al., 1987; Kondolf et al., 1987). Regulation or disruption in stream flow due to dams and reservoirs can eliminate natural variations in flow, including natural peak flows. It is believed that the disruption of flow conditions (in this case, reduced frequency and magnitude of peak or flushing flows) has caused Big Spring Creek to accumulate fine sediment. Without seasonal events that provide the necessary stream power to scour the substrate and remove fine sediment, it is expected that fine sediments will continue to accumulate and hinder the biological potential of the system.

5.1.2.2 Bank Erosion

Bank erosion sources consist of natural bank erosion and bank erosion that has been exacerbated by human impacts to the stream corridor and stream banks, predominantly through removal or alteration of native vegetation communities. Bank erosion is a natural process and natural sediment inputs are expected. A natural or ‘reference’ bank erosion condition exists where riparian vegetation is nearest a natural or reference state. ‘Natural’ condition does allow for anthropogenic influence ‘*where all reasonable land, soil and water conservation practices have been applied*.’ It can reasonably be assumed that natural background or ‘reference’ conditions are characterized by little to no riparian degradation, and hence little to no bank erosion or instability resulting from anthropogenic degradation of riparian vegetation.

What follows is a summary of bank erosion and riparian vegetation conditions on Big Spring Creek, based on 1989 aerial photography (Appendix B). It is intended to illustrate the links between riparian character and associated bank or channel disturbance, and can be used to approximate relative sediment source contributions as a function of riparian degradation or removal of streamside vegetation. Assessment data does not allow the calculation of numeric sediment loads. Rather, data is employed to compare vegetation character between least and most-impacted reaches, and provide justification and linkages to support bank erosion allocations (Section 5.1.3.2).

Based on vegetation assessment of 1989 aerial photos by Land & Water Consulting (L&W), five reaches, Big22a, Big22b, Big31, Big34, and Big35 (Figure 4-19) were determined to be ‘lightly impacted’ (Appendix B) and therefore provide the closest *approximation* to reference conditions. Lightly impacted reaches *did* contain evidence of anthropogenic disturbance in the form of vegetation removal and bank erosion, and so may not be considered a truly natural or ‘reference’ condition in the absence of all reasonable stream bank best management practices (BMPs).

Big31, Big34, and Big35 represent ‘lightly impacted’ conditions on **upper Big Spring Creek** upstream of Lewistown (Figure 5-3). Upstream of Lewistown, bank erosion and channel instability are relatively low compared to downstream reaches. Note that bank erosion due to clearing of riparian vegetation is evident in Figure 5-3, so even though 'lightly impacted' reaches represent the best condition present, they do not represent natural or 'reference' conditions.

Figure 5-3. Upper Big Spring Creek 'Lightly Impacted' Reach (Big31).

Upstream of Lewistown, Big28 (Brewery Flats area) is the only reach that is rated high for channel impacts; however, in the late 1990s, segments of Big28 were restored from a straightened reach to meandering channel. Riparian plantings and management of this area as a natural city park have resulted in a transformation of 'Brewery Flats' to a minimally impacted reach. A summary of 'lightly impacted' conditions for upper Big Spring Creek based on reaches Big31, Big34, and Big35 is given in Table 5-2.

Table 5-2. Riparian and Channel Conditions for 'Lightly Impacted' Reaches on Upper Big Spring Creek.

Indicator	Percent of Streambank
Unstable banks	0%-10% (avg 4%)
Bank Erosion	1%-6% (avg 3%)
Trees & woody shrubs	50% avg
Degraded riparian vegetation	25% avg

Reaches Big22a and Big22b, and reaches Big17 and Big21 (Figure 5-4) represent some of the best riparian vegetation conditions observed **on middle and lower Big Spring Creek** (Figure 4-17) and may be used to approximate reference conditions. Consequently, these reaches also had some of the lowest bank erosion and instability levels downstream from Lewistown (Figure 4-15).

Figure 5-4. Lower Big Spring Creek 'Lightly Impacted' Reach (Big21).

Based on these assessments and values for these reaches, conditions range from 4% to 22% unstable banks and 4% to15% severely eroding banks. The average amount of degraded riparian vegetation for these reaches was 24%, with trees and woody shrubs making up over 60% of the riparian corridor. Table 5-3 summarizes 'lightly impacted' conditions for Big Spring Creek downstream from Lewistown.

Table 5-3. Riparian and Channel Conditions for 'Lightly Impacted' Reaches on Middle and Lower Big Spring Creek.

Indicator	Percent of Streambank
Unstable banks	4%-22% (avg 11%)
Bank Erosion	4%-15%(avg 7%)
Trees & woody shrubs	60% avg
Degraded riparian vegetation	25% avg

In comparison to reference reaches, there were 16 reaches in the Vegetation Impact Category and 13 reaches in the Channel Condition Category that rated as ‘highly impacted’ (Appendix B). There were no reaches that rated as ‘highly impacted’ upstream of Lewistown. Table 5-4 summarizes average conditions for highly impacted reaches. Note that reaches lined with >20% rip rap (Big23) or confined to the urban setting (Big25, Big26, Big28) were removed from this analysis, as channel stability was a result of rock and concrete structures rather than the stabilizing influence of riparian vegetation. Figure 5-5 shows an example of a ‘highly impacted’ reach. Channel straightening, riprap, and lack of stabilizing riparian vegetation are evident.

Table 5-4. Riparian and Channel Conditions for ‘Highly Impacted’ Reaches of Lower Big Spring Creek.

Indicator	Percent of Streambank
Unstable banks	18%-68% (avg 45%)
Bank Erosion	8%-35% (avg 18%)
Trees & woody shrubs	35% avg
Degraded riparian vegetation	70% avg

Figure 5-5. Example of a ‘Highly Impacted’ Reach.

Figure 5-6 illustrates the difference between ‘lightly impacted’ and ‘highly impacted’ reaches on Big Spring Creek for a variety of indicators that influence sediment loading.

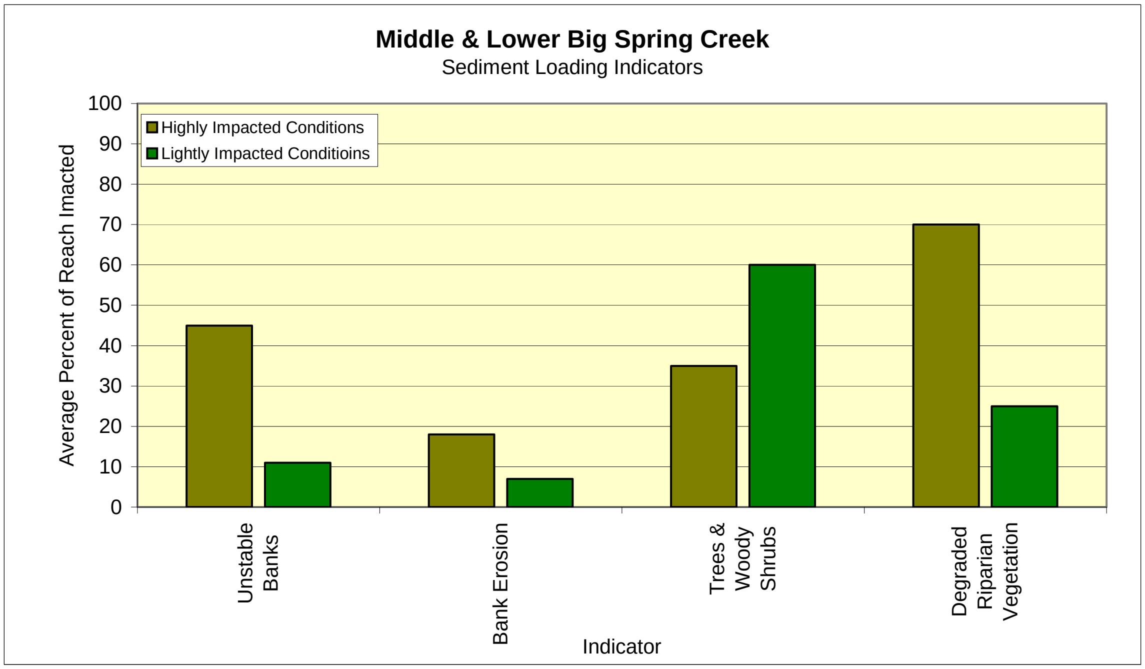

Figure 5-6. Comparison of 'Highly Impacted' and 'Lightly Impacted' Reaches on Middle and Lower Big Spring Creek.

In general, bank erosion and instability on Upper Big Spring Creek is much lower than downstream reaches, even though levels of riparian degradation are similar between upper and middle Big Spring Creek. Difference in 'lightly impacted' conditions between upper and middle/lower Big Spring Creek suggest that factors other than riparian degradation are influencing channel stability and bank erosion upstream from Lewistown.

Upstream from Lewistown, Big Spring Creek is classified as an E Channel Type (Rosgen, 1996). As upper Big Spring Creek is augmented by tributaries (East Fork, Big Spring Creek, Casino Creek, Little Casino Creek), its flow increases and it is classified as a C-type channel below Lewistown. Higher flows in the C channel make stream banks more susceptible to erosion and instability. Figure 5-7 shows the relationship between riparian degradation and bank erosion/bank stability for C and E channel types in Big Spring Creek based on aerial assessment information (Land & Water, 2003).

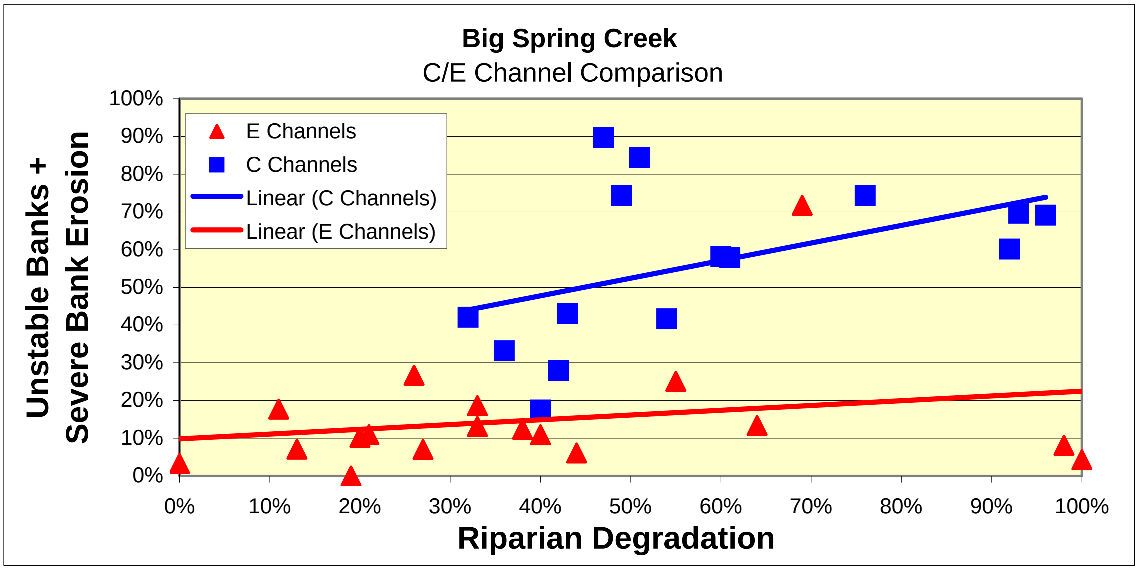

Figure 5-7. Comparison Between C and E Channel Types in Big Spring Creek.

E channel types are present upstream from Lewistown and have lower levels of bank instability and bank erosion that C type channels with similar levels of riparian degradation. It appears that E channels upstream are capable of maintaining higher bank stability in spite of higher levels of riparian degradation. In contrast, C channels exhibit a clear relationship between increased riparian degradation and an increase in bank instability and erosion. Consequently, the importance of woody riparian vegetation as means to protect stream banks against erosion cannot be underestimated, especially for C channels. As upstream E-reaches do not appear to be suffering deleterious effects from increased siltation, efforts to control sediment should therefore be focused on controlling sediment sources through the urban interface and on reaches downstream from Lewistown. Sediment sources throughout the urban interface include not only urban stormwater and runoff, but also inputs from tributaries (Boyd Creek, Casino Creek, Little Casino Creek) that enter Big Spring Creek in this area, as well as sediment from residential clearing and land use practices just upstream from and through the city of Lewistown. Localized areas of bank erosion do exist on upstream reaches, however, and should not be overlooked.

Channelization and riprap areas (Figure 5-8) are prevalent on reaches through and downstream from the city of Lewistown. Channelization straightens sections of stream, and can cause increases in stream velocities that can lead to headcutting, and erosion. Channelization also decreases aquatic habitats for fish by reducing habitat complexity and diversity through disruption of riffle and pool complexes needed by aquatic organisms (FISRWG, 1998). Riprap is rocks placed along stream banks to protect banks from the eroding action of the current. Riprap is often used in areas where the natural riparian vegetation has been removed and eroding banks become a problem (Figure 5-9). Both channelization and riprap can contribute to conditions that result in impairment, through disruption of stream channel processes, and aquatic and riparian habitat alteration.

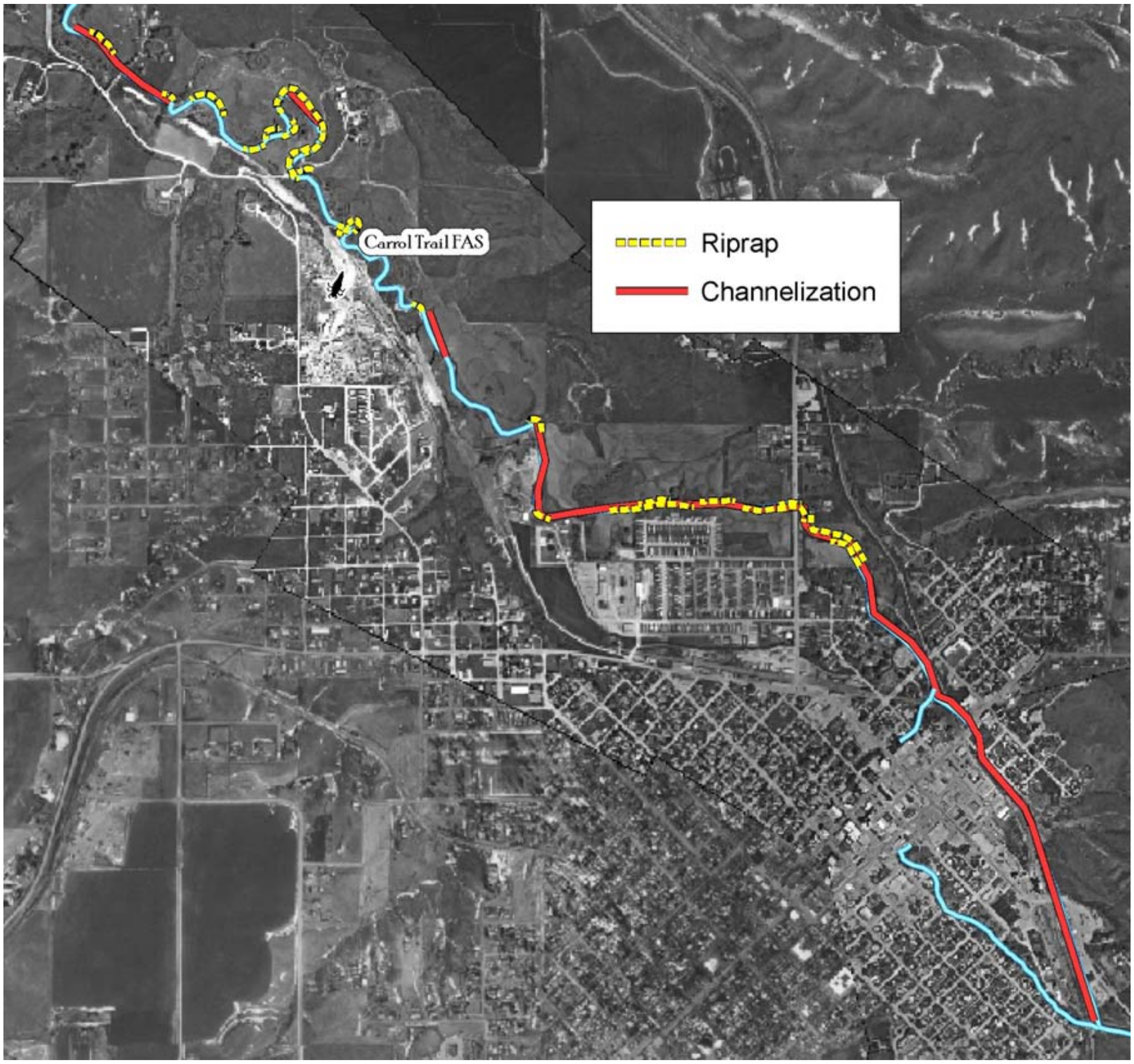

Figure 5-8. Riprap and Channelization Through and Downstream from Lewistown.

Figure 5-9. Bank Stabilization with Riprap.

Figure 5-10: Bank Stabilization with Native Vegetation.

In addition to natural and anthropogenic bank erosion discussed above, landslides and mass wasting may be a source of significant sediment inputs on lower Big Spring Creek. Hawn, (1990) identified areas experiencing mass wasting on lower Big Spring Creek (Figure 4-13), as did the assessment conducted by Land & Water Consulting. Where Big Spring Creek cuts into natural terrace deposits, potential for large sediment inputs exist. These inputs are considered part of the natural condition of Big Spring Creek and may contribute to naturally high sediment loads to lower Big Spring Creek during erosive high flows. Figure 5-11 shows an example of this condition.

Figure 5-11. Natural Erosion/Mass Wasting, Big Spring Creek Watershed.

5.1.2.3 Overland Flow

Overland sediment inputs (rill & sheet erosion) derived from land-use practices adjacent to Big Spring Creek can be a significant source of sediment. The potential for sediment delivery to Big Spring Creek is a function of land use type, topography/slope, soil type and the size and condition of vegetative buffer zones. While not specifically assessed through empirical means, modeling suggests that overland inputs are not significant in relation to bank erosion inputs (Appendix E).

5.1.2.4 Tributaries

Several tributaries contribute sediment loads to Big Spring Creek. Notable tributaries include Cottonwood Creek, Beaver Creek, Casino Creek, East Fork Big Spring Creek, and Burnette Creek. Several smaller tributaries also contribute sediment loads to Big Spring Creek (Map 7). In 1995 an aerial inventory by helicopter was conducted on the major tributary streams to Big Spring Creek (Hawn, 1997). The objective of the inventory was to characterize the condition of streams and riparian areas and to identify nonpoint pollution sources. Nonpoint pollutions sources identified included:

- **HU** - Heavy Livestock Use Areas
- **DA** - Disturbed/Active Erosion Sites
- **CS** -Channelized Areas
- **LA** - Recent Logged Areas (scour or gully erosion evident)
- **DS** - Degraded Streams (entrenched channel, stream bank erosion)
- **DR** - Degraded Riparian Areas (absence of or reduced shrub/tree community)
- **EA** - Other (housing development impact, car bodies, riprap)

Overall, nearly 50 miles of tributary streams and riparian areas exhibited degradation caused by nonpoint sources. Results of this survey are given in Table 5-5.

Table 5-5. Aerial Nonpoint Source Inventory Results (Hawn, 1997).

Stream	HU	DA	CS	LA	DS	DR	EA	Total
Beaver Creek	3,851	388	3,426	N/A	3,168	15,362	448	26,643
Middle Fork Beaver Creek	373	N/A	N/A	N/A	241	4,432	200	5,246
W Fork Beaver Creek	N/A	N/A	404	N/A	1,671	3,512	424	6,011
Middle Fork Big Spring Creek	3,589	3,098	N/A	4,006	2,367	7,791	323	21,174
E Fork Big Spring Creek	11,287	N/A	6,724	N/A	2,995	6,005	N/A	27,011
Buffalo Creek	419	N/A	5,231	N/A	N/A	N/A	N/A	5,650
Burnette Creek	3,921	5,572	1,203	N/A	370	6,079	N/A	17,145
Casino Creek	14,632	398	768	N/A	N/A	N/A	7,000	22,798
Little Casino Creek	805	N/A	N/A	N/A	N/A	N/A	N/A	805
Castle Creek	4,343	6,436	3,579	N/A	N/A	938	N/A	15,296
Cottonwood Creek	20,060	3,684	2,977	14,800	19,119	31,282	422	92,344
Half Moon Creek	8,959	N/A	N/A	N/A	N/A	N/A	N/A	8,959
Hansen Creek	N/A	2,107	N/A	N/A	N/A	N/A	N/A	2,107
Total (ft)	**72,239**	**21,683**	**24,312**	**18,806**	**29,931**	**75,401**	**8,817**	**251,189**

The results of the 1995 aerial survey reflect cumulative linear feet of riparian area affected by nonpoint pollution sources. Data does not allow an estimation of actual feet of streambank impacted, and so caution should be used when making interpretations. Considering methods employed to collect information and the objectives of the survey, information obtained from this survey should be considered a general screening-level assessment of tributary condition, and not suitable for sediment loading estimates.

Information derived from the survey was used by local NRCS staff to prioritize and implement restoration projects and conservation practices on impacted reaches. Since the date of the 1995 survey, improvements have been made on over 13 miles of streams and riparian areas, resulting in improvements to riparian health and reductions in nonpoint sources of pollution. A summary of feet of improved stream and resultant reductions in degraded areas is given in Table 5-6.

Table 5-6. Riparian and Channel Improvement Project Summary (NRCS Unpublished Data).

Stream	Cumulative Degradation (Table 5-5)	Improvement Projects Reduction	Total Degradation
Beaver Creek	26,643	12,220	**14,423**
Middle Fork Beaver Creek	5,246		**5,246**
W Fork Beaver Creek	6,011	3,000	**3,011**
Middle Fork Big Spring Creek	21,174		**21,174**
E Fork Big Spring Creek	27,011	18,585	**8,426**
Buffalo Creek	5,650		**5,650**
Burnette Creek	17,145	8,860	**8,285**
Casino Creek	22,798	3,000	**19,798**
Little Casino Creek	805		**805**
Castle Creek	15,296	13,060	**2,236**
Cottonwood Creek	92,344	14,250	**78,094**
Half Moon Creek	8,959		**8,959**
Hansen Creek	2,107		**2,107**
Total (ft)	**251,189**	**72,975**	**167,148**

While a sediment load calculation is not possible without more detailed field assessments, it is assumed that as cumulative degradation increases, the potential for increased sediment delivery to streams increases. Load allocations to tributaries in general are given in Section 5.1.3.

5.1.2.5 Roads and Road Crossings

Sediment loads associated with roads and road crossings can consist of sediments derived from disturbed or eroding areas adjacent to bridges and crossings and direct overland input washed from roads into waterways. In the 24-miles of Big Spring Creek downstream from Lewistown, 12 roads cross the creek. Upstream from Lewistown, there are approximately 20 crossings over a 9-mile stretch. Visual observation of several crossings did not identify significant sediment sources. While it appears that roads and road crossings to not appear to be a significant source of sediment to Big Spring Creek, further ground truthing and assessment to estimate potential sediment loads related to roads and crossings is recommended.

5.1.2.6 Forest Harvest and Logging

Logging on private and public lands in the Big Spring Creek Watershed is not thought to be a significant influence on water quality conditions. The most recent harvest on National Forest Service lands was in the 1940’s (Steve Martin, USFS, personal communication 2004), allowing ample time for regeneration and healing of historical logging impacts. The 1995 Aerial Assessment conducted by Hawn (1997) identified areas of recent logging on private lands. Streams that had identifiable areas of timber harvest were Middle Fork Big Spring Creek and Cottonwood Creek (Table 5-5). The influence of these areas on water quality has not been assessed, nor has the extent and type of logging been verified by field assessments. However, due to the limited extent of harvest and the lack of noticeable in-stream impacts, it appears that impacts to water quality are not significant.

5.1.2.7 Urban Sources

Big Spring Creek flows through the city of Lewistown picking up nonpoint source sediment from industrial, residential, and commercial sources (Figure 5-11). A stream reach assessment conducted by OEA Research in 1990 identified the this portion of Big Spring Creek as having a 'very high' potential for impacts from a variety of nonpoint pollution sources. While less extensive in geographical distribution, sediment yields from urban or developed areas are greater per acre than those from forested or agricultural lands (Waters, 1995). Storm water runoff from streets, construction sites, parking lots, or other impervious or disturbed areas can be a significant source of sediment if proper controls are not in place.

The total suspended solid load from **storm water runoff** through Lewistown was computed using a simple storm water model. Storm water load is the cumulative TSS load that enters storm water collection drains and is discharged to Big Spring Creek. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

Annual runoff was calculated as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P * P_j * Rv$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

Load ranges were calculated by using a median concentration value of 242 mg/l, representing arid and semi-arid watersheds (Caraco, 2000) and a median concentration value of 55mg/l, based on a comprehensive study of storm water concentrations nationwide (Smullen and Cave, 1998). Results of the loading calculation are shown in Table 5-7.

Table 5-7. Annual Total Suspended Solids (TSS) Storm Water Loads to Big Spring Creek.

	Maximum Annual Load	Minimum Annual Load
Annual Residential TSS Load	197,049	44,784
Annual Commercial TSS Load	66,794	15,180
Annual Industrial TSS Load	12,847	2,920
Annual Roadway TSS Load	5,685	1,292
Total Annual Storm water Load (lbs/yr)	**282,375**	**64,176**

Stormwater loads should be considered with caution, as they are based on regional values from literature and not actual stormwater monitoring. Given the high level of uncertainty in calculated loading values, stormwater monitoring and assessments are recommended in order to reduce uncertainty associated with urban stormwater loads (Section 5.1.5).

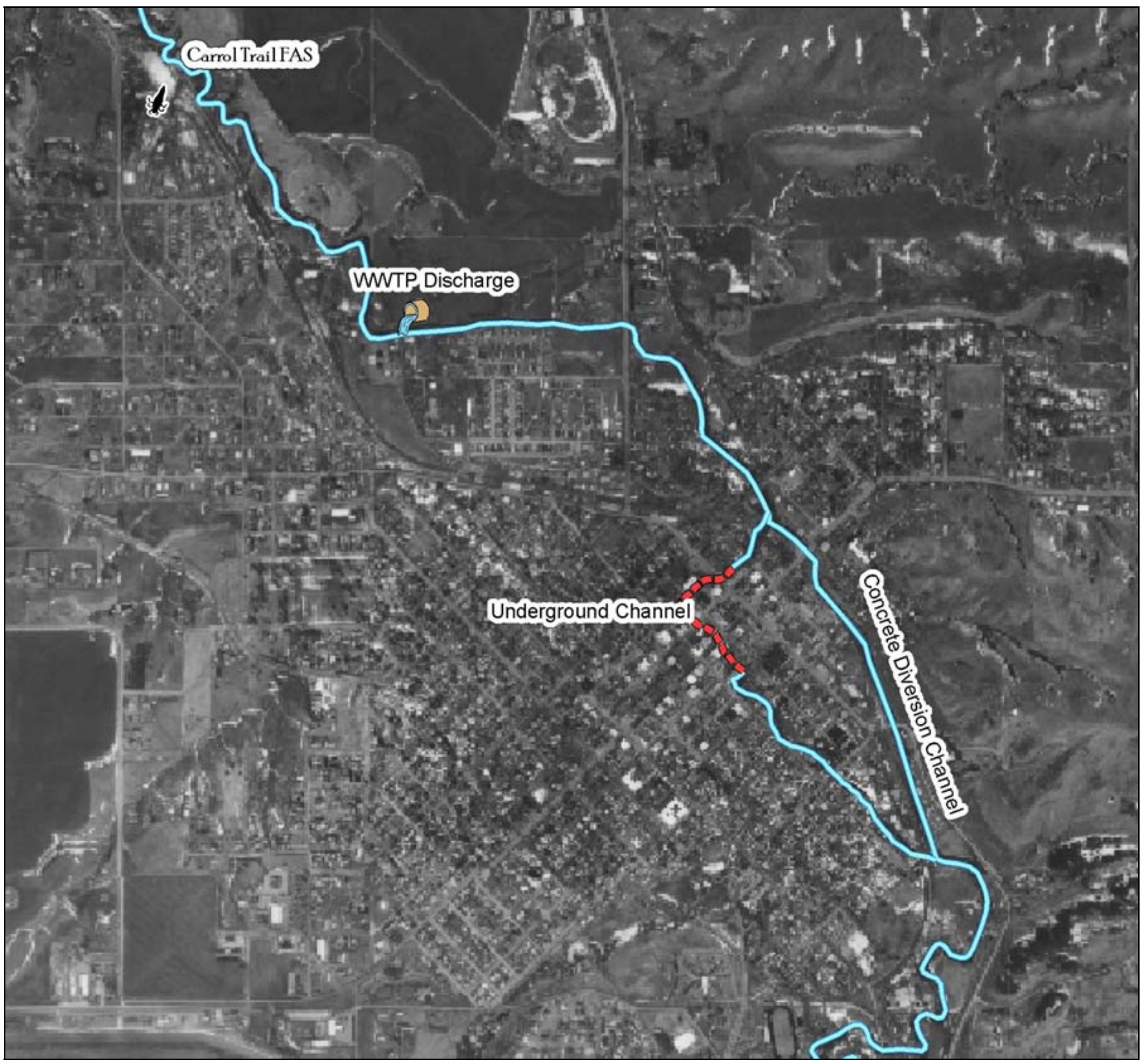

Figure 5-12. Big Spring Creek Routed Through Lewistown.

5.1.2.8 Lewistown Wastewater Treatment Plant

The Lewistown wastewater treatment plant (WWTP) discharges into Big Spring Creek between the city of Lewistown and the Carroll Trail FAS (Figure 5-12). Total suspended solids (TSS) concentrations are measured daily and submitted to the Montana DEQ in Discharge Monitoring Reports (DMR). TSS is reported as an average concentration (mg/l) and as a load (lbs/day). For calendar years 1996 through 2000, the average annual effluent TSS load to Big Spring Creek was **55,785 lbs/yr** (DEQ DMR data).

5.1.2.9 Sediment Modeling

As a means of comparison to assessment data and information, sediment loads from natural and anthropogenic sources were modeled by the DEQ using a STEPL model. Appendix E provides the results of this modeling exercise. Modeling results are based on a series of general assumptions and cannot be relied on to generate accurate sediment loading numbers. Rather, modeling results were used to determine the relative significance of overland flow sources to bank erosion sources. Modeling results suggest that overland flow sources are not significant in comparison to bank erosion sources.

5.1.2.10 Source Assessment Summary

The most significant influences on sediment impairment conditions in Big Spring Creek appear to **be flow alteration**, **bank erosion**, **tributary inputs,** and **urban nonpoint sediment sources**. It is expected that reduction in sediment loads from bank erosion, tributaries and urban nonpoint sources will result in achieving water quality targets, provided Big Spring Creek has the competency to transport sediment effectively. Allocations to these source categories are further discussed in Section 5.1.3.

5.1.2.11 Source Assessment - Adaptive Management and Uncertainty

Sediment source assessments were conducted using a variety of data types and methods. Due to the nature and age of the available data, uncertainty in the conclusions drawn regarding the significance or relative contribution of sediment source categories is acknowledged. Due to inherent uncertainties, flexibility to adjust sediment-loading estimates based on inferences drawn from limited data is principal to adaptive management. It is expected that, as additional data and information becomes available, inferences and assumptions will be revisited and reevaluated. Relevant uncertainties associated with selected source categories are addressed below.

Flow-Related Uncertainties

Ash street bridge data is incomplete for flow years 1979-1993, and therefore may not reflect the full range of flow conditions for these years. While it appears that peak flows are not common, this conclusion may be the result of incomplete flow data. Also, because pre-reservoir flow data through Lewistown does not exist, it is not possible to compare the range of natural flow conditions on Big Spring Creek to post-reservoir flow conditions.

Also, uncertainty regarding the accuracy of the Ash Street flow data is an issue. Data does not exist regarding the calibration of the staff gauge; so recorded flows may not reflect actual in-stream flows. Streamflow data collected by the DEQ downstream of the Ash Street site, and above Carroll Trail record a difference in nearly 20 cfs. It is unknown whether theses discrepancies are due to irrigation withdrawals, groundwater losses, or errors in measurement or calibration. Understanding flow conditions on Big Spring Creek is integral to developing appropriate prescriptions for both sediment and nutrients; additional flow monitoring is recommended and addressed in Section 5.1.5.

Bank-Erosion Uncertainties

Estimates of bank erosion were conducted by Hawn (1990) and by Land & Water Consulting (2003). Bank erosion inventories by Hawn were conducted on the ground and likely to be a better reflection of bank erosion conditions than the Land & Water aerial assessment. The aerial assessment conducted by L&W, however, assessed riparian vegetation condition, and this information was used to correlate to bank erosion and bank instability information. The result was a strong correlation between riparian degradation and unstable/severely eroding banks (Figure 5-7). This correlation provides justification for performance-based allocations and implementation measures.

Both assessments were based on stream conditions in 1989. Since 1989, considerable effort has been made through agency (NRCS, DEQ, FWP) collaboration with the Big Springs Watershed Partnership, Fergus County Conservation District, and local landowners to enhance and improve riparian and channel condition on Big Spring Creek. Consequently, assessments conducted based on 1989 conditions may not reflect present conditions. Because of the uncertainties surrounding bank erosion estimates, a numeric load for eroding banks is not attempted. In lieu of a numeric load allocation to eroding banks, a performance-based allocation to eroding banks is presented (Section 5.1.3.2). Performance-based approaches are appropriate where data precludes a numeric load allocation, and implicitly accommodate for a margin of safety.

Overland Flow Uncertainties

Overland flow and upland inputs are estimated using a model. A STEPL model was used to estimate inputs from rill and interill erosion. Because these estimates are not based on empirical data, caution should be used when interpreting the results. Comparison of *relative* levels of sediment input from modeled sources does, however, provide confirmation of the relative significance of specific sources.

Urban Source Uncertainties

The large range of TSS load estimated from a simple storm water model (Section 5.1.2.6) underscores the level of uncertainty in estimating sediment loads from urban sources. Development and implementation of a monitoring strategy (Section 5.1.4) to gather storm water and urban nonpoint source data will greatly reduce this uncertainty and allow for accurate estimates of storm water loads entering Big Spring Creek.

Additional Source Assessment Uncertainties

It is recognized that not all potential sources of sediment have been fully identified and assessed. In addition to the major source categories addressed in Section 5.1.2, smaller local sources of sediment input to Big spring Creek are likely to exist. The cumulative effects of smaller sources may be significant at certain times of year, however the cumulative impact of potential smaller sources cannot be assessed without a more detailed source assessment effort. Potential sources that may contribute significant sediment to Big spring Creek include but are not limited to:

- An abandoned industrial site (Berg Lumber) immediately upstream from Carroll Trail FAS
- Streamside agricultural operations
- Residential land clearing and/or bank instability

Assessing and mitigating these additional sources of sediment should be done with the cooperation of local landowners, city officials, and resource professionals.

5.1.3 Total Maximum Daily Loads and Allocations

The Clean Water Act requires States to identify waters not meeting water quality standards and to develop a plan that when implemented, will result in achievement of water quality standards. The framework for these plans is the Total Maximum Daily Load (TMDL) program. A TMDL is essentially a prescription designed to restore the health of the polluted body of water by indicating the amount of pollutants that may be present in the water and still meet water quality standards. The restoration targets presented in Section 5.1.1 provide the endpoint water quality goal. The TMDL provides a quantification of the means to achieve this goal.

While sediment from waste loads and storm water loads can be quantified, available data on bank erosion, overland inputs tributary inputs and roads does not easily facilitate a quantifiable load, and therefore does not allow the specific allocation of sediment loads to these sources. Evidence, however, suggests that flow alteration, bank erosion, tributary inputs and urban sediment sources have the greatest influence on sediment-related impairment conditions in Big Spring Creek. Allocations will be based on controlling or managing these sources because they:

1) Appear to pose the greatest threat to Big Spring Creek
2) Are known, based on the literature, to be significant sources and influences on sediment
3) Are controllable with respect to current efforts and resources

Because type and quality of data preclude calculation of a numeric (lbs/day) Total Maximum Daily Load for sediment, TMDLs will be achieved through a combination of load reductions, performance based allocations and flow management strategies. The cumulative result of implementing all performance-based allocations and reductions will result in meeting the TMDL, and achieving water quality standards. The EPA recognizes that quantification of all sediment loads may not be possible, and endorses the use of performance-based allocations, providing proper rationale that prescribed actions are expected to be adequate to achieve necessary load reductions (EPA, 1999). A summary of allocations is given in Table 5-8.

5.1.3.1 Flow Allocation

In regulated stream systems, particularly systems downstream of dams, there exists an option to manage stream flows in order to enhance biological condition and maintain a desired channel condition. Channel maintenance or 'flushing flow' operations involve a programmed release of a predetermined discharge over a specified duration of time. Flushing flows may be employed to meet a variety of interrelated management goals: removal of fine sediment from surface substrate, scouring of pool habitats, cleaning and sorting of spawning gravels, and basic channel maintenance are among some of the major reasons cited (Resier, et al., 1990).

There is no standard methodology used to develop proper flushing flow requirements. Rather, an appropriate approach must be tailored to the specific needs and characteristics of Big Spring Creek. Reiser, et al. (1990) describes 16 methods for establishing flushing flow recommendations.

Habitat benefits and substrate cleansing were observed benefits from a recent, yet uncommon, flushing event on Big Spring Creek in March, 2003 that was estimated at ~600 cfs (Tews, personal communication, 2003). While it is premature to recommend a specific flushing flow requirement without further analysis and information, the importance of natural flow regime to provide proper sediment transport, channel maintenance, and habitat values cannot be understated. Consequently, **a load allocation, undetermined at present, is made to flow**. One focused objective of determining appropriate flushing flows shall be to increase stream competency to effectively clean substrate gravels of fine sediment and transport the sediment through the system.

5.1.3.2 Bank Erosion Allocation

Reaches of Big Spring Creek are subject to significant bank erosion, both natural and anthropogenic. Anthropogenic bank erosion is correlated to removal or degradation of natural riparian vegetation (Figure 5-6), however, livestock use of riparian areas, while not specifically assessed, is may contribute to bank erosion conditions through bank trampling and damage to woody plants. Because available data precludes calculation of a numeric sediment load from eroding banks, a **performance-based allocation to eroding banks is given**.

Best Management Practices for grazing and agriculture are designed to protect stream banks against erosion by employing management techniques that maintain stabilizing stream bank vegetation and buffer zones. BMP techniques involve adopting management plans: maintaining woody streambank vegetation and buffer zones, developing off-stream watering projects, adjusting timing and use by livestock, controlling distribution and access of livestock (BLM, 1998) or other management options designed to protect and promote riparian health. Because areas experiencing bank erosion and instability are predominantly in areas of agricultural land uses, it is thought the implementation of BMPs will effectively reduce bank erosion levels resultant from riparian degradation and livestock utilization. In addition, implementation of BMPs will reduce potential overland flow inputs. Ongoing efforts through FWP, NRCS, and the Fergus County Conservation District (Tables 4-3 and 5-6) have already resulted in significant improvements to riparian areas along Big Spring Creek. Continuing these efforts to ensure that "reasonable land, soil and water conservation practices" are emplaced will result in healthy riparian areas capable of maintaining bank stability and resistance to bank erosion, and thereby reduce sediment loads from eroding banks to levels that approximate natural conditions.

By reducing eroding stream banks to levels identified as 'lightly impacted' it is assumed that sediment loads from eroding banks will be reduced to levels that, in combination with other allocations, will result in achievement of water quality targets. Based on summaries presented in Figure 5-6, anthropogenic eroding banks and unstable banks on middle and lower Big Spring Creek should cumulatively be less than 20% for any specific reach in order to achieve a 'lightly impacted' condition.

5.1.3.3 Tributary Allocation

Because data does not allow a calculation of sediment loading from tributary sources, a numeric allocation to sediment is not possible. Given the variety of nonpoint source impacts and the uncertainty in measuring the extent and degree of impact to the stream channel, it is premature to assign allocation measures to tributaries at this time. More detailed assessments should be conducted on tributaries to determine the extent to which different nonpoint source categories contribute sediment loads to Big Spring Creek. Basic inferences may be drawn from the information presented in Table 5-5; however, linkages between loads and sources cannot be derived from the data.

At this time no allocation is made to tributaries. Rather, a phased allocation is recommended. Tributaries should be assessed to a level of detail that allows linkages between known sources and potential loads from these identified sources.

5.1.3.4 Urban Allocation

Section 5.1.2.7 estimates the sediment load coming from storm water runoff through the city of Lewistown at between 64,000 and 282,000 lbs/yr. While this load may not be significant compared to the total potential load from stream bank and tributary sources, it can be significant when one considers the limited area from which it originates. Given the uncertainty in the loading estimate and lack of storm water monitoring data, a specific numeric load reduction to urban storm water is not warranted until stormwater monitoring can more accurately define sediment loads. In lieu of specific sediment load reductions, a percent reduction in present storm water loads is presented herein.

Studies have shown that up to 80% of total suspended solids loads in storm water runoff are from streets and parking lots (Bannerman et al., 1993). Considering the potential impact to Big Spring Creek from storm water sediment loads and the ability to manage these loads through best management practices and community involvement, a **60% reduction in TSS loads is given as an allocation to storm water and urban nonpoint sources.**

5.1.3.5 Allocation Summary

Table 5-8. Sediment Load Allocations for Big Spring Creek.

Source	Allocation Type	Allocation
Flow	Performance based	Flushing flow: discharge, timing, and duration to be determined.
Bank Erosion	Performance based	<20% eroding and unstable banks on middle and lower Big Spring Creek.
Tributaries	No allocation at this time	Phased allocation. Further source assessments are required.
Urban Storm Water & NPS Runoff	Percent reduction	60% reduction in TSS loads from storm water and urban NPS sources.

5.1.3.6 TMDLs and Allocations - Adaptive Management, Uncertainty and Margin of Safety

Available data does not allow the calculation of numeric total maximum daily loads and allocations. In lieu of numeric TMDLs and allocations, an approach that incorporates a variety of performance-based measures, flow management strategies and percent load reductions is used. Based on present knowledge of conditions and processes affecting impairment, it is expected that when all recommended reductions are met and performance-based allocations are achieved, Big Spring Creek will meet water quality targets.

However, **uncertainty** is inherent when developing allocation schemes. Understanding and developing appropriate allocation schemes requires an **adaptive management** approach that allows for adjustment as uncertainty is reduced. As additional information and data becomes available, adjustments to performance-base measures or load reductions may be warranted and should be considered. Consequently, performance-based allocation schemes should not be considered a static, rigid endpoint, but a flexible guideline that is apt to change as additional information is assessed and evaluated.

Likewise, applying a margin of safety is a required component of TMDL development. The **margin of safety (MOS)** accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (EPA, 1999). Where performance-based allocations are employed, an explicit reservation of loading capacity as a margin of safety is unnecessary: **margins of safety are implicit in performance-based allocations**. Adaptive management, uncertainty, and applicable margin of safety considerations for each allocation are addressed below.

Flow

Because there is no standard methodology for determining flushing flow requirements, considerable thought must be given to deriving appropriate and effective flushing flow requirements. Prior to designing the timing, magnitude, and duration of a flushing flow prescription, planning must be conducted to establish and define objectives. Specific considerations include: habitat requirements of desired aquatic communities, hydraulic parameters necessary for channel maintenance, maintenance of existing land uses and private property values. In addition, resources available to implement flushing flow operations, and roles and responsibilities of local municipalities, natural resource management agencies, and community members must be addressed to ensure that proper, effective, and beneficial flushing flow recommendations are made. It is for these reasons a specific flow recommendation is not made at this time.

To reduce uncertainty and allow for adaptive management of flow prescriptions, the following recommendations are given (Resier, et al., 1990):

- Clear and measurable flushing flow objectives and proper flow requirements should be developed through a disciplinary team involving a hydraulic engineer, hydrologist, fisheries biologist, appropriate individuals from local and state resource management agencies (NRCS, FWP, DNRC, DEQ, FCCD) and representatives from city government and the community of Lewistown.
- Flows and objectives should be tailored specifically to Big Spring Creek.
- As a means of comparison, use a variety of methods to derive flushing flow recommendations.
- Follow-up investigations should be conducted to evaluate the effectiveness of flows in meeting the project objectives. Follow-up investigations should include monitoring and analysis of the benefits and potential costs of flushing flows.

An appropriate margin of safety for flushing flow prescriptions is implicit in the above recommendation and will be considered when specific flow requirements are developed. Seasonality will also be considered when establishing the timing and duration of flows.

Bank Erosion

The performance-based allocation to bank erosion is based on the established link between bank stability and stream bank vegetation. Because nearly all of the land adjoining Big Spring Creek is privately owned, it is understood that considerable effort must be put forth to work with landowners to implement projects that will result in attainment of performance-based allocations. Evaluation of the success of BMPs to reduce bank erosion levels to ‘lightly impacted’ conditions must be conducted to ensure that BMPs are effective and are being maintained. As information on types of BMPs enacted and corresponding water quality improvements becomes available, the effectiveness of implementation efforts will be evaluated and necessary adjustments to allocation schemes can be made.

Urban Sources

An allocation of 60% reduction is given to urban stormwater and nonpoint sources. Unknown at present is the actual sediment load entering Big Spring Creek from these sources. Also unknown are the extent to which BMPs are already emplaced, by both municipalities and by the public in general. The allocation is based on the assumption that the sediment load entering Big Spring Creek from urban contributes in part to siltation conditions observed downstream from Lewistown, and that further stormwater controls and BMPs can reduce this input. To reduce this level of uncertainty, monitoring and assessment of urban sources (Section 5.1.5) is necessary. As new data and information regarding stormwater loads and the effectiveness of present and proposed BMPs becomes available, adjustments to allocations may be made.

5.1.4 Restoration and Implementation Strategy

Building and maintaining relationships between landowners and local natural resource agencies (FWP, NRCS) is integral to on-the-ground efforts to restore Big Spring Creek to an unimpaired state. To date, local agencies and organizations such as NRCS, FWP, Fergus County Conservation District, and the Big Spring Creek Watershed Partnership have succeeded in developing and implementing a variety of projects (Table 4-3 and 5-6) that have enhanced riparian health through BMP implementation and fisheries improvement projects. The success of the public/private partnership is realized through these efforts, and the continuation of these efforts is crucial and should be the major mechanism for implementing projects aimed at restoring beneficial uses in Big Spring Creek.

Restoration objectives should focus on the three major influences/sources on sediment impairment conditions: flow, riparian health, and the urban environment. Recommendations for each are given below.

Flow

As outlined in Section 5.1.3, managing reservoirs upstream of Lewistown in order to provide a seasonal flushing flow is recommended. A cadre of local natural resource professionals, city officials, and community organizations should develop flushing flow requirements. Without further studies, specific flow prescriptions at this time would be premature.

Riparian Health

Key to reducing bank erosion and overland flow inputs is the establishment of natural woody riparian vegetation. Vegetation can increase bank stability, protect banks against high flows, filter and capture overland flow inputs, and provide habitat for fish and aquatic insects. Restoration objectives should focus on reducing bank erosion and instability by reestablishment of streamside vegetation through private/public partnerships and assistance from local and state agencies.

Urban Sources

Controlling stormwater and nonpoint source pollutants through the city of Lewistown can influence water quality conditions through and immediately downstream of Lewistown. Sediment from streets and parking lots may be a significant source of pollutants to Big Spring Creek. Likewise, disturbed areas such as construction sites and areas of bare ground may contribute significant sediment loads to Big Spring Creek. Programs that remove these sources or prevent their conveyance to surface waters can result in substantial reductions in sediment loading from storm water. BMPs are effective at reducing stormwater suspended sediment loads to surface waters. Properly implemented, simple BMPs can result in a greater than 60% reduction in Total Suspended Solids loads (EPA, 1993c). Applicable BMPs may include: constructing detention basins, vegetated filter strips, street and parking lot sweeping, or other measures proven to reduce pollutant loading to streams. In addition to BMPs, the EPA recommends six minimum control measures designed to significantly reduce pollutants discharged to receiving waters.

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post-Construction Runoff Control
- Pollution Prevention/Good Housekeeping

Restoration strategies for reducing urban pollutant loading should include implementing BMPs, where appropriate, and developing a public information and education (I&E) strategy to raise community awareness of commercial and residential pollutant sources. Public outreach activities should be conducted in coordination with local watershed groups, municipalities and local state and federal agencies. Adoption and enforcement of strong erosion control laws (ordinances) at the local level can also help in both raising awareness and reducing urban pollutant inputs to Big Spring Creek.

In addition to the above recommendations, efforts should also be made **to increasing sinuosity** in channelized segments and to **discourage the use of riprap** as a bank stabilizer. Both channelization and riprap can act to increase stream velocities and therefore exacerbate stream headcutting and erosion, affecting segments both upstream and downstream of the altered segment.

5.1.5 Monitoring and Assessment Strategy

Monitoring and assessment will assist in evaluating the success of implementation projects and restoration efforts. Assessments will also gather information to provide a baseline from which to evaluate present departure from target conditions, and provide a means to assess progress toward meeting targets. The following discussion is intended to be conceptual. It is envisioned that the first step in the implementation of this monitoring and assessment strategy will be the development of a detailed work plan and sampling and analysis plan.

Monitoring and assessment goals include:

1. Monitoring to evaluate targets and target attainment
2. Conducting further assessments of sediment sources
3. Evaluation of BMP implementation and its effectiveness at meeting target conditions.

5.1.5.1 Target Evaluation

Continued monitoring of macroinvertebrates and periphyton at established biomonitoring sites (Burleigh Easement, Carroll Trail, Hruska FAS, Spring Creek Colony) is recommended so that trends and progress toward targets can be evaluated. It is also recommended that an additional monitoring site upstream from town, but outside the 'urban influence' be established so that comparisons between this site and the Carroll Trail FAS site may better define the impact from urban sources. It is recommended that Wolman Pebble Counts also be collected at these sites to track percent surface fines <20%. Sampling at these sites should be conducted once per year in late summer (July-Sept).

5.1.5.2 Sediment Sources

Further assessment of sediment sources should be conducted in order to reduce uncertainty and assist in refinement of restorative priorities and strategies.

Development of an effective **flushing flow** prescription will require considerable analysis and will undoubtedly require monitoring and measurement of hydraulic parameters. A monitoring and assessment strategy will be developed in order to gather data necessary to define appropriate flow requirements and to assess its effectiveness once flow management recommendations are enacted.

Roads and road crossings should be more thoroughly assessed. While it is not expected that roads and crossings contribute significant sediment loads relative to other sources, as a minimum, a qualitative assessment of roads and crossings should be conducted to confirm this assumption.

A **stream channel inventory** should be conducted. Bank erosion and riparian health conditions discussed in Sections 5.1.2.2 and 5.1.2.4 are based on aerial photography from 1989 and 1995. Since this time, significant improvements in stream channel condition and riparian vegetation have occurred as a result of local improvement efforts. It is recommended that aerial photography be taken and on-the-ground stream channel and riparian assessments be conducted in order to better determine existing conditions, and to document riparian improvement.

Urban sources include stormwater discharges and nonpoint source inputs to Big Spring Creek through the city of Lewistown. A monitoring and assessment strategy to evaluate urban sources should include:

- Monitoring of stormwater discharges to determine event mean concentrations (EMC) for TSS at a variety of locations.

- Inventorying all major urban nonpoint pollutant sources.
- Inventorying present private, public, and municipal stormwater BMPs.
- Establishment of additional monitoring sites to ascertain the extent to which urban sources contribute to pollutant loads to Big Spring Creek.

The above information will allow a more accurate calculation of urban NPS and stormwater sediment loads to Big Spring Creek. An inventory of existing BMPs, in conjunction with event mean concentration (EMC) data, will assist in identifying possible areas for load reductions and can help to prioritize the type and location of BMPs that will be most effective at reducing sediment loads.

Because observed in-stream impacts downstream from Lewistown are likely a result of the cumulative influence of tributary inputs, urban inputs and residential/streamside inputs, and geomorphic disturbance, establishing monitoring stations and sampling plans to determine the relative contribution of each source category (tributaries, urban, residential, geomorphic) is necessary in order to develop effective strategies to reduce sediment loads to Big Spring Creek. Specific sampling locations and sampling and analysis plans (SAPs) should be developed through consultation and coordination with the DEQ.

5.1.5.3 BMP Implementation and Effectiveness

Monitoring of BMPs is necessary to evaluate whether restoration activity results in achieving allocations and whether allocations result in attainment of water quality targets. Plans to evaluate BMP compliance and effectiveness for both grazing/agriculture and stormwater should be developed to compliment and correlate with data from target evaluation and attainment.

5.1.6 Seasonality Considerations

Addressing seasonal variations is an important and required component of TMDL development. Throughout this plan, seasonality is an integral factor. Water quality and habitat parameters such as flow, fine sediment, and macroinvertebrate and periphyton communities are all recognized to have seasonal cycles.

Specific examples of how seasonality has been addressed include:

- Targets where developed with seasonality in mind: the % fine sediment target data is collected in the summer, after the flushing flows have passed; macroinvertebrate and periphyton targets and supplemental indicator data is collected during the summer months when these biological communities most accurately reflect stream conditions.
- Detailed monitoring strategies shall be designed with seasonal considerations in mind, and under the guidance of trained monitoring professionals.
- Sediment modeling of sediment loading inherently incorporates runoff flows when erosion is greatest.
- Flushing flow recommendations recognize the need to mimic seasonal flow regimes.
- Throughout this document, the data reviewed cover a wide range of seasons, years, and geographic area within the Big Spring TPA.

SECTION 6.0
PCB

The following section provides information regarding PCB impairment conditions in the Big Spring TMDL Planning Area: data supporting impairment determinations, sources and processes affecting impairment, desired target conditions, and prescriptive strategies to restore affected waterbodies to full beneficial use support.

6.1 About PCBs

Polychlorinated Biphenyls (PCBs) are a family of synthetic organic compounds formed by the addition of chlorine (Cl_2) to biphenyl ($C_{12}H_{10}$), a double ring structure comprised of two Benzene rings linked by a single carbon-carbon bond (Figure 6-1). The nature of the double-benzene ring structure allows bonding of a single chlorine atom to any of the free carbon atoms that make up the ring, thus allowing ten possible positions (2, 3, 4, 5, 6, 2', 3', 4', 5', 6') for attachment of a single chlorine (Cl) atom. Consequently, up to ten chlorine atoms may be bonded to the biphenyl in a variety of configurations.

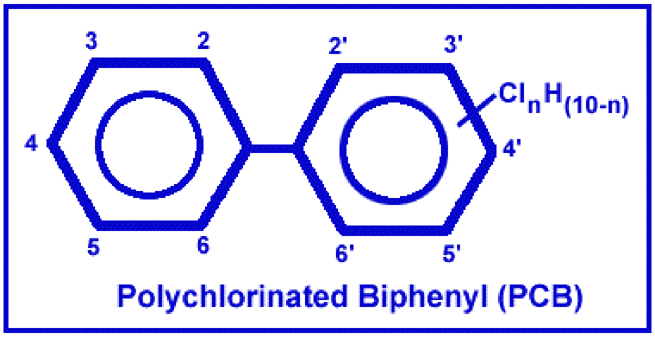

Figure 6-1. PCB Molecular Structure.

Any unique configuration of chlorine atoms bonded to a biphenyl is called a "congener," and specifies the number of chlorine placements and the position of each placement. For example, the congener, 4,4'-Dichlorobiphenyl, is comprised of the biphenyl structure with two chlorine substituents located at the 4 and 4' positions of the two rings. In all, 209 congener combinations are possible.

Commonly, PCBs were manufactured as a *mixture* of congeners, the endpoint being a target percentage of chlorine by weight for each mixture. These PCB mixtures were manufactured and sold under a variety of names. Most common, however, were the 'Aroclor series' in which a numeric identifier included the percentage of chlorine present in the mixture (e.g. 'Aroclor 1254' contains 54% chlorine). Due to their chemical stability, insulating properties and non-flammability, Aroclor's were used in a variety of industrial and commercial applications: electrical, heat transfer, hydraulic equipment, plasticizers in paints, plastics and rubber products, in pigments, dyes and carbonless copy paper and other applications.

The same properties that make PCBs useful in industrial applications enable PCBs to persist in the environment for long periods of time. Concern over the toxicity and persistence in the environment of PCBs led Congress in 1976 to enact §6(e) of the *Toxic Substances Control Act* (TSCA) that included prohibitions on the manufacture, processing, and distribution of PCBs. Of the greater than 1.2 billion pounds of PCB purchased by US industry prior to cessation of production in 1977, it is estimated that ~36% reside in landfills, dumps or are dispersed throughout the environment: 60% remain in transformers and capacitors and 4% have been destroyed by incineration.

PCBs have been demonstrated to cause a variety of adverse health effects. PCBs have been shown to cause cancer in addition to a number of serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, endocrine system and other health effects. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs. The different health effects of PCBs may be interrelated, as alterations in one system may have significant implications for the other systems of the body.

PCBs are highly lipophilic and tend to accumulate in the fatty tissue of aquatic organisms and are biomagnified through the aquatic food chain. "Concentrations of PCBs in aquatic organisms may be 2,000 to more than a million times higher than the concentrations found in the surrounding waters, with species at the top of the food chain having the highest concentrations" (EPA, 1999). Bioaccumulation of PCBs poses a human health threat with respect to fish consumption, and advisories are issued by the *Montana Department of Public Health and Human Services* (DPHHS) when PCB concentrations in sport fish exceed 0.025 ppm.

6.2 Existing Conditions and Source Assessment

Within the Big Spring Creek TMDL Planning Area, Big Spring Creek is presently listed for PCB impairment. A variety of data and information was considered in making PCB impairment decisions. These include:

- Fish tissue concentrations and fish consumption advisories
- Stream substrate/sediment concentrations
- Field observations

Big Spring Creek (MT41S004_020), from the East Fork confluence to the mouth, was first listed for PCB impairment on the 2000 303(d) list based on substrate/sediment data and fish tissue concentrations. There was no change in listing status on the 2002 303(d) list. Based on recent sediment and fish tissue data collected by both the Montana Department of Environmental Quality (DEQ) and Montana Department of Fish, Wildlife and Parks (FWP), Big Spring Creek (MT41S004_010) from the headwaters at the Big Springs Trout Hatchery to the East Fork confluence was found to be impaired due to PCBs. The 2004 303(d) list reflects this change in PCB impairment status for Big Spring Creek (MT41S004_010). TMDLs have been prepared for both segments, MT41S004_020 and MT41S004_020.

6.2.1 Historical Condition and Source Assessment

PCBs were first detected in fish tissue from feral fish collected below Lewistown in 1981. Since initial detection of PCBs in fish tissue, considerable investigation to ascertain the source and distribution of PCBs in the Big Spring Creek watershed has been conducted by a variety of individuals and agencies: DEQ, FWP, Fergus County Conservation District (FCCD), Montana Bureau of Mines and Geology (BMG), U.S. Environmental Protection Agency (EPA), private citizens, school groups. Recent (2003) efforts to locate the source of PCB have led investigators upstream to the Big Springs Trout Hatchery where marine paints, applied to hatchery raceways in the 1960s and 1970s, are thought to be the source of PCB contamination in Big Spring Creek. The following synopsis of activity from 1981 to date describes data collection and assessments conducted by multiple efforts.

In 1981, fish tissue sampling in Big Spring Creek downstream of Lewistown detected PCBs in rainbow trout. Two trout were sampled yielding PCB levels of 0.08 and 0.07 ppm. These levels were well below the U.S. Food and Drug Administration (FDA) recommended action level of 3.0 ppm. Fish tissue sampling was conducted again in 1986 (near Mill Ditch), 1992 (below Lewistown) and 1998 (Brewery Flats). The PCB mixture, Aroclor 1254, was detected in all fish sampled.

Levels of PCBs found in fish tissue prompted several efforts to identify the source of the PCBs. In October of 1996, FWP sampled sediments in Big Spring Creek at three locations, Burleigh FAS (Fishing Access Site), Brewery Flats and near Highway 200. PCBs were detected at each location. In 1997, Isaac Opper, a concerned local youth aided by Montana Bureau of Mines and Geology, sampled stream sediment at 13 sites along a 10-mile length of Big Spring Creek centered around the Brewery Flats area. Brewery Flats is upstream from Lewistown and was used as an industrial site for nearly one hundred years. Historically, Brewery Flats served as a rail yard, feedlot, brewery, oil refinery, and loading station for nearby coalmines (Figure 6-2). Results of Isaac’s sampling showed four of the 13 sites had positive PCB (Aroclor, 1254) detections ranging from 0.0193 to 0.052 ppm. The positive PCB results came from a stretch of Big Spring Creek between the southern boundaries of the Brewery Flats Fishing Access to just upstream of Lewistown.

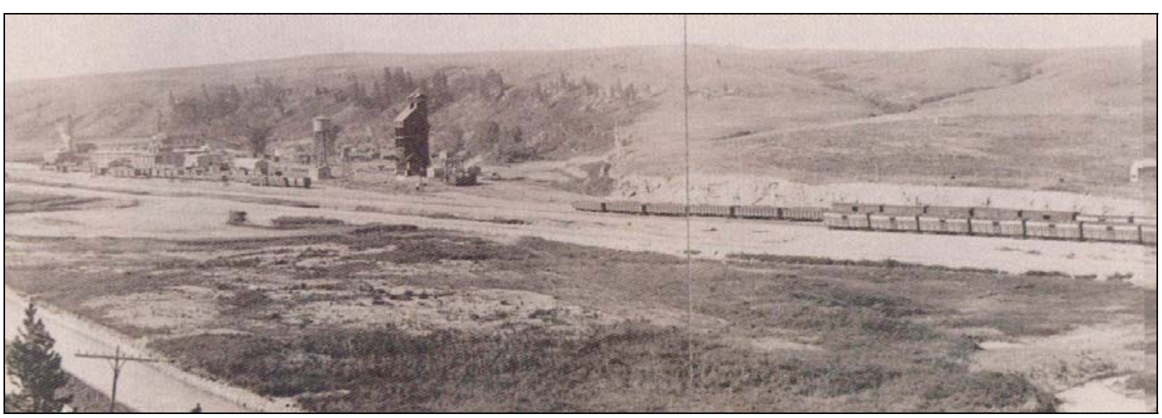

Figure 6-2. Brewery Flats in the Early 1900’s.

Based on the positive sediment sample results, DEQ led four sampling events in early 1998 (Jan., Mar., Apr., May), aimed at collection of stream substrate samples in the Brewery Flats area. The upstream boundary of the sampling was the southern boundary of the Brewery Flats Fishing Access. The sampled reach covered approximately 2,900 feet of stream channel. Thirty-five samples were collected over the four field visits. All had detectable PCB (Aroclor, 1254) ranging from 0.0025 to 0.221 ppm. During the same sample period, DEQ attempted to relate PCB detection in sediment samples to soil and groundwater in the Brewery Flats area. All soil and groundwater samples were below detection limits for PCBs.

In May and June of 2000, a ***Site Inspection*** and ***Brownfields Assessment Report*** were completed by the EPA. The objective of these studies was to characterize contaminants (volatile organic compounds, semi-volatile organic compounds, PCBs, diesel range organics, and metals) in order to determine suitability of the Brewery Flats site for recreational development. The ***Site Inspection*** was centered at the old Milwaukee Road Railroad roundhouse on Brewery Flats (Figure 6-3). Sixty-one waste source, soil, groundwater, surface water, and sediment samples were collected. No PCBs of the Aroclor 1254 type were detected in any samples.

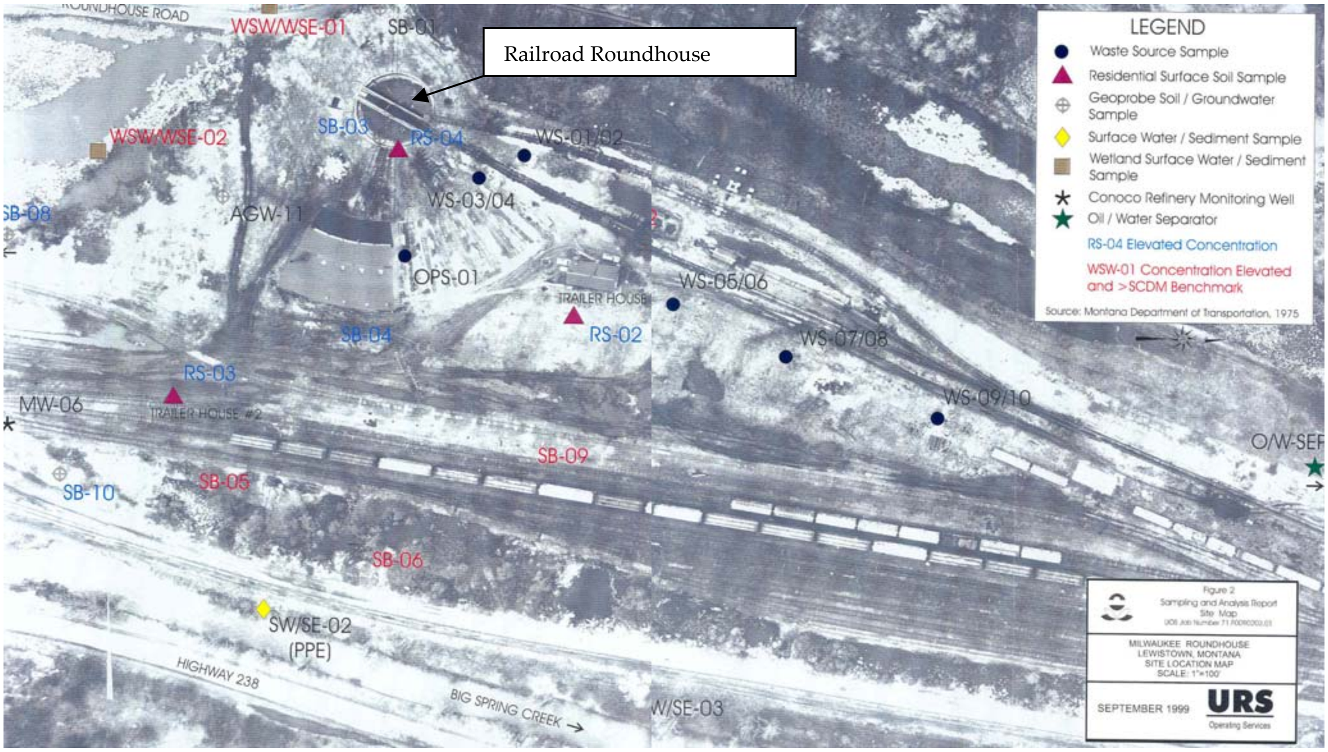

Figure 6-3. Brownfields Assessment Site Map.

The ***Brownfields Assessment*** sampled soil, subsurface soil, groundwater, surface water, and **stream sediment** for volatile organic compounds, semi-volatile organic compounds, PCBs, diesel range organics, and metals at a variety of locations on Brewery Flats. PCBs were detected in surface soil samples yet were of a different PCB mixture (Aroclor, 1260) than those found in fish tissue and stream sediment. PCBs were not detected in any of the surface water, sediment, groundwater, or subsurface soil samples.

6.2.2 Recent Condition and Source Assessment - DEQ

With 319 funding through the Fergus County Conservation District, the Montana DEQ again sampled Big Spring Creek sediments in April 2003. Having failed to find the source of PCB at Brewery Flats in past sampling events, efforts focused on locations upstream from Brewery Flats. Samples were collected along Brewery Flats, in a recently restored channel in Brewery Flats, and at several sites upstream from Brewery Flats to just above the confluence with East Fork Big Spring Creek. Values were erratic and ranged from below detection limits to 1.9 ppm, the highest PCB concentration detected thus far. All samples collected from the newly constructed stream channel in the Brewery Flats Restoration Project were below detection limits, suggesting that accumulation of PCB in the new stream channel over the previous three years (from the time of channel construction to the time of sampling) was negligible.

Following the April 2003 results, sediment sampling resumed in June of 2003, starting at the site upstream of the Big Spring Creek’s confluence with the East Fork and continuing upstream. Six sites were sampled along the mainstem of Big Spring Creek from the confluence of the East Fork to just above the Big Springs Trout Hatchery. Positive detection for Aroclor 1254 was found in all six mainstem sites with values ranging from 0.074 to 5.9 ppm. In addition, two small tributary streams, Hansen and Castle Creeks, were sampled at their mouths. Hansen Creek and Castle Creek enter Big Spring Creek above and just below the Big Springs Trout Hatchery, respectively. Both samples were below detection limits for PCBs suggesting the source of the PCB (Aroclor, 1254) is in the general area of the Big Spring Trout Hatchery and not from sources upstream from the hatchery.

6.2.3 Recent Sampling and Source Assessment - FWP

Prompted by the levels of PCB detected in stream sediments, Montana Department of Fish, Wildlife & Parks investigated the hatchery facilities to determine whether PCBs found in fish tissue and sediments might be originating from sources at the facility. Samples of hatchery raceway paints tested positive for PCBs (Aroclor, 1254).

FWP contacted the EPA requesting guidance on what appropriate action was required. The EPA referred to the Federal *Toxic Substances Control Act* (TSCA), which requires cleanup of any ‘unauthorized’ use of PCB-containing substances. The EPA deemed that the raceway paints used at the hatchery were an unauthorized use of PCB-containing substance. Acting under EPA guidance, FWP initiated a site characterization of the hatchery raceways to determine the magnitude and extent of raceway contamination by paint containing PCBs. Results of this characterization indicate that three different paints were used to line the hatchery raceways. Since initial application of a blue-green colored ‘swimming pool’ paint in the early 1960s (Don Skaar, 2004 personal communication), three different paints have been used to line the hatchery raceways: blue-green #1, red #2, and red #3. Analysis of the blue-green #1 paint yielded PCB concentrations of 86,500 ppm. The red #2 paint was applied in the years before 1980 and was comprised of 674 ppm PCB. The third variety of paint, red paint #3, was applied after 1980 and yielded a PCB concentration of <0.15 ppm.

In October 2003, composite rainbow trout tissue samples were collected at several locations above and below Lewistown (Figure 6-6). Results are shown in Figure 6-4. Average PCB concentrations increase with proximity to the trout hatchery and size of fish. As is typical of biomagnified toxins, the highest PCB concentrations were found in the largest fish. In addition to the rainbow trout sampled, a composite tissue sample of brown trout >14" yielded a PCB concentration of 21.9 ppm, the highest PCB concentration yet found in fish tissue from Big Spring Creek.

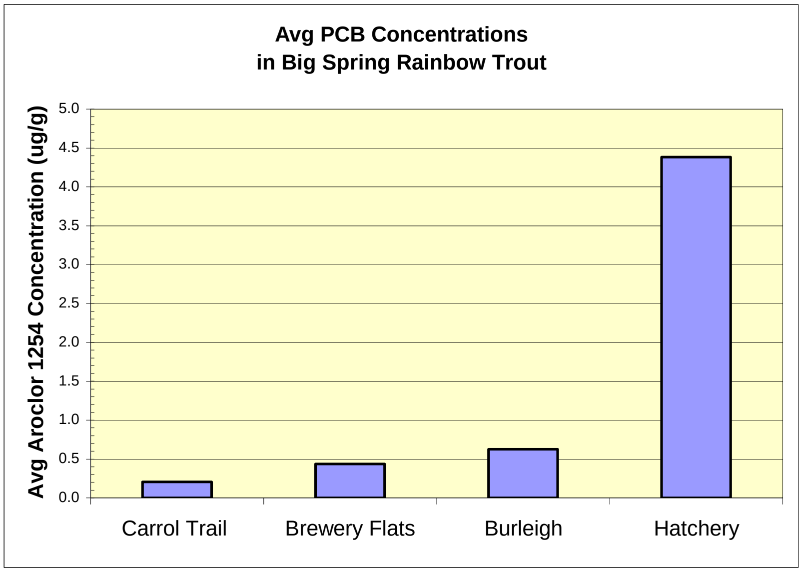

Figure 6-4. October 2003 Fish Tissue PCB Concentrations.

In December 2003 and Feb 2004, FWP collected and analyzed 41 stream sediment samples from Big Spring Creek for PCBs. Including the samples taken by the DEQ in April and June 2003, 67 sediment samples were analyzed for PCB concentrations.

Sediment PCB concentrations range from below detection limits in Hansen Creek (above the upper hatchery) to greater than 2.0 ppm below the lower hatchery. PCB concentrations decrease dramatically below the confluence of East Fork Big Spring Creek. Above the East Fork Confluence, spring inputs maintain a fairly constant flow year-round in Big Spring Creek. In the absence of high flow events, paint chips derived from hatchery raceways accumulate in this upper reach. Consequently, PCB concentrations are significantly higher in the stretch above the East Fork confluence (by up to two orders of magnitude). Figure 6-5 and 6-6 display the magnitude and distribution of sediment PCB concentrations at all 67 sampling sites collected from April 2003 through February 2004.

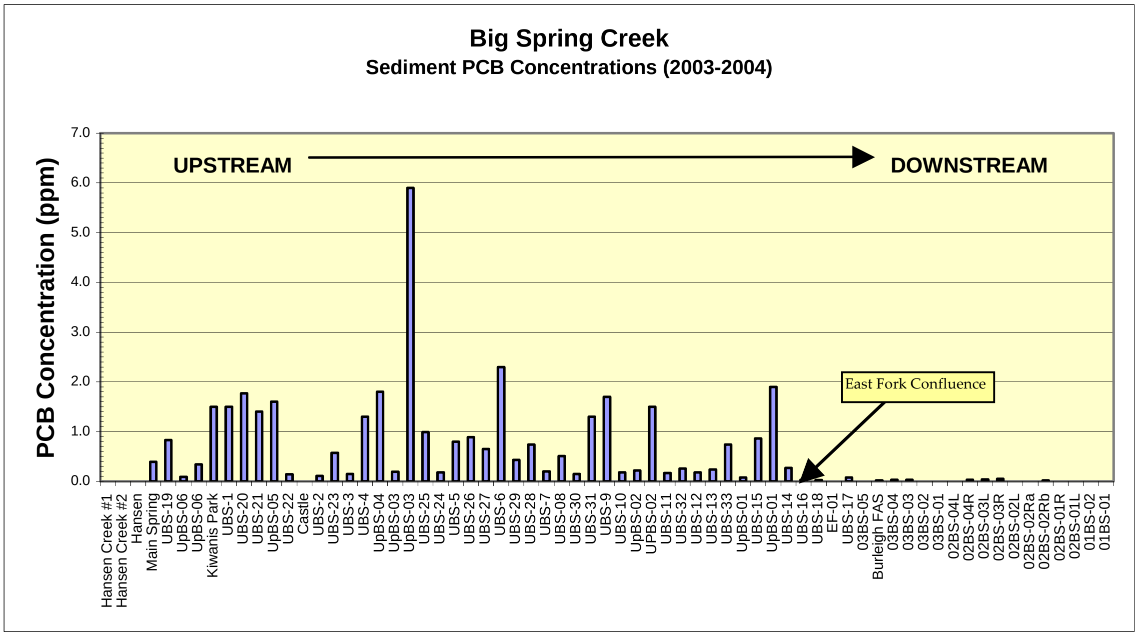

Figure 6-5. PCB Concentrations in Stream Sediments, Upper Big Spring Creek.

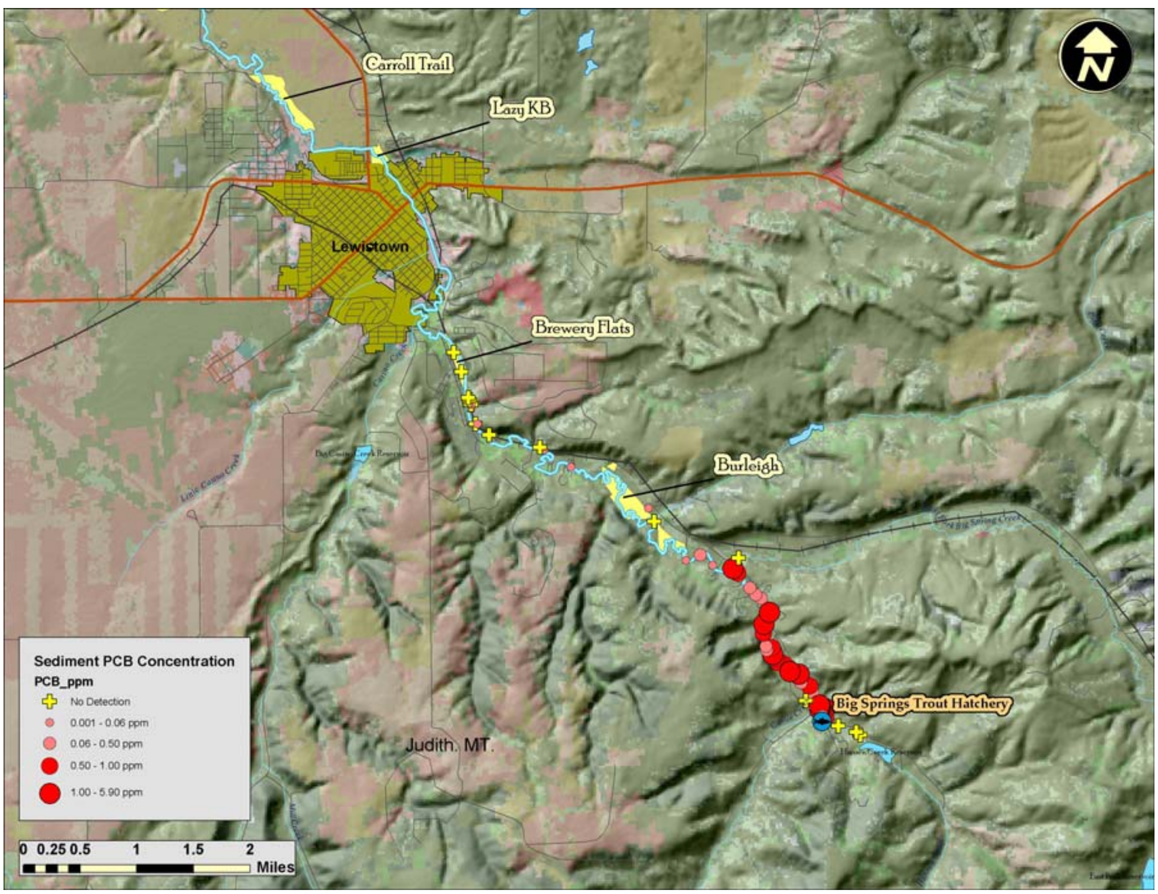

Figure 6-6. Big Spring Creek PCB Sediment Sampling Locations and Relative Magnitudes (2003 DEQ & FWP Data).

Water samples from spring sources at and above the trout hatchery were also collected. No PCBs were detected in any samples.

Some fish feed has been known to contain low levels of PCBs that can result in detectable bioaccumulation in hatchery-raised trout (Carline et al., 2001). Feed was investigated as a potential source of PCBs in Big Spring Creek. Rangen fish feed used at Big Spring Trout Hatchery (and all other state hatcheries) has been analyzed twice for PCBs. On 8/4/03, fish pellets (3/32") were analyzed and found to be below detection limits at the 0.1 mg/kg level. Then, on 4/27/04, fish pellets (3/32") were analyzed again, and found to be below detection limits the 0.018 mg/kg level (dry wt basis).

In spite of these results, there still remains the possibility that there are PCBs in the feed, at levels below detection, in lots have not been sampled, or in lots used in the past. To assess some of these other possibilities, tissue from trout raised for extended periods of time at other hatcheries where PCB paint was not used or is no longer present was sampled. The results are presented in Table 6-1.

Table 6-1. Fish Tissue Samples from Hatcheries across Montana.

Species	Size (in)	Hatchery	PCB (mg/kg wet wt)
Yellowstone cutthroat	13.5-16.4	Yellowstone	<0.051
Arctic grayling	8.3-8.8	Bluewater	<0.034
Rainbow trout	5.9-7.6	Bluewater	<0.033
Largemouth bass	6.2-7.8	Miles City	<0.034
Kokanee	1.8-2.6	Somers	<0.034
Westslope cutthroat	8.2-13.3	Murray Springs	<0.034

None of the fish analyses were accompanied by a "J" value, which would indicate the detection of PCBs below the reporting limit but above the detection limit, which is roughly 0.01 mg/kg. This analysis supports that the fish feed used at a variety of state hatcheries is not resulting in PCB accumulations in hatchery-raised fish tissue and therefore is not a likely source of PCBs in Big Spring Creek.

6.2.4 Source Assessment Summary

Recent source assessments have identified a significant source of PCBs present in Big Spring Creek. Marine paints used to line raceways at the Big Springs Trout Hatchery (Figure 6-7) from 1960 through 1980 contain significant concentrations of PCB (86,500 ppm) and are the likely source of the PCB mixture, Aroclor 1254, found in fish tissue and stream sediments. The raceways discharge directly into Big Spring Creek, allowing an avenue to easily convey any peeling or chipping raceway paints to the creek: field sampling visits have noted paint chips in stream sediment samples.

Figure 6-7. Paint containing PCBs at the Big Springs Trout Hatchery – Lower Raceways.

PCB sediment concentrations are highest just below the trout hatchery and attenuate significantly below Big Spring Creek's confluence with the East Fork of Big Spring Creek. PCBs normally have an affinity for organic-rich sediments, however, no strong relationship between organic carbon content and PCB concentration is evident from the data.

6.3 Water Quality Criteria: Sediment Quality Guidelines (SQGs) and Fish Consumption Advisories

Sediment Quality Guidelines (SQG) and Fish Consumption Advisories (FCA) provide benchmarks for assessing PCB impairment of aquatic life support in surface waters.

6.3.1 Sediment Quality Guidelines

While Montana does not have sediment standards for PCBs, several agencies have developed sediment quality guidelines that identify levels of PCBs that have probable toxic effects. These SQGs have been developed as a screening tool rather than criteria for cleanup or remediation endpoints. The SQGs presented herein do, however, provide a baseline against which to judge the magnitude of the PCB contamination in Big Spring Creek, and confirm that Big Spring Creek sediments contain PCB concentrations significantly above screening criteria established by a variety of agencies.

Sediment Quality Guidelines evaluate the potential affect of a specific pollutant on aquatic life and are expressed in a variety of forms: Effects Range-Low (ERLs), Effects Range-Median (ERMs), Threshold Effects Levels (TELs), Probable Effects Levels (PELs), Upper Effects

Threshold (UET), Severe Effects Levels (SEL), Toxic Effect Threshold (TET) (Buchman, 1999). SQG values for Total PCB and Aroclor 1254 are given in Table 6-2.

Table 6-2. PCB Sediment Quality Guidelines Overview.

Source	ERL	ERM	TEL	PEL	UET	SEL	TET
NOAA1 (total PCBs)	0.0227		0.0341	0.277	0.026*		
USGS/USEPA2 (total PCBs)		0.400		0.277		5.300	1.000
USEPA3 (Aroclor 1254)	0.0227	0.180	0.0216	0.189			
Environment Canada4 (Aroclor 1254)				0.340		34*	

(all values expressed apply to freshwater sediments in ppm dry weight, except where noted)
*normalized to 1% TOC

6.3.2 Fish Consumption Advisories

Fish Consumption Advisories are issued by the Montana Department of Public Health and Human Services (DPHHS), and are designed to protect human health from potential adverse affects of PCB ingestion through the consumption of sport fish. Fish consumption thresholds for fish contaminated with PCBs are given in Table 6-3 (MDPHHS, 2003).

Table 6-3. Meal Guidelines for Fish Contaminated with PCBs.

PCB concentration in parts per million	**< 0.025**	**0.025 - 0.10**	**0.11 - 0.47**	**>0.47**
Meal[1]Advice	unlimited	1 meal/wk	1 meal/mo	Don't eat

[1]One meal for men is considered to be 0.5 lbs of cleaned fish (8 oz wet-weight before cooking). One meal for women and children 6 & under is considered to be 6 oz. (wet-weight before cooking).

Based on PCB concentrations found in fish tissue in Big Springs Creek, the DPHHS issued a Fish Consumption Advisory for Big Spring Creek in 1995, the first year such advisories were issued statewide. From 1995 until December 2003, a one-meal-per-month FCA had been in effect for Big Spring Creek.

Recent tissue PCB concentrations (December, 2003) for fish collected above the East Fork Big Spring Creek confluence, however, are considerably above the level (0.47 ppm) at which the DPHHS issues a *'do not eat'* fish consumption advisory. Based on these findings, in December of 2003, FWP, in conjunction with DPHHS, changed the classification for Upper Big Spring Creek from a one-meal-a-month advisory to "catch and release only."

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1 Buchman, M.F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, NOAA, 12 pages. Also…*Sediment Quality Guidelines developed for the National Status and Trends Program*
2 Ingersoll et al, 2000. Prediction of sediment toxicity using consensus-based freshwater sediment quality guidelines.
3 EPA - Appendix D: Screening Values for Chemicals Evaluated (National Sediment Inventory)
4 Canadian Environmental Quality Guidelines, 2002.

6.4 PCB Targets

Targets are established to provide a benchmark for assessing the attainment of water quality standards and ultimately the determination of beneficial use support. Achievement of targets/endpoints for Big Spring Creek will indicate that water quality is meeting applicable standards and is supporting all beneficial uses. PCB targets are developed considering a suite of data and information including: Montana water quality standards, fish consumption advisories, and sediment quality guidelines from a variety of sources.

6.4.1 Basis for Target Indicators

The Montana numeric aquatic life standard for PCB in surface water is 0.014 ppb. The drinking water (human health) standard for PCBs in surface water is 0.0017 ppb. Because PCBs are not readily dissolved in water, concentrations in the water column are typically low, especially in lotic systems. Because exceedances of the water quality standard may not occur in lotic systems even though sediment concentrations are above established Sediment Quality Guidelines, measures of water column chemistry may not be appropriate as water quality targets.

PCBs are contained in paint chips that have accumulated in stream sediments. Macroinvertebrates, a food source for Big Spring Creek trout, were sampled by FWP and found to contain high levels of PCBs. PCB levels in trout sampled from Big Spring Creek are likely due to the bioaccumulative effects of PCBs through the food chain. Hence, PCB concentrations in fish tissue and sediment are an appropriate measure of the extent and magnitude of PCB impairment in Big Spring Creek. As PCB concentrations in fish tissue are a direct measurement of a factor affecting aquatic life support and recreational beneficial use and the ultimate justification for the impairment of beneficial uses on Big Spring Creek, it is chosen as a target *indicator* used to assess beneficial use. The target *value* for PCB concentrations in fish tissue is based on the *Montana Department of Public Health and Human Services* Fish Consumption Advisory. According to the DPHHS, fish with tissue PCB concentrations below 0.025 ppm PCB warrant no consumptive restrictions (Table 6-3).

Since direct relationships between in-stream sediment PCB concentrations and corresponding fish tissue levels are difficult to quantify, PCB concentrations in stream sediments are chosen as a surrogate target, and may be considered provisional, pending the outcomes of an ecological risk assessment (ERA). The ERA may provide further information regarding remediation and restoration endpoints that are protective of aquatic and human health. The appropriateness of these endpoints will be evaluated and may warrant adjustments of targets for both fish tissue and sediment concentrations at a future date.

The EPA and Environment Canada have established sediment quality guidelines (Table 6-2) for Probable Effects Levels (PEL) associated with Aroclor 1254. The PEL is defined as the lower limit at which biological effects are probable. For Aroclor 1254, the PELs established by the EPA and Environment Canada is 0.189 ppm and 0.340 ppm, respectively. In the absence of a numeric total maximum daily load for PCBs, a PCB sediment concentration of 0.189 ppm is being used as a surrogate target. This surrogate concentration of 0.189 ppm provides a guide for which to establish load reductions in terms of sediment PCB concentrations.

6.4.2 PCB Targets Values for Big Spring Creek

Fish Tissue Target

The fish tissue target is PCB concentrations <0.025 ppm. Attainment of target conditions will be assessed through annual composite sampling of rainbow trout tissue at established compliance points on Big Spring Creek: below trout hatchery, Burleigh FAS, Carroll Trail FAS. Composite samples include filet tissue samples from five or more fish of the largest size class (>12 inches).

In-Stream Sediment Target

The sediment target is average sediment PCB concentrations <0.189 ppm. Attainment of target conditions will be assessed through annual sampling of stream sediments at six locations on Big Spring Creek, upstream from its confluence with the East Fork. A summary of fish tissue and in-stream targets is given in Table 6-4.

Table 6-4. TMDL Targets for PCB in Big Spring Creek.

Indicator	Target Value	Compliance Point	Measurement Method	Frequency
Fish tissue PCB concentrations	<0.025 ppm	Established sites along Big Spring Creek (below hatchery, Burleigh FAS, Carroll Trail FAS)	Composite RB Trout filet samples (5 fish) at each compliance point. Analysis using EPA method *SW8082.*	once/year
In-stream sediment PCB concentrations	<0.189 ppm	Established sampling locations on Upper Big Spring Creek	EPA method *SW8082.*	once/year

Interim Benchmarks

Since it may require considerable time before restoration targets are met, interim benchmarks at 5-10-15 years are suggested as a means to track water quality improvements and assess progress toward target attainment. Benchmarks are not considered numeric targets, but instead are measures of success that will allow evaluation of water quality improvements resulting from on-going remediation and restoration activities. Interim benchmarks are a combination of identified water quality trends and management activities that track reduction in in-stream loads and progress toward ultimate restoration targets for Big Spring Creek.

Interim Benchmarks – 5 Year:

Implementation of remediation strategy (see Section 6.6)
Declining trend in PCB concentrations in sediment

Interim Benchmarks – 10 Year:

Further reduction in PCB concentrations in sediment
Declining trend in PCB concentrations in fish tissue.

Removal of ‘catch-and-release-only’ designation for Upper Big Spring and East Fork Big Spring Creek

Interim Benchmarks – 15 Year:

Continued declining trend in PCB concentrations in sediment and fish tissue.
Removal of Fish Consumption Advisory for Big Spring Creek.

6.4.3 Comparison of Targets to Existing Conditions

Table 6-5 displays the difference between present conditions, and target conditions for PCBs in Big Spring Creek.

Table 6-5. Comparison of Existing Conditions to Target Conditions.

Target Indicator	Present Conditions	Target Conditions
Fish Tissue PCB Concentration (Rainbow Trout)	0.07 – 6.4 ppm	<0.025 ppm (Unlimited consumption)
In-Stream Sediment PCB Concentration	0 – 5.9 ppm Avg Concentration in upper Big Spring Creek is 0.896 ppm	<0.189 ppm

6.5 Total Maximum Daily Loads and Allocations

6.5.1 Current PCB Loads

PCB loads consist of two distinct sources: point source loads from the Big Springs Trout Hatchery and in-stream PCB load associated with contaminated sediments. Quantification of these PCB loads is problematic. PCB-laden paints were applied to the hatchery raceways from the 1960s through the 1980, and have entered the creek as paint has peeled, chipped or otherwise been removed through maintenance operations. It is not known how much paint has entered the creek nor is the present or past loading rate known. Paints containing PCBs are still present on hatchery raceways and represent a current point source of PCBs. PCB concentrations in Upper Big Spring Creek sediments vary considerably and are likely a function of the spatial distribution of contaminated paint chips, making a quantifiable load difficult to ascertain. Considering these factors, a conventional TMDL loading analysis is not easily conducted.

6.5.2 Load Reductions and Allocations

In order to achieve full support of beneficial uses for Upper Big Spring Creek, reduction in both in-stream PCB loads and PCB loads entering Big Spring Creek from the Big Springs Trout Hatchery are necessary.

In-Stream PCB Load Reduction

The average in-stream PCB concentration in sediment from 41 samples taken above the East Fork confluence is 0.896 ppm. In order to meet the surrogate target of 0.189 ppm in stream sediment PCB concentrations, a 79% reduction in average PCB concentrations in stream sediments is necessary.

Big Springs Trout Hatchery PCB Load Reduction

A 100% reduction in PCB loads entering Big Springs Creek is an attainable goal. Successful remediation of the hatchery raceways will result in the removal and/or encapsulation of PCBs and PCB containing materials (see Section 6.6). A summary of PCB allocations is given in Table 6-6.

Table 6-6. PCB Allocations/Load Reductions.

PCB Source	Allocation/Reduction
In-stream Sediment	79% reduction in average PCB concentration in stream sediments
Big Springs Trout Hatchery	100% reduction in PCB load

6.6 Remediation and Restoration

6.6.1 Hatchery Raceway Remediation

Since identification of PCBs in raceway paints in the fall of 2003, FWP has coordinated cleanup and remediation planning with the EPA. The EPA, acting with authority issued under the Toxic Substances Control Act (TSCA), reviews and authorizes remediation plans submitted by the FWP. The first phase of raceway remediation, site characterization, has been completed and EPA and FWP are discussing potential remediation options. It is expected that remediation will effectively reduce PCB inputs by 100% from the Big Springs Trout Hatchery raceways. Consequent to acceptance and approval of FWP’s remediation plan, a monitoring strategy will be designed and implemented to assess the success of remediation. The monitoring strategy will employ a variety of methods to sample for detection of PCB in hatchery-raised fish tissue and sediments and/or algae accumulation.

6.6.2 In-stream Restoration

In May 2004, the FWP initiated both a human health and an ecological risk assessment designed to develop risk profiles for a variety of different categories of exposure to PCB contamination: aquatic life, human health, water fowl, fur bearers, etc. One of the expected outcomes of these risk assessments will be to establish PCB concentration levels for sediment and fish tissue that are protective of human and aquatic health. Potential restoration alternatives that have the capability of reaching protective PCB concentrations in both fish tissue and sediments will then be evaluated.

6.7 Adaptive Management and Uncertainty

6.7.1 Source Assessment

Monitoring and assessment conducted in 2003 and 2004 identified raceway paints at the Big Springs Trout Hatchery as a significant source of PCBs in the watershed. While the concentrations of PCBs in Big Spring Creek sediments and fish tissue may be solely from paint sources at the hatchery and can explain the spatial extent and magnitude of PCB contamination, the possibility of additional sources has not been ruled out. Congener-specific analysis of the Aroclor 1254 mixture contained in raceway paints can be compared to the Aroclor 1254 mixture found in stream sediments and fish tissue in order to more definitively link paint sources to in-stream accumulations.

6.7.2 Targets

The targets presented in **Section 6.4** are based on *existing* information. While correlation between sediment PCB concentrations and fish tissue PCB concentrations exists, the quantitative relationship between sediment PCB concentrations and fish-tissue concentrations is not clearly understood. As the outcomes of pending hatchery remediation and risk assessment become available, the target values presented herein may be adjusted to reflect appropriate endpoints defined by the risk assessment investigation. These endpoints may apply to both sediment targets and fish tissue concentrations, and may provide information to derive stronger links between tissue and sediment PCB levels.

Existing fish consumption advisories are based on total PCB concentrations. It is possible that, based on an ecological risk assessment, fish tissue target values for Aroclor 1254 that are protective of human health and aquatic life may be different from total PCB values. Adjustment of tissue target values to account for this new information and analysis will be evaluated based on the outcome of the ERA.

6.7.3 Remediation & Restoration

Remediation and restoration planning is underway (Section 6.6). FWP is coordinating the removal of PCB-laden paint from hatchery raceways with the EPA. While it is expected that remediation of hatchery raceways will result in the removal and/or encapsulation of all material containing PCBs, the possibility exists that residual PCB may still be detectable. A sampling and monitoring plan will be developed to determine whether residual PCBs remain after remediation is completed. The method and frequency of sample collection and analysis will be appropriate to hatchery operation and maintenance activities and will meet requirements necessary to properly assess the success of remediation actions. The DEQ will develop such future sampling activities in consultation with FWP, and the EPA.

6.8 Margin of Safety

A complete removal or encapsulation of PCB-containing materials will ensure that no PCBs from paint sources at the hatchery will enter Big Springs Creek after remediation is complete. It is possible, however, that residual PCBs may be detected in hatchery raceway sediments after remediation. These PCBs may come from a variety of sources including: cleaning and maintenance tools, soils, or gravels at the hatchery, incomplete or flawed remedial actions, or other sources.

Margins of safety for TMDL targets will be developed pending the outcome of an ecological risk assessment (ERA). Based on the outcomes of the ERA, the DEQ will establish a minimum margin of safety that meets TMDL criteria for state water quality standards as defined in the Montana Water Quality Act. A PCB Advisory Council, established by the Montana Department of Fish, Wildlife & Parks, comprised of representatives from FWP, DEQ, the city of Lewistown, local interest groups and landowners will provide a public venue for evaluating margins of safety as they relate to ecological risk categories and may or may not recommend more stringent margins of safety than those required by existing statute.

6.9 Monitoring Strategy

TMDL effectiveness monitoring will evaluate the success of restoration and remediation efforts and provide a means to assess whether targets and interim milestones are being met.

Monitoring goals include:

1. Assessing the success of remediation activities at the Big Springs Trout Hatchery
2. Assessing whether interim benchmarks are being accomplished and final target conditions are met
3. Identifying all possible sources of PCB contamination

<u>Goal #1: Assess the success of hatchery remediation</u>
Remediation of hatchery raceways at the Big Springs Trout Hatchery is expected to reduce inputs of PCBs to Big Springs Creek by 100%. It is possible, however, that residual PCBs resultant from incomplete or unsuccessful remediation, or additional unidentified sources may still be present in sediments that accumulate in hatchery raceways. Sampling of raceway sediments and water column will assess whether remediation is successful at reducing PCB inputs, or if additional sources are present. Method, location, and frequency of future sediment sampling will depend on the type of remediation employed, and therefore will be developed once decisions on the appropriate remediation strategy have been made. Upon completion of remediation activity, the DEQ may re-evaluate the Big Springs Trout Hatchery MPDES permit in accordance with the Montana Water Quality Act and the Administrative Rules of Montana governing the issuance of MPDES permits. This permit will define the appropriate sampling strategy necessary to effectively monitor PCB concentrations in effluent discharged from the hatchery.

<u>Goal #2: Ascertain whether interim benchmarks are being accomplished</u>
Interim benchmarks include:

- Declining trends in PCB concentrations in fish tissue
- Declining trends in PCB concentrations in stream sediments

- Removal of the ‘catch-and-release’ designation for Upper Big Springs Creek and East Fork Big Springs Creek

Meeting TMDL targets requires a reduction of PCB concentrations in substrate material. Removal of PCBs will result in a decrease in PCB concentrations in both sediment and fish tissue. However, depending on the restoration and/or remediation methods employed, instream reductions will likely occur over a period of time.

In order to track the reductions in fish tissue concentrations, fish tissue sampling will be conducted at least annually at a series of sampling locations along Big Springs Creek. Composite filet samples (of no less than 5 rainbow trout >12”) will be collected by FWP personnel at the following sampling locations: the first bridge below the lower hatchery raceways, Burleigh FAS, and Carroll Trail FAS. Composite samples will be extracted using proper laboratory procedures and analyzed for PCB (Aroclor, 1254) using EPA-approved method SW8082. Results will be reported in mg/kg wet weight.

Stream sediment sampling will be conducted at least annually. Sampling locations will be chosen based on the location and timing of restoration activities, however it is expected that sampling locations will coincide with sediment sampling locations that have already been established by either the DEQ or FWP. Samples from a minimum of six representative sites will be collected annually. Composite samples will be extracted using proper laboratory procedures and analyzed for PCB (Aroclor, 1254) using EPA-approved method SW8082. Results will be reported in mg/kg dry weight.

Interim benchmarks act as a means to track progress toward attainment of final target conditions. Fish tissue and sediment sampling will continue at least until final restoration targets are met and full support of recreational beneficial use is attained.

<u>Goal #3: Identify all possible sources of PCB contamination</u>
While it is very likely that PCB contamination in Big Springs Creek is the result of PCB-laden paint that has chipped of hatchery raceways and been transmitted to the creek, the possibility exists that paint is not the sole source of PCBs in the watershed. Fish feed has been known to cause bioaccumulative effects in hatchery-raised trout (Carline et al., 2001). Presently, feed does not appear to be a cause for concern, however feed lots should be sampled on a regular basis to ensure to no inputs of PCBs. Industrial or other sources may exist as well.

Analysis of PCB congeners present in Aroclor 1254 found in fish tissue, sediment and paint may allow linkage of the PCBs found in fish to paint sources at the hatchery and thereby rule out other potential sources of PCB contamination in the watershed. It is suggested that congener-specific analysis be conducted to ‘fingerprint’ the source of PCBs. In addition to providing information on source, congener analysis can also provide information on toxicity of the Aroclor in question and important information for ecological risk assessments. If congener-specific fingerprinting does not provide a strong link between hatchery paint and in-stream accumulations, it is likely that additional sources of PCB exist and additional source assessment and identification must be conducted.

Additional sources of PCB-laden paint may exist, as well. Unknown is the extent to which PCB-laden paint was used at the hatchery facilities, and whether PCB delivery pathways other than the hatchery raceways exist. Also unknown is fate of any potential PCB-containing materials that were disposed of locally, and whether any existing material may be sources of PCB to Big Spring Creek or other waterbody.

SECTION 7.0
NUTRIENT IMPAIRMENT STATUS

This section provides detailed information regarding nutrient impairment conditions in the Big Spring TMDL Planning Area. Presented is a review of available data relevant to impairment status determinations, and a summary of water quality impairment status for streams listed for nutrient-related impairments in the Big Springs TPA. Because processes and practices affecting nutrient-related impairments differ from waterbody to waterbody, each waterbody will be addressed individually in the following subsections. A summary of present water quality status for nutrients is given in Table 3-4.

7.1 Causes of Nutrient-related Impairment

The 303(d) list status of waters in the Big Spring TMDL Planning Area is summarized in Section 3.1. Streams in the Big Spring Creek TMDL Planning Area listed for nutrient-related impairments include (Figure 3-1):

- Big Spring Creek (MT41S004_010, MT41S004_020)
- Beaver Creek (MT41S004_030)
- Cottonwood Creek (MT41S004_051, MT41S004_052)
- Casino Creek (MT41S004_040)

Several probable causes identified on the 1996 and 2002 303(d) lists contribute to nutrient-related impairment of beneficial use. These include nutrients, noxious aquatic plants and organic enrichment/low dissolved oxygen.

7.1.1 Nutrients

Nutrients can affect a number of beneficial uses such as the fishery and associated aquatic life, aesthetics, agricultural and drinking water uses. Algal mats, decaying algal clumps, odors, low dissolved oxygen levels and discoloration of water are adverse environmental effects associated with excess nutrients. These conditions may interfere with recreational uses or affect the aesthetic value of the stream. Excess algae can interfere with irrigation systems and pose problems for public water supply use by fouling intake structures. Aquatic life and fish can suffer from depleted dissolved oxygen as a result of plant respiration at night.

Plants require a balance of nutrients for growth. Nitrogen (N) and phosphorus (P) are the two macronutrients most commonly found to affect algae growth in aquatic systems (Ryther and Dunstan, 1971; Schindler, 1977; Howarth, 1988). While nitrogen and phosphorous are naturally occurring chemical constituents, elevated levels can have adverse effects on designated beneficial uses and lead to impairment conditions. Most aquatic algae contain nitrogen, phosphorus and carbon in a ratio by weight of 41/ 7/ 1 (Redfield, 1958). Increases in plant production may occur if the limiting nutrient, or all nutrients, is elevated. Most aquatic plants in Montana are not limited by carbon, however, either nitrogen or phosphorus can limit growth. If a N/P ratio is lower than 7.2 the stream is most likely limited by nitrogen, if the ratio is greater than 7.2 it is most likely to be limited by phosphorus (Chapra, 1997). Conditions that affect the nitrogen to phosphorus ratio may change in streams daily or seasonally and either nutrient may be limiting at different times. N/P ratio of the water can be used as an indicator of which nutrient is most likely limiting algae growth in a stream.

Cottonwood and Casino Creek algae are nitrogen limited, whereas Big Spring Creek algae are phosphate limited. Increases in the limiting nutrient will create nuisance algae growth. Nitrogen sources are commonly linked to human and/or animal waste or fertilizers. Sources of phosphorous can be linked to fine sediment.

7.1.2 Noxious Aquatic Plants

Noxious aquatic plants refer to algae and other plant growth that is deemed 'nuisance', and is usually a result of excessive nitrogen and/or phosphorous concentrations. Water temperature can also have an effect on nuisance plant growth. Nuisance plant growth is plant growth that interferes with the attainment of beneficial uses, mainly recreation, fish and aquatic life, and agriculture.

7.1.3 Organic Enrichment/Low Dissolved Oxygen

Natural and anthropogenic organic material that enters streams from both point and nonpoint sources can have an effect on water quality. As organic material decomposes, it robs water of oxygen and can result in depletion of dissolved oxygen, affecting aquatic life and potentially leading to additional deleterious affects. Organic enrichment is commonly associated with nutrient enrichment as well, and often the effects of both organic and nutrient enrichment can result in depletion of dissolved oxygen.

7.2 Water Quality Indicators

This section of the document provides a summary and evaluation of available data relative to potential nutrient-related impairments in Big Spring Creek, Beaver Creek, Cottonwood Creek, and Casino Creek. A summary of the available data types is presented first, followed by a waterbody-by-waterbody evaluation of the data.

Description of Available Data Types

A variety of data and information was assessed in order to make nutrient-related impairment determinations. These include:

- Biological data (macroinvertebrates, periphyton, benthic chlorophyll-a)
- Water chemistry data (nitrogen and phosphorous)
- Physical observations and measurements

7.2.1 Biological Data

Biological data consists of information on macroinvertebrate, periphyton and chlorophyll a. Biological data are a direct measure of the aquatic life beneficial use and provides an understanding of the cumulative and intermittent impacts that may have occurred over time in a stream. The Montana DEQ utilizes a variety of assessment methods and metrics to evaluate the response of biological systems to environmental stressors.

7.2.1.1 Macroinvertebrates

Macroinvertebrate data are typically evaluated according to a multimetric index of biological integrity (IBI), or a "multimetric index". A multimetric index integrates the values of several separate biological health indicators (metrics) into a single numeric score that describes the biological integrity of the macroinvertebrate assemblage sampled. A variety of multimetric indices have been developed for Montana's different ecoregions. Because streams in the Big Spring TMDL Planning Area fall on the boundary between the Montana Valley & Foothill Prairie and Northwestern Great Plains ecoregions, the appropriateness of a single ecoregion-specific multimetric index is suspect. Consequently, professional judgment was employed when evaluating and assessing metric response to biologic assemblages.

7.2.1.2 Periphyton

Like macroinvertebrates, periphyton communities respond to changes in water quality conditions and can therefore be used as indicators of water quality. Diatoms, in particular, are considered useful water quality indicators because much is known about the relative pollution tolerances of different taxa and the water quality preferences of common species (Barbour et al., 1999). Where periphyton data was available, assemblages were evaluated qualitatively for nutrient related impacts.

7.2.1.3 Benthic Chlorophyll-*a*

Benthic algae (also known as *periphyton*) are found growing on substrate surfaces in streams, as opposed to free-floating organisms found in the water column (phytoplankton). Measures of benthic algal biomass helps to provide a better understanding of the cumulative and intermittent impacts that may have occurred over time in a stream, and are useful for determining if impairments due to nutrients are present. Benthic algae biomass is used as an indictor of excessive nutrient enrichment, as algal biomass increases with increasing nutrients. Acceptable benthic chlorophyll-a values vary depending on stream type, ecoregion, and natural processes. **Recommended levels in the literature range from maximum summer values of 110 to 150 mg/m^2** (Suplee, 2004) for streams in the MVFP and *Northwestern Glaciated Plains* ecoregions. These values are used as general criteria when assessing chlorophyll-a values in the Big Springs TMDL planning area.

7.2.2 Water Chemistry Data

Nitrogen and phosphorous are the two common nutrients found to affect aquatic algal growth. N and P concentrations in surface waters can be indictors of nutrient enrichment and are considered in conjunction with other forms of data and information when making impairment determinations.

While assessment of existing conditions and all sources related to nutrient enrichment has been limited in breadth and scope, water chemistry data collected during the past four years by DEQ show elevated concentrations of nitrogen and phosphorus in Big Spring, Beaver, Cottonwood and Casino Creeks relative to USEPA ecoregion guidelines (EPA, 2001). **EPA's recommended values for the ecoregion in which Big Spring Creek is located range from 0.023-0.029 mg/L for TP and 0.380-0.650 mg/L for TN**. A study on the Clark Fork River showed that holding TN below 0.500 mg/L greatly decreased the likelihood of nuisance algae levels (Dodds et al., 1997). In the absence of detailed long-term data on both algal biomass levels and nutrient concentrations, appropriate Chlorophyll-a, total N and total P criteria for the Big Spring Creek TMDL planning area is based on a combination of ecoregional criteria, available data, and professional judgment.

7.2.3 Physical Measurements and Observations

Physical measurements and observations include a variety of data and information that includes but is not limited to: stream reach assessments, photographs, and field notes from a variety of sources. Stream reach assessments provide information on a variety of parameters related to stream and bank stability, riparian vegetation, aquatic habitat, and anthropogenic impacts. These assessments provide limited information regarding nutrient impairment conditions and are addressed where they provide information relevant to nutrient evaluation. Photographs, field notes and observations consist mainly of qualitative data regarding stream and riparian condition. Taken alone, the utility of these types of information is limited, however they supplement and provide supporting evidence for other more quantitative forms of information.

7.3 Big Spring Creek Existing Water Quality Conditions

Big Spring Creek is a spring-fed stream that flows northwest from the foothills of the Big Snowy Mountains 32 miles to its confluence with the Judith River. Big Spring Creek is segmented into two distinct reaches (Figure 3-1). MT41S004_010 is a four-mile reach from Big Spring Creek's headwaters at Big Springs to its confluence with East Fork Big Spring Creek. This reach is dominated by the influence of Big Springs, a spring with an annual average discharge >100cfs. MT41S004_020 is ~28 miles long and extends from the confluence of East Fork Big Spring Creek to the confluence with the Judith River.

Big Spring Creek (MT41S004_010) was listed on the 1996 303(d) list; cold-water fishery and aquatic life beneficial uses were listed as threatened due to nutrients, suspended solids, and habitat alterations. The basis for the 1996 listing is unknown. Big Spring Creek (MT41S004_010) was found to be fully supporting all its beneficial uses on the 2002 303(d) list.

Big Spring Creek (MT41S004_020) was listed on the 1996 303(d) list; cold-water fishery, aquatic life, and contact recreation beneficial uses were listed as partially supporting due to noxious aquatic plants, nutrients, siltation, and other habitat alterations. The basis for the 1996 listing is unknown. On the 2002 303(d) list, cold-water fishery and aquatic life were listed as partially supporting due to nutrients, siltation, polychlorinated biphenyls (PCBs), riparian degradation, fish habitat and other habitat degradation.

Note that the data presented in the following evaluation considers data relevant to nutrient-related impairments. An evaluation of sediment conditions is presented in Section 4.0.

7.3.1 Biological Data

7.3.1.1 Macroinvertebrates

Macroinvertebrates have been collected at a variety of locations on Big Spring Creek, however five of these sites, Below Fish Hatchery, Burleigh Easement, Carroll Trail Fishing Access Site (FAS), Hruska FAS and Spring Creek Colony, have been sampled for macroinvertebrates periodically since 1990, making an assessment of spatial and temporal trends in water quality possible (Figure 4-1).

At the **Below Fish Hatchery** site, macroinvertebrate samples collected in 1996 indicate an assemblage influenced by spring and groundwater sources (McGuire, 1995). Bioassessment scores based on a multimetric index developed by Wisseman (Wisseman, 1992b) scored 75% or greater in all years sampled, indicating unimpaired conditions. At the **Burleigh Easement** site, “functional components of the benthic invertebrate community seem to be well balanced, with adequate representation of grazers, scrapers, predators, and shredders” (Bollman, 2001b).

Macroinvertebrate surveys conducted for reach MT41S004_010 indicate a biologically diverse and unimpaired benthic community. At both the *Burleigh Easement* site and *Below Fish Hatchery* site, recent bioassessments indicate **unimpaired** benthic macroinvertebrate communities and **optimal** habitat conditions.

Bioassessment scores below Lewistown (Carroll Trail FAS, Hruska FAS) indicate a decrease in biological integrity (Figure 4-2). Compared to upstream sites, EPT Richness and Hilsenhoff Index of Biologic Integrity (HIBI) scores (an indicator of nutrient enrichment), implying degradation of water quality at both the Carroll Trail FAS and the Hruska FAS. Macroinvertebrate samples taken at the Spring Creek Colony site show improvements in bioassessment scores, HIBI scores (Figure 7-1) and EPT richness.

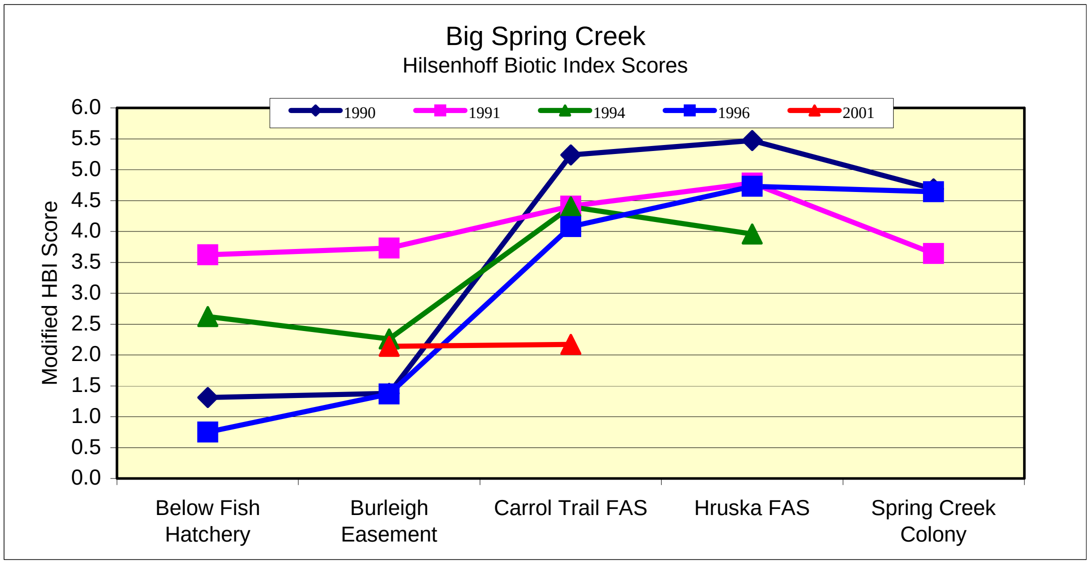

Figure 7-1. HIBI Scores for Big Spring Creek.

7.3.1.2 Periphyton

Periphyton have been collected at a total of 9 sites on Big Spring Creek in years 1998 and 2001 (Figure 4-8). Periphyton at sites downstream from the city of Lewistown all had indications of nutrient enrichment: abundant green algae from Carroll trail downstream and abundance of Cladophora at downstream sites.

7.3.1.3 Benthic Chlorophyll-*a*

Chlorophyll-a data has been collected at five sites on Big Spring Creek in 2001 and 2003: M22BSPRC02, M22BSPRC03, M22BSPRC08, M22BSPRC010, and M22BSPRC0312 (Figure 7-3). Results are shown in Table 7-1.

Table 7-1. Chlorophyll-a Values for Big Spring Creek.

Site	Result (mg/m^2)	Date
M22BSPRC03	380	8/20/2001
M22BSPRC10	15	8/20/2001
M22BSPRC12	280	8/20/2001
M22BSPRC02	156.0	7/24/2003
M22BSPRC03	344.0	7/24/2003
M22BSPRC08	133.0	7/24/2003
M22BSPRC10	19.0	7/24/2003

Several chlorophyll-a values show nuisance levels of algae. The highest values (380 and 344 mg/m^2) were recorded below the City of Lewistown at M22BSPRC03. With the exception of the site located closest to the mouth of Big Spring Creek (M22BSPRC10), all sites were above recommended guidelines.

Macrophyte growth (Figure 7-2) dominated flora communities in upper Big Spring Creek, MT41S004_010. Lack of scouring flows and stable channel conditions provide appropriate natural conditions for the growth and propagation of macrophyte communities on upper Big Spring Creek, and are not considered an indication of excessive aquatic plant growth.

Figure 7-2. Luxuriant Macrophyte Growth on Upper Big Spring Creek.

7.3.2 Water Chemistry Data

Water Chemistry data has been collected at a variety of sites since 1974, however efforts since 1998 to collect nutrient data on Big Spring Creek provide data that best characterizes the nutrient status of Big Spring Creek and are thought to be the best representation of existing conditions. Sampling locations for data collected since 1998 are shown in Figure 7-3.

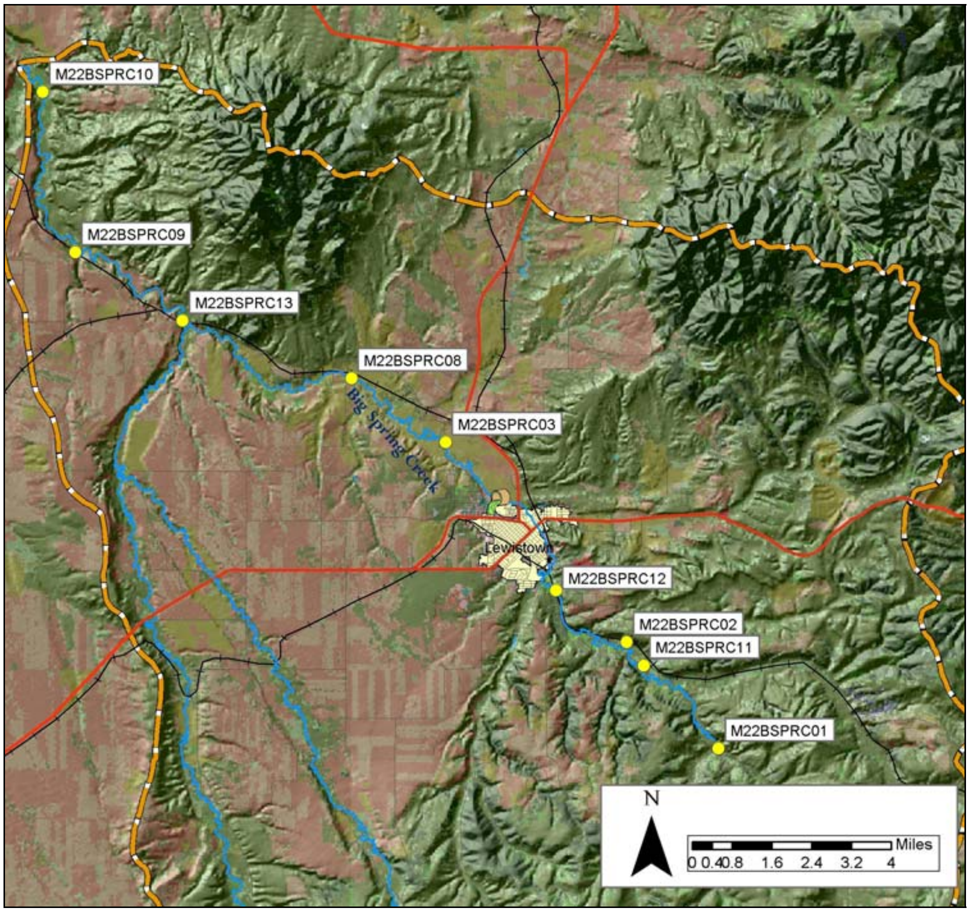

Figure 7-3. Nutrient and Chlorophyll-a Sampling Locations on Big Spring Creek (1998-2003).

Of eight water chemistry samples taken <u>upstream from the city of Lewistown</u> over this time period, total phosphorous values ranged from 0.005 to 0.011 mg/L with an average concentration of 0.008 mg/L TP. Total nitrogen ranged from 0.090 mg/L to 0.38 mg/L with and average of 0.173 mg/L TN.

Nine water chemistry samples were taken <u>downstream from the city of Lewistown to the confluence of Cottonwood Creek</u> (sites M22BSPRC03 & M22BSPRC08). Total phosphorous ranged from 0.022 to 0.068 mg/L, with an average of 0.044 mg/l TP. Total nitrogen ranged from 0.100 to 1.010 mg/L, with an average of 0.453 mg/l TN.

Nine water chemistry samples were taken <u>from cottonwood Creek to the mouth of Big Spring Creek</u> (sites M22BSPRC09, M22BSPRC10 & M22BSPRC13). Total phosphorous ranged from 0.013 to 0.036 mg/L, with an average of 0.023 mg/l TP. Total nitrogen ranged from 0.100 to 0.650 mg/L, with an average of 0.319 mg/l TN.

A summary of four sites on Big Spring Creek where synoptic data was available is given in Figures 7-4 and 7-5.

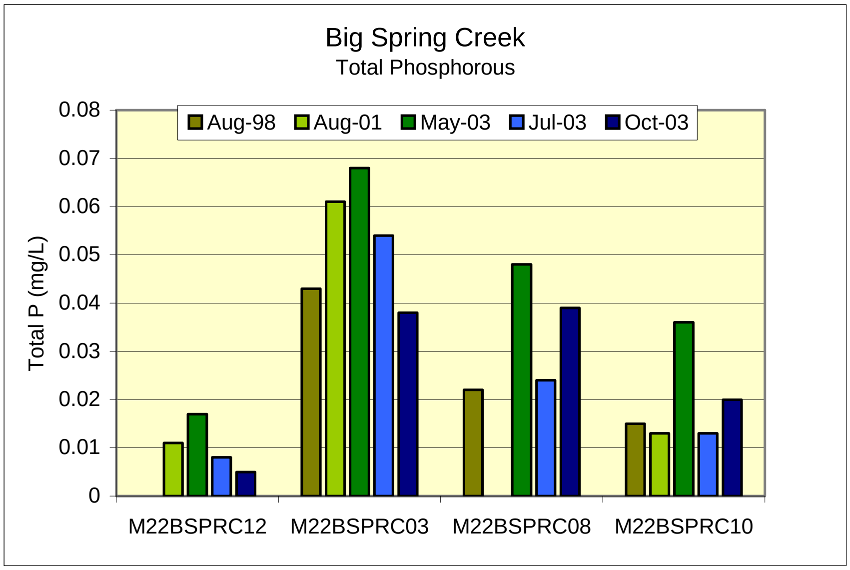

Figure 7-4. Big Spring Creek Total Phosphorous Concentrations.

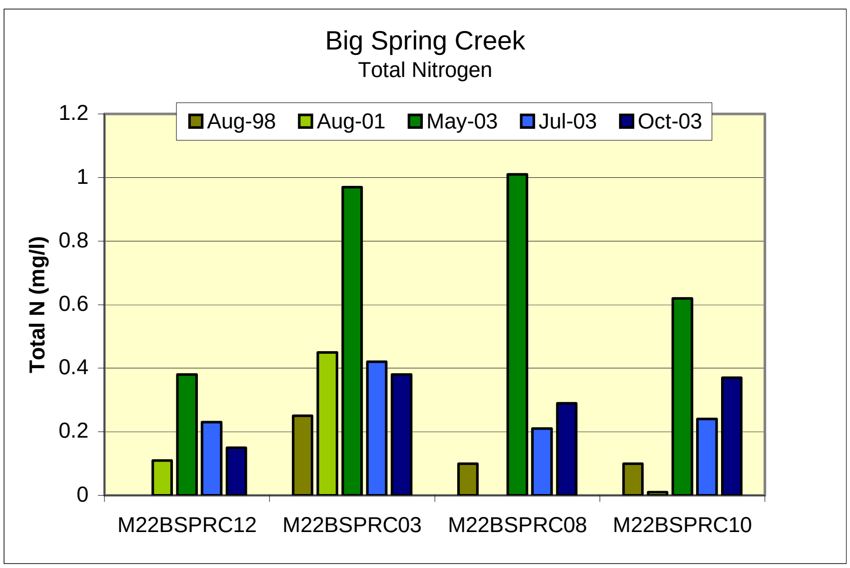

Figure 7-5. Big Spring Creek Total Nitrogen Concentrations.

For the most part, TN concentrations are below ecoregional criteria of 0.38-0.65 mg/L. Spikes in TN concentrations in spring runoff were witnessed, however increased nitrogen concentrations during spring runoff periods are expected and do not usually result in increases in plant biomass.

Total phosphorous concentrations, however, exceeded ecoregional criteria of 0.023-0.029 mg/L at sites M22BSPRC03 and M22BSPRC08 during most sampling events. Average TP concentration in this segment was 0.044 mg/L, well above the ecoregional guidelines set by the EPA.

7.3.3 Existing Conditions Summary

Big Spring Creek (MT41S004_010) supports a functionally diverse macroinvertebrate fauna and flora indicative of cold-water temperatures and low disturbance. Nutrient levels in this segment of Big Spring Creek are well below EPA guidelines for the control of aquatic algal growth, and nuisance algal growth was not observed. **Therefore, Big Spring Creek, segment MT41S004_010, is not impaired for nutrients and a nutrient TMDL is not required.**

Big Spring Creek (MT41S004_020) has several indications that nutrients are a source of impairment. Upstream of Lewistown, TN and TP levels are low. However, analysis of chlorophyll-a samples at M22BSPRC12 and M22BSPRC02 resulted in algal biomass densities of 280 mg/m^2 and 156 mg/m^2, levels considered nuisance. Below the city of Lewistown, chlorophyll-a levels were recorded at 388 mg/m^2 and 344 mg/m^2 at M22BSPRC03, a significant increase from upstream conditions. Water chemistry data for the segment downstream from Lewistown exceeded total phosphorous guidelines. Also, biologic data (periphyton and macroinvertebrate) show clear evidence of water quality impairment from nutrients downstream from Lewistown. Considering multiple lines of evidence, **Big Spring Creek (MT41S004_020) is impaired due to nutrients, specifically phosphorous, and a nutrient TMDL is required.**

7.4 Beaver Creek Existing Water Quality Conditions

Beaver Creek (MT41S004_030) originates in the foothills of the Big Snowy Mountains and flows northeast 21 miles to its confluence with Cottonwood Creek, a tributary to Big Spring Creek. Beaver Creek flows through both foothill and plains ecoregions (Map 2). In its upstream reaches, Beaver Creek has the characteristics of a foothill/valley stream. As it reaches lower elevations, Beaver Creek takes on the characteristics of a plains stream: water is warmer and slower, soft substrates are common, and bank vegetation consists of woody shrubs and grasses and less trees. With the exception of a small plot of state land in the upper watershed, nearly the entire Beaver Creek watershed is privately owned. Land uses in the watershed are predominantly agriculture and livestock grazing.

Grasses and woody shrubs dominate the riparian area of Beaver Creek, and beaver activity is common. Beaver dams are responsible for slack-water areas on several segments of the creek, while other segments are comprised of riffle and pool sequences. A number of natural springs in the upper watershed provide inputs to Beaver Creek. The stream is classified as an E-type channel and is slightly entrenched in places, perhaps due to downcutting as a result of historic beaver dam removal. In general, the stream channel is rather stable and is comprised of fine-grained organic rich soil.

Beaver Creek was listed on the 1996-303(d) list; cold-water fishery and aquatic life beneficial uses were listed as partially supported due to nutrients and suspended solids. The basis for the 1996 listing is unknown. On the 2002 303(d) list, cold-water fishery, aquatic life, drinking water and contact recreation were listed as partially supporting due to nutrients, siltation, dewatering, bank erosion, riparian degradation, fish habitat and other habitat degradation.

Note that the data presented in the following evaluation considers data relevant to nutrient-related impairments. An evaluation of sediment conditions is presented in Section 4.0.

7.4.1 Biological Data

7.4.1.1 Macroinvertebrates

Macroinvertebrates have been collected at 3 sites on Beaver Creek: M22BEVRC01, M22BEVRC02, and M22BEVRC04 (Figure 4-20). The upper site, M22BEVRC01, falls within the Montana Valley and Foothill Prairie (MFVP) ecoregion, while M22BEVRC02 and M22BEVRC04 fall within the Northwestern Great Plains (NGP) ecoregion. It is expected that nutrient levels in NGP streams are higher than in MVFP streams, and that macroinvertebrate assemblages reflect this natural change. Consequently, it is expected that biotic assemblages may reflect this environmental gradient.

Bioassessment results indicate that warm water temperatures and mild nutrient enrichment are likely influences limiting the macroinvertebrate assemblages in Beaver Creek. Potential dewatering could also not be ruled out as a factor limiting macroinvertebrate faunae (Bollman, 2004).

7.4.1.2 Periphyton

Periphyton was collected in July of 2003 at sites, M22BEVRC01, M22BEVRC02, and M22BEVRC04 (Figure 4-20). Results of the analysis suggested a diverse algal flora typical of nutrient-rich waters. When compared to criteria for evaluating biologic integrity in mountain streams, diatom assemblages at the uppermost site, M22BEVRC01, indicated minor impairment from organic enrichment. When compared to criteria for evaluating biologic integrity in prairie streams, diatom assemblages at sites M22BEVRC02 and M22BEVRC04, showed signs of nutrient enrichment. However, species richness and diversity was within expected conditions for streams of the NWG ecoregion and analysis results indicated unimpaired conditions (Bahls, 2004).

7.4.1.3 Benthic Chlorophyll-*a*

Benthic Chlorophyll-a samples were collected at four sites on Beaver Creek in July, 2003 (Figure 7-6).

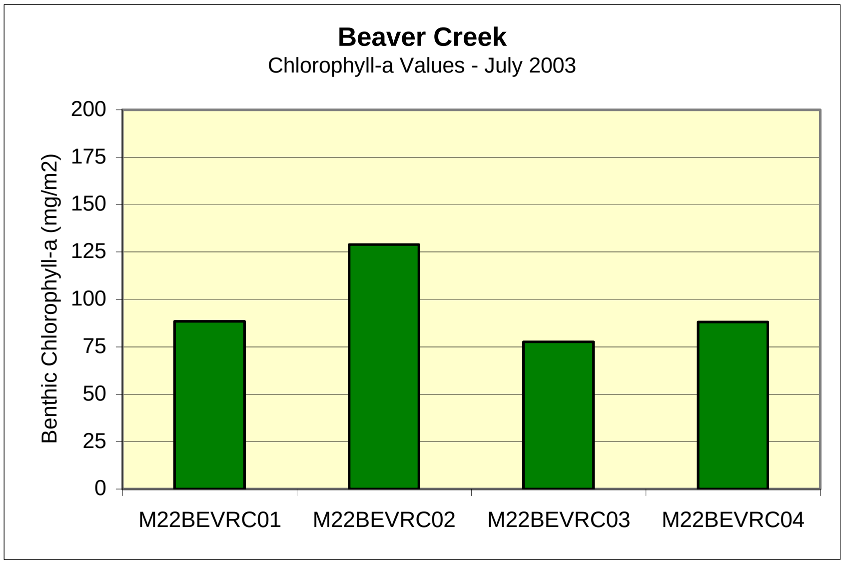

Figure 7-6. Benthic Chlorophyll-a Values in Beaver Creek, July 2003.

The highest chlorophyll-a value collected was 129 mg/m^2 (M22BEVRC02). All other values were below 100 mg/m^2. The average summer chlorophyll-a value of the four sites samples was 96 mg/m^2, below criteria generally considered as nuisance levels.

7.4.2 Water Chemistry Data

Water chemistry data for Beaver Creek is limited. Only three samples were taken by DEQ before 2003, the most recent in 1994. In May, July and October of 2003, however, four sites on Beaver creek were sampled for nutrients, phosphorous and nitrogen (Figures 7-7 and 7-8).

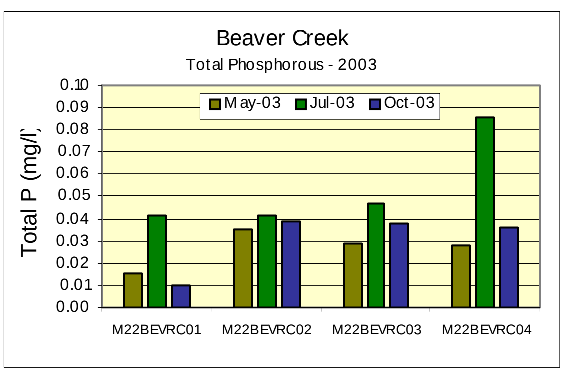

Figure 7-7. Total P: Beaver Creek 2003.

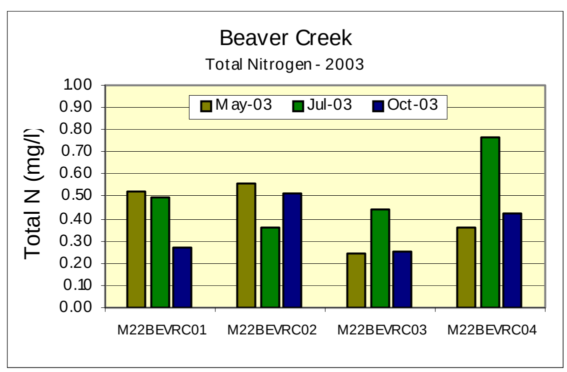

Figure 7-8. Total N: Beaver Creek 2003.

Total phosphorous values ranged from 0.010 to 0.086 mg/L with a mean of 0.037 mg/L. Total nitrogen values ranged from 0.24 to 0.77 mg/L with a mean of 0.43 mg/L. Average nutrient levels appear to be elevated above general EPA guidance levels considered to control nuisance algae, however accompanying algal biomass measures were below conditions considered nuisance levels.

An unnamed spring near site M22BEVRC01 was also sampled in July and October of 2003. TN values were 0.97 mg/L and 1.15 mg/L, illustrating the naturally high TN from local spring sources.

7.4.3 Physical Measurements and Observations

Stream reach assessments were conducted in July 2003 by DEQ staff at three sites on Beaver Creek: M22BEVRC01, M22BEVRC02 and M22BEVRC04. All three reach assessments scored the riparian condition of Beaver Creek at >80%, indicating sustainable conditions. Riparian vegetation cover was noted as excellent and having mature woody species prevalent. Beaver activity was noted at all sites and warm water and sediment deposition was attributed to the affects of beaver dams. Streamflow was noted as the greatest limiting factor, perhaps due to a combination of natural and anthropogenic factors.

7.4.4 Existing Conditions Summary

It appears that nutrient conditions in Beaver Creek do not impair beneficial uses. Organic material and fine grain sediments associated with historic and present beaver activity appear to contribute a substantial natural nutrient load, and are likely responsible for mild nutrient enrichment conditions found in Beaver Creek. Natural spring inputs to Beaver Creek may also contribute significant nutrients. In the absence of significant anthropogenic sources of phosphorous, it is thought that natural processes are responsible for phosphorous levels that are slightly above criteria that are believed to control algal biomass. In spite of apparent natural elevation of nutrient levels, benthic chlorophyll-a samples were below general criteria used as indicators of nuisance algal growth. **Consequently, Beaver Creek is not impaired due to nutrients and no nutrient TMDL is required.**

7.5 Cottonwood Creek Existing Water Quality Conditions

Cottonwood Creek originates in the Big Snowy Mountains at an elevation of 8,000 feet and flows northeast 32 miles to its confluence with Big Spring Creek. Cottonwood Creek is segmented into two distinct reaches (Figure 3-1). MT41S004_051 is a 19-mile reach from Cottonwood Creek's headwaters to where it exits the foothills of the Big Snowy Mountains. MT41S004_052 is 13-mile reach and extends to Cottonwood Creek's confluence with Big Spring Creek about ½ mile west of the town of Hanover. Upper Cottonwood Creek is within the Montana Valley & Foothill Prairie (MVFP) ecoregion and exhibits characteristics of a mountain stream. Lower Cottonwood Creek, although lying within the Northwestern Glaciated Plains ecoregion, exhibits some characteristics of a valley & foothill prairie type stream: cobbled substrates are common and water temperature is, in general, colder.

Cottonwood Creek was listed on the 1996 303(d) list; cold-water fishery beneficial use was listed as threatened due to nutrients, organic enrichment/low dissolved oxygen, and suspended solids. The basis for the 1996 listing is unknown. Since the 1996 listing, Cottonwood Creek was segmented into two separate reaches. The upper reach, MT41S004_051, was found to be fully supporting its beneficial uses on the 2002 303(d) list. The lower reach of Cottonwood Creek, MT41S004_052, was listed as impaired on the 2002 303(d) list: aquatic life, cold water fishery, drinking water, industry and contact recreation were listed as partially supporting their beneficial use due to nutrients, organic enrichment/low dissolved oxygen, siltation, flow alteration/dewatering, riparian degradation, fish habitat degradation and other habitat alterations.

Note that the data presented in the following evaluation considers data relevant to nutrient-related impairments. An evaluation of sediment conditions is presented in Section 4.0.

7.5.1 Biological Data

7.5.1.1 Macroinvertebrate Assessments

Macroinvertebrate were collected at 3 sites on Cottonwood Creek in August of 2001, M22CTWDC01, M22CTWDC02, and M22CTWDC03 (Figure 7-9). Single traveling kick net samples were taken at sites in the upper watershed, below the confluence with Beaver Creek, and near the confluence with Big Spring Creek. The results of the analysis indicated slight impairment in the upper portion of the watershed. Data from both of the lower sites indicated moderate impairment. In general communities at all three sites suggested tolerance to lower oxygen levels such as might be caused by warm water temperatures or luxuriant algal growths. The macroinvertebrate communities at the lower 2 sites were notably depauperate in long-lived taxa, suggesting episodic dewatering or other catastrophic habitat disturbance.

7.5.1.2 Periphyton

Periphyton was collected at the same three sites, as were macroinvertebrate samples on August 21, 2001. Results of the analysis suggested a diverse algal flora typical of nutrient-rich waters and a stable community with little disturbance. The samples also indicated a downstream trend in increasing nutrients, dissolved solids and temperature, with indication of organic enrichment (presence of *Euglena*) near the mouth of the Creek. Overall, water quality impairment was indicated only in the lowermost site by the periphyton samples. The presence of the bluegreen alga *Nostoc* and a large number of diatoms in the family Epithemiaceae suggested nitrogen as the limiting nutrient in Cottonwood Creek.

At first glance the “stable community with very little disturbance” may appear to be at odds with the “episodic catastrophic disturbance” indication noted in the macroinvertebrate analysis previously summarized. This apparent conflict must be placed in the perspective of the rapid generation times of diatoms (hours) compared to the considerably longer generation times (2-4 years) of macroinvertebrates used as indicators of disturbance. Also recent, more detailed, efforts focused on improving our use of diatoms as indicators have shed doubt on their efficacy as indicators of disturbance for other than short time periods.

7.5.1.3 Benthic Chlorophyll-*a*

Benthic chlorophyll-a was collected in the summers of 2001 and 2003 at a variety of locations on Cottonwood Creek (Figure 7-9). Results are shown in Figure 7-10.

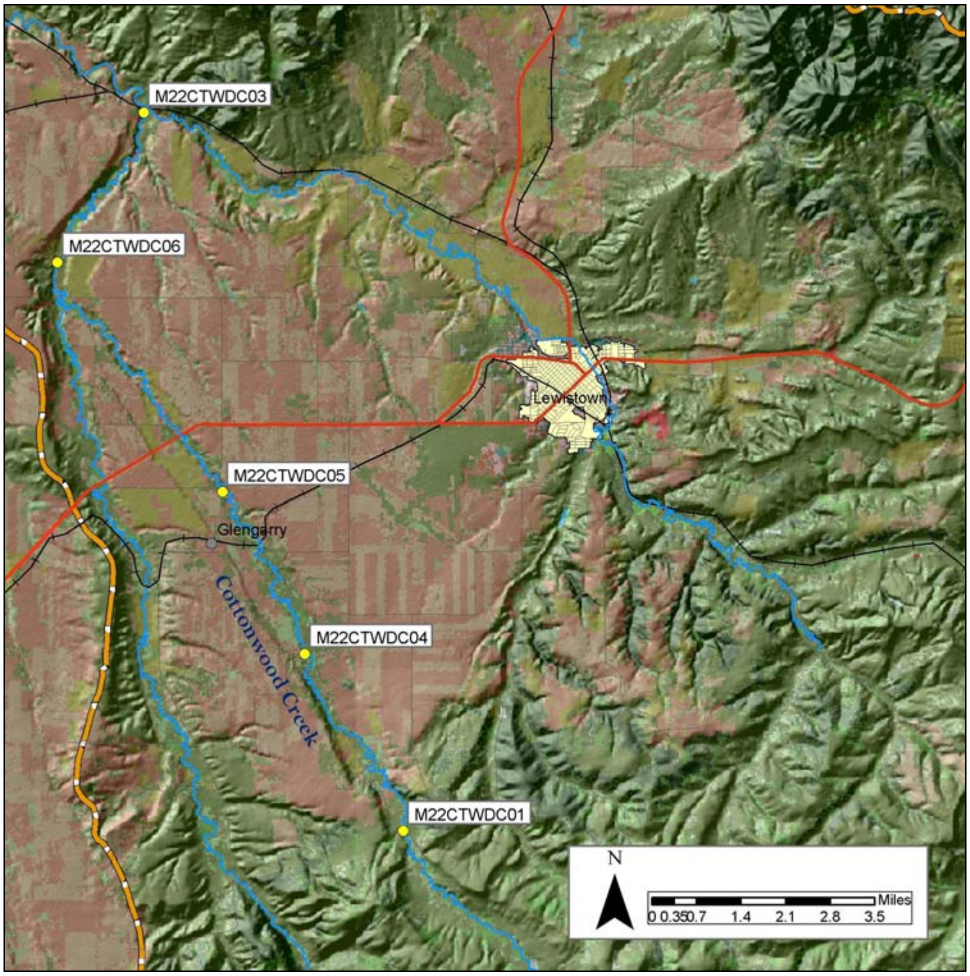

Figure7-9. Chlorophyll-a and Nutrient Sampling Sites on Cottonwood Creek.

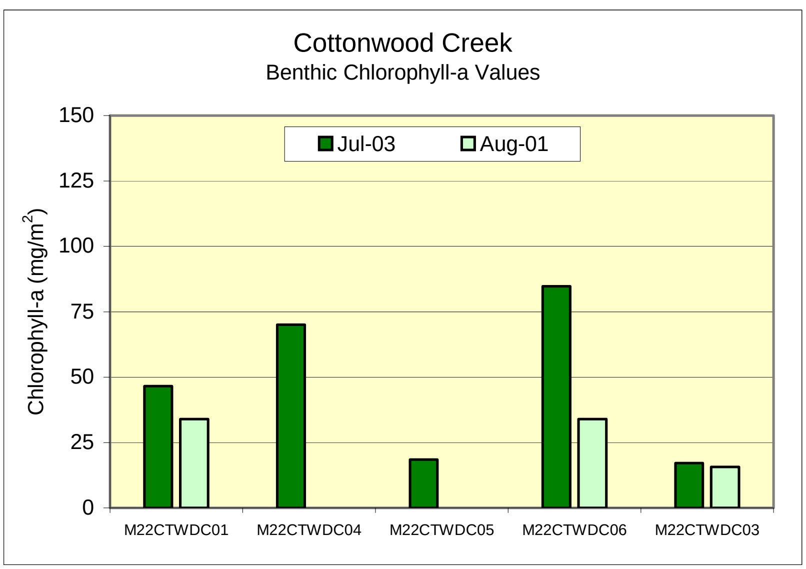

Figure 7-10. Benthic Chlorophyll-a Values in Cottonwood Creek.

Chlorophyll-a values ranged from 17 to 86 mg/m^2 with an average of 40 mg/m^2 for all sites on Cottonwood Creek. All values fell below 'nuisance algae' criteria. However, photographs taken in August 2001 (Figure 7-11) and July 2003 (Figure 7-12) show excessive growths of algae at MTCWDC03. It is likely that the method used to collect samples was inappropriate. DEQ's 'rock' method was used at the some sites, whereas the appropriate sampling method employed should have been the 'hoop' method (DEQ SOPs). The rock method can be unrepresentative of chlorophyll-a densities in systems where much of the algae are unattached to the substrate, as was the case at lower sites (MTCWDC03 & MTCWDC06).

Figure 7-11. Lower Cottonwood Creek MTCWDC03 in 2001.

Figure 7-12. Lower Cottonwood Creek MTCWDC03 in 2003.

7.5.2 Water Chemistry Data

Nutrients

Water Chemistry samples, primarily nutrients, were collected during May, July and October of 2003 (Figures 7-13 and 7-14). In general values were below those considered to support nuisance algal blooms in the Northwestern Great Plains Ecoregion. One exception was in the lower end of the Creek, below the confluence with Beaver Creek, where total phosphorus exceeded the guideline of 0.029 mg/L.

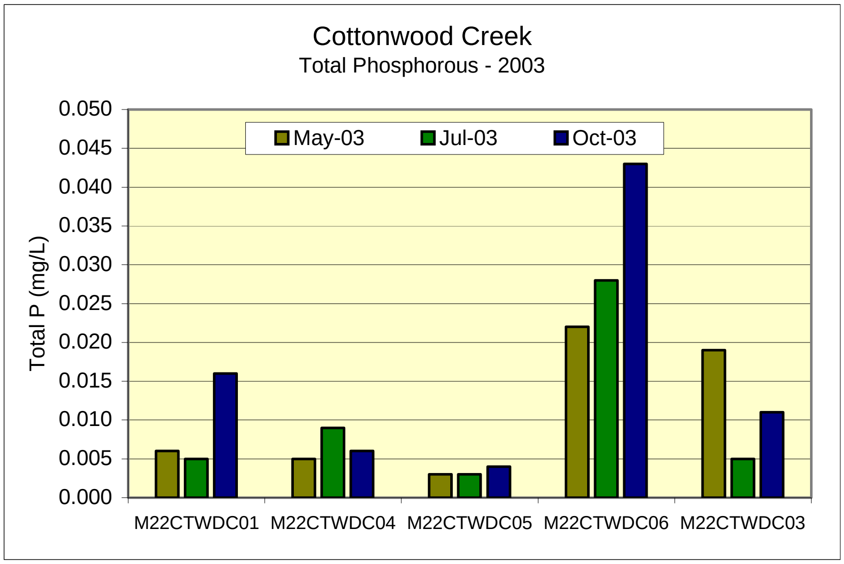

Figure 7-13. Total P: Cottonwood Creek 2003.

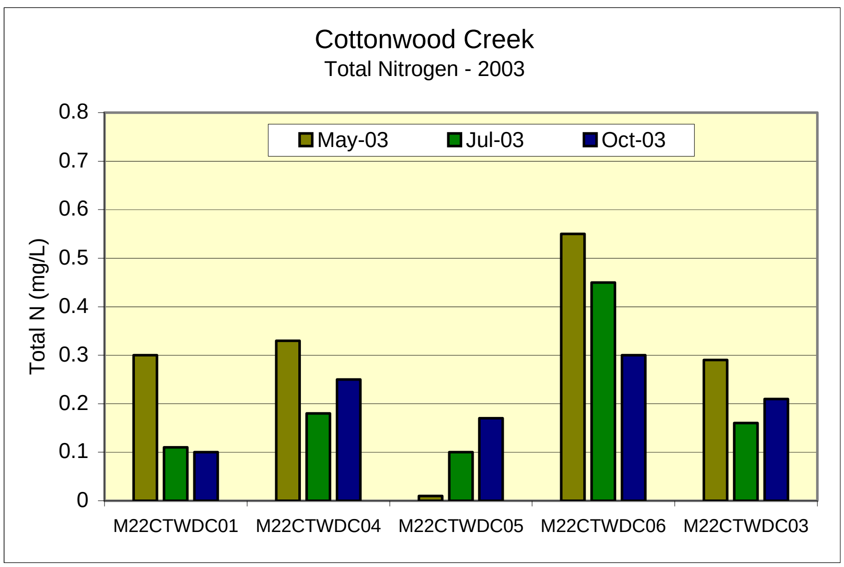

Figure 7-14. Total N: Cottonwood Creek 2003.

A conspicuous rise in TP and TN concentrations is evident at site, M22CTWDC06. Accompanying this rise are increases in algal growth at sites M22CTWDC06 and M22CTWDC03 (Figures 7-13 and 7-14). The mechanism behind this increase in nutrient concentrations is not fully understood, and may be a combination of nutrient inputs from Beaver Creek, natural P inputs from eroding banks (Figure 7-13) on Cottonwood Creek, nutrient-enriched groundwater inputs, or other unidentified sources.

Dissolved Oxygen

24-hour dissolved oxygen data were logged from July 22-24th, 2003 at the mouth of Cottonwood Creek (M22CTWDC03) and also upstream at a site near the Beaver Creek confluence

(M22CTWDC06). Dissolved oxygen at the mouth of Cottonwood Creek ranged from 14 mg/L in the late afternoon to 3.1 mg/L at night during a single diel cycle, and the magnitude of these daily changes were much more pronounced than at the upstream location (Figure 7-15).

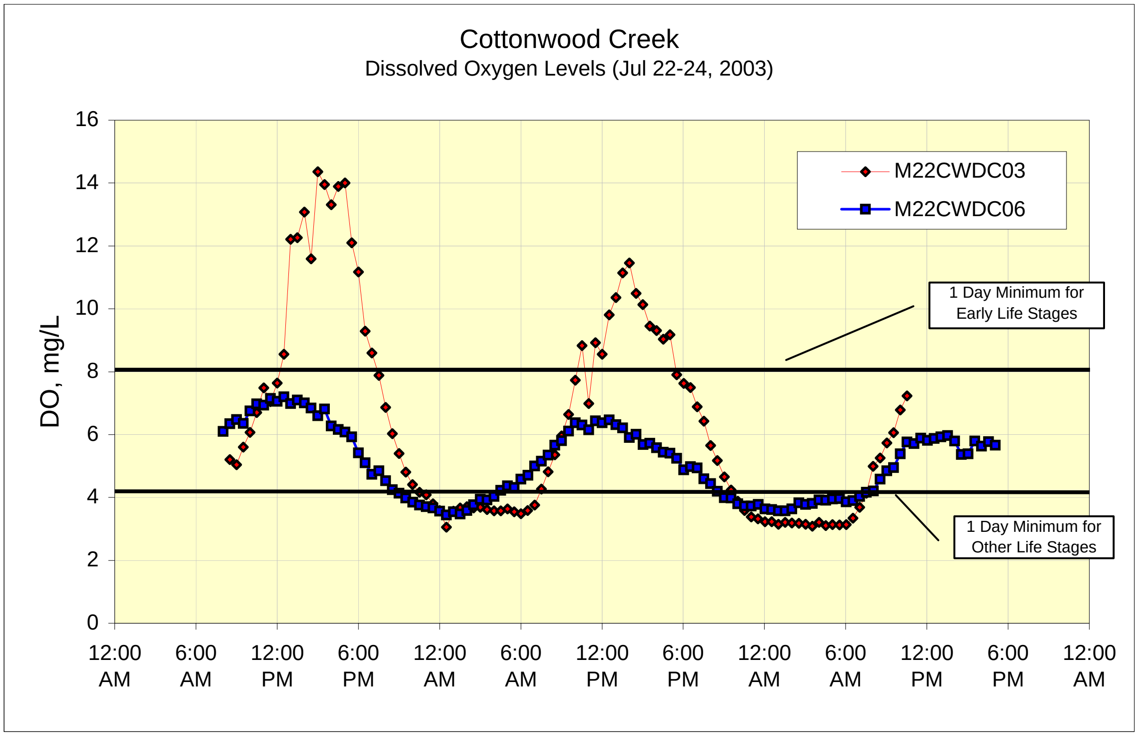

Figure 7-15. Lower Cottonwood Creek Dissolved Oxygen Levels, July 22-24, 2003.

Dissolved oxygen concentrations at the mouth have fallen to levels well below the State's instantaneous minima of 4 mg/L, which is applicable to "other life stages" (see footnote 15, WQB-7; DEQ, 2004). "Other life stages" refers to young and adult fish, which certainly live in or at least transit through the mouth of Cottonwood Creek. Large DO fluctuations frequently result from heavy growths of aquatic plants (including algae) that produce oxygen during the day but then utilize it at night (Chambers et al., 1999). Nighttime dissolved oxygen decline also results from decomposing organic material. Excess decomposing organic material was evidenced at the mouth by the presence of *Euglena*, which is very tolerant of the presence of decomposing organic matter (Bahls, 2001b). *Euglena* were not found at other upstream sites on Cottonwood Creek

7.5.3 Existing Conditions Summary

Cottonwood Creek (MT41S004_051)

Nutrient concentrations in upper Cottonwood Creek are well below EPA ecoregional nutrient criteria. The maximum chlorophyll-a value is 47 mg/m^2, also below criteria indicating nuisance algal growth. Evidence indicates that nutrients do not impair upper Cottonwood Creek (MT41S004_051); therefore **no nutrient TMDL is required for this segment.**

Cottonwood Creek (MT41S004_052)

While lower Cottonwood Creek nutrient values are largely within ecoregional criteria generally believed to control nuisance algal growth, high levels of aquatic algae growth were witnessed at sites M22CTWDC06 and M22CTWDC03, exceeding the state of Montana's narrative nutrient standard. In addition to excessive algae growth, dissolved oxygen levels below the State's instantaneous minima of 4 mg/L were recorded at sites M22CTWDC06 and M22CTWDC03. Data shows that lower Cottonwood Creek (MT41S004_052), particularly below Glengarry, exceed both the state's dissolved oxygen and nutrient standards, and **therefore Cottonwood Creek is impaired due to nutrients and low dissolved oxygen, and nutrient/DO TMDLs are required.**

7.6 Casino Creek Existing Water Quality Conditions

Casino Creek (MT41S004_040) originates in the foothills of the Big Snowy Mountains and flows north 12 miles to its confluence with Big Spring Creek just south of the city of Lewistown. Casino Creek has the characteristics of a foothill/valley stream and falls within the Montana Valley & Foothill Prairie ecoregion. The Casino Creek watershed is almost entirely privately owned. Land uses in the watershed are predominantly agriculture and livestock grazing.

Grasses and woody shrubs dominate the riparian area of Casino Creek, and beaver activity is common. Beaver dams are responsible for slack-water areas on several segments of the creek, while other segments are comprised of riffle and pool sequences. A number of natural springs in the upper watershed provide inputs to Casino Creek. The stream is classified as an E-type channel and is highly entrenched in places, perhaps due to downcutting as a result of historic beaver dam removal. Deep organic-rich soils are common throughout the Casino Creek watershed. In general, the stream channel is rather stable and streambanks are comprised of fine-grained organic rich soil.

Casino Creek was listed on the 1996-303(d) list; cold-water fishery beneficial use was listed as threatened due to nutrients and suspended solids. The 1996 listing was based on a nonpoint source assessment conducted in 1989. The 1989 assessment relied on existing data and reports, and acknowledged that limited data existed for Casino Creek. No field assessments or new data collection was used to make the listing determination. On the 2002 303(d) list, cold-water fishery, aquatic life, and contact recreation were listed as partially supporting due to nutrients, riparian degradation, and other habitat degradation. The following data review examines data and information to verify the 1996 303(d) listing for the water quality pollutant, suspended solids.

Note that the data presented in the following evaluation considers data relevant to nutrient-related impairments. An evaluation of sediment conditions is presented in Section 4.0.

7.6.1 Biological Data

7.6.1.1 Macroinvertebrates

Macroinvertebrates were collected in August 2000 at 2 sites on Casino Creek: C1 and C2 (Figure 7-17). For both sites, the MVFP metric index developed by Bollman (1998) was used to evaluate beneficial use support. Site C1 scored 33% and Site C2 scored 39% indicating moderate impairment and partial support of beneficial uses at both sites. Both macroinvertebrate assemblages showed strong indicators of water quality impairment due to nutrients/organic enrichment and warm water temperatures (Bollman, 2001c).

7.6.1.2 Periphyton

Periphyton was collected in August of 2000 at sites C1 and C2 (Figure 7-17). Periphyton analysis indicated nutrient-enriched conditions. The periphyton assemblage at C2 held evidence of increases in nutrients and organic loading between the two sites.

7.6.1.3 Benthic Chlorophyll-*a*

During August of 2000 and July of 2003, chlorophyll-a samples were taken at M22CSNOC04, M22CSNOC06, C1 and C2. Of four samples taken, algal biomass ranged from 50 to 163 mg/m^2 with an average of 98 mg/m^2. In addition to high chlorophyll-a levels, moderate to heavy algae was estimated to cover 40% of the stream substrate at site M22CSNOC04 (Figure 7-16).

Figure 7-16. Macroalgae Coverage on Casino Creek, 2003 (M22CSNOC04).

7.6.2 Water Chemistry Data

Water chemistry data for Casino Creek is limited. Seven TN samples and nine TP samples were taken from 2000 through 2003. Total nitrogen ranged from 0.320 to 0.880 mg/L, with an average of 0.620 mg/l TN. Total phosphorous ranged from 0.021 to 0.123 mg/L, with an average of 0.066 mg/l TP. Only five samples were taken by DEQ before 2003. In May, July and October of 2003, however, two sites on Casino Creek (M22CSNOC04 and M22CSNOC06) were sampled for phosphorous and nitrogen (Figure 7-17). Results are shown in Figures 7-18 and 7-19.

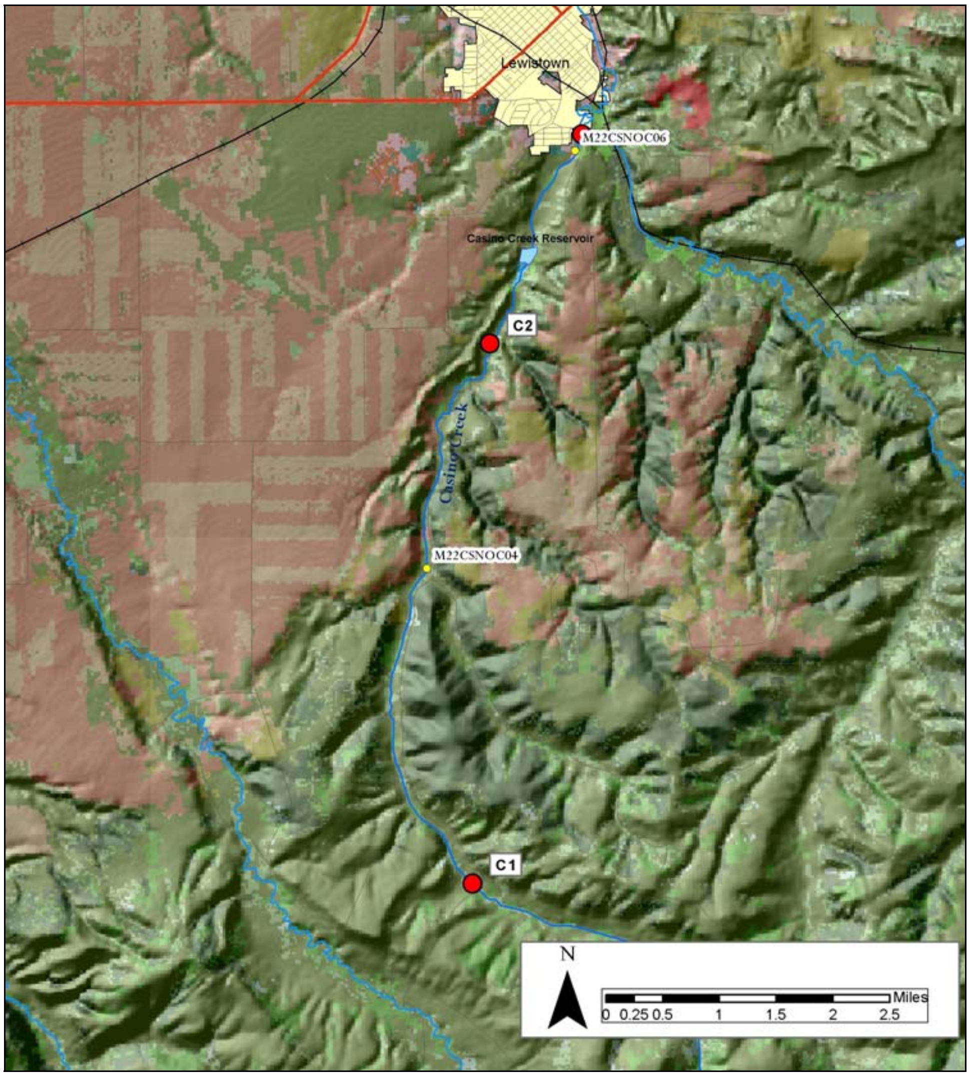

Figure 7-17. Casino Creek Nutrient & Chlorophyll-a Sampling Sites.

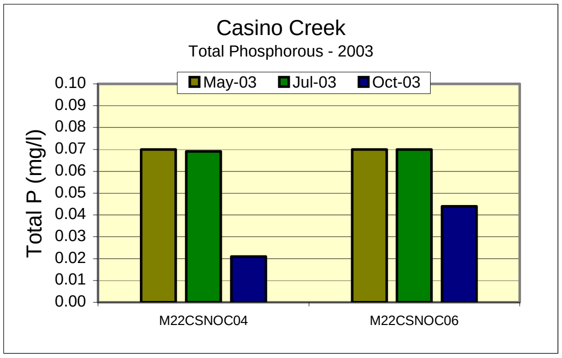

Figure 7-18. Total P: Casino Creek 2003.

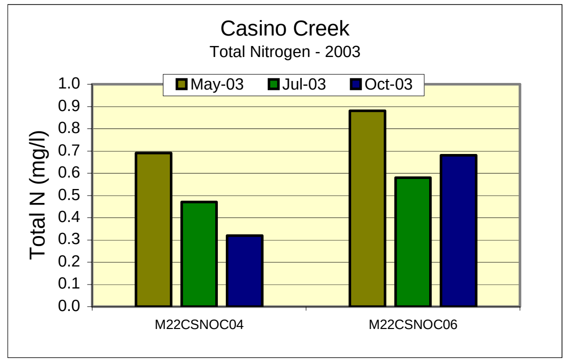

Figure 7-19. Total N: Casino Creek 2003.

Total phosphorous values ranged from 0.021 to 0.070 mg/L with a mean of 0.057 mg/L. Total nitrogen values ranged from 0.32 to 0.88 mg/L with a mean of 0.60 mg/L. Nutrient levels are significantly elevated above levels considered to control nuisance algae, and were within the range of what is considered 'excessive', according to EPA regional criteria.

7.6.3 Existing Conditions Summary

It appears that nutrient conditions in Casino Creek impair beneficial uses. Algal growth (163 mg/m^2) on Casino Creek is considered excessive, and algal coverage (40%) is high. Likewise, nutrient levels (total P and total N) significantly exceed criteria generally believed to control excessive algal growth. While Casino Creek, is thought to have naturally high levels of nutrients, nutrient concentration appear to be at levels beyond what is expected for natural conditions. While data does not allow an adequate assessment of natural and anthropogenic nutrient contribution, the impairment of biologic condition, significantly elevated nutrient concentrations, and excessive algal growth provide adequate evidence to conclude that **Casino Creek is impaired due to nutrients and a nutrient TMDL is required.**

SECTION 8.0
NUTRIENTS – REQUIRED TMDL ELEMENTS

As described in Section 7.0, the nutrient water quality standards do not currently appear to be met in Big Spring Creek, Cottonwood Creek and Casino Creek, requiring that TMDLs be developed for each of these waterbodies. This section of the document presents the required TMDL elements (i.e., targets, source assessment, TMDLs & allocations, adaptive management, margin of safety, implementation and monitoring strategies) to address nutrient impairments on Big Spring Creek, Cottonwood Creek and Casino Creek.

8.1 Big Spring Creek

8.1.1 Nutrient Targets

Nutrient TMDL targets provide a means to assess whether water quality standards are being met, and act as water quality endpoints for nutrient-impaired streams. Nutrient targets are essentially a translation of the state's water quality standards for nutrients, and achievement of water quality targets will, by definition, result in achievement of water quality standards for the specific pollutant of concern (phosphorous).

In accordance with the Montana Water Quality Act (MCA 75-5-703(7) and (9)), the DEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. This assessment will use the suite of targets specified in Section 8.1.1.2 to measure compliance with water quality standards. If all of the target values are met, it will be assumed that water quality standards for sediment have been achieved. Alternatively, if one or more of the target values are exceeded, it will be assumed that water quality standards have not been achieved. However, it will not be automatically assumed that implementation of a TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. As noted above, the circumstances around the exceedance will be investigated. For example, might the exceedance be a result of natural causes such as floods, drought, fire, or the physical character of the watershed? In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards; or
- Revisions to components of the TMDL are necessary.

Figure 8-1 illustrates the process by which target compliance is evaluated after control measures are implemented.

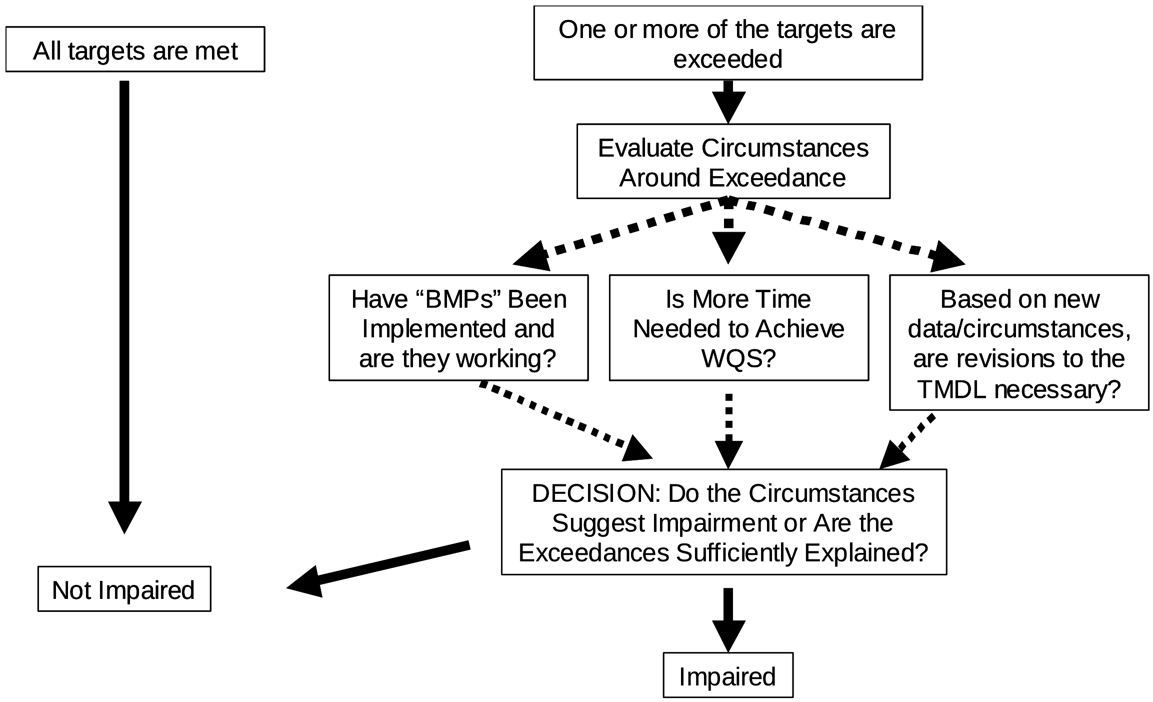

Figure 8-1. Methodology for Determining Compliance with Water Quality Standards.

8.1.1.1 Basis for Targets

Nutrient targets are based upon Montana's narrative standards and regional nutrient criteria. The standard pertaining to nutrients indicates that, "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 (1)(e)). Montana's standards that relate to nutrient enrichment are described in slightly more detail in Section 3.2. The undesirable aquatic life most commonly associated with elevated nutrient concentrations in streams are excess benthic algae and aquatic vascular plants. Aquatic plant growth becomes a nuisance when it adversely affects beneficial uses of a stream. Fisheries, recreation and aesthetics are usually the most sensitive beneficial uses of streams in Montana when considering nutrient enrichment. In shallow riffles, benthic algal chlorophyll *a* concentration is commonly used to measure the amount of aquatic plant growth on the stream bottom. Therefore, TMDL water chemistry and benthic chlorophyll *a* targets are based upon preventing excess growth of benthic algae.

The exception to the application of narrative standards is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (0.300 mg/l) and total phosphorus (0.020 mg/l upstream of the confluence with the Blackfoot River and 0.039 mg/l downstream of the confluence) as well as algal biomass measured as chlorophyll *a* (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

Water Chemistry Targets

Two nutrient concentration target values have been developed for Big Spring Creek. These values are: 0.035 mg/L total phosphorus (TP) and 0.500 mg/L total nitrogen (TN). Nitrogen and phosphorus are the two macronutrients most commonly found to limit algae growth in aquatic systems (Ryther and Dunstan, 1971; Schindler, 1977; Howarth, 1988). The N and P concentrations above were derived using the following approach. A starting point was provided by the ecoregional nutrient concentration recommendations of the U.S. EPA (EPA, 2001). EPA's recommended values for the ecoregion in which Big Spring Creek is located range from 0.023-0.029 mg/L for TP and 0.380-0.650 mg/L for TN. A study on the Clark Fork River (CFR) showed that holding TN below 0.500 mg/L greatly decreased the likelihood of nuisance algae levels (Dodds et al., 1997). Total N concentration water quality data for Big Spring Creek were scant, but generally ranged from about 0.250 to 0.600 mg/L. **Therefore, 0.500 mg/L TN was selected as a reasonable target value.**

Kahlert (1998) reports that freshwater benthic algae cellular N:P ratios higher than 15 (by weight) indicate that algal growth are limited by P. The Big Spring Creek target values should strive to maintain stream-water N:P concentration ratios at 15 or higher if limitation of nuisance algae growth by P is to be achieved. At a total N:P ratio of 15, the 0.500 mg/L TN discussed above equates to 0.035 mg/L TP. This value is only slightly above the EPA's recommended ecoregional values, and also falls between the two TP standards for the Clark Fork River which are 0.020 and 0.039 mg/L for the upstream and downstream segments of the river, respectively (ARM 17.30.631). Review of water quality data from Big Spring Creek from STORET showed that above the Lewistown wastewater treatment plant (WWTP) median TP concentrations were 0.010 mg/L, whereas just below the plant they increased to 0.075 mg/L (median). **Given these considerations, 0.035 mg/L TP appears to be a reasonable target for Big Spring Creek.**

As TP and TN target concentrations are intended to control nuisance algal growth during summer growing periods, **TP and TN targets will apply from June 1st to November 1st.**

Benthic Chlorophyll-a Targets

The Clark Fork River Nutrient Standards and DEQ data for prairie regions were used to guide professional judgment on appropriate chlorophyll *a* targets for the Big Spring Creek TPA. Detailed analysis of the relationship between benthic algal chlorophyll-*a* densities and nutrient concentrations has been conducted in the Clark Fork River, Montana. Benthic algal chlorophyll *a* standards for the Clark Fork River are 100 mg/m^2 mean summer concentration and 150 mg/m^2 maximum summer concentration. The algal and nutrient standards for the Clark Fork River are comparable to Big Spring Creek because portions of the Clark Fork River watershed and the Big Spring Creek watershed lie within the same ecoregion (Montana Valley & Foothill Prairie).

Montana DEQ has also conducted field sampling for setting algal biomass and nutrient standards in wadeable streams of the *northwestern glaciated plains* ecoregion (Suplee, 2004). Results from this effort show that average summer chlorophyll-*a* concentrations for streams that have filamentous algae and macrophyte growth are in the 10-130 mg/m^2 range. It appears that even though the *northwestern glaciated plains* ecoregion contains soils and geology with higher nutrient composition than the *Montana valley and foothill prairies* ecoregion, the 100 mg/m^2 average and 150 mg/m^2 maximum benthic chlorophyll-*a* CFR standards are a reasonable approximation of appropriate target values for Big Spring Creek.

CFR chlorophyll-*a* standards are also comparable to benthic chlorophyll *a* concentration guidance for trout streams outlined in a New Zealand periphyton guideline document (Biggs, 2000). In New Zealand, gravel-bottomed trout streams are recommended to have no more than 120 mg/m^2 chlorophyll-*a*. Although New Zealand is geographically distant, water quality information from this country is comparable to many of Montana's streams because landscape, water uses and climate is similar.

Considering acceptable ranges of benthic chlorophyll-a concentrations from a variety of sources, the **target for chlorophyll-a concentration in Big Spring Creek is 100 mg/m^2 mean summer (June 1st – Nov 1st) concentration and 150 mg/m^2 maximum summer concentration.**

8.1.1.2 Nutrient Target Values

A summary of nutrient target values, compliance points, sampling methods and sampling frequency is given in Table 8-1.

Table 8-1. Nutrient Water Quality Targets for Big Spring Creek (MT41S004_020).

Indicator	Target Value	Compliance Points	Sampling Method	Frequency
Total Nitrogen Concentration	June 1st – Nov 1st **0.500 mg/L**	M22BSPRC12 M22BSPRC03 M22BSPRC08 M22BSPRC10	Grab Samples DEQ SOPs	3x/year July Aug October
Total Phosphorous Concentration	June 1st – Nov 1st **0.035 mg/L**	M22BSPRC12 M22BSPRC03 M22BSPRC08 M22BSPRC10	Grab Samples DEQ SOPs	3x/year July Aug October
Benthic Chlorophyll-a Summer Concentration	June 1st – Nov 1st **100 mg/m^2 mean** **150 mg/m^2 maximum**	M22BSPRC12 M22BSPRC03 M22BSPRC08 M22BSPRC10	DEQ SOPs	3x/year July Aug October

8.1.1.3 Comparison of Target Values to Existing Conditions

Water Chemistry (TN and TP)

Upstream of Lewistown, eight nutrient samples were taken from 1998 through 2003. Total nitrogen ranged from 0.090 mg/L to 0.38 mg/L with and average of 0.173 mg/L TN. Total phosphorous values ranged from 0.005 to 0.011 mg/L with an average concentration of 0.008 mg/L TP. There were no exceedances of TP and TN targets.

Downstream of Lewistown, from the Lewistown to Cottonwood Creek, nine nutrient samples were taken from 1998 through 2003. Total nitrogen ranged from 0.100 to 1.010 mg/L, with an average of 0.453 mg/l TN. Total phosphorous ranged from 0.022 to 0.068 mg/L, with an average of 0.044 mg/l TP. TN target values were exceeded in two of the nine samples (22%) and occurred during spring runoff (May 2003). **TP target values were exceeded in seven of the nine samples (78%).**

Downstream of Lewistown, from Cottonwood Creek to the mouth, nine nutrient samples were taken from 1998 through 2003. Total nitrogen ranged from 0.100 to 0.650 mg/L, with an average of 0.319 mg/l TN. Total phosphorous ranged from 0.013 to 0.036 mg/L, with an average of 0.023 mg/l TP. TN target values were exceeded in only two of the nine samples (22%) and occurred during spring runoff (May 2003). TP target values were exceeded in one sample (11%).

When seasonality of targets (June 1st – Oct 1st) is considered, TN concentrations meet target conditions at all sampling sites. TP targets are presently not being met at sites M22BSPRC03 and M22BSPRC08 downstream from the city of Lewistown (Table 8-2). **Source assessments and allocations will therefore focus on assessing and reducing sources of total phosphorous in order to meet target conditions.**

Table 8-2. Big Spring Creek - Comparison of TP & TN Targets to Existing Conditions.

Segment	Result (avg mg/L)	Target	Status
Upper Big Spring	0.173 mg/L TN	0.500 mg/L TN	Meeting Targets
Upper Big Spring	0.008 mg/L TP	0.035 mg/L TP	Meeting Targets
Middle Big Spring	0.453 mg/l TN	0.500 mg/L TN	Meeting Targets
Middle Big Spring	**0.044 mg/l TP**	**0.035 mg/L TP**	**Exceeding targets**
Lower Big Spring	0.319 mg/l TN	0.500 mg/L TN	Meeting Targets
Lower Big Spring	0.023 mg/l TP	0.035 mg/L TP	Meeting Targets

Benthic Chlorophyll-a

Benthic chlorophyll-a values exceed target conditions at all sites sampled upstream from the confluence of Cottonwood and Big Spring Creeks (Table 8-3). Samples taken on lower Big Spring Creek about ¼ mile from the mouth are meeting target conditions.

Table 8-3. Big Spring Creek - Comparison of Chlorophyll-a Targets to Existing Conditions.

Segment/Date	Result (mg/m^2)	Target	Status
Upper Big Spring Creek 2001	**280**	June 1st – Nov 1st 100 mg/m^2 mean 150 mg/m^2 maximum	**Exceeding targets**
Upper Big Spring Creek 2003	**156**		
Middle Big Spring Creek 2001	**380**		**Exceeding targets**
Middle Big Spring Creek 2003	**344** **133**		
Lower Big Spring Creek 2001	15		Meeting Targets
Lower Big Spring Creek 2003	19		

8.1.1.4 Targets - Adaptive Management, Uncertainty and Margin of Safety

Water quality targets have been established based on the best available information and the current understanding of the relationship between nutrients and aquatic plant growth. As Big Spring Creek is a unique system, predictions of biologic response to nutrient loads may not adhere to present ecoregional criteria used to establish chlorophyll-a targets.

It is understood that target attainment will not simply be an endpoint, but a process by which targets are regularly evaluated. As additional data and information is gathered and evaluated, it is anticipated that these targets may be modified to better reflect natural condition of Big Spring Creek and attainment of water quality standards.

8.1.2 Source Assessment

Nutrient source assessment includes identifying and assessing the contribution from all significant natural and human-caused sources of sediment, and factors affecting nutrient impairment conditions in Big Spring Creek (MT41S004_020). Source assessments information will be presented by major stream segment:

- Upper Big Spring Creek from headwaters to Casino Creek
- Middle Big Spring Creek from Casino Creek to Cottonwood Creek
- Lower Big Spring Creek from Cottonwood Creek to the mouth

Nutrient sources in Big Spring Creek include point (Lewistown wastewater treatment plant) and nonpoint sources (land use and streambank sources, urban). Source assessments were conducted using mainly empirical data on nutrient concentrations. A nutrient model was also employed to estimate the contribution from land use and streambank sources (Appendix E). Nutrient inputs derived from the model were based on a series of assumptions, and should not be relied on to generate numeric nutrient loads. Modeling output has been used to provide general estimations of relative natural and anthropogenic loads derived from land uses and bank erosion estimates in Big Spring Creek, and should be considered as evidence to support empirical conclusions.

Based on source assessments from both empirical and modeled phosphorous loads, the major factor influencing nutrient impairment conditions in Big Spring Creek is phosphorous discharge from the Lewistown wastewater treatment plant (WWTP). Lesser inputs are received from nonpoint source urban inputs and nonpoint source inputs from agricultural and other land uses, however these are minor in relation to the present WWTP load.

Figure 8-2 shows all phosphorous data locations on Big Spring Creek since 1998, from June 1st though Nov 1st. Total phosphorous target exceedances are marked as red dots, sampling sites with no TP exceedances are marked as yellow dots.

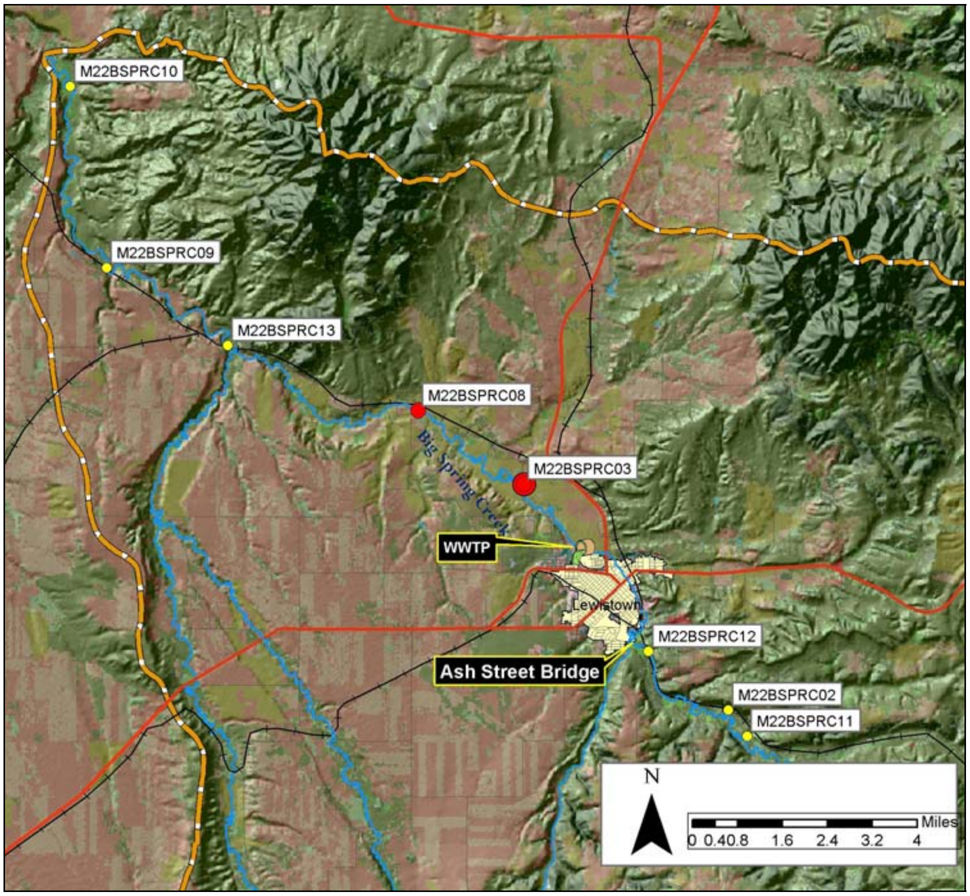

Figure 8-2. Total P Sampling Locations on Big Spring Creek (1998-2003).

8.1.2.1 Upper Big Spring Creek from Headwaters to Casino Creek

Water quality data shows that TN and TP targets in upper Big Spring Creek are currently being met (Section 8.1.1.3). However, chlorophyll-a targets are exceeded at two sites (M22BSPRC02, BSPRC12). While nutrient concentrations in upper Big Spring Creek are low (0.173 mg/L avg TN, 0.008 mg/L vg TP), the presence of high chlorophyll-a levels suggests that nutrients are available for algal growth. In the absence of supporting numerical nutrient data and detailed source assessments for upper Big Spring Creek, it is difficult to ascertain whether this condition is natural or a response to local anthropogenic inputs.

Residential development, streambank erosion, fish hatcheries, and agriculture along upper Big Spring Creek may contribute nutrients affecting aquatic growth. Natural spring inputs may also be contributing nutrient loads responsible for aquatic growth. Modeled annual TP loads for upper Big Spring Creek estimated that 89% of the total phosphorous load was from natural sources. Anthropogenic sources related to land use accounted for the remaining 11%. Modeling loads, however, were computed as an annual load. As most nutrient loads from land use and streambank sources enter streams during spring runoff periods, it is expected that summertime nutrient loads from these sources are significantly less than that which is estimated using an ‘annual load’ approach. Considering this, it is presumed that anthropogenic summertime TP loads are considerably less than 10% of the total load from upstream sources. Additional investigation, however, is required to determine the causes of chlorophyll exceedances upstream from Lewistown, and to fully assess the load contributions from individual source categories.

A numeric load, however, can be computed using water quality data. Measured flows at the Ash Street bridge (years 1979-1993), just upstream from the Casino Creek confluence, ranged from 88 cfs to a maximum of 726 cfs, with an estimated average of 110 cfs for months June through October. Assuming an average flow of 110 cfs and an average measured TP concentration of 0.008 mg/L, the average summer phosphorous load from upper Big Spring Creek is **4.75 lbs/day.** Phosphorous concentrations are typically higher during runoff and high flow events. Data on phosphorous concentrations associated with higher flows is necessary in order to estimate phosphorous loads under different flow conditions. Based on three data points, the flow/concentration curve in Figure 8-3 was generated to estimate phosphorous concentrations under different flow conditions.

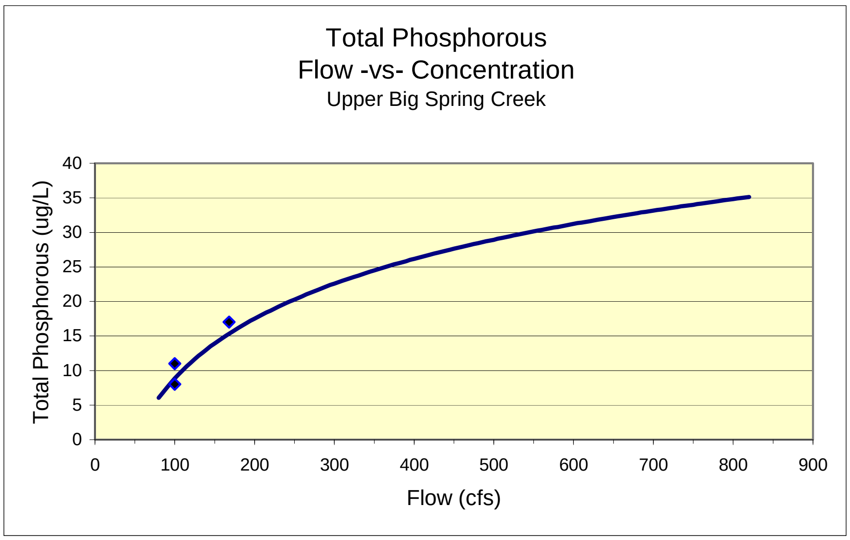

Figure 8-3. Total phosphorous concentration/Flow curve for upper Big Spring Creek.

Phosphorous loads for different flow conditions (Table 8-4) were estimated using TP concentrations from Figure 8-3. Further data collection should be conducted to calibrate the flow/concentration curve in Figure 8-4 so that more accurate loading estimates may be made.

Table 8-4. Estimated Phosphorous Loads from Upper Big Spring Creek.

Flow (cfs)	Phosphorous Load (lbs/day)
80	2.59
88	3.46
110	4.75
150	11.24
200	18.88
250	27.34

8.1.2.2 Middle Big Spring Creek from Casino Creek to Cottonwood Creek

Water quality data shows that TN targets in middle Big Spring Creek are currently being met (Section 8.1.1.3). TP targets are exceeded in all samples (n=5) taken at M22BSPRC03 and 50% of the samples (n=4) taken at M22BSPRC08 (Figure 8-2). Likewise, chlorophyll-a targets are exceeded at sites M22BSPRC03 and M22BSPRC08. Significant increases in chlorophyll-a concentrations between upstream and downstream sites points to an increase in nutrient loading in this reach.

Phosphorous sources in middle Big Spring Creek include:

- Lewistown WWTP
- Urban stormwater and nonpoint sources
- Land use sources
- Tributary inputs.

Lewistown Wastewater Treatment Plant

The average daily summer phosphorous load from the Lewistown WWTP is <u>22.9 lbs/day</u>, based on discharge monitoring report (DMR) data submitted to DEQ for years 1995-2000. Measured at the Ash St Bridge, flows range from 88 to 238 cfs for months July through October (unpublished data). At average low summer flows (110 cfs estimated), a 22.9 lbs/day load discharge from the WWTP plant corresponds to an increase of 0.039 mg/l in TP concentration in Big Spring Creek. Data collected at sites upstream and downstream from the WWTP in 1998, 2001 and 2003 confirm this calculated increase in summer TP concentrations (Figure 8-4).

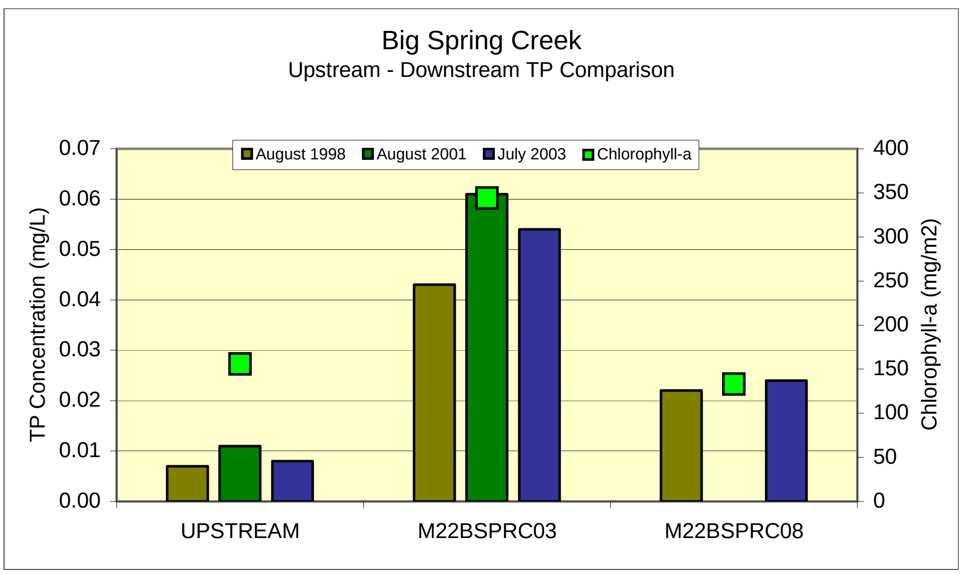

Figure 8-4. Big Spring Creek Upstream/Downstream TP comparison.

Attenuation of TP values downstream (M22BSPRC08) is likely a function of several factors: addition of low-P groundwater inputs, diversion of high-P creek water for irrigation between

M22BSPRC03 and M22BSPRC08, assimilation and cycling of nutrients through biologic activity.

Accompanying the increase in TP loading from the Lewistown WWTP are significant increases in algal biomass densities recorded at sites, M22BSPRC03 and M22BSPRC08. Chlorophyll-a values at site M22BSPRC03 were 380 mg/m^2 and 344 mg/m^2 in 2001 and 2003. A drop in chlorophyll-a (133 mg/m2) correlated to a corresponding drop in nutrient concentrations at site M22BSPRC08 (Figure 8-4).

Urban Storm Water and Nonpoint Sources

Big Spring Creek flows through the city of Lewistown picking up nonpoint source nutrients from industrial, residential and commercial sources (Figure 5-11). Storm water runoff and nonpoint pollution inputs from streets, construction sites, parking lots, or other impervious or disturbed areas can be a source of nutrients if proper controls are not in place.

The total phosphorous load from **storm water and nonpoint sources** through Lewistown was computed using a simple model. Storm water and nonpoint source load is the cumulative TP load that enters storm water collection drains or is directly delivered to Big Spring Creek. The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration, as:

$$L = 0.226 * R * C * A$$

Where: L = Annual load (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

Annual runoff was calculated as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P * P_j * Rv$$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches)
P_j = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

Loads were calculated by using a median concentration value of 0.65 mg/l TP, representing arid and semi-arid watersheds (Caraco, 2000). Results of the loading calculation are shown in Table 8-5.

Table 8-5. Annual Total Phosphorous (TP) Storm Water Loads to Big Spring Creek.

	Estimated Annual Load (lbs/yr)
Annual Residential TP Load	529
Annual Commercial TP Load	179
Annual Industrial TP Load	35
Annual Roadway TP Load	15
Total Annual Storm water Load (lbs/yr)	**758**

Based on this analysis, the average TP load to Big Spring Creek is 2.1 lbs/day. Considering that annual TP loads are based on annual precipitation, that summertime load inputs are largely driven by precipitation events, and approximately 1/3 of Lewistown's annual precipitation falls during the target dates of June 1st to Nov 1st, an average summertime load of less than 2.1 lbs/day is expected: **0.7 lbs/day seems a reasonable estimate of average TP summer loads from urban stormwater and nonpoint sources.**

Land Use and Streambank Sources

Phosphorous inputs from land use sources and streambank sources for this segment was not calculated based on empirical data or field verification. A nutrient export model (Appendix D) was used to estimate *annual* TP contributions from these sources. Based on estimated annual loads for the entire reach from Casino Creek to Cottonwood Creek, 52% of TP loads were from natural sources (streambank erosion and land use inputs), 18% were from anthropogenic sources (streambank erosion and land use inputs), and 30% was from TP discharges from the Lewistown WWTP. Again, this estimate likely represents an overestimation on anthropogenic streambank erosion and land use sources as most nutrient input from these sources occurs outside the period of summer low-flow conditions. In addition, modeling estimates anthropogenic TP loading from streambank and land uses are computed for the *entire* reach from Lewistown to Cottonwood Creek: any potential phosphorous loads between Casino Creek and sampling site M22BSPRC03 are minimal, and likely not significant when compared to the load contributed from the Lewistown WWTP. Empirical data shows a strong correlation between known WWTP inputs and instream water quality data, suggesting summer land-use loads are not significant phosphorous contributors in this segment**. Based on this information, a best professional judgment estimate of the daily phosphorous load from land use and streambank sources for the reach from Casino Creek to sampling site M22BSPRC03, is estimated at <1 lb/day.**

Tributary Sources

Tributaries that enter Big Spring Creek through the urban area of Lewistown include Casino Creek, Little Casino Creek, Breed Creek, and Boyd Creek. Cumulatively, the flow from these tributaries during summertime low-flow conditions does not typically exceed 4 to 5 cfs maximum (Tews 2005, personal communication). Using the maximum summertime TP concentration measured on Casino Creek (0.070 mg/l TP) and a cumulative flow of 5 cfs for these four tributaries, the load from tributaries is estimated to be a maximum of 1.9 lbs/day. **Actual loads during low flow conditions (<4 cfs) can reasonably be estimated at <1 lb/day.** This load estimate is based on assumptions regarding phosphorous concentrations and flows;

additional flow and water quality monitoring should be conducted to provide data with which to calculate actual phosphorous loads. Nutrient condition in Casino Creek is discussed more thoroughly in Section 8.3.

8.1.2.3 Lower Big Spring Creek from Cottonwood Creek to the Mouth

Water quality data shows that TN, TP and chlorophyll-a targets in this segment are currently being met (Section 8.1.1.3). Phosphorous TMDLs should therefore be aimed at controlling phosphorous sources in middle Big Spring Creek to ensure that water quality targets are being met. By controlling upstream phosphorous sources, it is assumed that water quality targets in lower Big Spring Creek will be maintained.

A major tributary to Big Spring Creek, Cottonwood Creek, enters Big Spring Creek at the upstream boundary of this segment. Cottonwood Creek is listed for impaired for nutrients, however, summertime flows from Cottonwood Creek are very low (typically less than 5 cfs) and do not appear to contribute appreciable nutrient loads to Big Spring Creek: nutrients and chlorophyll-a data in this section of Big Spring Creek meet water quality targets. Cottonwood Creek, itself, is addresses in Section 8.2.

Modeling estimated that for the entire reach, 83% of TP loads were from natural sources (streambank erosion and land use inputs) and 17% was from anthropogenic sources (streambank erosion and land use inputs). Again, this estimate likely represents an overestimation on anthropogenic streambank erosion and land use sources as most nutrient input from these sources occurs outside the period of summer low-flow conditions.

8.1.2.4 Source Assessment Summary

Based on discharge monitoring reports, empirical TP data, modeled estimates and professional assumptions, the Lewistown WWTP appears to be the major source of TP loads to Big Spring Creek during critical flow periods (<110cfs). It is expected that reduction in phosphorous loads from the WWTP will result in achieving water quality targets at all sites downstream from the WWTP. A summary of estimated phosphorous loads under different flow conditions is given in Table 8-6.

Table 8-6. Estimated Phosphorous Loads to Middle Big Spring Creek (lbs/day) by Source Category.

Flow	Upper Big Spring Creek	Urban	Land Use	Tributaries	WWTP	Total Load
80	2.6	0.7	1.0	1.0	22.9	**28.2**
88	3.5	0.7	1.0	1.0	22.9	**29.1**
110	4.8	0.7	1.0	1.0	22.9	**30.4**
150	11.2	0.7	1.0	1.5	22.9	**37.3**
200	18.9	0.7	1.0	1.5	22.9	**45.0**
250	27.3	0.7	1.0	2.0	22.9	**53.9**

8.1.2.5 Source Assessment - Uncertainty and Adaptive Management

Nutrient source assessments were conducted using a variety of data and methods. Due to inherent uncertainties, flexibility to adjust nutrient-loading estimates based on inferences drawn from limited data is principal to adaptive management. It is expected that, as additional data and information becomes available, inferences and assumptions will be revisited and reevaluated. Relevant uncertainties associated with selected source categories are addressed below.

Flow Uncertainties

Estimates of in-stream TP concentrations were based on flow assumptions. Flow data for Big Spring Creek is incomplete. Flow data taken at the Ash Street Bridge and historic flow data from USGS station No. 06111500 was used to base estimates of streamflow for loading purposes. As additional flow data is collected, loading estimates may be adjusted to reflect all current and available flow data.

Modeling Uncertainties

It is understood that nutrient source modeling is intended to provide general estimations of loading from different sources. A discussion of uncertainties inherent in this approach is given in Appendix E.

Urban Source Uncertainties

While TP load estimated from a simple storm water model is a source of low significance, it is a conceptual estimation and may not reflect actual conditions. Development and implementation of a monitoring strategy (Section 5.1.4) to gather storm water and urban nonpoint source data will greatly reduce this uncertainty and allow for accurate estimates of storm water loads entering Big Spring Creek.

Other Sources

Phosphorous source assessments were conducted using available data. Effort was made to assess the most significant sources of phosphorous loading to Big Spring Creek. It is possible that additional unassessed sources exist. If and when additional sources are identified and defined, they will be included in phosphorous loading analysis.

While it is not expected that tributaries that enter Big Spring Creek through the urban influence (Casino Creek, Little Casino Creek, Boyd Creek) contribute a significant nutrient load to Big Spring Creek, little data exists to confirm this supposition. Loading estimates from tributaries was based on observed rather than measured flows. In addition, no TP concentrations were available for tributaries, Breed Creek, Boyd Creek, and Little Casino Creek. It was assumed that TP concentrations in these tributaries are similar to or less than TP concentrations measured in Casino Creek. Additional monitoring of tributaries and Big Spring Creek above and below tributary inputs will assist in determining whether tributary inputs contribute appreciable nutrient loads, specifically TP, to Big Spring Creek, and will assist in refining loading estimates from tributaries.

Upstream loads are estimated using a flow/concentration curve given in Figure 8-3. At higher flows, loads from Upper Big Spring Creek given in Table 8-6 are a significant component of the TMDL. Actual TP concentrations at higher flows are speculative at this time, however, and additional TP concentrations should be collected under a variety of flow conditions in order to better estimate phosphorous loads from upstream sources.

8.1.3 Total Maximum Daily Loads and Allocations

8.1.3.1 TMDLs

The Clean Water Act requires States to identify waters not meeting water quality standards and to develop a plan that when implemented, will result in achievement of water quality standards. The framework for these plans is the Total Maximum Daily Load (TMDL) program. A TMDL is essentially a prescription designed to restore the health of the polluted body of water by indicating the amount of pollutants that may be present in the water and still meet water quality standards. The water quality targets presented in Section 8.1.1 provide the endpoint water quality goal. The TMDL provides a quantification of the means to achieve this goal.

The phosphorous TMDL for Big Spring Creek is the amount of total phosphorus (TP) that the stream can receive from all sources and still meet TP targets at selected compliance points. The TMDL is the sum of the waste load allocation (WLA), or point sources, plus the sum of the load allocations (LA), or natural and anthropogenic nonpoint sources, plus a margin of safety (MOS).

$$\textbf{TMDL} = \Sigma \textbf{WLA} + \Sigma \textbf{LA} + \textbf{MOS}$$

The phosphorous TMDL is set for the summer (June 1st – October 1st) when biological in-stream beneficial uses are impacted by the availability of excess nutrients. Big Spring Creek summer phosphorous TMDLs are based upon a maximum in-stream target concentrations of 0.035 mg/L total phosphorous. Since in-stream TP concentrations are a function of streamflow, the allowable total maximum daily load of a pollutant will vary with flow.

While accurate summertime flow data through the city of Lewistown is scant, flows range from extreme highs over 600 cfs to extreme lows of 80 cfs. Typically, average summertime flows range from 100 to 200 cfs, with higher flows reported in June and early July. At typical low summertime flows (~88cfs), the total maximum daily load of phosphorous that will result in compliance with the in-stream target concentration of <0.035 mg/L TP is 16.6 lbs/day. At average summertime flows (~110 CFS), the total maximum daily load is 20.8 lbs/day of phosphorous. Figure 8-5 illustrates the relationship between the total maximum daily load of phosphorous and streamflow.

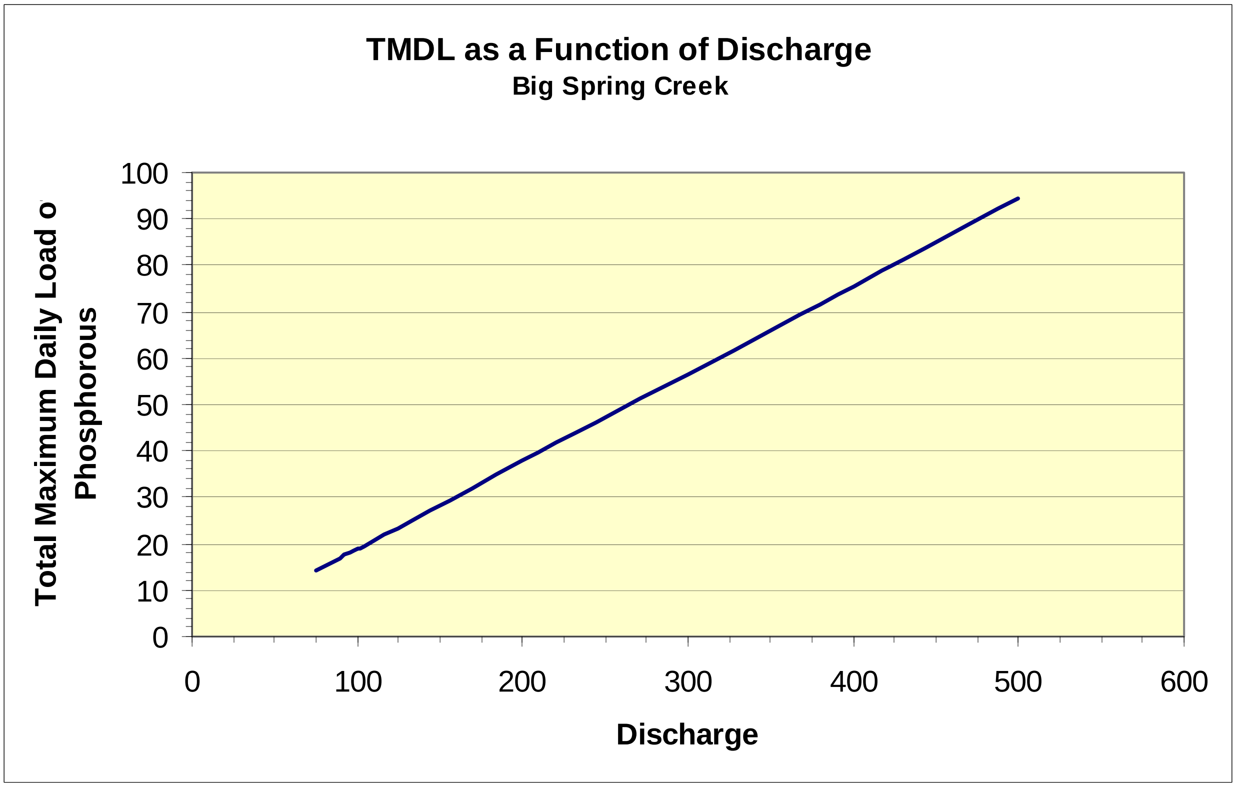

Figure 8-5. Allowable total maximum daily loads as a function of discharge for Big Spring Creek.

Because the allowable phosphorous load is a function of flow, a static TMDL for phosphorous is not appropriate. Rather, the TMDL shall be the maximum phosphorous load allowed under specific flow conditions that will result in meeting water quality targets. Table 8-7 presents the Total Maximum Daily Load, estimated existing loads, and the necessary load reduction needed to meet the TMDL for phosphorous under different flow conditions.

Table 8-7. TMDL, Existing Loads, and Load Reductions for Middle Big Spring Creek.

Flow (cfs)	TMDL (lbs/day)	Existing Load (lbs/day)	Load Reduction (lbs/day)
80	15.1	28.2	13.1
88	16.6	29.1	12.5
110	20.8	30.4	9.6
150	28.3	37.3	9.0
200	37.8	45.0	7.2
250	47.2	53.9	6.8

Compliance with targets shall be used as the water quality endpoint, and determines whether the TMDL is achieved. For instance, at 88 cfs (typical low summer flows), the TMDL of phosphorous is calculated to be 16.6 lbs/day. At a flow of 200cfs, the TMDL of phosphorous is calculated to be 37.8 lbs/day. Permitted discharges should take flow into account when establishing load limits.

8.1.3.2 Allocations

At lower flows (<110 cfs) greater that 75% of the total phosphorous load from sources upstream of M22BSPRC03 is from effluent discharges from the Lewistown wastewater treatment plant. Additional load comes from unsourced upstream contributions, however modeling results estimate that this load is >90% from natural sources. The sum of additional loads (tributaries, urban, land use) makes up less than 10% of the total load.

The TMDL for phosphorous will be achieved through a load reduction allocated to the Lewistown wastewater treatment plant, and will result in meeting water quality targets at downstream compliance points (Table 8-1). The TMDL of phosphorous is the sum of the wasteload allocations, load allocations and a margin of safety: TMDL = ΣWLA + ΣLA + MOS. A margin of safety of 10% of the total maximum daily load is used, and is incorporated into load allocations given below. Table 8-8 presents TMDLs and load allocations for different flow conditions in Big Spring Creek.

Table 8-8. Phosphorous TMDLs and Allocations for Big Spring Creek.

Flow	**TMDL**	**ΣWLA** (lbs/day)	**ΣLA** (lbs/day)				**MOS**
(cfs)	(lbs/day)	**Lewistown WWTP**	**Upstream Load**	**Urban**	**Land Use**	**Tributaries**	(lbs/day)
80	15.1	8.3	2.6	0.7	1.0	1.0	1.5
88	16.6	8.8	3.5	0.7	1.0	1.0	1.7
110	20.8	11.3	4.8	0.7	1.0	1.0	2.1
150	28.3	11.0	11.2	0.7	1.0	1.5	2.8
200	37.8	11.9	18.9	0.7	1.0	1.5	3.8
250	47.2	11.9	27.3	0.7	1.0	1.5	4.7

It is expected that the load allocation given to the Lewistown WWTP will result in attainment of water quality targets, however, assumptions used in generating load allocation estimates from other phosphorous sources were based on limited data and information. Target compliance should be monitored according to the schedule given in Table 8-1 to verify whether recommended load reductions have the desired water quality effect.

8.1.3.3 TMDLs and Allocations - Adaptive Management, Uncertainty and Margin of Safety

Based on present knowledge of conditions and processes affecting impairment, it is expected that when recommended load reductions are emplaced Big Spring Creek will meet water quality targets. However, uncertainty is inherent when developing load allocations and reductions. Understanding and developing an appropriate allocation requires an adaptive management approach that allows for adjustment as uncertainty is reduced. As additional information and data becomes available, adjustments to load reductions may be warranted and should be considered. Consequently, allocations should not be considered a static, rigid endpoint, but a flexible guideline that is apt to change as additional information is assessed and evaluated.

Likewise, applying a margin of safety is a required component of TMDL development. The margin of safety (MOS) accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. A margin of safety of <u>10% of the total maximum daily load</u> is incorporated into the allocations given in Table 8-8.

8.1.4 Restoration and Implementation Strategy

Load reductions will be conducted through the State of Montana's implementation of the National Pollutant Discharge Elimination System (NPDES). The DEQ issues permits under this system to regulate pollutant discharges to state waters. Based on discharge load limits and information presented in Section 8.1.3.2, the Permitting Section of the Montana Department of Environmental Quality will develop appropriate permit limitations and requirements for discharges from the Lewistown WWTP to Big Spring Creek.

8.1.5 Monitoring and Assessment Strategy

A monitoring and assessment strategy will evaluate the success of load reductions and permitting requirements in meeting TMDL targets. The following discussion is intended to be conceptual. It is envisioned that the first step in the implementation of this monitoring and assessment strategy will be the development of a detailed work plan and sampling and analysis plan.

Monitoring and assessment goals include:

1. Evaluating targets and assessing target attainment
2. Establishing adequate flow information
3. Investigating & delineating potential nutrient sources

8.1.5.1 Evaluating Targets and Assessing Target Attainment

Water quality targets, compliance points, sampling methods and sampling frequencies are given in Table 8-1. Established sampling sites are chosen above Lewistown (M22BSPRC12), below the WWTP (M22BSPRC03 and M22BSPRC08) and downstream from Cottonwood Creek near the mouth (M22BSPRC10). Monitoring of water quality targets at each site will assess whether load reductions result in target attainment. If load reductions do not result in the expected water quality response, targets will be evaluated according to the methodology presented in Figure 8-1.

8.1.5.2 Establishing Adequate Flow Information

Accurate flow information is integral to developing a TMDL that reflects proper conditions and includes an accurate and acceptable margin of safety. Flows used to develop the TMDL were based on the best available data, however establishing a flow gauging station downstream from Lewistown and upstream from the WWTP will allow accurate flow measurement with which to measure low flow conditions and to adequately determine the upstream TP load. Establishing the range of flows and low flow conditions immediately upstream from the Lewistown WWTP outfall will allow a more accurate flow with which to establish future NPDES permit requirements. Flows on tributary inputs are also essential to estimating phosphorous loads from tributary inputs.

8.1.5.3 Investigating Potential Nutrient Sources

The continued assessment and evaluation of nutrient source should be monitoring and assessment priority. Although presently unassessed, residential development on upper Big Spring Creek has the potential to increase nutrient loads to Big Spring Creek. High chlorophyll-a values at sites M22BSPRC02 and M22BSPRC12 suggest that localized nutrient sources may be significant and contributing to algal growth. Whether this algal growth is a natural condition is unknown at this time.

Other potential local nutrient sources that should be assessed through monitoring and source assessments include:

- Storm water and nonpoint sources through the city of Lewistown
- Residential sources associated with housing development, land clearing and construction
- Livestock feedlots and animal feeding operations (AFOs)
- Fish hatchery discharges

While numeric data suggests that the above sources do not currently appear to be contributing appreciable nutrients concentrations to Big Spring Creek, the potential exists for local impacts in the form of depressed aquatic communities, nuisance algal growth or other detrimental effects. Local resource managers, landowners and city officials should be vigilant in addressing and reducing pollutant sources where appropriate.

Establishment of a monitoring site to differentiate nutrient loads from urban and rural that enters Big Spring Creek through the city of Lewistown is integral to understanding nutrient source loading to Big Spring Creek. Given the variety of potential nutrient sources, it is recommended that monitoring sites be established, and water quality be monitored in order to distinguish between different nutrient source loads that enter Big spring Creek in the proximity of Lewistown.

8.2 Cottonwood Creek

8.2.1 Nutrient Targets

In accordance with the Montana Water Quality Act (MCA 75-5-703(7) and (9)), the DEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. This assessment will use the suite of targets specified in subsequent Sections to measure compliance with water quality standards and achievement of full support of all applicable beneficial uses. If all of the target values are met, it will be assumed that beneficial uses are fully supported and water quality standards have been achieved. Alternatively, if one or more of the target threshold values are exceeded, it will be assumed that beneficial uses are <u>not</u> fully supported and water quality standards have <u>not</u> been achieved. However, it will not be automatically assumed that implementation of a TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. As noted above, the circumstances around the exceedance will be investigated. For example, might the exceedance be a result of natural causes such as floods, drought, fire, or the physical character of the watershed? In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards; or
- Revisions to components of the TMDL are necessary.

This methodology is described in Figure 8-1.

8.2.1.1 Basis for Targets

Most waters of Montana are protected from excessive nutrient concentrations by narrative standards, with the exception of the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/l) and total phosphorus (20 ug/l upstream of the confluence with the Blackfoot River and 39 ug/l downstream of the confluence) as well as algal biomass measured as chlorophyll *a* (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

The narrative standards applicable to nutrients elsewhere in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.). The prohibition against the creation of "*conditions, which produce undesirable aquatic life*" is generally the most relevant to nutrients. This narrative standard does not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. Narrative standards translated into water quality goals should strive toward a condition that reflects a waterbody's greatest potential for water quality given current and historic land use activities, where *all reasonable land, soil, and water conservation practices* have been applied.

Water quality targets for Cottonwood Creek (MT41S004_052) include parameters that reflect:

- Reduction of summertime dissolved oxygen fluctuations.
- Decrease in streambed coverage by filamentous algae.
- Maintenance of benthic chlorophyll density.

Dissolved Oxygen Target

The target value for dissolved oxygen is to maintain minima above the Montana water quality standard for B-1 waters of 4 mg/l. Dissolved oxygen concentrations at the mouth (Figure 7-15) have fallen to levels below the State's instantaneous minima of 4 mg/L, which is applicable to "other life stages" (WQB-7; DEQ, 2004). "Other life stages" refers to young and adult fish, which certainly live in or at least transit through the mouth of Cottonwood Creek. Large DO fluctuations frequently result from heavy growths of aquatic plants (including algae) that produce oxygen during the day but then utilize it at night (Chambers et al., 1999). Dissolved oxygen depletion also results from decomposing organic material.

Filamentous Algae Cover Target

The target value for summertime streambed coverage by filamentous algae in Cottonwood Creek is ≤ 30%. This target is based on recommendations developed by DEQ to prevent nuisance algal growth. The recommendation for Montana prairie streams is for filamentous algae cover of the stream bottom to be a maximum of 30% (Suplee, 2004).

Benthic Chlorophyll-a Target

The target for chlorophyll-a concentration in Cottonwood Creek is 100 mg/m^2 mean summer (June 1st – Nov 1st) concentration and 150 mg/m^2 maximum summer concentration. Justification for this target is given in Section 8.1.1.1.

8.2.1.2 Nutrients Target Values

A summary of nutrient target values, compliance points, sampling methods and sampling frequency is given in Table 8-9.

Table 8-9. Nutrient Water Quality Targets for Cottonwood Creek (MT41S004_052).

Indicator	Target Value	Compliance Point	Measurement Method	Frequency
Dissolved Oxygen	>4 mg/l	M22CTWDC03 M22CTWDC05 M22CTWDC06	24 hour continuous field measurement of both dissolved oxygen and water temperature	1x/month mid July mid August
Filamentous algae cover	June 1st – Nov 1st ≤30 %	M22CTWDC03 M22CTWDC05 M22CTWDC06	Field observation DEQ monitoring SOPs	1x/month mid July mid August
Benthic chlorophyll	June 1st – Nov 1st ≤ 110 mg Chl a/m^2	M22CTWDC03 M22CTWDC05 M22CTWDC06	Hoop method DEQ monitoring SOPs	1x/month mid July mid August

8.2.1.3 Comparison of Target Values to Existing Conditions

Dissolved Oxygen

The useful data set for dissolved oxygen in Cottonwood Creek is limited to a single continuous-sampling event at two sites (Figure 7-9). Twenty four-hour dissolved oxygen data were logged from July 22-24th, 2003 at the mouth of Cottonwood Creek (M22CTWDC03) and upstream at a site near the Beaver Creek confluence (M22CTWDC06). Dissolved oxygen at the mouth of Cottonwood Creek ranged from 14 mg/L in the late afternoon to 3.1 mg/L at night and daily maxima and minima were 7.2 mg/L and 3.4 mg/L at the upstream location. The minima at both sites were below the target.

Filamentous Algae Cover

There are only a few ocular estimates of filamentous algae cover for Cottonwood Creek. These filed observations were made on 23 and 24 July 2004 and indicate a downstream progression of increasing algal cover as follows: M22CTWDC01 - 5 %, M22CTWDC05 30%, **M22CTWDC06 >50%**, and **M22CTWDC03 - 60 %.** Both estimates of coverage in the lower portion of Cottonwood Creek (M22CTWDC06 and M22CTWDC03) exceeded the proposed target.

Benthic Chlorophyll-a

Similar to other target parameters, there are only a single set of samples taken in July of 2003. The results ranged from 17 to 85, all below the target value. However it is believed that these data are unusable due to serious concern that the appropriate sampling method was not used for sample collection (see Section 7.5.1.3).

8.2.1.4 Targets - Adaptive Management and Uncertainty

The restoration targets have been established based on the best available information and the current understanding of the relationship between nutrients and stream health. It is understood that target attainment will not simply be an endpoint, but a process by which targets are regularly evaluated. As additional data and information is gathered and evaluated, it is anticipated that these targets may be modified to better reflect attainment of water quality standards.

8.2.2 Source Assessment

Source assessment is difficult at this point due to the paucity of data available for Cottonwood Creek. We do know that dissolved oxygen was showing extreme fluctuation at the mouth of Cottonwood Creek in July of 2003. The dissolved oxygen profiles were taken during low-flow conditions and warm temperature and are most likely representative of “worst-case” conditions. During the July 2003 dissolved oxygen study both daytime and night dissolved oxygen were depressed below the confluence with Beaver Creek.

8.2.2.1 Natural Sources

There are several apparent natural sources of nutrients and organic loading in the Cottonwood Creek watershed. There is a large complex of Beaver ponds on Cottonwood Creek in the vicinity of the confluence with Beaver Creek, in addition to extensive beaver pond complexes on Beaver Creek. Perhaps years of accumulation of organically rich sediment, plant material, and other detritus in the beaver pond complex impose heavy biological oxygen demand on Cottonwood Creek. The organically rich soils in current and historic beaver pond complexes and now stored as bank and bottom material may be nutrient sources. Higher temperature and low flows exacerbated by recent drought conditions also likely contribute to nuisance algal growth and low dissolved oxygen conditions.

8.2.2.2 Anthropogenic Sources

As in any developed watershed, there are potential anthropogenic sources of nutrients in the Cottonwood Creek watershed including management-exacerbated erosion, irrigation return flows, and potential for nitrogen-rich groundwater input from fallow land.

8.2.2.3 Source Assessment - Adaptive Management and Uncertainty

A detailed source assessment that identifies natural and anthropogenic sources contributing to impairment conditions in Cottonwood Creek is lacking. In the absence to information that allows identification, quantification and allocation to specific sources and contributing factors, it would be premature to speculate on the causes of impairment in Cottonwood Creek. It is likely that a suite of interrelated factors, natural and non-natural are responsible for wide dissolved oxygen fluctuations, algal growth, high water temperature and low flows. It is expected that, as additional data and information becomes available, contributing sources will be identified and over time, inferences and assumptions will be revisited and reevaluated. Section 8.2.5 outlines a monitoring strategy designed to collect data to support source assessment that will lead to appropriate TMDLs and load allocations.

8.2.3 Total Maximum Daily Loads and Allocations

As stated in Section 8.2.2.3, lack of adequate source assessment information precludes the development of total maximum daily loads, and therefore load allocations at this time. Monitoring and assessment activities are proposed to gather information in order to properly assess source contributions.

8.2.4 Restoration and Implementation Strategy

At this time, the recommendation of restoration activities is premature. Implementation of the monitoring and assessment strategy set forth in Section 8.2.5 will provide the foundation for future restorative prescriptions.

8.2.5 Monitoring and Assessment Strategy

Monitoring and assessment will focus on obtaining nutrient and dissolved oxygen/organic enrichment source information with which to base TMDLs and allocations. Monitoring and assessment goals include:

- Monitoring to evaluate targets and target attainment
- Conducting further assessments of potential nutrient sources

8.2.5.1 Target Evaluation

Targets are to be evaluated as outlined in Table 5-1, with attention to the following considerations:

1. All measurements and observations need to be done under typical late summer low-flow conditions.
2. Dissolved oxygen profiles should be done under typical summer warm to hot sunny weather conditions in addition to the flow consideration above.

8.2.5.2 Nutrient Sources

Further assessment of nutrient sources should be conducted in order to reduce uncertainty and to support development of TMDLs and load allocations, and ultimately restoration activities designed to meet water quality targets:

1. Conduct watershed field evaluation to identify potential obvious potential sources such as springs, irrigation return flows, land use practices inconsistent with water quality protection, etc. The results of the watershed field evaluation should suggest appropriate sampling sites for synoptic sampling.
2. Conduct synoptic nutrients (Total Phosphorus, Nitrate + Nitrite, Total Kjeldahl Nitrogen, and Total Suspended Solids) surveys to be collected under the following 3 scenarios:
    a. Low flow non-growing season.
    b. Low flow growing season (add chlorophyll A and ocular estimates of filamentous algae coverage for this run).
    c. High flow conditions.

   Sampling sites for the synoptic surveys should be done above and below potential sources of increased nutrients (as determined from field evaluation)
3. Dissolved oxygen, chlorophyll-a, and ocular estimates of filamentous algal growth to be collected in conjunction with target monitoring above the beaver pond complex on both Beaver and Cottonwood Creeks (upstream of the confluence of these).

8.2.5.3 Additional monitoring

Continued monitoring of macroinvertebrates and periphyton at established biomonitoring sites is recommended so that trends in biological community health can be evaluated. Duplicate samples should be taken at these sites on alternate years during the third week in August.

8.3 Casino Creek

8.3.1 Nutrient Targets

In accordance with the Montana Water Quality Act (MCA 75-5-703(7) and (9)), the DEQ is required to assess the waters for which TMDLs have been completed to determine whether compliance with water quality standards has been attained. This assessment will use the suite of targets specified in subsequent Sections to measure compliance with water quality standards and achievement of full support of all applicable beneficial uses. If all of the target values are met, it will be assumed that beneficial uses are fully supported and water quality standards have been achieved. Alternatively, if one or more of the target threshold values are exceeded, it will be assumed that beneficial uses are <u>not</u> fully supported and water quality standards have <u>not</u> been achieved. However, it will not be automatically assumed that implementation of a TMDL was unsuccessful just because one or more of the target threshold values have been exceeded. As noted above, the circumstances around the exceedance will be investigated. For example, might the exceedance be a result of natural causes such as floods, drought, fire, or the physical character of the watershed? In addition, in accordance with MCA 75-5-703(9), an evaluation will be conducted to determine whether:

- The implementation of a new or improved suite of control measures is necessary;
- More time is needed to achieve water quality standards; or
- Revisions to components of the TMDL are necessary.

This methodology is described in Figure 8-1.

8.3.1.1 Basis for Targets

Nutrient targets are based upon Montana's narrative standards and regional nutrient criteria. The standard pertaining to nutrients indicates that, "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 (1)(e)). Montana's standards that relate to nutrient enrichment are described in slightly more detail in Section 3.2. The undesirable aquatic life most commonly associated with elevated nutrient concentrations in streams are excess benthic algae and aquatic vascular plants. Aquatic plant growth becomes a nuisance when it adversely affects beneficial uses of a stream. Fisheries, recreation and aesthetics are usually the most sensitive beneficial uses of streams in Montana when considering nutrient enrichment. In shallow riffles, benthic algal chlorophyll *a* concentration is commonly used to measure the amount of aquatic plant growth on the stream bottom. **Therefore, TMDL water chemistry and benthic chlorophyll *a* targets are based upon preventing excess growth of benthic algae.**

The exception to the application of narrative standards is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (0.300 mg/l) and total phosphorus (0.020 mg/l upstream of the confluence with the Blackfoot River and 0.039 mg/l downstream of the confluence) as well as algal biomass measured as chlorophyll *a* (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

Water Chemistry Targets

Two nutrient concentration target values have been developed for the Big Spring Creek TMDL planning area. These values are: 0.035 mg/L total phosphorus (TP) and 0.500 mg/L total nitrogen (TN). Nitrogen and phosphorus are the two macronutrients most commonly found to limit algae growth in aquatic systems (Ryther and Dunstan, 1971; Schindler, 1977; Howarth, 1988). The N and P concentrations above were derived using the following approach. A starting point was provided by the ecoregional nutrient concentration recommendations of the U.S. EPA (EPA, 2001). EPA's recommended values for the ecoregion in which Casino Creek is located range from 0.023-0.029 mg/L for TP and 0.380-0.650 mg/L for TN. A study on the Clark Fork River

(CFR) showed that holding TN below 0.500 mg/L greatly decreased the likelihood of nuisance algae levels (Dodds et al., 1997). Total N concentrations for Casino Creek were scant, but generally ranged from about 0.320 to 0.880 mg/L, with a mean of 0.620 mg/L. **Therefore, 0.500 mg/L TN was chosen as a reasonable target value.**

Kahlert (1998) reports that freshwater benthic algae cellular N:P ratios higher than 15 (by weight) indicate that algal growth are limited by P. The Casino Creek target values should strive to maintain stream-water N:P concentration ratios at 15 or higher if limitation of nuisance algae growth by P is to be achieved. At a total N:P ratio of 15, the 0.500 mg/L TN discussed above equates to 0.035 mg/L TP. This value is only slightly above the EPA's recommended ecoregional values, and also falls between the two TP standards for the Clark Fork River which are 0.020 and 0.039 mg/L for the upstream and downstream segments of the river, respectively (ARM 17.30.631). Total P data for Casino Creek were scant, but generally ranged from 0.020 to 0.123 mg/L, with a mean of 0.066 mg/L. **Given these considerations, 0.035 mg/L TP is chosen as a reasonable target for Casino Creek.**

As TP and TN target concentrations are intended to control nuisance algal growth during summer growing periods, **TP and TN targets will apply from June 1st to November 1st.**

Benthic Chlorophyll-a Targets

The CFR Nutrient Standards and DEQ data for prairie regions were used to guide professional judgment on appropriate chlorophyll *a* targets for the Big Spring Creek TMDL Planning Area. Detailed analysis of the relationship between benthic algal chlorophyll-*a* densities and nutrient concentrations has been conducted in the Clark Fork River, Montana. Benthic algal chlorophyll *a* standards for the Clark Fork River are 100 mg/m^2 mean summer concentration and 150 mg/m^2 maximum summer concentrations. The algal and nutrient standards for the Clark Fork River are comparable to Casino Creek because portions of the Clark Fork River watershed and the Casino Creek watershed lie within the same ecoregion (*Montana Valley and Foothill Prairie*).

CFR chlorophyll-*a* standards are also comparable to benthic chlorophyll *a* concentration guidance for streams supporting trout outlined in a New Zealand periphyton guideline document (Biggs, 2000). In New Zealand, gravel-bottomed trout streams are recommended to have no more than 120 mg/m^2 chlorophyll-*a*. Although New Zealand is geographically distant, water quality information from this country is comparable to many of Montana's streams because landscape, water uses and climates are similar.

Considering acceptable ranges of benthic chlorophyll-a concentrations from a variety of sources, the **target for chlorophyll-a concentration in Casino Creek is 100 mg/m^2 mean summer (June 1st – Nov 1st) concentration and 150 mg/m^2 maximum summer concentrations.**

8.3.1.2 Nutrient Target Values

A summary of nutrient target values, compliance points, sampling methods and sampling frequency is given in Table 8-10.

Table 8-10. Nutrient Water Quality Targets for Casino Creek (MT41S004_020).

Indicator	Target Value	Compliance Points	Sampling Method	Frequency
Total Nitrogen Concentration	June 1st – Nov 1st **0.500 mg/L**	M22CSNOC04 M22CSNOC06	Grab Samples DEQ SOPs	3x/year July Aug October
Total Phosphorous Concentration	June 1st – Nov 1st **0.035 mg/L**	M22CSNOC04 M22CSNOC06	Grab Samples DEQ SOPs	3x/year July Aug October
Benthic Chlorophyll-a Summer Concentration	June 1st – Nov 1st **100 mg/m^2 mean** **150 mg/m^2 maximum**	M22CSNOC04 M22CSNOC06	DEQ SOPs	3x/year July Aug October

8.3.1.3 Comparison of Target Values to Existing Conditions

Water Chemistry (TN and TP)

Seven TN samples and nine TP samples were taken from 2000 through 2003. Excluding samples taken during spring runoff periods (n=2), total nitrogen ranged from 0.320 to 0.720 mg/L, with an average of 0.554 mg/l TN. Total phosphorous ranged from 0.020 to 0.123 mg/L, with an average of 0.064 mg/l TP. TN target values were exceeded in 3 of the 5 samples (60%) taken during target periods (June 1st – Nov 1st). TP target values were exceeded in 6 of 7 samples (86%). A comparison of nutrient concentration results to target conditions is given in Table 8-11.

Table 8-11. Casino Creek - Comparison of TP & TN Targets to Existing Conditions.

Sampling Site	Result (avg mg/L)	Target	Status
M22CSNOC04	0.554 mg/L TN	0.500 mg/L TN	**Exceeding Targets**
M22CSNOC06	0.064 mg/L TP	0.035 mg/L TP	**Exceeding Targets**

Benthic Chlorophyll-a

Benthic chlorophyll-a values exceeded target conditions at site M22CSNOC04. The average benthic chlorophyll-a concentration was 98 mg/m^2 for four sites sampled on Casino Creek in 2000 and 2003. A comparison of chlorophyll-a results to target conditions is given in Table 8-12.

Table 8-12. Casino Creek - Comparison of Chlorophyll-a Targets to Existing Conditions.

Sampling Site	Result (mg/m^2)	Target	Status
C1	50	June 1st – Nov 1st 100 mg/m^2 mean 150 mg/m^2 maximum	Meeting Target
M22CSNOC04	**163**		**Exceeding Target**
C2	81		Meeting Target
M22CSNOC06	99		Meeting Target
Mean summertime concentration	98		Meeting Target

8.3.1.4 Targets - Adaptive Management and Uncertainty

Water quality targets have been established based on the best available information and the current understanding of the relationship between nutrients and aquatic plant growth. It is understood that target attainment will not simply be an endpoint, but a process by which targets are regularly evaluated. As additional data and information is gathered and evaluated, it is anticipated that these targets may be modified to better reflect the 'natural condition' of Casino Creek.

8.3.2 Source Assessment

Source assessments in Casino Creek are limited to field reconnaissance and information from aerial assessments. Water quality data does not have the spatial coverage to adequately characterize contributions from different natural and anthropogenic sources. In the absence of numeric source assessment information that allows nutrient loads to be allocated to specific sources, a qualitative approach that identifies source categories and employs performance-based approaches to reduce loads for these categories is employed. A qualitative discussion of natural and anthropogenic nutrient sources in the Casino Creek watershed follows.

8.3.2.1 Natural Sources

Casino Creek has a variety of natural nutrient sources in the watershed: nutrient-rich soils, natural spring inputs, and beaver activity appear to be the most significant. Soils in the Casino Creek drainage have a high organic matter content. This, coupled with a seasonally high water table, increases the potential for nutrient contribution to Casino Creek (Rick Bandy, 2002 personal communication). The natural nutrient leaching load to Casino Creek is unknown, however, TN concentrations measured in spring inputs to Beaver Creek were measured at 0.97 and 1.15 mg/L TN, suggesting that natural nutrient loads from soils and groundwater sources in the watershed may be significant.

In addition to natural spring and soil nutrient inputs, nutrient concentrations in Casino Creek may also be naturally elevated due to the cumulative effect of past and present beaver activity (Figure 8-6). Accumulation of organically rich sediment, plant material, and other detritus in historic beaver pond complexes, now stored as bank and bottom material may be nutrient sources.

Figure 8-6. Beaver Complex on Casino Creek.

8.3.2.2 Anthropogenic Sources

Casino Creek is almost entirely privately owned and agricultural land uses dominate the watershed. Row cropping and livestock use are the predominant agricultural activities that have the potential to influence nutrient conditions in Casino Creek. Also, steep sided slopes along Casino Creek may increase overland runoff from adjacent agricultural lands and increase nutrient delivery to streams, especially where stream buffer zones are limited or streamside vegetation has been removed.. Figures 8-7 and 8-8 show potential nutrient sources on Casino Creek.

Figure 8-7. Casino Creek Cropping near the Stream Channel.

Figure 8-8. Evidence of Potential Overland Nutrient Inputs to Casino Creek.

8.3.2.3 Source Assessment - Adaptive Management and Uncertainty

A detailed source assessment that identifies natural and anthropogenic sources contributing to impairment conditions in Casino Creek is lacking. However, nutrient targets are being exceeded at several locations on Casino Creek, making a nutrient TMDL necessary. Until contributions from natural and other sources can be adequately quantified, it would be premature to speculate on the nutrient source contributions from specific sources. It is expected that, as additional data and information becomes available, contributing sources will be identified and over time, inferences and assumptions will be revisited and reevaluated. Section 8.3.5 outlines a monitoring strategy designed to collect data to support source assessment that will lead to adequate estimates of nutrient sources on Casino Creek.

8.3.3 Total Maximum Daily Loads and Allocations

The Clean Water Act requires States to identify waters not meeting water quality standards and to develop a plan that when implemented, will result in achievement of water quality standards. The framework for these plans is the Total Maximum Daily Load (TMDL) program. A TMDL is essentially a prescription designed to restore the health of the impaired body of water by indicating the amount of pollutants that may be present in the water and still meet water quality standards. The restoration targets presented in Section 8.3.1 provide the endpoint water quality goal. The TMDL provides a quantification of the means to achieve this goal.

Lack of information on natural and anthropogenic nutrient sources does not allow a quantifiable load, and therefore does not allow the specific allocation of nutrient loads to these sources. Evidence, however, suggests that nutrient levels may be elevated due to agricultural land uses in the Casino Creek drainage. Allocations will be based on controlling or managing these land use sources.

Because type and quality of data preclude calculation of a numeric (lbs/day) Total Maximum Daily Load for sediment, TMDLs will be achieved through performance based allocations. In the end, the cumulative result of implementing performance-based allocations will result in meeting the TMDL, and therefore achieving water quality standards. The EPA recognizes that quantification of all sediment loads may not be possible, and endorses the use of performance-based allocations, providing proper rationale that prescribed actions are expected to be adequate to achieve necessary load reductions (EPA, 1999).

In the absence of significant nutrient sources aside from natural and agricultural land-use sources, a performance-based allocation is given agricultural land uses in the form of compliance with Best Management Practices (BMPs).

Best Management Practices for grazing and agriculture are designed to protect stream corridors from excessive nutrient inputs by employing management techniques that maintain stabilizing stream bank vegetation and buffer zones, and by managing the timing and location of livestock grazing in riparian areas. BMP techniques involve adopting management plans: maintaining buffer zones, developing off-stream watering projects, adjusting timing and use by livestock, controlling distribution and access of livestock (BLM, 1998) or other management options designed to protect and promote riparian health and reduce nutrient input to streams.

Ongoing efforts through FWP, NRCS and the Fergus County Conservation District have already resulted in significant improvements to riparian areas along Casino Creek. Since 1995, stream improvement projects through landowner partnerships with the NRCS has resulted in over 3,000 ft of improved stream through off-stream water projects, grazing management plans and stream channel revegetation (Ted Hawn, 2003 personal communication and unpublished data). Continuation of these efforts to ensure that "reasonable land, soil and water conservation practices" are emplaced should continue and will result in reduction of nutrient inputs to 'natural' levels.

Because specific nutrient sources have not been adequately assessed, allocation of loads to specific sources cannot be conducted at this time. Rather, attention should be focused on developing land use practices that protect and maintain water quality. In the absence of information that allows load allocations to known sources, **an <u>85% compliance with agriculture and residential BMPs</u> along the length of Casino Creek is employed as an allocation scheme.**

8.3.4 Restoration and Implementation Strategy

Building and maintaining relationships between landowners and local natural resource agencies (FWP, NRCS) is integral to efforts to restore Casino Creek to an unimpaired condition. To date, local agencies and organizations such as NRCS, FWP, Fergus County Conservation District, and the Big Spring Creek Watershed Partnership have succeeded in developing and implementing a variety of projects (Table 4-3 and 5-6) that have enhanced riparian health through BMP implementation and fisheries improvement projects. The success of the public/private partnership is realized through these efforts, and the continuation of these efforts is crucial and should be the major mechanism for implementing projects aimed at restoring beneficial uses in Casino Creek and meeting water quality targets.

8.3.5 Monitoring and Assessment Strategy

Monitoring and assessment strategies will focus on gathering information that will aid in evaluating the success of BMPs in meeting water quality targets for Casino Creek. Following the methodology set forth in Figure 8-1, monitoring and assessments will focus on monitoring water quality targets following the sampling frequency and compliance points presented in Table 8-7. In addition to monitoring of water quality target compliance, additional source assessments should be conducted to help define the contribution from different nutrient source categories. The following discussion is intended to be conceptual. It is envisioned that the first step in the implementation of this monitoring and assessment strategy will be the development of a detailed work plan and sampling and analysis plan.

8.3.5.1 Evaluation of Nutrient Targets

Nutrient targets for Casino Creek have been developed based on the best available information regarding nutrient (TN and TP) concentrations and their influence on aquatic plant growth. Water quality targets will be monitored following the target compliance scheme presented in Table 8-7. As more information is gathered on Casino Creek, and natural or 'reference' condition is better defined, nutrient targets may be adjusted. Source assessments that distinguish between natural and anthropogenic loads (Section 8.3.5.1) will provide information that may help to refine water quality targets for Casino Creek.

8.3.5.2 Evaluation of Natural and Anthropogenic Nutrient Loads

Existing source assessment information does not allow loads to be allocated to specific source categories. Target exceedances are presumably the result of both natural and anthropogenic nutrient loads, however the relative contribution of natural and anthropogenic loads is unknown at this time. A detailed nutrient source assessment designed to differentiate between the two is necessary in order to adequately allocate loads to sources and develop appropriate restoration plans.

8.3.5.3 Evaluation of BMP Compliance

Monitoring of BMPs is necessary to evaluate whether performance-based allocations result in attainment of water quality targets. Plans to evaluate BMP compliance and effectiveness for both grazing/agriculture should be developed to compliment and correlate with data from target evaluation and attainment (Figure 8-1).

8.4 Seasonality Considerations

Addressing seasonal variations is an important and required component of TMDL development. Throughout this plan, seasonality is an integral factor. Water quality and habitat parameters such as flow, fine sediment, and macroinvertebrate and periphyton communities are all recognized to have seasonal cycles.

Specific examples of how seasonality has been addressed include:

- Targets where developed with seasonality in mind: nutrient TMDL targets are in effect during the summer and early fall months (June – Oct) when flows are critical, water temperatures warmer, and biologic activity the highest.
- Monitoring of flows, target indictors, and water chemistry are designed to assess critical summertime water quality conditions.
- Detailed monitoring strategies shall be designed with seasonal considerations in mind, and under the guidance of trained monitoring professionals.
- Urban stormwater phosphorous loading estimates are adjusted to accommodate for rainfall and runoff during summer months only (Section 8.1.2.2)
- Throughout this document, the data reviewed cover a wide range of seasons, years and geographic area within the Big Spring TPA.

SECTION 9.0
PUBLIC INVOLVEMENT

Public and stakeholder involvement is a component of TMDL planning efforts supported by EPA guidelines and Montana State Law. Public and stakeholder involvement ensures the development of high quality, feasible plans and increases public acceptance. Stakeholders, including the Fergus County Conservation District, Natural Resource Conservation Service, Big Springs Watershed Partnership, Montana Department of Fish, Wildlife & Parks, and the Big Spring Creek PCB Advisory Committee were involved in review and technical assistance with the final draft document. Stakeholder review drafts were provided to several agency representatives, landowners, conservation district and government representatives, and representatives from conservation and watershed groups. Comments, both verbal and written, were accepted and addressed.

An additional opportunity for public involvement is the 30-day public comment period. This public review period was initiated on December 20th, 2004 and extended to Jan 21st, 2005. At public meeting on January 10th in Lewistown, Montana provided an overview of the Water Quality Protection Plan and TMDLs for the Big Spring Creek TMDL Planning Area and an opportunity to solicit public input and comments on the plan. Appendix F includes the verbal public comments received from this meeting and via mail, as well as the DEQ response to each of these comments. Many of the comments were incorporated into this plan.

DEQ provides another opportunity for public comment during the biennial review of the 303(d) list. This includes public meetings and opportunities to submit comments either electronically or through traditional mail. DEQ announces the public comment opportunities through several media including press releases and the Internet.

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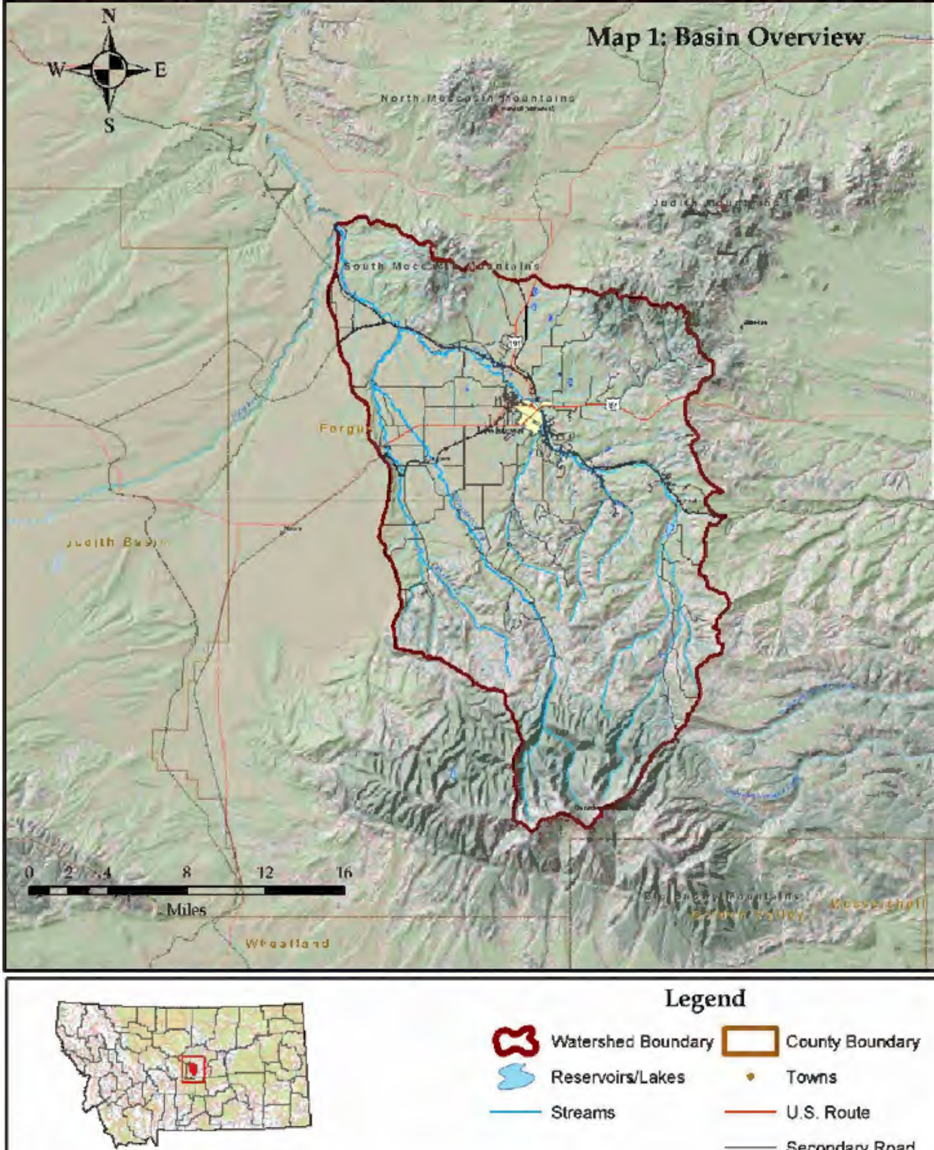
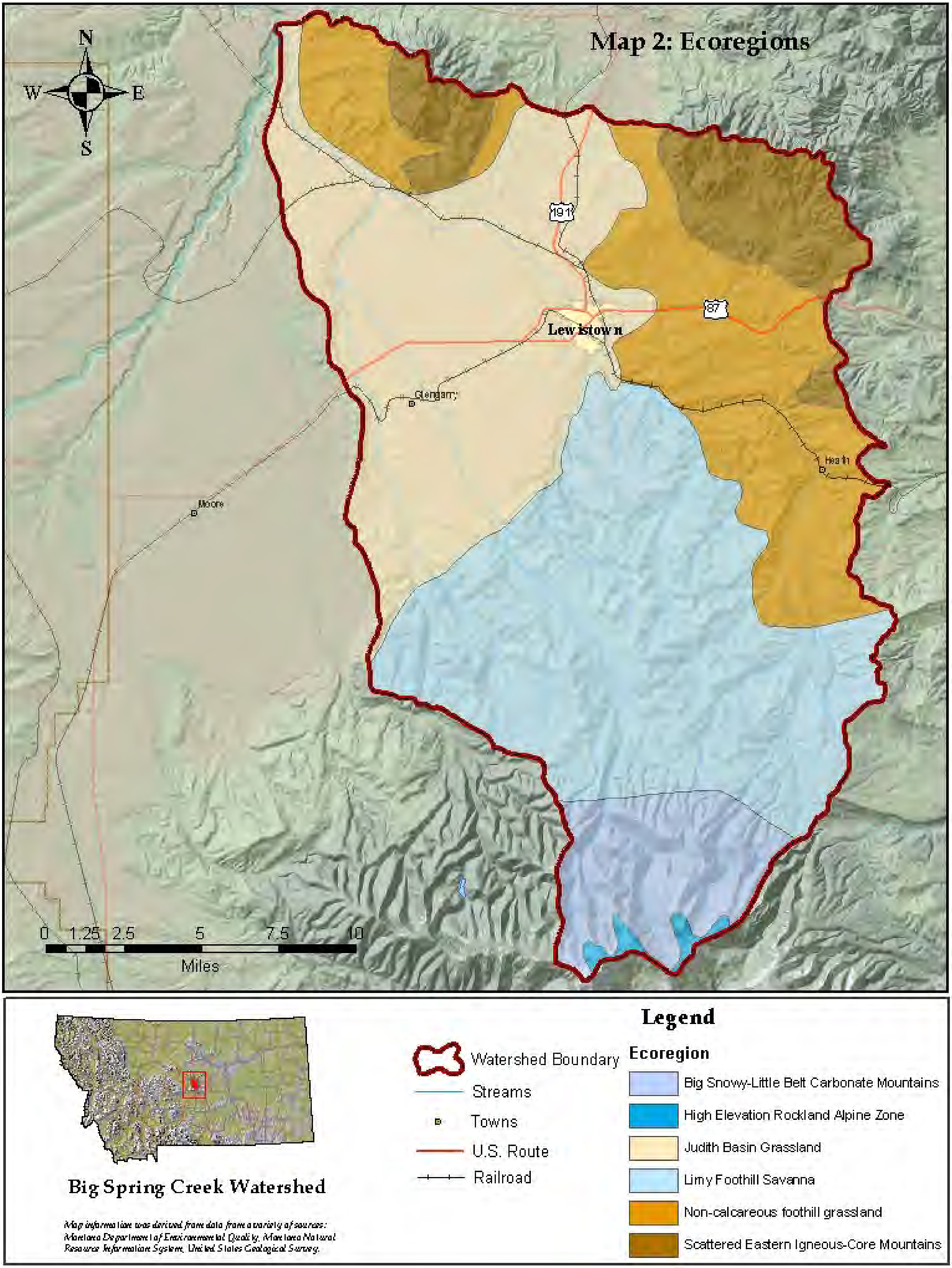
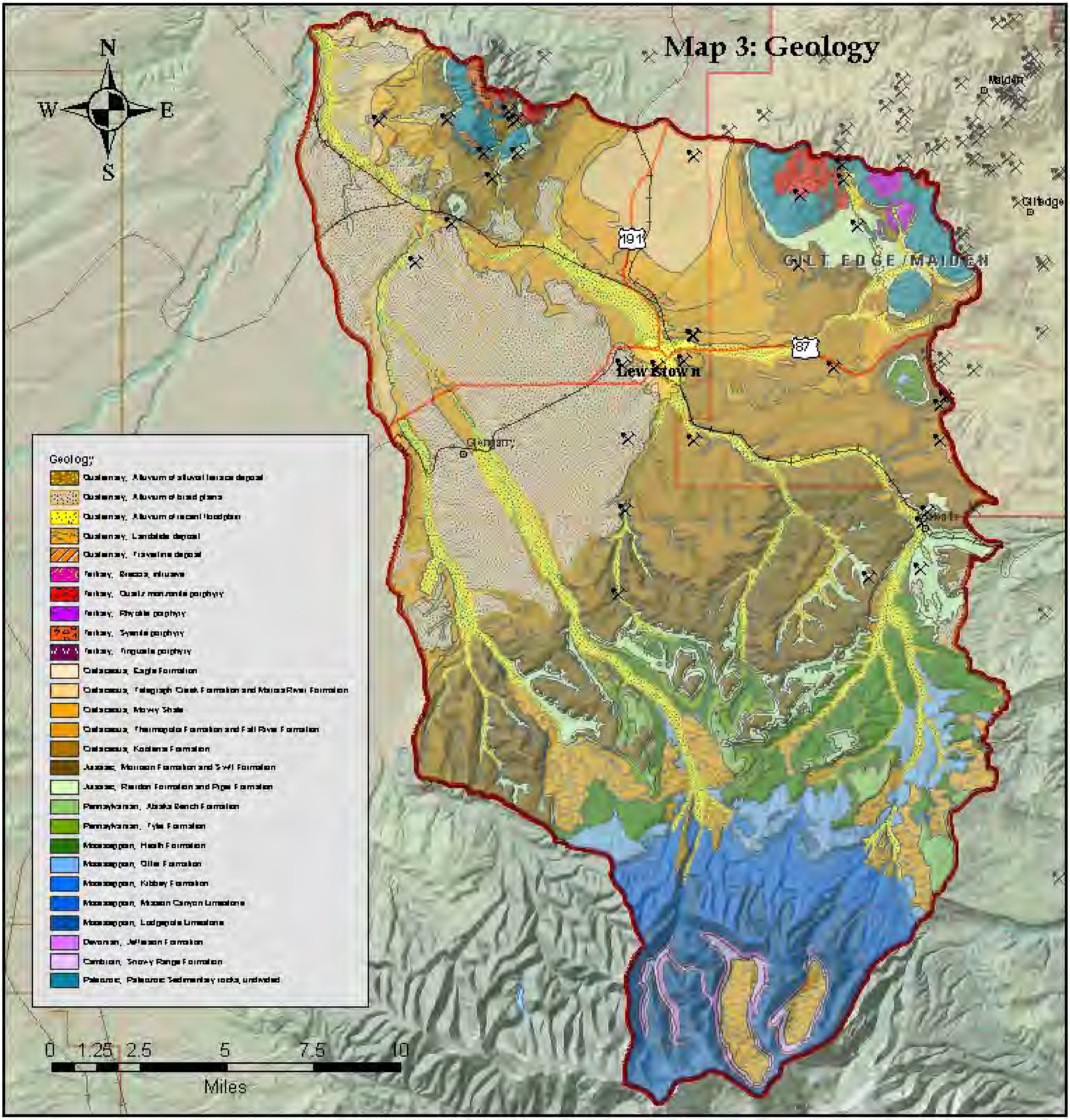


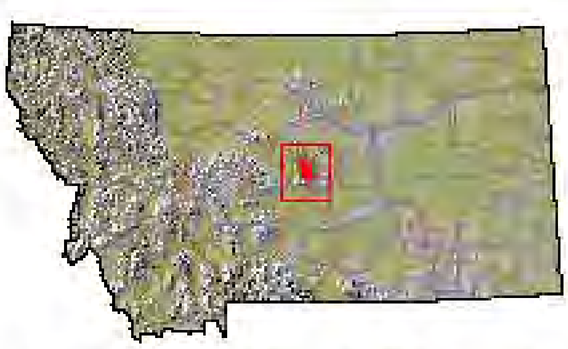
Big Spring Creek Watershed

Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.



Map 2: Ecoregions
N
S
E
W
191
87
Lewistown
Glengarry
Moore
Heath
0 1.25 2.5 5 7.5 10
Miles
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
Watershed Boundary
Streams
Towns
U.S. Route
Railroad
Ecoregion
Big Snowy-Little Belt Carbonate Mountains
High Elevation Rockland Alpine Zone
Judith Basin Grassland
Limy Foothill Savanna
Non-calcareous foothill grassland
Scattered Eastern Igneous-Core Mountains





Legend

Watershed Boundary

Gilt Edge/Maiden Mining District

Mines

Towns

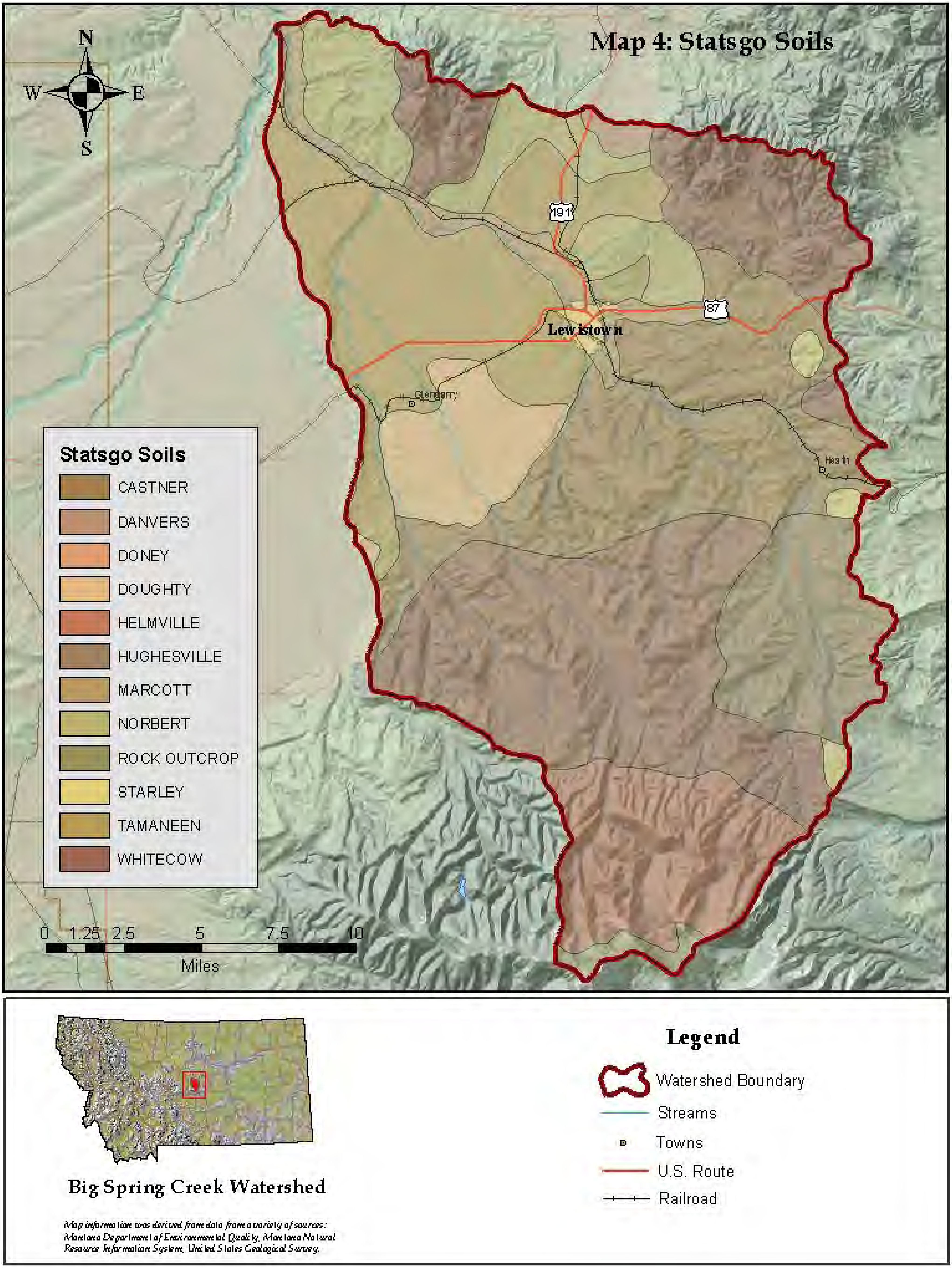
Streams

U.S. Route

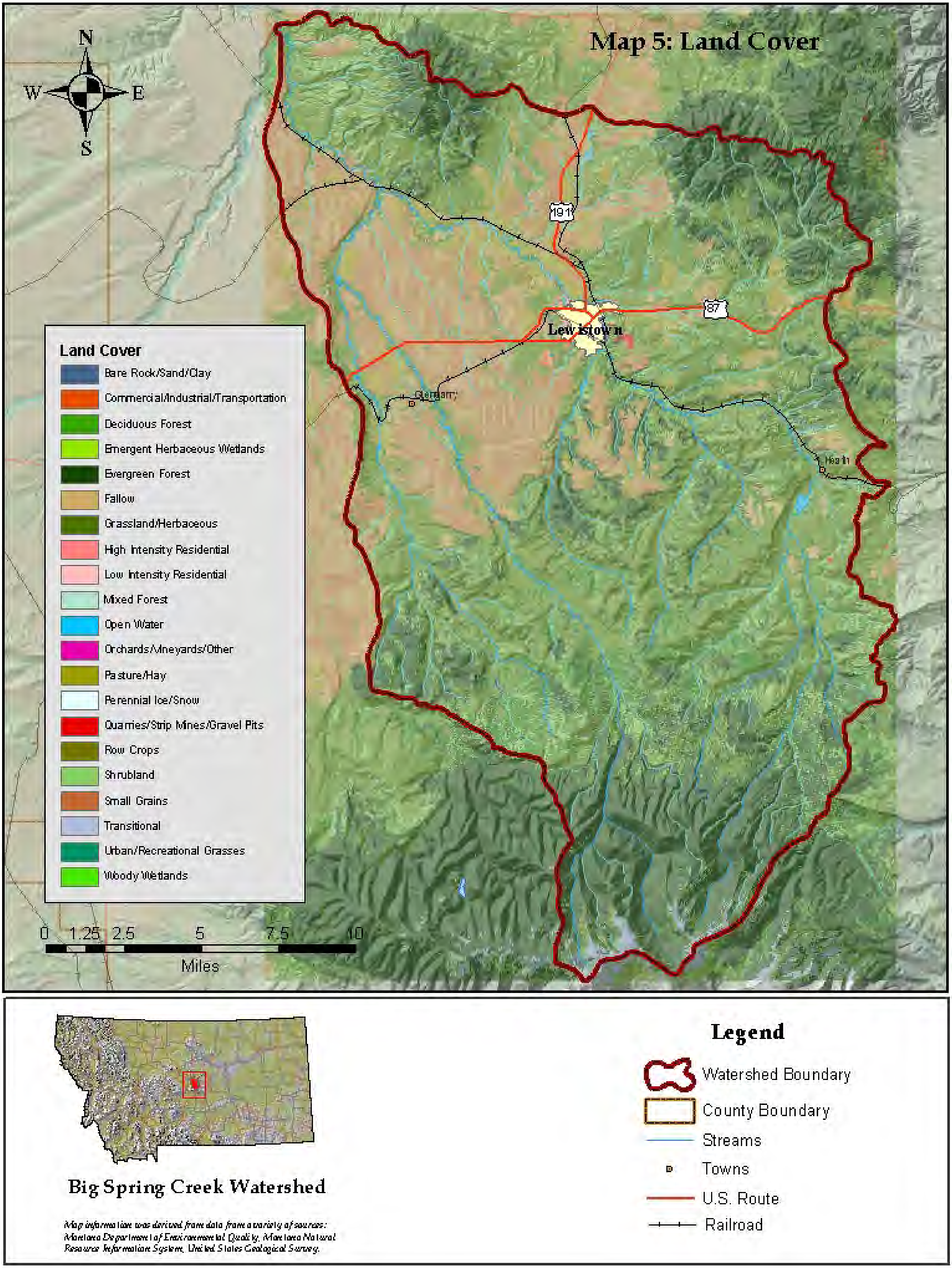
Railroad

Big Spring Creek Watershed

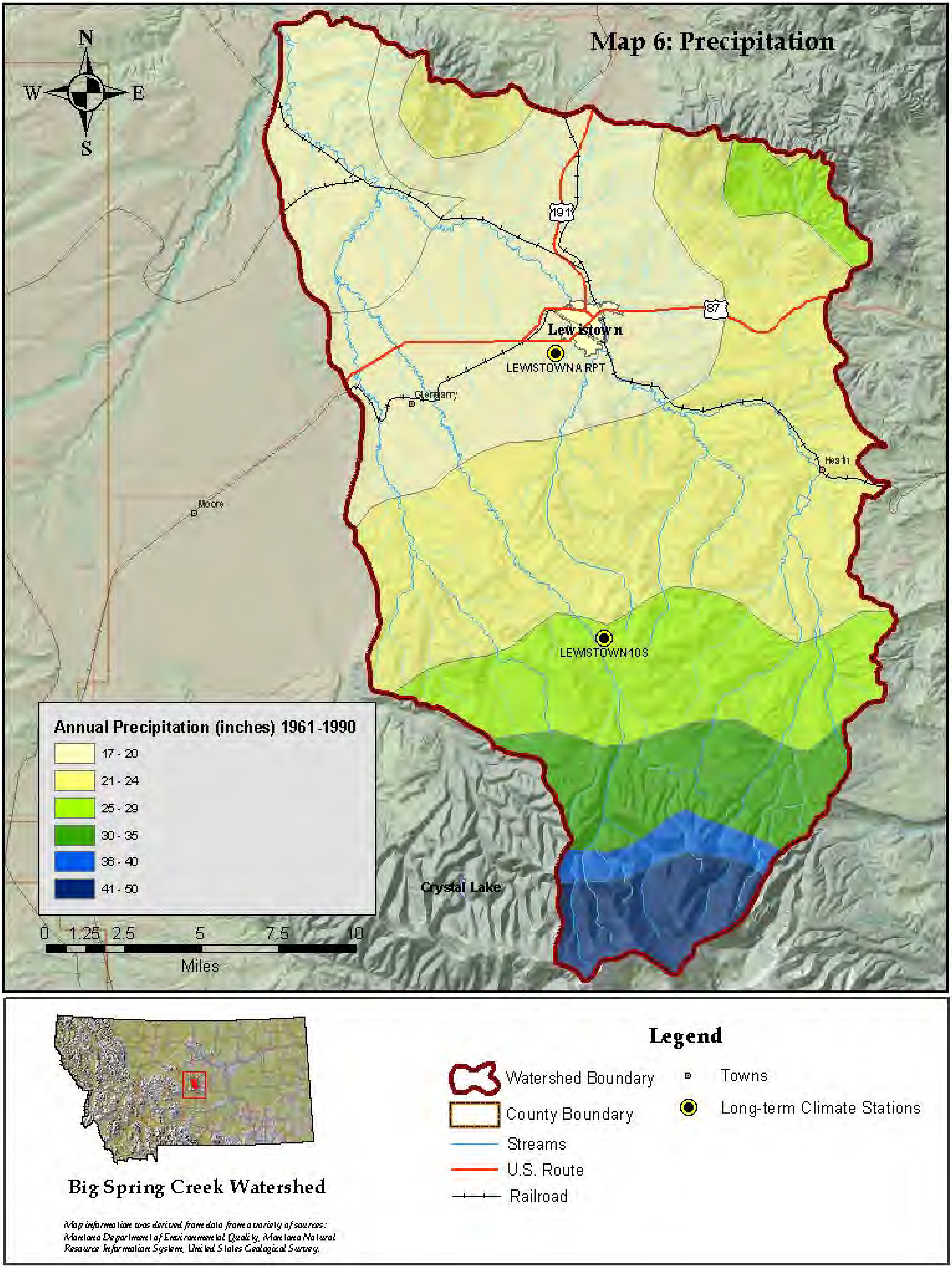
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.



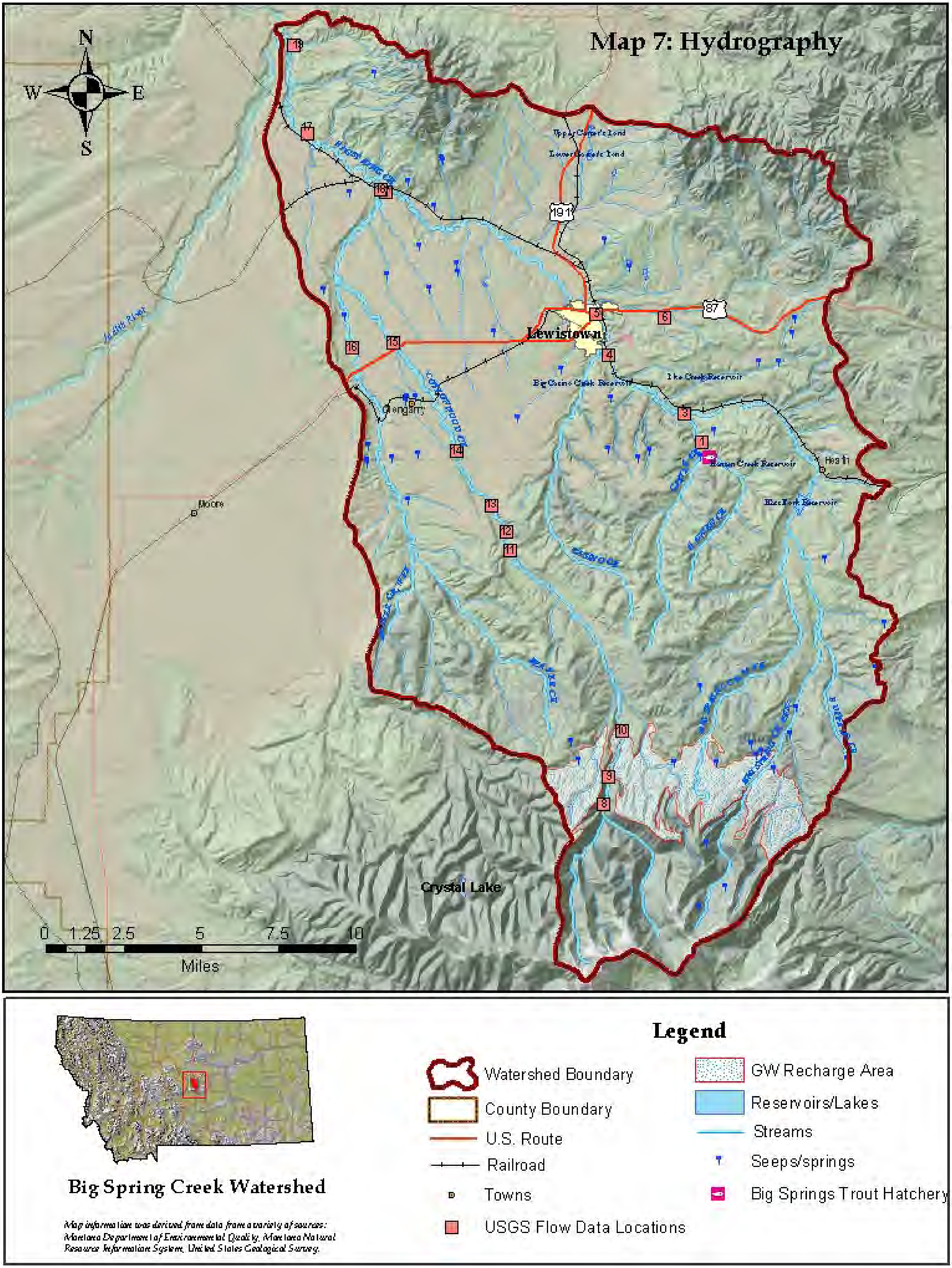
Map 4: Statsgo Soils
N
W
E
S
Lewistown
Glengarry
Heath
191
87
Statsgo Soils
CASTNER
DANVERS
DONEY
DOUGHTY
HELMVILLE
HUGHESVILLE
MARCOTT
NORBERT
ROCK OUTCROP
STARLEY
TAMANEEN
WHITECOW
0 1.25 2.5 5 7.5 10
Miles
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
Watershed Boundary
Streams
Towns
U.S. Route
Railroad



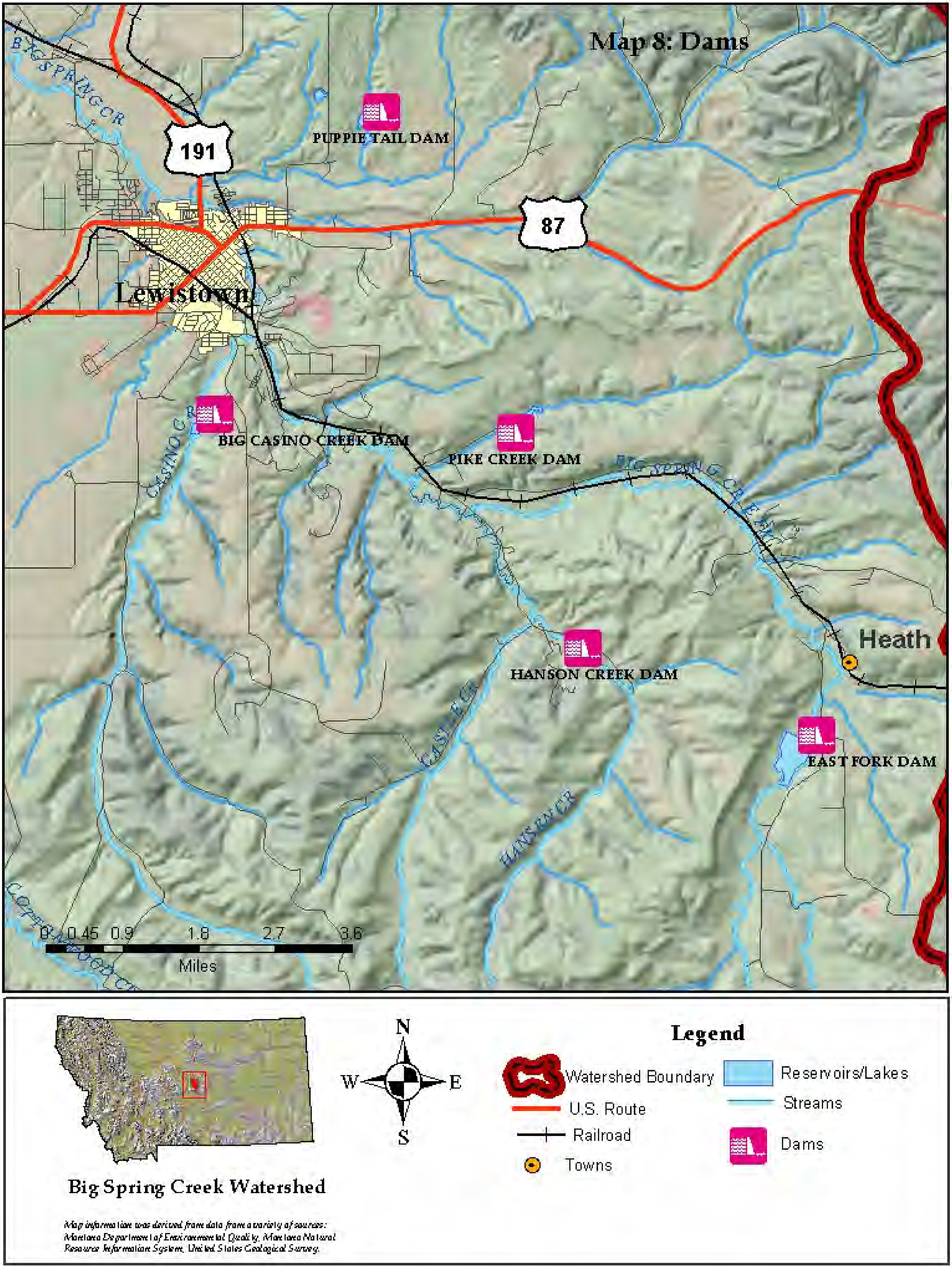
Map 5: Land Cover
N
W
E
S
Land Cover
Bare Rock/Sand/Clay
Commercial/Industrial/Transportation
Deciduous Forest
Emergent Herbaceous Wetlands
Evergreen Forest
Fallow
Grassland/Herbaceous
High Intensity Residential
Low Intensity Residential
Mixed Forest
Open Water
Orchards/Vineyards/Other
Pasture/Hay
Perennial Ice/Snow
Quarries/Strip Mines/Gravel Pits
Row Crops
Shrubland
Small Grains
Transitional
Urban/Recreational Grasses
Woody Wetlands
0 1.25 2.5 5 7.5 10
Miles
191
87
Lewistown
Heath
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
Watershed Boundary
County Boundary
Streams
Towns
U.S. Route
Railroad

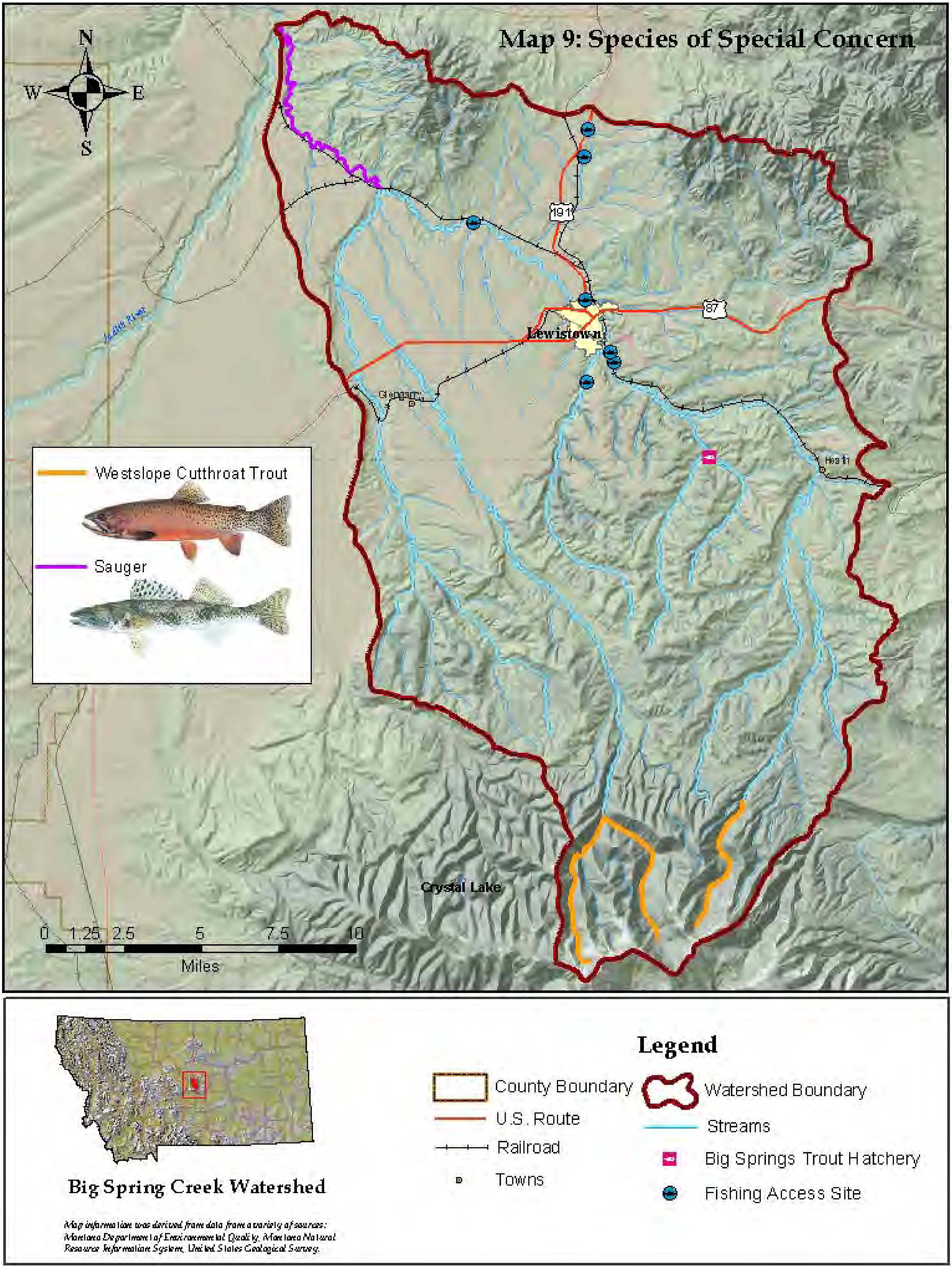


Map 6: Precipitation
N
S
E
W
191
87
Lewistown
LEWISTOWN ARPT
Glengarry
Moore
Heath
LEWISTOWN 10S
Crystal Lake
Annual Precipitation (inches) 1961-1990
17 - 20
21 - 24
25 - 29
30 - 35
36 - 40
41 - 50
0 1.25 2.5 5 7.5 10
Miles
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
Watershed Boundary
County Boundary
Streams
U.S. Route
Railroad
Towns
Long-term Climate Stations



Map 7: Hydrography
N
W
E
S
191
87
Lewistown
Glengarry
Moore
Heath
Crystal Lake
1
3
4
5
6
8
9
10
11
12
13
14
15
16
17
18
19
0
1.25
2.5
5
7.5
10
Miles
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
Watershed Boundary
County Boundary
U.S. Route
Railroad
Towns
USGS Flow Data Locations
GW Recharge Area
Reservoirs/Lakes
Streams
Seeps/springs
Big Springs Trout Hatchery


Map 8: Dams
PUPPIE TAIL DAM
191
87
Lewistown
BIG CASINO CREEK DAM
PIKE CREEK DAM
HANSON CREEK DAM
EAST FORK DAM
Heath
BIG SPRING CR
CASINO CR
CASTLE CR
HANSEN CR
0 0.45 0.9 1.8 2.7 3.6
Miles
N
W
E
S
Big Spring Creek Watershed
Legend
Watershed Boundary
U.S. Route
Railroad
Towns
Reservoirs/Lakes
Streams
Dams
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.


Map 9: Species of Special Concern
N
W
E
S
191
87
Lewistown
Glengarry
Heath
Westslope Cutthroat Trout
Sauger
Crystal Lake
0 1.25 2.5 5 7.5 10
Miles
Big Spring Creek Watershed
Map information was derived from data from a variety of sources: Montana Department of Environmental Quality, Montana Natural Resource Information System, United States Geological Survey.
Legend
County Boundary
Watershed Boundary
U.S. Route
Streams
Railroad
Big Springs Trout Hatchery
Towns
Fishing Access Site