BIG SANDY CREEK SALINITY TMDL & WATER QUALITY RESTORATION PLAN

January 16, 2002

FINAL

Montana Department of
ENVIRONMENTAL QUALITY

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EXECUTIVE SUMMARY: WATER QUALITY RESTORATION PLAN AND TMDL FOR BIG SANDY CREEK

***Waterbody Type*:**	B-3 classified stream in the Northwestern Glaciated Plains Ecosystem
***Pollutant*:**	Salinity/Total Dissolved Solids/Sulfates Siltation Thermal Modification
***Impaired Uses*:**	Aquatic Life Support — partial support Warm Water Fisheries — partial support
***Size of Watershed*:**	851 miles^2
***Water Quality Standards*:**	State of Montana narrative standards for B-3 waters
Targets:	Specific Conductance — 1,600 µmhos/cm at 25 °C Total Dissolved Solids — 1,000 milligrams per liter Siltation — see *1996 Pollutants* below Thermal Modification — see *1996 Pollutants* below
***TMDL*:**	Total Dissolved Solids (lbs/d) = Target * Q * 5.39 Target = 1,000 mg/L TDS Q = surface water flow in cfs 5.39 = conversion factor to pounds per day
***Allocation*:**	Dry-land farming practices, such as crop/fallow, near areas with sensitive soil and geologic conditions that are conducive to saline seeps.
Margin of Safety:	Conservative assumptions in setting standards and targets. Toxicity associated with the concentration of major ions at the target for TDS and specific conductance are predicted at six (6) percent mortality in 48-hour exposures to neonate *Daphnia magna*. The salinity targets are considered very protective and provide an adequate margin of safety relative for irrigation, stockwater, and aquatic life.
Seasonal Variation:	This stream does not flow during drought conditions. The targets and TMDL for TDS consider the variation in flow and climate conditions.
1996 Pollutants:	Thermal modifications and siltation are judged to be within the expected natural range for a prairie stream in the Northwestern Glaciated Plains Ecoregion. Comparing Big Sandy Creek to reference stream conditions using existing and recently collected data shows the stream to be within its range of natural conditions and geomorphically stable. There are no necessary TMDLs required for these parameters.

SECTION 1.0
INTRODUCTION

The waterbody addressed in this water quality restoration plan is the lower reach of Big Sandy Creek (MT40H001_010) which is found in the 851 mi² Big Sandy hydrologic unit (HUC 10050005). The reach addressed flows through Chouteau and Hill counties in central Montana and is 37 miles long extending from the confluence with Lonesome Lake Coulee to the Milk River (Figure 1).

Big Sandy Creek is a tributary to the Milk River in north central Montana and has its headwaters in the Bears Paw Mountains (Figure 2). The majority of the basin is in private ownership or is part of the Rocky Boy's Indian Reservation. Other prominent land management agencies include the Bureau of Land Management (BLM) in the Lonesome Lake area and the state of Montana with scattered parcels throughout the basin. Primary land uses in this sparsely populated, rural area include dry-land crop production and livestock grazing, as well as evergreen forest in the Bears Paw Mountains (Figure 3).

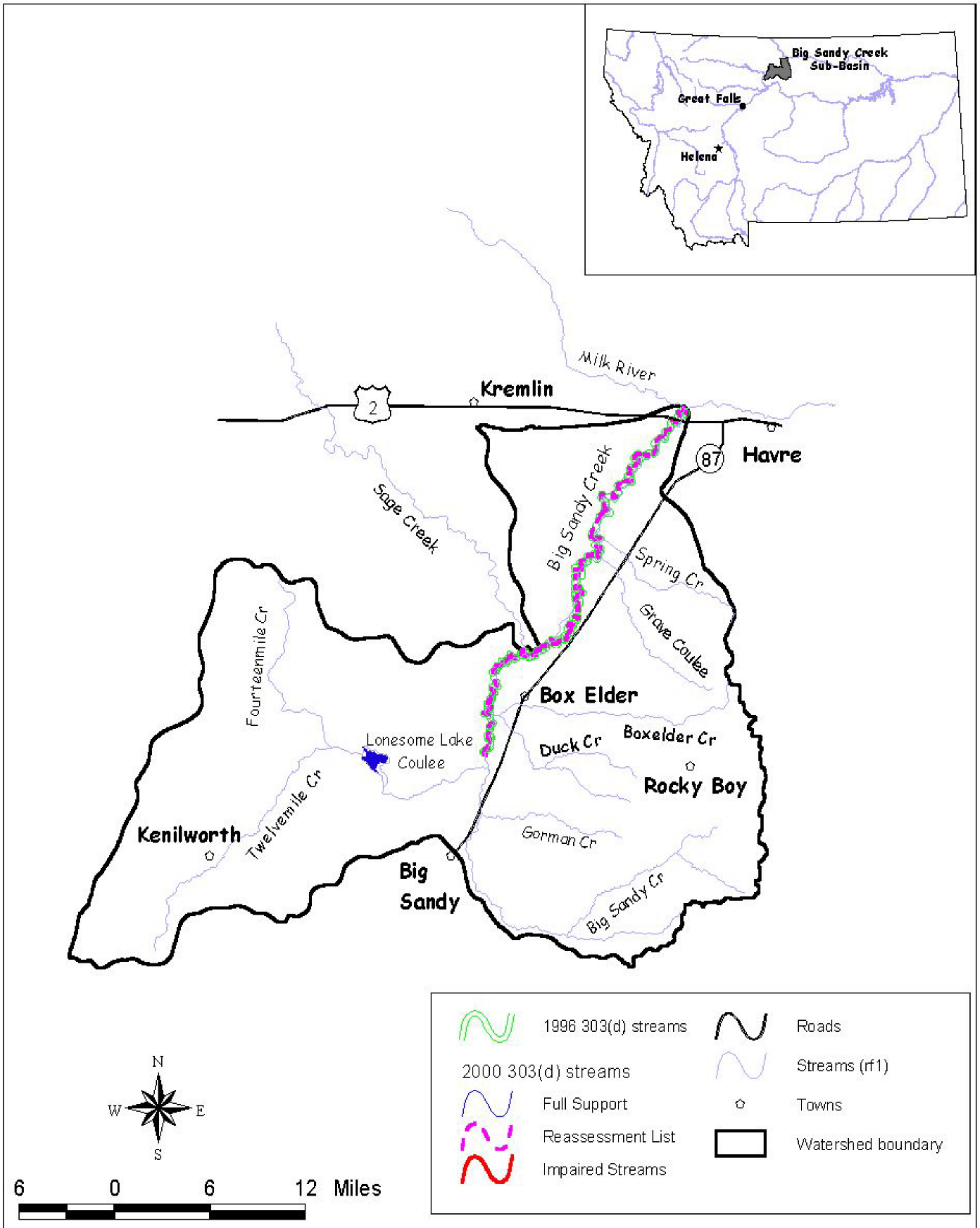
This document fulfills the requirements of the Montana Water Quality Act (Chapter 75, Part 7) and the federal Clean Water Act (33USC1313d). The purpose of the document is to describe the impairments to water quality that affect Big Sandy Creek, outline measures to restore water quality, and present all necessary Total Maximum Daily Loads (TMDLs) for all pollutants appearing on the 1996 Montana 303(d) List.

1.1 Listing Status and Water Quality Impairments

Waters of the state must fully support beneficial uses associated with its classification and water quality standards. Water bodies that do not support all beneficial uses are placed on the Montana 303(d) List. The list includes identification of the probable causes of impairment (pollutants such as metals or sediment) and probable sources of the impairment (such as dry land farming or mining). This list is updated once every two years per Section 303 of the Federal Clean Water Act.

The 2000 Montana 303(d) List is the most current EPA-approved list and based on more rigorous scientific analyses. However, a U.S. District Court ruling (CV97-35-M-DWM) on September 21, 2000 stipulated that the state must complete "all necessary TMDLs for all waters listed as impaired or threatened on the 1996 303(d) list". This means that a TMDL needs to be developed for each pollutant (probable cause) and water body combination on the 1996 list. The exception is where subsequent data and assessments reveal that there is no further impairment associated with the pollutant of concern, meaning that a TMDL is not necessary for the purpose of restoring water quality and associated beneficial uses.

The 1996 Montana 303(d) List stated that probable causes of impairment for Big Sandy Creek were salinity/TDS/chlorides, siltation, and thermal modifications. Probable sources were listed agriculture, irrigated crop production, range land, and stream bank modification/destabilization (Table 1). Beneficial uses identified as not fully supported included aquatic life and warm water fisheries (Table 2).



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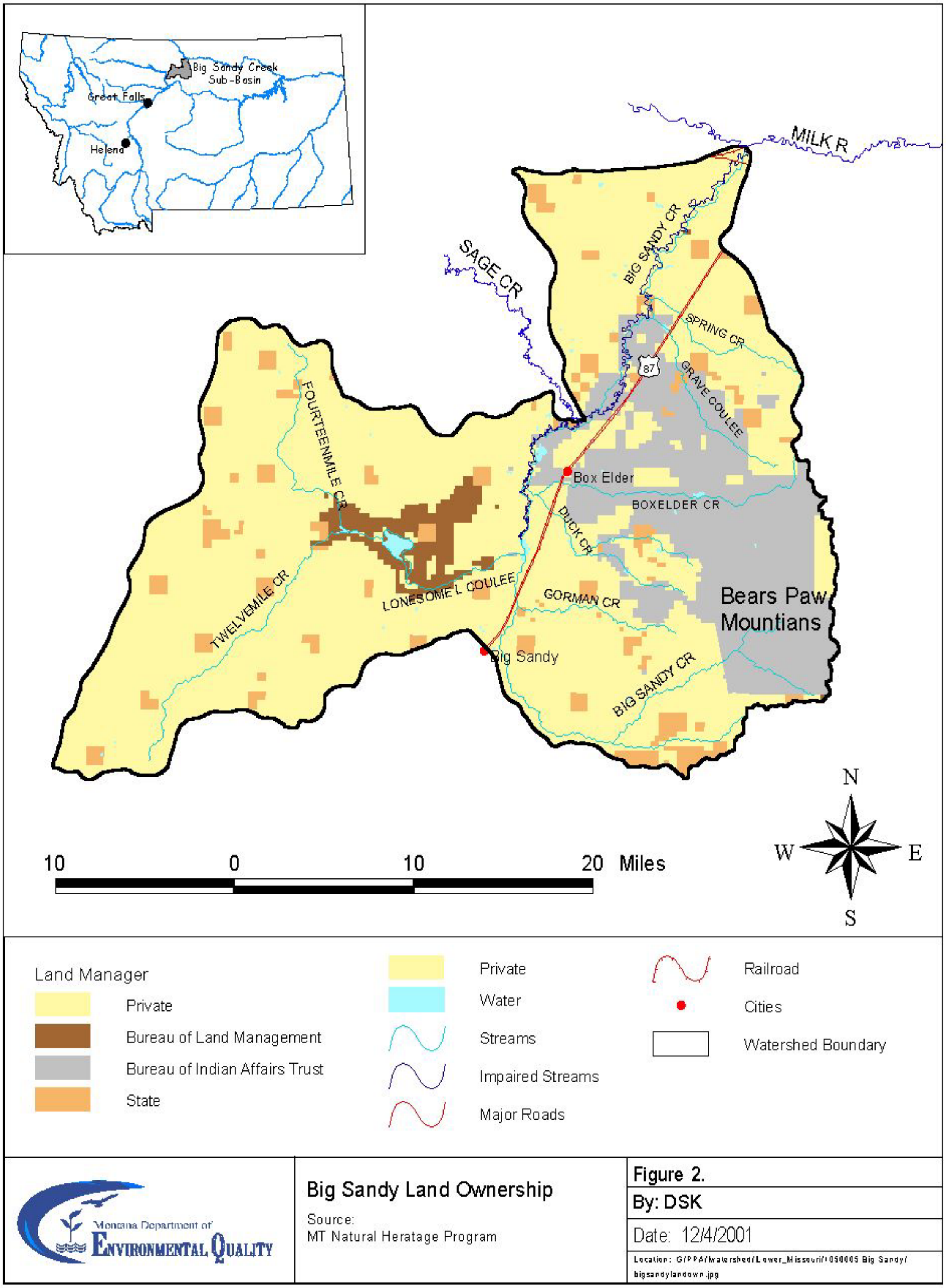
Big Sandy Creek sub-basin location and setting with 303(d) listed waters and generalized stream network.

Figure 1

By: MJP

Date: 12/01


Big Sandy Creek
Sub-Basin
Great Falls
Helena
MILK R
SAGE CR
BIG SANDY CR
SPRING CR
87
GRAVE COULEE
FOURTEENMILE CR
Box Elder
BOXELDER CR
DUCK CR
TWELVEMILE CR
LONESOME L COULEE
GORMAN CR
Bears Paw
Mountians
Big Sandy
BIG SANDY CR
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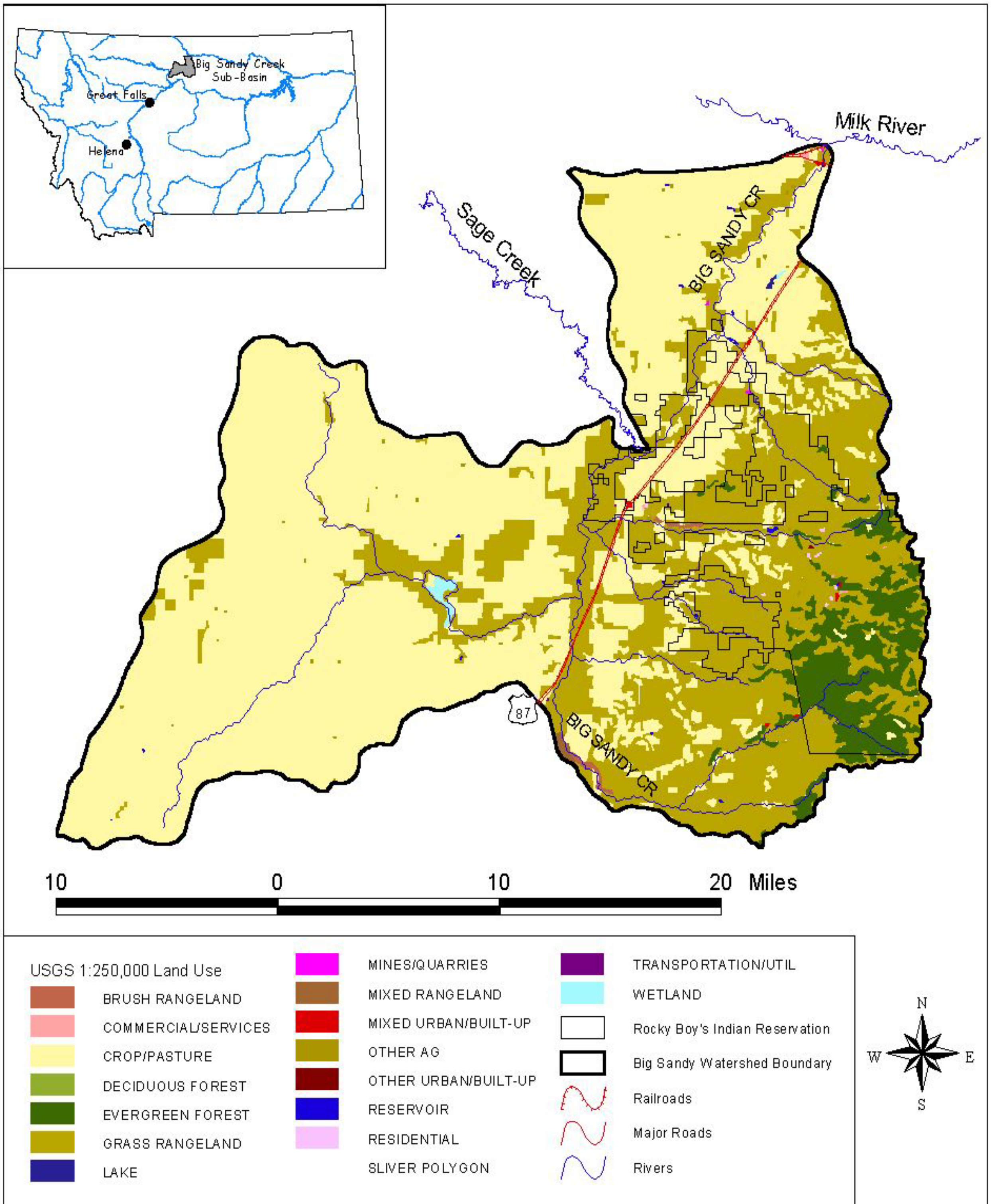
Private
Bureau of Land Management
Bureau of Indian Affairs Trust
State
Private
Water
Streams
Impaired Streams
Major Roads
Railroad
Cities
Watershed Boundary
Montana Department of
Environmental Quality
Big Sandy Land Ownership
Source:
MT Natural Heratage Program
Figure 2.
By: DSK
Date: 12/4/2001
Location: G/PPA/watershed/Lower_Missouri/1050005 Big Sandy/
bigsandylandown.jpg



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Big Sandy Land Use

Source: 1:250,000 USGS Land Use
Shelby Area 1980
Havre Area 1982

Figure 3.

By: DSL

Date: 12/4/2001

Location: G/PPA/watershed/Lower_Missouri/10050005 Big Sandy/bigsandylanduse.jpg

Big Sandy Creek was not listed on the 2000 Montana 303(d) List due to a lack of "sufficient credible data". Based on a review of data compiled by the DEQ since the publication of the 2000 Montana 303(d) List, no water quality impairments appear to be associated with siltation and thermal modification. Salinity/Total Dissolved Solids/Sulfates, however, are linked to potential water quality impairments in Big Sandy Creek.

The following sections of the document present: a summary description of the watershed in Section 2.0; supporting documentation for water quality restoration targets and a TMDL for Salinity/Total Dissolved Solids/Sulfates in Section 3.1; justification for the lack of siltation and thermal modification impairments in Section 3.2; monitoring and restoration strategies in Sections 4.0 and 5.0, respectively; and a summary of the DEQ's public involvement activities in Section 6.0.

Table 1. Impairment Causes and Sources for Big Sandy Creek

Information Source	Probable Causes of Impairment	Probable Sources of Impairment
1996 Montana 303(d) List	Salinity/TDS/chlorides, Siltation, Thermal modifications	Agriculture: Irrigated crop production, Non-irrigated crop production, Stream bank modification/ Destabilization
2000 Montana 303(d) List	Not listed; lacked Sufficient Credible Data	Not listed; lacked Sufficient Credible Data

Table 2. Beneficial-use Support Determination for Big Sandy Creek

Information Source	Beneficial Uses	Determination
1996 Montana 303(d) List	Aquatic life Warm water fishery	Partial support Partial support
2000 Montana 303(d) List	Aquatic life Warm water fishery Drinking Water Swimming (Recreation) Agricultural Industrial	Lacked Sufficient Credible Data

SECTION 2.0
WATERSHED DESCRIPTION

2.1 Physical and Biological Characteristics

2.1.1 Vegetation and Topography

The watershed consists of arid grassland plains and sparsely timbered foothills of the Bears Paw Mountains. The ecoregion is classified as Mountain Valley and Foothill Prairie. The lowest elevation in the watershed is 2,500 feet above sea level at the confluence with the Milk River and the highest elevation is Baldy Mountain at 6,916 feet. Cultivated cropland is concentrated in the lower elevations of the Big Sandy Creek. Grazing land is found interspersed in the cropland where stock water is available and in the foothills of the Bears Paw Mountains and East Butte of the Sweetgrass Hills. The higher elevations of the Bears Paw Mountains are timbered.

2.1.2 Climate and Hydrography

The average daily high and low temperatures are 84.4 °F and 53.7 °F in July and 24.0 °F and 3.0 °F in January. Annual precipitation averages 11.4 inches on the prairie and increases to 20 inches over the Sweet Grass Hills and Bears Paw Mountains (Tuck, 1993). Precipitation comes mostly in the late spring and during infrequent intense summer storms. On the average, 45 inches of snow falls on the prairie with more in the nearby mountains. Snowmelt in the Sweet Grass Hills and the Bears Paw Mountains is an important component of flow in Big Sandy Creek.

2.1.3 Geology and Soils

The watershed is composed of isolated mountain ranges of igneous intrusive rocks on broad alluvial valleys. The cores of the Sweet Grass Hills and Bears Paw Mountains are igneous rock that rose in molten form through layers of sedimentary rocks and then cooled. Sedimentary formations dip gently east from the flanks of the Sweet Grass Hills and underlie the eastern portion of the watershed (Tuck, 1993).

The gently rolling plains are mantled by glacial sediments and eroded by storm runoff and stream channels. Glacial deposits of clay, silt, and sand are deposited over an eroded bedrock valley filled with sand and gravel. Soil types in the watershed include loam and fine sandy loam. Soil fertility and erodability vary depending on the percentage of sand in the loams.

2.1.4 Stream Characteristics

Streams in the watershed flow primarily in response to brief storms in late spring and early summer and to runoff from snowmelt from the Sweet Grass Hills and Bears Paw Mountains in late winter and early spring. The USGS gaging station (06139500) on Big Sandy Creek near Havre shows an average flow of 25 cubic feet per second (cfs) for a drainage area of 1,805 square miles. Maximum flow recorded for this station is 5,570 cfs in 1952 and with minimum flow being no-flow (USGS 1993). Figure 4 shows the hydrograph for this station between 1984 and 1999. This can be compared to Figure 5 showing the hydrograph for the USGS gaging station (06137400) on Big Sandy Creek at its headwaters in the Bears Paw Mountains. Note the intermittent nature of Big Sandy Creek near its confluence with the Milk River (Figure 4) as compared to the more continuous flow recorded in its upper reaches (Figure 5).

The Big Sandy valley is believed to be the pre-glacial channel of the Missouri River (Alden, 1932). The buried channel follows Big Sandy Creek north from the current Missouri River channel then follows the Milk River downstream from the mouth of Big Sandy Creek.

2.1.5 Fisheries and Other Aquatic Species

The lower portion of Big Sandy Creek supports a diversity of fish species (Table 3) and is used as rearing and spawning habitat for walleye, sauger, and northern pike (Drewes and Gilge, 1986). The fish community appears to be healthy for a prairie stream; and DEQ has determined that Big Sandy fully supports a warm water fishery. Other aquatic species such as painted turtles (*Chrysemys picta*), crayfish (*Orconectes virilis*), and mollusks (*Anodonta grandis* and *Sphaerium straitinum*) were abundant when Big Sandy Creek was assessed by MDFWP in 1986 (Drewes and Gilge, 1986).

Figure 4. Hydrograph of mean daily discharge in Big Sandy Creek near Havre 1984 - 1999 (USGS gage 06139500).

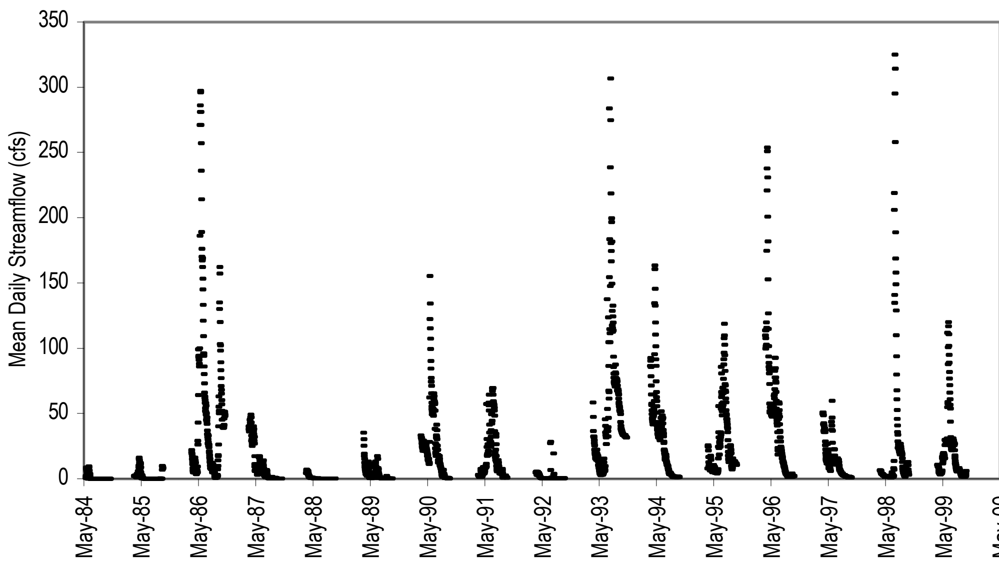


Figure 5. Hydrgograph of Big Sandy Cr. near the reservation boundary 1982 - 2000 (USGS gage 06137400)

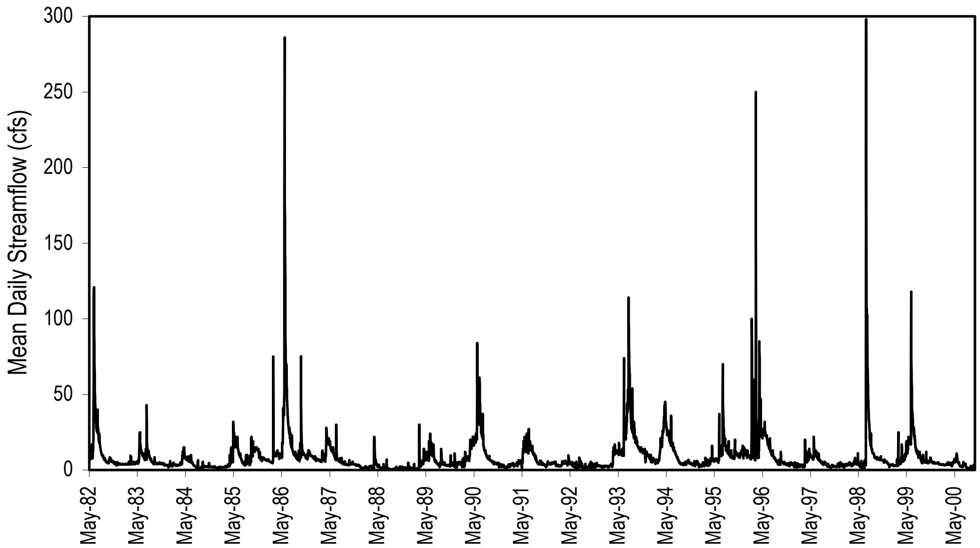


Table 3. Summary of fisheries information for Big Sandy Creek (Montana Rivers Information System http://nris.state.mt.us/)

Species	Location in Reach	Status
Black Bullhead	Entire	Abundant year round
Fathead Minnow	Entire	Abundant year round
Lake Chub	Entire	Abundant year round
White Sucker	Entire	Abundant year round
Yellow Perch	Lower third	Abundant year round
Yellow Perch	Upper two-thirds	Common year round
Northern Pike	Entire	Common year round
Northern Redbelly Dace	Entire	Common year round
Western Silvery/Plains Minnow	Entire	Common year round
Spottail Shiner	Lower third	Common
Iowa Darter	Entire	Uncommon year round
Longnose Dace	Entire	Uncommon year round
Walleye	Lower third	Uncommon
Sauger	Lower third	Uncommon
Flathead Chub	Entire	Rare year round
Brassy Minnow	Entire	Rare year round

2.2 Cultural Characteristics

Big Sandy Creek has its headwaters in Chouteau County and flows through Hill County where it joins the Milk River. US Highway 87, which connects the regional cities of Great Falls and Havre, passes through the watershed (Figure 1).

The 851 square-mile watershed is rural in character with a low population density, about 4.5 people per square mile. The 2000 Census Block Population data shows the total population for the watershed is 3,722 people. The population trend is fairly stable as compared to other areas of Montana. Land ownership has remained predominantly private after this productive farming area was settled during the Homestead Era. About 73 percent of the land is privately owned. The Rocky Boy's Indian Reservation, established in 1916, is located within the eastern portion of the watershed and occupies about 18 percent of the land. On the western side, the Bureau of Land Management manages about 3 percent of the watershed as the Lonesome Lake Management Area. Distributed throughout the watershed are State Trust Lands that occupy about 6 percent of the land (Figure 2).

Agriculture is the major economic activity in the watershed. Most farming operations use dry-land cropping practices in the production of grain crops. The majority of livestock production is in cattle. Oil and gas activity and mining activity have occurred in the past but have declined since the 1980s.

SECTION 3.0
WATER QUALITY RESTORATION TARGETS AND TMDLS

3.1 Salinity/TDS/Sulfates

3.1.1 Existing Water Quality Concerns

Primary land uses in the Big Sandy Creek watershed include dry-land grain production and livestock grazing. Crop/fallow cropping practices and other agricultural practices that store soil moisture are the primary sources of anthropogenic salinity.

During 1999, DEQ conducted an analysis of Big Sandy water chemistry results comparing chloride to sulfate concentrations. Between 1974 and 1989, the USGS analyzed 19 water samples in this reach for chloride showing an average value of 55 mg/L (1.5 meq/L), with a range between 5.8 and 300 mg/L. This compares to water samples analyzed for sulfate showing an average value of 272 mg/L (28 meq/L), with a range between 63 and 870 mg/L (Table 4). Because of this analysis the 1996 listing Salinity/TDS/Chlorides will be changed to Salinity/TDS/Sulfates to reflect that Big Sandy Creek contains primarily sodium sulfate dominated water. Chloride is a minor component of the minerals in the water (Table 4).

Table 4. Total dissolved solids (TDS) data from USGS gaging station 06139500 on Big Sandy Creek near Havre, 1985 - 1989.

Date	TDS (mg/L)	Instantaneous stream flow (cfs)	Sodium Absorption Ratio	Chloride (mg/L)	Sulfate (mg/L)
10-2-85	420	7.1	3	9.1	72
7-9-86	370	41.0	2	5.8	63
8-21-86	530	5.8	4	19	150
11-6-86	410	42	2	7.8	86
2-9-87	520	18	3	11	160
4-21-87	500	25	2	11	130
5-18-87	530	11	3	15	140
6-19-87	500	2.9	4	29	130
7-15-87	670	2.1	5	40	240
8-10-87	1,100	0.15	10	160	290
9-29-87	1,800	0.1	13	260	640
3-15-88	474	28	3	12	150
5-2-88	1,480	0.64	8	110	530
5-31-88	2,180	0.01	13	220	870
3-21-89	265	16	2	8.8	73
5-3-89	795	9.6	5	27	280
6-15-89	648	13	5	17	220
7-18-89	616	0.7	7	36	200
11-28-89	2,230	0.2 (est.)	15	300	740

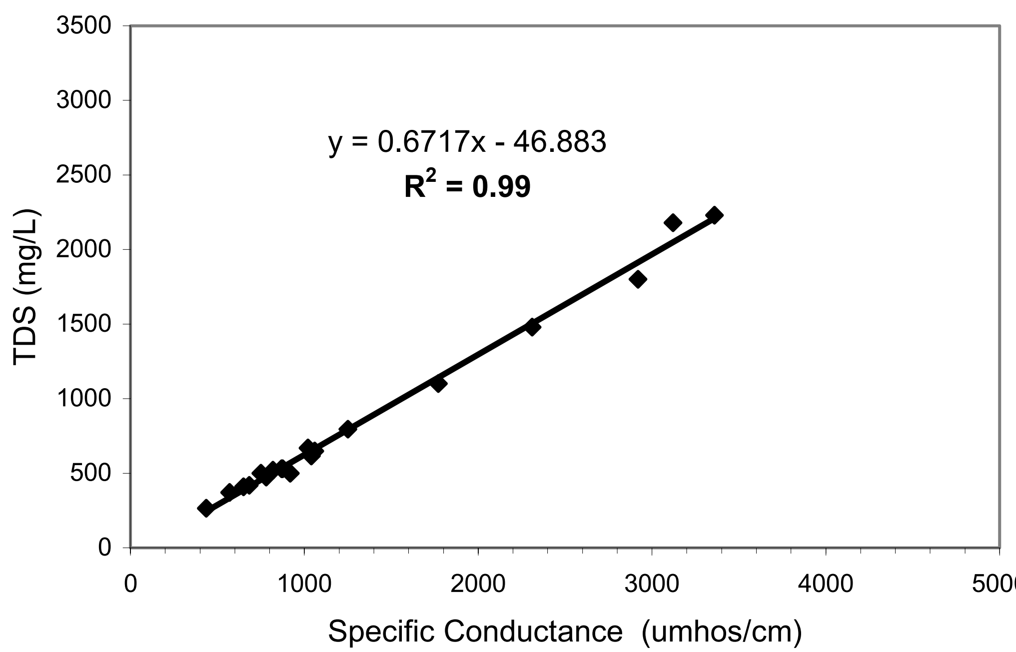
3.1.2 Applicable Water Quality Standards

The applicable water quality standard for Salinity/TDS/chlorides is: *"State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life"* (ARM 17.30.637(1)(d)).

3.1.3 Target Identification

Specific conductance (SC) and total dissolved solids (TDS) are related measurements of the total mineral content of water. This relationship is usually unique to a stream and Figure 6 depicts the relationship for Big Sandy Creek. Total dissolved solids levels are determined through chemical analysis of water samples conducted by a qualified laboratory, while SC can be directly measured in the stream using a SC meter.

Figure 6. Relationship Between Total Dissolved Solids and Specific Conductance (at 25 C) 1985 - 1989. (USGS gage 06139500, near Havre)

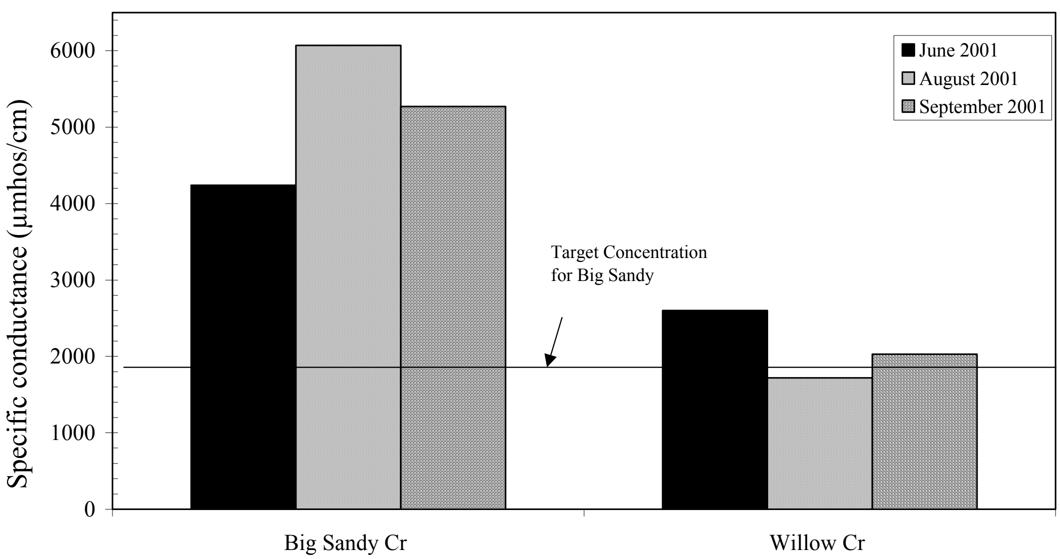


The proposed target value for salinity in Big Sandy Creek is SC of 1,600 µmhos/cm at 25 degrees Celsius. The target SC level is protective of the beneficial uses, is comparable to SC levels in a reference stream in the Northwestern Glaciated Plains (Figure 7), and is easily measured on site with a SC meter. The target value for total dissolved solids (TDS), which correlates to the SC target, is 1,000 mg/L (Figure 6).

The following beneficial uses were considered in setting the target value. The highest SC that is acceptable for use in stock water is 5,000 µmhos/cm. Water with a SC of 2,200 µmhos/cm will result in a 10 percent decrease in yield for irrigated alfalfa (Ayers and Westcot, 1986). During a critical life stage, *Daphnia magna,* a water flea that represents the aquatic life beneficial use, is predicted to show six (6) percent mortality in 48-hour exposure at 1,600 μmhos/cm (Mount *et al.*, 1997) (Figure 8).

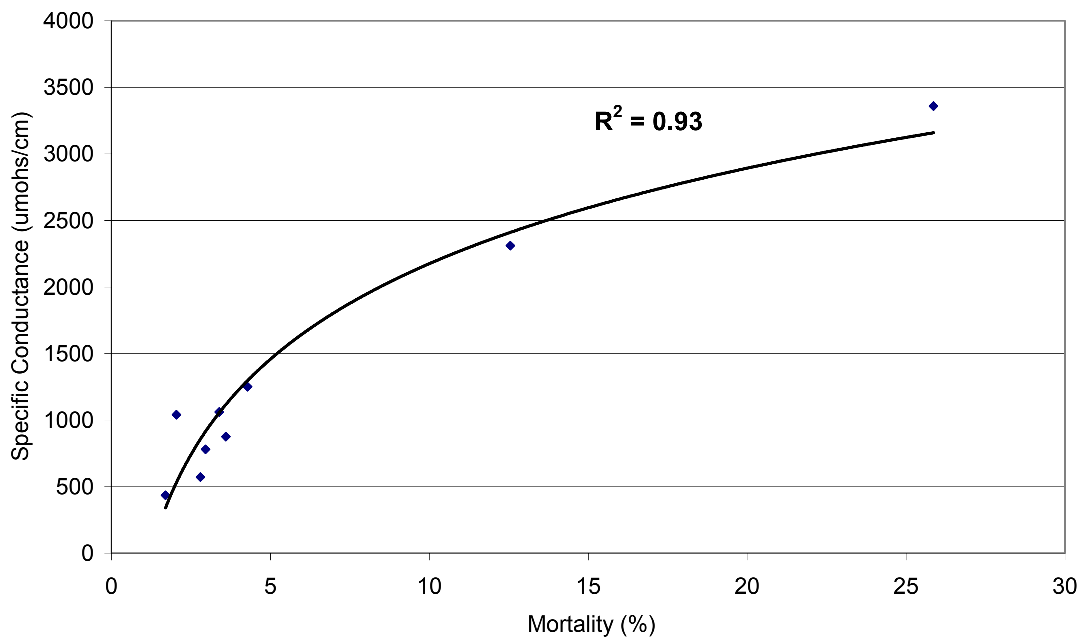
Modeling of major ion contributions to acute toxicity outlined in Mount et al. (1997) was used to provide a link between biological beneficial uses and the water quality restoration targets proposed for Big Sandy Creek, and is also presented as a margin of safety (MOS). Mount et al. (1997) is a very conservative model that tends to over predict toxicity. There are indications that the "Mount model" often over predicts toxicity in bicarbonate dominated waters, but accurately predicts toxicity in sulfate dominated waters (personal comm. Don Skaar, Pollution Control Biologist, Montana Fish, Wildlife, and Parks). Caution should be used when comparing modeled toxicity results to the biological

Figure 7. Specific conductance in Big Sandy Creek and reference stream (DEQ, 2001b)



impact of toxicity on in-stream aquatic communities. In general, test species are not always the same as the species of concern, tested life stages do not span all life stages of exposure in nature, test durations are not the natural exposure durations, modeled responses do not include all responses of concern, and test endpoints are at an organism level, not at a population level. An unknown portion of the modeled toxicity associated with major ions in Big Sandy Creek is from natural sources. Modeled 48-hour mortality of six percent in neonate *Daphnia magna* for Big Sandy Creek is thought to be protective of biological beneficial uses. In addition, preliminary mortality thresholds calculated for major ions associated with coal bed methane using Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic organisms and Their Uses (1985) are comparable and support this conclusion.

Figure 8. Predicted neonate Daphnia magna (water flea) 48-hour mortality in Big Sandy Creek due to major ions.



National secondary drinking water standards identify a concentration of 500 mg/L TDS as a maximum level for guidance of drinking water aesthetics. Secondary drinking water regulations are not federally enforced, but are provided as a "guideline" for states to use. Montana does not have a drinking water standard that addresses TDS concentrations. Historic data at the Milk River USGS gaging station near Havre indicate no secondary drinking water excursions of raw Milk River water near Havre's municipal water intake between the years of 1969 to 1972. The City of Havre (2000) provides a more recent data summary in their Source Water Delineation and Assessment Report. The report indicates that the minimum, average and maximum TDS concentrations measured between 1992 and 1996 were 190, 336, and 640 mg/L, respectively. Water quality restoration targets proposed for Big Sandy Creek will likely be protective of Havre's drinking water source as well as reduce any secondary drinking water regulation excursions at Havre's public water intake.

3.1.4 TMDL

The proposed target level for specific conductance (SC) is 1,600 μmhos/cm at 25 °C or 1,000 mg/L TDS in Big Sandy Creek (Figure 6).

The TMDL can be expressed as follows:

TDS (lbs/d) = Target * Q * 5.39

Target	= 1,000 mg/L TDS
Q	= surface water flow in cfs
5.39	= conversion factor to pounds per day

The TMDL is based on a target concentration of 1,000 mg/L TDS. Variability in TDS concentration, and therefore load, is expected because of the natural buildup of saline conditions during dry weather periods. It is recognized that there may be short periods of time associated with the rising limb of the hydrograph that the TMDL may be exceeded.

Seasonal variation is taken into account by considering how TDS concentrations vary in relation to flow conditions (Figure 9). TDS concentrations tend to increase as flow decreases or during the falling limb of the hydrograph (Figure 9, Table 5). The lowest flows tend to occur in late summer and fall. When flow is less than one cfs, groundwater with a higher TDS concentration composes the major portion of total flow.

Figure 9. TDS vs. stream flow on Big Sandy Cr. near Havre 1985 to 1989 (USGS gage 06139500)

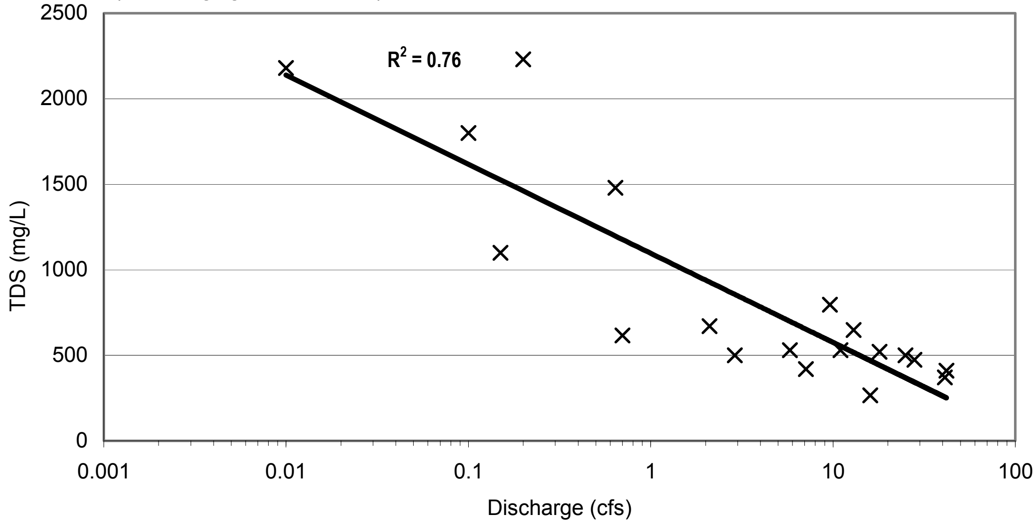


Table 5. TDS loads from Big Sandy Creek near Havre at USGS gaging station 06139500, 1985 to 1989

Date	TDS (mg/L)	Instantaneous streamflow (cfs)	TDS (lbs/day)
10-2-85	420	7.1	842
7-9-86	370	41.0	3,094
8-21-86	530	5.8	813
11-6-86	410	42	4,301
2-9-87	520	18	582
4-21-87	500	25	2,830
5-18-87	530	11	1,304
6-19-87	500	2.9	203
7-15-87	670	2.1	475
8-10-87	1,100	0.15	34
9-29-87	1,800	0.1	12
3-15-88	474	28	3,169
5-2-88	1,480	0.64	252
5-31-88	2,180	0.01	2
3-21-89	265	16	5,778
5-3-89	795	9.6	983
6-15-89	648	13	5,886
7-18-89	616	0.7	75
11-28-89	2,230	0.2 (est.)	45

Sage Creek is the largest tributary to Big Sandy Creek and has a proposed TMDL based on a TDS of 1,250 mg/L. Each waterbody, however, has the same target for specific conductance, which is 1,600 μmhos/cm at 25 °C. The difference in TDS targets for these waterbodies reflects the difference in mineral content of the water and the relative solubility of the ionic components. The toxic effects of the minerals are correlated to the concentration of the ionic components (Mount *et al.*, 1997).

Sage Creek is the largest tributary to Big Sandy Creek and has a proposed TMDL based on a TDS of 1,250 mg/L. Each waterbody, however, has the same proposed target for specific conductance of 1,600 μmhos/cm at 25 °C. The difference in TDS targets for Sage and Big Sandy Creeks reflects the difference in mineral content of the water and the relative solubility of the ionic components (charged particles like Na^{+1} or SO_4^{-2}). The toxic effects are correlated to the concentration of the charged particles (Mount *et al.*, 1997). Specific conductance is a measure of the charged particles in the water; whereas TDS is the summed concentration of all measured minerals in the water reported in mg/L.

3.1.5 Source Assessment

The pollutant sources of salinity/total dissolved solids/sulfate are classified as nonpoint and natural. There are no point sources identified in this reach of Big Sandy Creek.

Salinity is a water quality problem that may result where dry-land agricultural activities, such as crop/fallow occur over geologic formations, such as Claggett shales, that are conducive to the formation of saline seeps. Saline seeps form when water infiltrates downward through surface layers of glacial till and flows to low-lying discharge points along impermeable marine shale bedrock. Salts in the soil and underlying shale are leached, resulting in high dissolved solids concentrations found in the seep discharge. Cropping practices that increase soil moisture can also increase the size of saline seeps and accelerate soil erosion. Seeps leave white crusts of minerals in the soils that inhibit plant growth (Holzer, 1995) and can be found in both the uplands and along the stream channel.

The Claggett formation is the marine deposit of a shallow inland sea comprised of very erodible shale and siltstone. It contains the salts and minerals associated with sea brines. Bentonite clay beds are common near the base of the Claggett formation which ranges between 200 and 500 ft. in thickness (Condon, 2000). Activities that increase water infiltration into the soil may leach these minerals, move them to the surface along impermeable layers, and result in the formation of saline seep areas. Saline seeps can affect the water quality of nearby streams when salts are washed into the stream during precipitation events. In some cases, the seeps develop along stream banks and are washed into the stream during high flows.

Crop/fallow cropping practices and other practices that store soil moisture in the recharge area of saline seeps can accelerate the development of the seeps. This is especially prevalent where the Claggett Shales are found. In the Big Sandy watershed Claggett shales underlie the glacial tills of the Lonesome Lake sub-watershed and the alluvial deposits of Big Sandy Creek between the towns of Big Sandy and Box Elder (Figure 10). Note the proximity of Big Sandy Creek to the Claggett formation above Lonesome Lake Coulee (Figure 10). This area is also identified and photographed in the Big Sandy Creek Aerial Assessment (Big Sandy CD, 2000; Appendix A).

3.1.6 Load Allocation

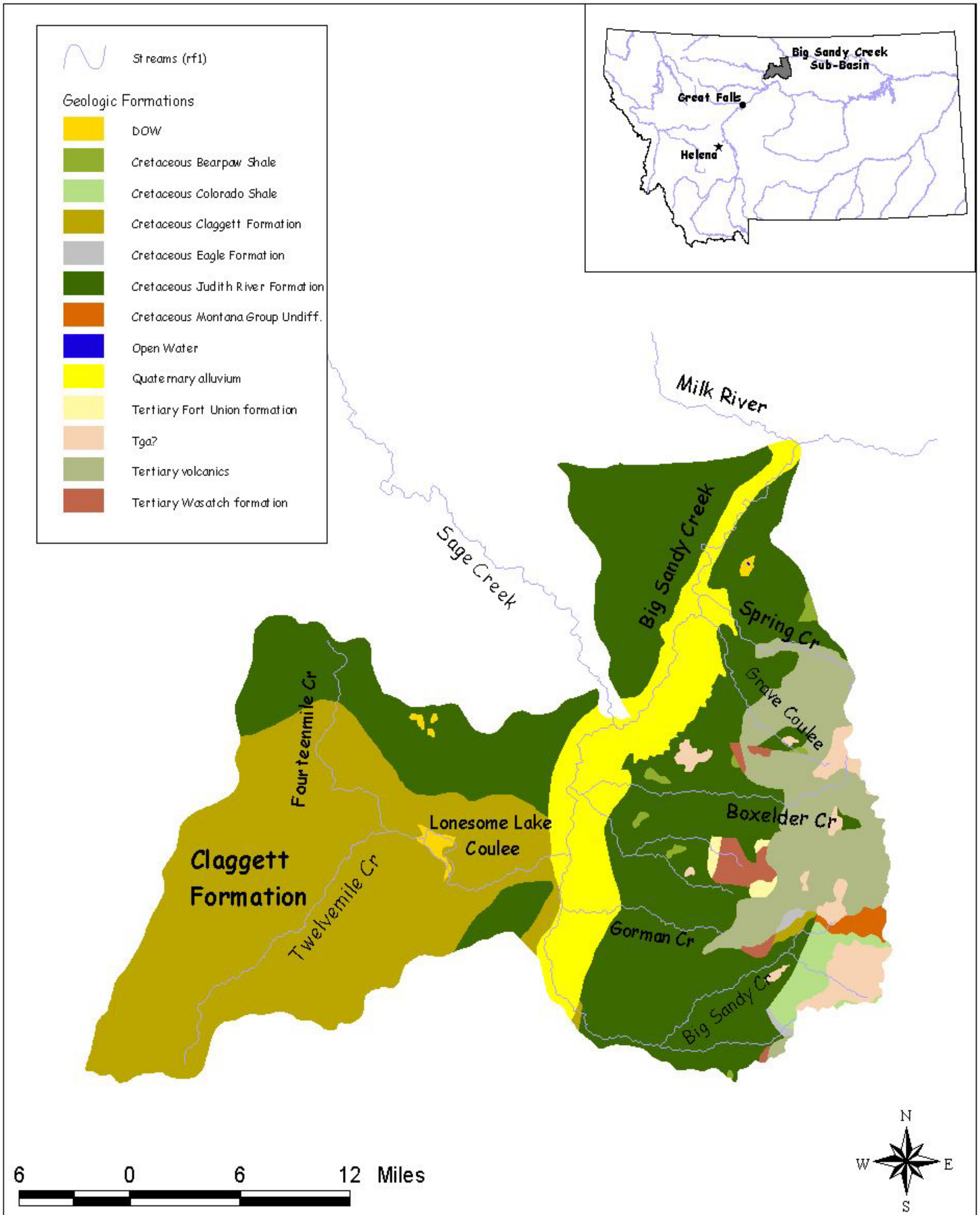
Crop/fallow cropping practices and other dry-land farming practices that store soil moisture are the primary source of anthropogenic salinity. Implementation of the following agricultural best management practices (BMPs) should achieve water quality standards for salinity/total dissolved solids/sulfates in Big Sandy Creek.

Dry-land farming operations in recharge areas contributing to saline seeps are encouraged to select one of the following methods to mitigate salinity discharge into Big Sandy Creek: (1) adopt a 5 to 10 year rotation from crop to perennial forage for haying/grazing; (2) place recharge areas into the Conservation Reserve Program; or (3) switch from crop/fallow to annual or flex cropping. These practices should change vegetation in the recharge areas and facilitate the drying up of saline seeps. Therefore, the necessary load reductions to achieve the TMDL are allocated to this source.

3.1.7 Margin of Safety

Toxicity associated with concentrations of major ions at the annual target concentration for TDS and specific conductance are predicted at six percent mortality in neonate 48-hour exposures to *Daphnia magna* (Figure 8) (Mount *et al*., 1997). The Mount *et al*., (1997) model has been shown to be a conservative model because it usually over predicts toxicity. The salinity targets are considered protective and provide an adequate margin of safety relative to the biological, irrigation, drinking water and stock water uses.

Modeling of major ion contributions to acute toxicity outlined in Mount et al. (1997) was used to provide a link between biological beneficial uses and the water quality restoration targets proposed for Big Sandy Creek, and is also presented as a MOS. Mount et al. (1997) is a very conservative model that tends to over predict toxicity. There are indications that the "Mount model" often over predicts toxicity in bicarbonate dominated waters, but accurately predicts toxicity in sulfate dominated waters (personal comm. Don Skaar, Pollution Control Biologist, Montana Fish, Wildlife, and Parks). Caution should be used when comparing modeled toxicity results to the biological impact of toxicity on in-stream aquatic communities. In general, test species are not always the same as the species of concern, tested life stages do not span all life stages of exposure in nature, test durations are not the natural exposure durations, modeled responses do not include all responses of concern, and test endpoints are at an organism level, not at a population level. An unknown portion of the modeled toxicity associated with major ions in Big Sandy Creek is from natural sources. Modeled 48-hour mortality of six percent in neonate *Daphnia magna* for Big Sandy Creek is thought to be protective of biological beneficial uses. In addition, preliminary mortality thresholds calculated for major ions associated with coal bed methane using Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic organisms and Their Uses (1985) are comparable and support this conclusion.



Montana Department of Environmental Quality

Geologic formations and largest streams in the Big Sandy Watershed.

Figure 10

By: MJP

Date: 12/01

3.2 Siltation

3.2.1 Existing Water Quality Concerns

Because erosion is a natural process and sediment transport is necessary for a healthy stream, more than one type of indicator is used in indicating appropriate sediment regimes in Big Sandy Creek. Total suspended solids, turbidity, bank erosion, biology, and geomorphologic data were assessed in an effort to characterize siltation.

Recently collected bank erosion, turbidity, and siltation data were examined as part of the effort to develop a TMDL for Big Sandy Creek. Bank erosion delineation was completed by an aerial helicopter assessment in 2000 (Big Sandy CD, 2000; Appendix A). Geomorphic and turbidity data were collected in summer 2001, as part of the larger Milk River nutrient study (DEQ, 2001b).

Physical measurements such as TSS and bank erosion indicate that there is potential sediment contribution to the stream from both natural and human induced sources. The aerial helicopter survey identified 9.5 miles of eroding bank in 2001 (Figures 11, 12). Total suspended sediment data were recorded sporadically at the USGS gaging station near Havre between 1985 to 1989 (Table 6). These measurements covered a range of flows but did not capture any high flow events (Figure 13). The average recorded sediment discharge (load) in 1986 was 1.4 tons per day; the average recorded sediment discharge in 1987 was 0.39 tons per day. The total suspended sediment concentration averaged 32 mg/L and ranged between 6 to 84 mg/L.

3.2.2 Applicable Water Quality Standards

Siltation was listed as a probable cause of impairment on the 1996 303(d) List. Warm water fisheries and aquatic life beneficial uses were listed as only partially supported. The applicable water quality standard found in ARM 17.30.625 (2)(f) states:

"(2) No person may violate the following specific water quality standards for waters classified B-3:
(f) No increases are allowed above naturally occurring concentrations of sediment, 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."

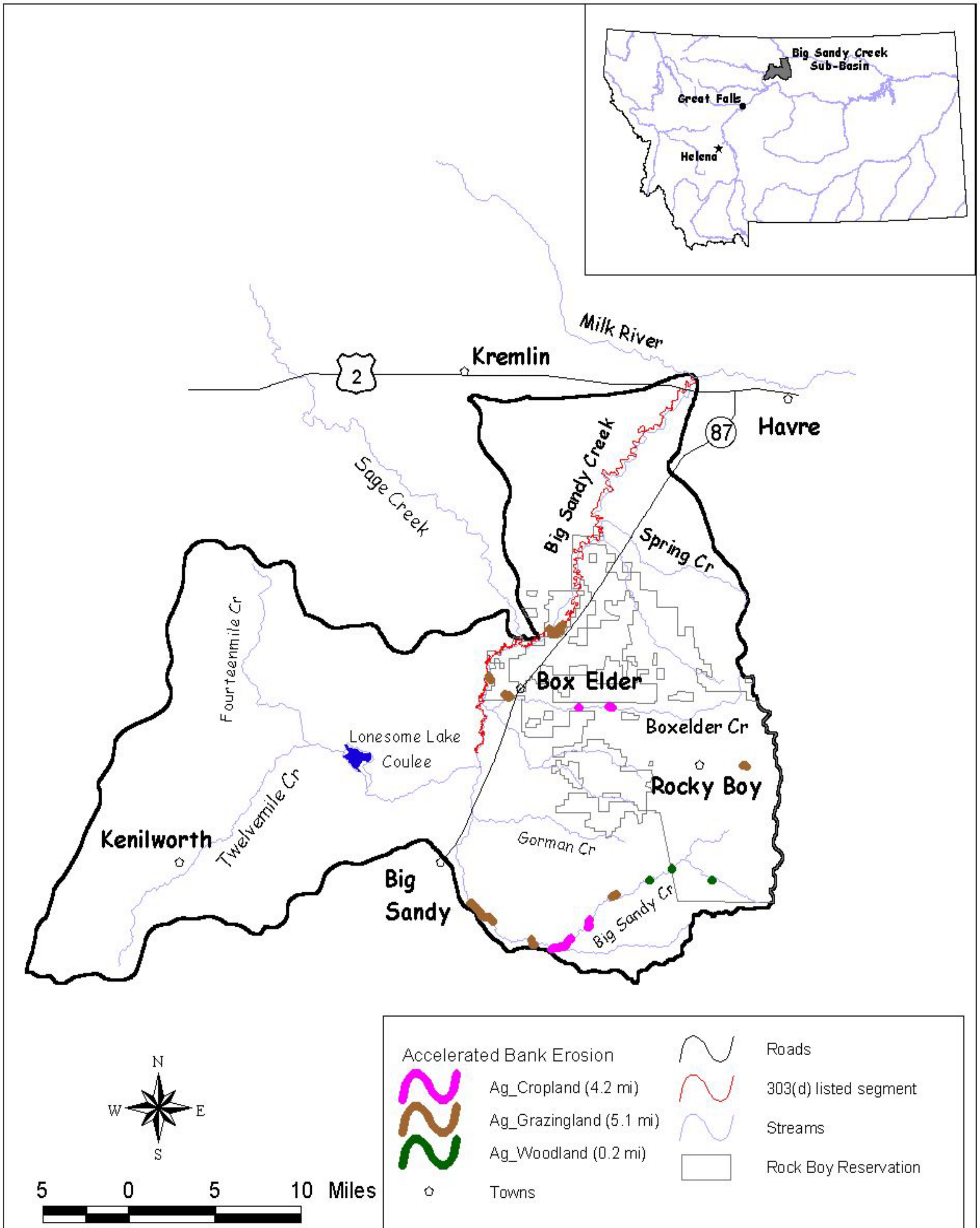
3.2.3 Beneficial-use Determination

Siltation was listed as a probable cause of impairment in Big Sandy Creek on the 1996 303(d) List. Insufficient credible data was available to verify this determination when Big Sandy Creek was re-evaluated for the 2000 303(d) List. The following presents a beneficial use determination for Big Sandy Creek that demonstrates that this water body does not appear to be impaired as a result of siltation.

A referenced-based approach was used to put the sediment characteristics of Big Sandy Creek in context with similar naturally functioning, and/or “least-impaired” streams. Segments of Willow Creek, Porcupine Creek, and Clear Creek were selected as reference streams based upon a recent study of the Milk River Watershed (DEQ, 2001b). The Milk River study considered each of these water bodies representative of naturally functioning conditions and/or representative of the least impaired water bodies within the Milk River Watershed.

According to the State of Montana, Big Sandy Creek and the reference streams are all classified as B-3 streams (ARM17.30.610{8}). Reference streams were classified from a geomorphological perspective, using the Rosgen stream classification system (Rosgen, 1996). Big Sandy Creek, below Sage Creek, classified as a C5 or C6 stream, Willow Creek, near Rock Creek, classified as a F5 stream, and Porcupine Creek east of Glasgow, MT classified as a C4 stream type. Clear Creek, on the north side of the Bears Paw Mountains classified as a C4 stream type. All streams are located within the Northwestern Glaciated Plains ecoregion except for Clear Creek, which is located in the MT Valley and Foothill Prairies ecoregion. Although Clear Creek is located in a different ecoregion, it is considered a valid reference site (along with Willow and Porcupine Creeks) for comparison with Big Sandy based on stream types and given that both streams originate in the Bears Paw Mountains.

In each reference site turbidity, total suspended solids, and field transparency were measured by grab sample in June, August, and September 2001. The turbidity standard for B-3 streams is ten NTUs allowed above naturally occurring levels (ARM 17.30.625{d}). Further, no increases are allowed above naturally occurring concentrations of sediment (ARM 17.30.625{f}). As can be seen in Figures 14 and 15, Big Sandy Creek is well within the water quality standards for these parameters, relative to the reference sites. These comparisons are also supported by in-field measurements, where transparency was measured at the time of water-sample collection (Figure 16).



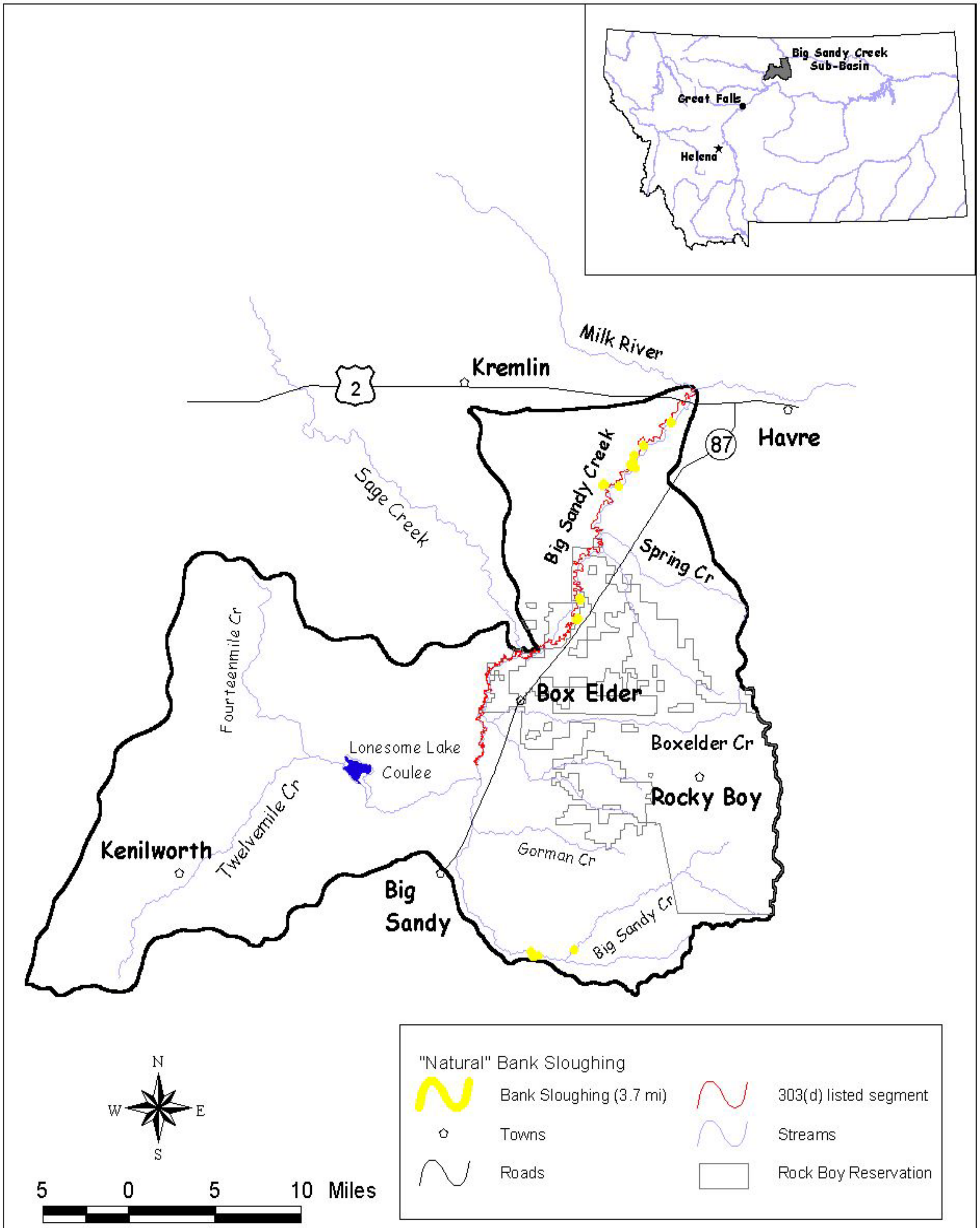
Montana Department of Environmental Quality

Areas of accelerated stream bank erosion.
Data Source (eroding banks):
Big Sandy Creek Aerial Assessment. 5/2000.
BSCD/USDA NRCS

Figure 11

By: MJP

Date: 12/01



Montana Department of Environmental Quality

Areas of "naturally" occuring stream bank sloughing.
Data Source (banks): Big Sandy Creek Aerial Assessment. 5/2000.
BSCD/USDA NRCS

Figure 12

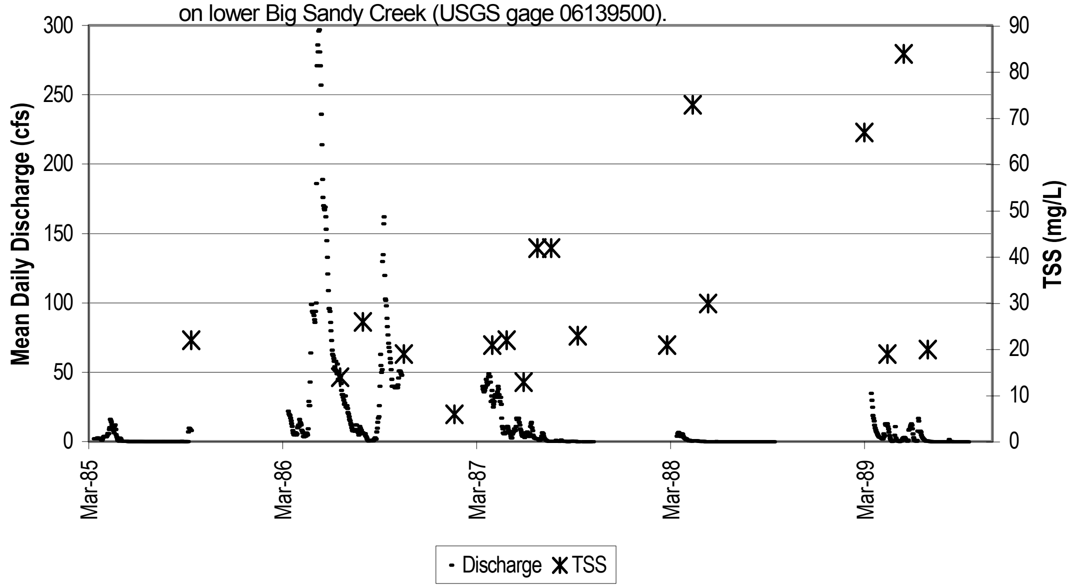
By: MJP

Date: 12/01

Table 6. Total suspended sediment data from Big Sandy Creek near Havre at USGS gaging 06139500 (1985 - 1989)

Date	TSS (mg/L)	Instantaneous streamflow (CFS)	TSS load (T/day)
10-2-85	22	7.1	0.42
7-9-86	14	41.0	1.6
8-21-86	26	5.8	0.41
11-6-86	19	42	2.2
2-9-87	6	18	0.3
4-21-87	21	25	1.4
5-18-87	22	11	0.65
6-19-87	13	2.9	0.1
7-15-87	42	2.1	0.23
8-10-87	42	0.15	0.02
9-29-87	23	0.1	0.01
3-15-88	21	28	1.6
5-2-88	73	0.64	0.13
5-31-88	30	0.01	0.001
3-21-89	67	16	2.9
5-3-89	19	9.6	0.49
6-15-89	84	13	2.9
7-18-89	20	0.7	0.04
11-28-89	42	0.2 (est.)	0.02

Figure 13. Total suspended sediment concentration and stream flows from 1985 to 1989 on lower Big Sandy Creek (USGS gage 06139500).

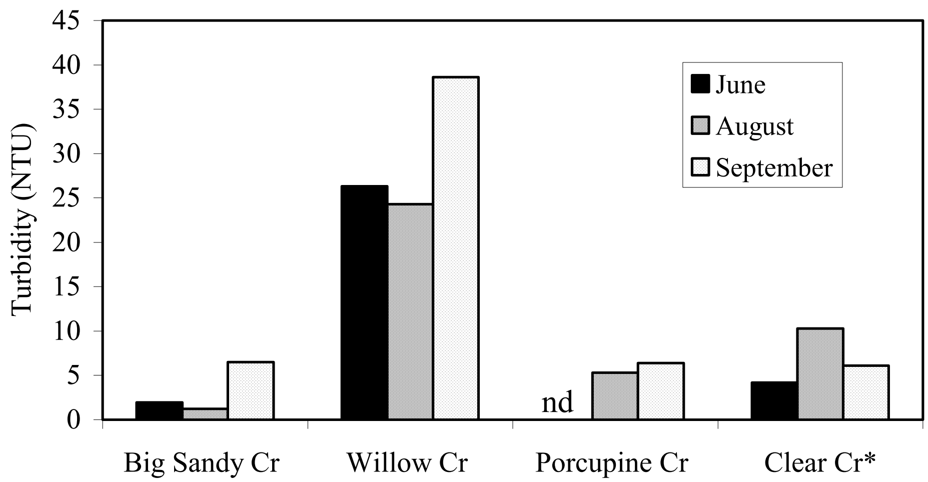


The data presented in Figures 14 - 16 indicate only part of the overall status of a stream's sediment regime. Geomorphologic classification and measurements of stream bottom constituents can further indicate the stream’s condition, and have the advantage that they incorporate larger spatial and time scales. As indicated, Big Sandy Creek was found to be a C5 or C6 stream. C-type streams are noted for their well developed flood plains, as well as point bars within the channel, and are easily altered by changes in flow and sediment regime (Rosgen, 1996). In the Northwestern Glaciated Plains ecoregion, it is easy to observe a number of former C channels that have downcut (incised) to become "G" or gully streams, a condition in the American West that has been noted by others (Leopold, 1994). Both Porcupine and Clear Creeks are C streams, one of the factors that led to their overall high condition ratings. The fact that Big Sandy Creek is also a C-type stream is a good indication of reasonable geomorphologic stability.

Pebble counts were conducted at the Big Sandy Creek site, which included one riffle section. Fine and coarse gravel and cobbles dominated this riffle. Therefore, coarser materials are well represented where adequate stream velocity exists to remove finer materials. In contrast, fines and sand dominated the pools and glides.

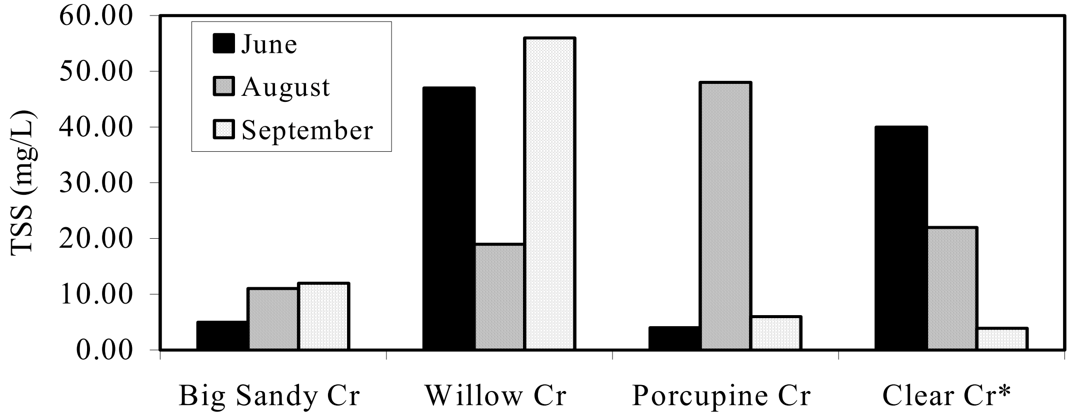
Big Sandy Creek also had strong growth of macrophytes and filamentous algae, as was observed in Porcupine and Clear creeks. Plants attached to the stream bottom were not observed in Willow Creek, which is an F-type stream. F-type streams tend to have accelerated channel aggradation or degradation (Rosgen, 1996). General stream bottom instability contributes to Willow Creek's higher turbidity and TSS measurements, and is probably the reason why it did not develop a benthic aquatic plant community. In the Milk River basin a robust development of benthic aquatic plants, especially macrophytes, is an indication of stream channel stability (Michael Suplee, personal communication 2001, DEQ WQ Standards Section). As noted, benthic aquatic plants are well developed in Big Sandy Creek, therefore this is yet another indication of its geomorphic stability.

Figure 14. Comparison of turbidity in Big Sandy Creek to reference streams in the Milk River basin (DEQ, 2001b)



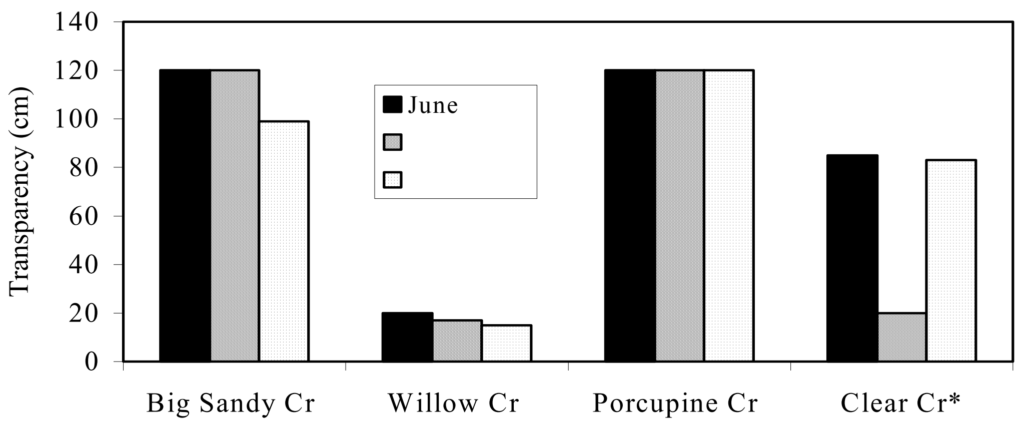
**From Valley and Foothill Praries ecoregion.*

Figure 15. Comparison of TSS in Big Sandy Creek to reference streams in the Milk River basin (DEQ, 2001b)



**From Valley and Foothill Praries ecoregion.*

Figure 16. Transparency of stream water measured at the time of sample collection. 120 cm was the maximum clarity value (DEQ, 2001b)



**From Valley and Foothill Praries ecoregion.*

Some of the most sensitive beneficial uses, fisheries and periphyton, indicate that sediment transport within Big Sandy Creek is functioning properly. Periphyton is also considered an indicator of water quality because of the naturally high number of species and their ability to respond rapidly to both exposure and recovery from pollution events. Diatoms in particular are useful indicators of biological condition because they are ubiquitous and found in all stream systems. In addition, most periphyton can be accurately identified by experienced biologists, and tolerance or sensitivity to specific changes in environmental condition is known for many species.

The siltation index evaluates the percent of diatoms that are mobile. It is expressed as the relative abundance of *Navicula* + *Nitzschia* + *Surirella* (Bahls et. al., 1992). These diatoms are able to crawl towards the surface if they are covered by silt; their abundance is thought to reflect the amount and frequency of siltation. A siltation index below 50 percent indicates a population that is not significantly affected by siltation. Periphyton studies of Big Sandy Creek (Ingman, 1979; Clay, 1996) showed diverse periphyton populations (44 to 39 species found) and siltation indices of 34.2 and 16.9 percent.

The lower portion of Big Sandy Creek supports a diversity of fish species (Table 3) and is used as rearing and spawning habitat for walleye, sauger, and northern pike. The fish community appears to be healthy for a prairie stream. Aquatic habitat data collected 2001 (DEQ, 2001b) indicates to a stable C-type channel that provides adequate riffle and macrophyte habitat.

During the summer of 2001, Big Sandy Creek did not violate any of the numeric or narrative standards for turbidity or total suspended solids. Furthermore, other lines of evidence (Rosgen stream type, channel materials, water column sediment, benthic aquatic plant growth, fisheries and periphyton) suggest overall geomorphologic stability and no significant siltation problems.

The narrative presented above demonstrates that Big Sandy Creek does not appear to be impaired as a result of siltation. For this reason, no water quality restoration targets or TMDL are necessary for siltation.

3.3 Thermal Modification

3.3.1 Existing Water Quality Concerns

Big Sandy Creek flows through the Northwestern Glaciated Plains ecoregion characterized by nearly level terrain, wide-open prairie, and rich glacial till. The exception to this landscape is the Bears Paw Mountains comprising the headwaters in the southeast portion of the basin.

Air temperatures in this region of Montana are characteristic of interior continental climatic regimes with extremes ranging from sub-zero lows to highs greater than 100 degrees Fahrenheit. Stream flows are also highly variable both within and between years. Highest flows usually occur during spring in response to snowmelt and spring rains and low flows occurring in late summer, fall, and winter (Figures 4 and 5). The lower reach of Big Sandy Creek often has periods of minimal or no flows during late summer and winter (Figure 4) where the stream may be little more than a series of pools without a measurable surface flow connection.

Big Sandy Creek was initially listed in Montana's 1988 Non-Point Source Assessment Report (Bahls, 1988) with thermal modification as a potential water quality impairment. The thermal modification listing has remained attached to Big Sandy Creek on all Non-Point Source Assessment Reports and 303(d) lists subsequent to the 1988 listing. However, supporting data and/or listing justification was not documented in any of these reports and, moreover, the initial 1988 listing decision was based on an evaluation of "information other than current site-specific ambient data" (Bahls, 1988).

3.3.2 Applicable Water Quality Standards

Big Sandy Creek from its mouth at the Milk River upstream to the town of Big Sandy is classified as B-3, a warm water fishery. The impaired reach of 37 miles extends from the confluence with Lonesome Lake Coulee to its confluence with the Milk River (Figure 1). Montana's 1996 303(d) List identified the aquatic life and warm water fishery beneficial uses as only partially supported.

Montana's temperature standard for B-3 waters (ARM 17.30.625(2)(e)) specifically states:

"(2) No person may violate the following specific water quality standards for waters classified B-3:
(e) A 3°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 77°F; within the naturally occurring range of 77°F to 79.5°F, no thermal discharge is allowed which will cause the water temperature to exceed 80°F; and where the naturally occurring water temperature is 79.5°F or greater, the maximum allowable increase in water temperature is 0.5°F. A 2°F per-hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F, and a 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F."

3.3.3 Beneficial-use Determination

Montana's water quality standards establish that B-3 waters may at times experience temperature regimes exceeding 80 degrees Fahrenheit under *natural conditions*. Data from the US Geological Survey (gage 06139500, Big Sandy Creek near Havre; 10-85 to10-90), Montana's STOREASE Water Quality Information Database (4-82 to 9-86), and University of MT research (Lhotac, 2001) were evaluated for the range of stream temperature measurements. In addition, stream temperatures were compared with concurrent measurements of dissolved oxygen. Finally, field monitoring data from Big Sandy Creek and other Milk River tributary streams collected in 2001 were reviewed (DEQ 2001b). This study measured water chemistry, biology, and stream morphology and made observations of riparian habitat conditions.

Summer stream temperatures (May to September) include 71 measurements at USGS gage 06139500 near Havre and three measurements at T31N R14E S16 collected by Lhotac (2001) between 1984 and 2001. Temperatures ranged from a minimum of 48 °F to a maximum of 88 °F. The mean monthly temperatures ranged between 54 and 73 °F (Figure 17). Stream temperatures greater than 80 °F were recorded in 6/84, 6/86, 7/99, 6/01, and 8/01.

Elevated water temperatures often can reduce the dissolved oxygen concentrations in the water and adversely affect fish populations. Montana Circular WQB-7 lists numeric water quality standards for dissolved oxygen for a B-3 stream as three mg/L for early life stages and five mg/L for other life stages. USGS data from 1985 to 1989 (Figure 18) indicates that DO levels did not exceed specified state water quality standards, suggesting that stream temperatures are not creating or contributing to a condition of depressed dissolved oxygen levels. Furthermore, fisheries data gathered by the Montana State Fish,

Figure 17. Stream temperatures measured on lower Big Sandy Creek by Lhotac (2001) and USGS (gage 06139500 near Havre) 1984 - 1999

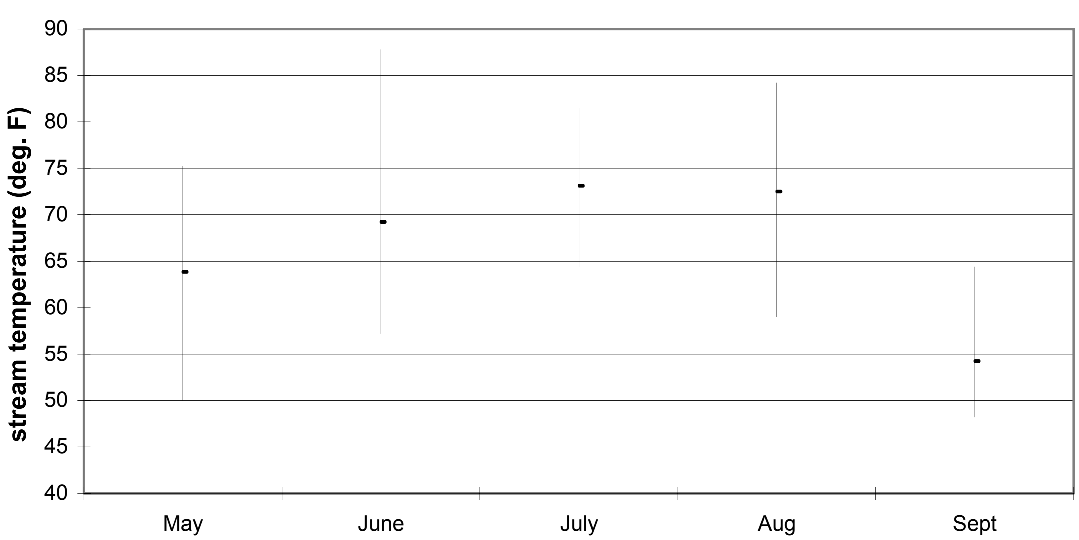
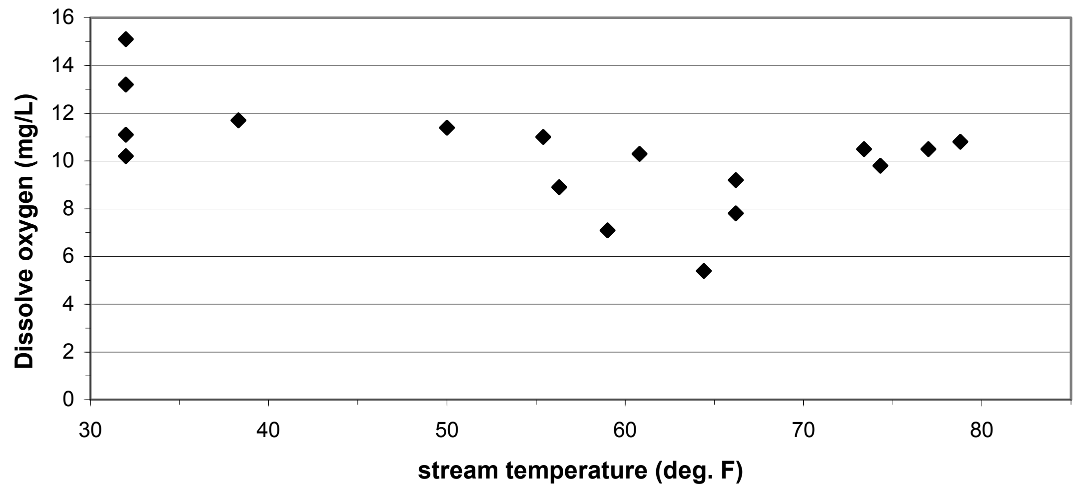


Figure 18. Dissolved oxygen vs. stream temperature on Big Sandy Creek near Havre, 1985 - 1989 (n = 17)



Wildlife, and Parks (Drewes, 1986) indicated that Big Sandy Creek's fisheries are diverse and representative for a warm water stream of this size in this region.

Field measurements and observations by DEQ staff suggest that Big Sandy Creek is within its range of natural geomorphic variability (DEQ, 2001b). As noted in Section 3.2.3, Big Sandy Creek was compared with other stream in the region that are considered reference streams and was found to have similar stream channel morphology. Additionally, riparian vegetation along Big Sandy Creek was judged to be at its expected potential. Field observations supported this noting no evidence of historic large cottonwood galleries or other taller shade producing vegetation such as willows. Stream temperature is predominantly a function of solar input, which can be influenced by channel geometry and riparian vegetation condition. Since both of these factors appear to be within their range of natural variability, it is determined that observed stream temperatures in Big Sandy Creek are also within the range of natural occurring conditions for this stream. In addition, photographs provided in Big Sandy CD (2000; Appendix A) shows a riparian community that is dominated by herbaceous vegetation with no evidence of large woody shading vegetation.

The narrative presented above demonstrates that Big Sandy Creek does not appear to be impaired as a result of thermal modification. For this reason, no water quality restoration targets or TMDL are necessary for thermal modifications.

SECTION 4.0
MONITORING & ADAPTIVE MANAGEMENT

A phased, or adaptive management, approach to water quality restoration and TMDL development is proposed due the lack of an exhaustive data set upon which to base current conclusions, uncertainty in the pollutant loading, and uncertainty in the load reductions that need to occur and targets that need to be met, in order to satisfy water-quality standards. This document constitutes Phase I, wherein the numeric targets and TMDL are based on the best available information and the hypothesis that achieving these targets and TMDL will result in restoring full support of the beneficial uses.

DEQ will assess water quality to determine whether water quality standards are attained. DEQ's monitoring program will include long-term monitoring to determine the effectiveness of voluntary measures. (75-5-703 (7) MCA)

If monitoring shows that water quality standards are not achieved within five-years after approval of a TMDL [or Water Quality Restoration Plan], the DEQ will evaluate the progress made in restoring water quality based on voluntary implementation of reasonable land, soil, and water conservation practices. The evaluation will determine if:
(a) a new or improved phase of voluntary reasonable land, soil, and water conservation practice is necessary;
(b) water quality is improving but a additional time is needed to achieve water quality standards; or
(c) revisions to the TMDL are necessary to achieve applicable water quality standards. (75-5-703 (9) MCA)

4.1 Salinity

Flow measurements and water samples should be collected monthly from April through October for five-years at the USGS gage station near Havre. A range of TDS concentrations, which would correspond with different flow conditions, should be targeted for sample collection. Water quality samples should be analyzed for TDS, chloride, potassium, bicarbonate, magnesium, sodium, calcium and sulfate. A specific conductance data logger is recommended for USGS gage site 06139500 (Big Sandy Creek near Havre). The data logger should be capable of sampling at least four times per day. Data generated from this effort will be used to calculate toxicity associated with major ions to *Daphnia magna* according to methods outlined in Mount *et al.*, (1997), evaluation of established targets, and help delineate the contribution of Sage/Big Sandy TDS to the Havre drinking water supply.

Detailed mapping of saline seep areas is recommended to identify areas and quantify acreage that may be effecting water quality in Big Sandy Creek. This assessment can be accomplished using large-scale aerial photography (1:12,000 or 1:15,000) or Digital Orthophoto Quadrangles using GIS analysis techniques. An initial inventory should be conducted as soon as possible, with a follow up assessment conducted at a five-year interval. Data provided from this assessment can be used to evaluate implementation and success of identified BMPs established to reduce saline seep acreage and salinity impairment to Big Sandy Creek. Technical assistance and/or support may be provided from Montana DEQ or other local natural resource agencies.

4.2 Siltation and Riparian Habitat

Although siltation and riparian habitat have been judged to be within the range of naturally occurring conditions in Big Sandy Creek, some anthropogenic sources (i.e. bank erosion) have been identified (Big Sandy CD, 2000, Appendix A). The extent or magnitude of sediment contribution that these areas contribute is not quantified and creates some uncertainty in that determination. Additional monitoring of stream channel morphology and physical habitat is recommended following the protocols established in the Milk River nutrient assessment study (DEQ, 2001b). Monitoring is recommended at five-year intervals at cross-sections previously established by the Milk River nutrient assessment. These data may be used to assess trends in stream stability and sediment regimes.

In addition, a quantitative evaluation of bank stability providing a measure of unstable bank surface area is recommended. Using the 2000 aerial assessment (Big Sandy CD, 2000) as a starting point, the identified mileage of eroding stream bank, both anthropogenic and natural, should be verified with on-the-ground site visits measuring bank height, length, soil type/composition, and depth of rooting mass (if any). This assessment should occur as soon as possible and be repeated at the five-year interval in concert with channel morphology and physical habitat monitoring.

SECTION 5.0
RESTORATION STRATEGY

The Big Sandy Conservation District, Hill County Conservation District, Rocky Boy's Conservation District , and Chippewa Cree Tribe cooperatively completed an aerial assessment of the Big Sandy Creek Watershed (Big Sandy CD, 2000). The next step is for each conservation district to ground truth the information collected in the aerial assessment in their area of responsibility. The assessment is intended to help local people prioritize and focus on reaches of concern.

Best management practices for reducing the effects of saline seep and bank erosion in the watershed are appropriate actions to achieve water quality standards for salinity/total dissolved solids/sulfates. Landowners who wish to participate in stabilizing saline seeps may be able to obtain cost-share grants for restoration activities. Farmers in saline seep recharge areas should consider changing from crop/fallow to other farming options such as continuous cropping. Landowners who wish to participate in bank stabilization activities may be able to obtain cost-share grant funds for restoration activities.

SECTION 6.0
PUBLIC INVOLVEMENT

A public notice of availability of the TMDL and opportunity for providing comments was published on the DEQ home page http://www.deq.state.mt.us on December 15, 2001. A press release was posted on DEQ's Press Release Web Page announcing the availability of the TMDL, the comment period and public meeting location and time. The press release was also posted on the listserve for watershed issues WASHED@listserv.montana.edu. In addition, a hardcopy of the press release was sent to the Mountaineer News in Big Sandy. The public meeting information was also posted on DEQ's Public Meetings Web Site. The Bureau of Land Management, the Chippewa Cree Tribe and the Milk River International Alliance were contacted and given review copies of the TMDL. A 30-day public comment period ends January 16, 2002. Appendix B summarizes the comments received and the agencies response.

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APPENDIX B

The Result of Public Participation in the Big Sandy Creek Salinity TMDL and Water Quality Restoration Plan

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A public notice of the availability of the draft Big Sandy Creek Salinity TMDL and Water Quality Restoration Plan, and opportunity for providing comments was published on the DEQ home page http://www.deq.state.mt.us on December 15, 2001. A press release was posted on DEQ's Press Release Web Page announcing that the draft document was available and that comments would be accepted until December 30, 2001. The press release was also posted on the listserve for watershed issues WASHED@listserv.montana.edu. In addition, a hardcopy of the press release was sent to the Havre Daily News, Ft. Benton River Press and Big Sandy Mountaineer. Several reviewers requested an extension of the comment period. The holidays made it difficult for interested individuals to acquire the document and respond in a timely manner. The comment period was extended to January 16, 2002. A press release announcing the extension was distributed as above.

The Hill County and Big Sandy conservation districts made copies of the document available for public review. A 30-day public comment period ended January 16, 2002. Four e-mail messages were received during the comment period. A summary of the comments and responses follows.

COMMENT	RESPONSE
The salinity problem is aggravated by dirt fill, culverts, rock crossings and other channel restrictions. The water backs up and floods the surrounding land, evaporates and leaves salts. Channel work is needed starting in T28N R15E.	A TMDL is required to address all significant sources of water quality impairments. While correction of these issues would help alleviate the impacts of salinity on the floodplain area, it would not address the source of the salinity.
On Page 5-1 add: The Big Sandy Conservation District, Hill County Conservation District, Rocky Boy's Conservation District (add: Chippewa Cree Tribe) cooperatively completed an aerial assessment of the Big Sandy Creek Watershed (Big Sandy CD, 2000).	The change was made.
Page 3-11: According to the State of Montana, Big Sandy Creek and the reference streams are all classified as B-3 streams (ARM17.30.610{8}. Then on page 3-15 it reads: Big Sandy Creek was found to be a C5 or C6 stream.	On page 3-15, the C5 and C6 refer to a stream channel classification system that was developed by David Rosgen. The system is a way of estimating if a stream channel is in equilibrium with the topography and climate of the valley it drains. The "C" describes Big Sandy as a meandering stream in a broad alluvial valley. The "5" describes the majority of channel sediment as being larger than sand. The "6" describes the majority of channel sediment as being larger than silt.

The SC of 1,600 umhos/cm as a target based upon protecting a beneficial use (aquatic life) is confusing. What is the natural SC for this reach of Big Sandy Creek. Is the value of 1600 low for most prairie streams that transect marine shales? Is SC of 1,600 a realistic target?	The data for Big Sandy suggests that the SC target of 1,600 micromhos per centimeter at 25 degrees Centigrade is achievable in most years when the precipitation is enough to provide a perennial flow in the channel. The range of measured SC values in Big Sandy Creek is from 200 to 6,070. The target is realistic in that it represents a goal that, if reached, will provide high quality water for both aquatic life and irrigation uses. Toxicity associated with the concentration of major ions at the TDS and specific conductance targets are predicted at six (6) percent mortality in 48-hour exposures to *Daphnia magna*. The national secondary drinking water regulation of 500 mg/l of total dissolved solids was not chosen as a target because it was not considered realistic for Big Sandy Creek.
The BSCD board would also like to see the basis for your statement that 1 cfs or less is ground water? There is no reference given for this claim.	It is DEQ's assumption that one cubic foot per second of flow represents the portion of the hydrograph known as baseflow. Baseflow is the groundwater seeping into the stream channel. The chemical characteristics of the water often change as groundwater becomes a significant portion of the flow in a stream. The data shows that at 1 cfs or less the mineral characteristic of the water typically has a TDS above the target.
Is there a threshold flow (Q) for SC/TDS? When does the TMDL target apply?	The TMDL target applies at all times and flows. It is a goal that may be achieved through voluntary implementation of reasonable land, soil and water conservation practices.
Please explain the "Mound toxicity model"	This model estimates the toxicity of common mineral constituents of water on fish and macroinvertebrates. Experiments were done on fathead minnow and *Daphnia magna* exposing them to varying concentrations of common substances and noting how many died. The common substances were potassium, magnesium, chloride, sulfate and bicarbonate. The data were used to develop a set of equations so that if the concentrations these substances were known, you could estimate the survival rate of these aquatic organisms.
Neither the chloride levels nor the sulfate levels look unusually high for a prairie stream, why was the chloride dropped and why was sulfate added as a water quality pollutant?	You are correct; neither chloride nor sulfate is a concern for Big Sandy Creek. However, the mineral character of the water is best described as sodium sulfate because these are the dominant constituents. That is why the salinity/TDS/chloride listing was changed to salinity/TDS/sulfate.

The following statement should be taken out or changed "the necessary load reductions to achieve the TMDL are allocated to this source" page 3-8.	The sentence is important in order to draw a logical conclusion from the information presented in the paragraph. The allocation approach identifies BMPs. The term "load reduction" refers to the reasonable land, soil, and water practices that dryland farming operations are encouraged to voluntarily implement.
The allocation described in Section 3.1.6 is a crucial element of the TMDL. The source category needing corrective action is "dry-land farming operations in recharge areas contributing to saline seeps". The allocation approach identifies BMPs. Please provide more description of the land use category. Is there a map that identifies these areas? Is there an approximate % of land use that comes under this category	Dryland farming operations cover approximately sixty percent of the watershed. Figure 3 shows that the majority of the dryland farming acreage is in the Lonesome Lake watershed west of Big Sandy and Box Elder. Delineation of recharge areas is recommended in Section 4 Monitoring and Adaptive Management. Figure 10 shows where the Claggett Formation is close to the surface. The Claggett Formation provides a barrier to downward migration of groundwater between the towns of Big Sandy and Box Elder. This is the worst area for saline seep development. Picture 5 from the aerial flight shows the white deposits along the banks of the creek. It is unknown at this time how much of the watershed recharges these seeps. But recharge likely occurs in the Lonesome Lake subwatershed.
Please provide adequate evidence to conclude that land uses have not altered siltation and temperature in Big Sandy. The channel is incised, dished-out, and bare of vegetation.	The best evidence is that Big Sandy Creek fully supports a warm water fishery. The aquatic life is partially supported; however, the pollutant most likely affecting survival is salinity/TDS/sulfate. DEQ used the Mount model to characterize this relationship. DEQ believes that the riparian habitat is within 75 percent of potential and that the channel geometry appears stable. These factors control water temperature. Section 4 Monitoring and Adaptive Management outlines a monitoring plan that will gather additional data and an adaptive management plan that uses the data to modify the TMDL if appropriate.

High siltation levels mainly occur during high flow; the TMDL did not present any high flow turbidity/TSS data. What part of the stream provided evidence of geomorphic stability and low diatom siltation indices and does the data cover enough of the stream to be representative.	Siltation is the fine sediment that accumulates on the channel bottom and covers aquatic plants, animals, and fish eggs. High flows often flush out this deposit; whereas low flows allow the deposits to build. DEQ agrees that high TSS is often correlated to high flow, but suspended solids have not been identified as an issue for Big Sandy Creek. Photos from the aerial flight of the entire stream shows a highly sinuous, narrow channel. Mike Suplee, a water quality specialist for the DEQ, assessed Big Sandy as part of the study of the Milk River drainage in the summer of 2001. A representative site near the mouth was measured and determined to be geomorphically stable. A Wollman pebble-count showed the stream was dominated by gravel- to cobble-sized particles (refer to Section 3.2). Diatom data have been gathered during tribal or DEQ investigations in the lower, middle and upper portions of the creek. In addition, Section 4 Monitoring and Adaptive Management outlines a monitoring plan that will gather additional data and an adaptive management plan that uses the data to modify the TMDL if appropriate.
Temperature and DO data from 1985-89, are too old and likely collected during the day when DO levels are high. I disagree that the riparian vegetation is at its expected potential. The stream probably included low shrubs capable of holding some overhanging banks and providing a little shade. Please supply the age and quality of the fish data and compare the data to that found in a reference stream. The TMDL must provide evidence that diversion/dewatering does not contribute to thermal modification.	Dissolved oxygen data were collected by the USGS during 1985-89. Temperature data were collected during this same period but continued on through 1999. Similar temperature trends were seen when comparing water years; high temperatures were during July and August when water was at low or no flow. Data collected by DEQ during the summer of 2001 provided values that agreed with the "old" USGS data and did not indicate significant changes. Temperature ranges in Big Sandy Creek during May and June are similar to temperature ranges in July and August when irrigation diversions would most likely affect flow. See Figure 17. Montana Department of Fish, Wildlife and Parks did an extensive fishery study in 1986; the fish biologist who participated in the 1986-assessment was consulted about using the data. He felt the data was still appropriate and representative of current conditions. No reference stream has yet been identified for a warm water fishery in this ecoregion. Big Sandy is in an area that has been in drought status for four years. Higher water temperatures would be expected.

A quantitative bank stability analysis that ground truths the results of the helicopter survey mentioned must be done before DEQ can determine that siltation and temperature are not an issue 2000/2001.	The court order mandates that DEQ address these issues according to the schedule for TMDL development. However, Section 4 discusses future monitoring and adaptive management that will determine the effectiveness of the water quality restoration plan. The TMDL may be modified in the future to include new information.
Fig 11 shows areas of 'accelerated bank erosion' while Fig 12 shows areas of 'natural sloughing'. How are they different?	Warren Kellogg, NRCS, who participated in the aerial flight, gave the following explanation: Bank erosion involves the banks within the floodplain of the stream. Bank sloughing involves the erosion of terraces above the floodplain of the stream. Bank sloughing is more likely to be a natural occurrence while bank erosion is either natural or anthropogenic. Terraces may be unstable because they are made of alluvium and lack cohesive soil. Natural processes, such as infiltration of water and gravity can also cause sloughing.
DEQ should wait to finalize this TMDL until after the above ground truthing is done, dewatering is addressed, and some spring high flow measurements are made.	Because of the court order, DEQ must meet the schedule for TMDL development. However, monitoring of Big Sandy will continue. Section 4 of the TMDL document discusses future monitoring and adaptive management that will determine the effectiveness of the water quality restoration plan. The TMDL may be modified in the future to include new information.
As a B3 stream, Big Sandy is supposed to meet drinking water standards. The secondary drinking water criteria is 500 mg/l TDS. The TMDL does not explain why a 1000 mg/l target is adequate for this beneficial use.	The target is realistic in that it represents a goal that, if reached, will provide high quality water for both aquatic life and irrigation uses. The national secondary drinking water regulation of 500 mg/l of total dissolved solids was not chosen as a target because it was not considered realistic for Big Sandy Creek were natural salinity levels would often exceed this value.