BELLE FOURCHE RIVER WATERSHED MANAGEMENT AND PROJECT IMPLEMENTATION PLAN SEGMENT 4 WATERSHED PROJECT FINAL REPORT SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM

Topical Report RSI-2296

prepared for

Belle Fourche River Watershed Partnership
1837 5th Avenue South
Belle Fourche, South Dakota 57717

December 2011

RESPEC
CONSULTING & SERVICES

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by

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1837 5th Avenue South
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This project was conducted in cooperation with the South Dakota Department of Environment and Natural Resources and the United States Environmental Protection Agency, Region VIII.

Grant # C-99818505, C-99818506, C-99818509, C-99818510

EXECUTIVE SUMMARY

Project Title:	Belle Fourche River Watershed Management and Project Implementation Plan Segment 4
Grant Number(S):	998185-09, 998185-10
Project Start Date:	June 1, 2009
Project Completion Date:	December 31, 2011
Funding	
Total EPA Grant Budget:	$1,296,150
Total Matching Funds Budget:	$2,355,926
Total Nonmatching Funds Budget:	$2,675,300
Total Budget:	**$6,327,376**
Budget Revisions	
June, 2009	
319 Award	$655,000
June, 2010	
319 Award	$641,150
Total Expenditures of EPA Funds:	$1,296,150
Total 319 Matching Funds Accrued:	$1,655,461
Total Nonmatching Funds Accrued:	$2,778,676
Total Expenditures:	**$5,730,287**

Belle Fourche River Watershed Management and Project Implementation Plan Segment 4 was sponsored by the Belle Fourche River Watershed Partnership (BFRWP) with support from agricultural organizations, federal and state agencies, and local governments. This project continued implementation of the Best Management Practices (BMPs) identified in the Total Maximum Daily Load

(TMDL) report for the Belle Fourche River. The objectives of this project segment were:

- Continue implementation of BMPs in the watershed to reduce total suspended solids (TSS) 21.5 milligrams per liter (mg/L) reduction below the Belle Fourche Reservoir; 33 mg/L reduction above the Belle Fourche Reservoir.
- Conduct public education and outreach to stakeholders within the Belle Fourche River Watershed.
- Track progress made toward reaching the goals of the TMDL to help ensure that the BMPs are being implemented in an effective manor.

Several of the completed activities resulted in a reduction of sediment-laden irrigation waste water discharged from the Belle Fourche Irrigation District (BFID) delivery system into surrounding water by 2,811 acre-feet per year. This brings the total acre-feet reduction to 8,466, or 49 percent of the 10-year goal. Eleven real-time stage control units installed on the gates of check structures on both the north and south canals reduced nonused irrigation water by more precisely maintaining the level within the canals and laterals. The BFID lined 1,300 feet of the inlet canal and replaced open ditches with pipe on 6,718 feet of the laterals that delivers water from the BFID to the producers.

Several activities were completed to improve irrigation efficiencies after water was delivered to irrigators within the Belle Fourche River Watershed. A total of 54,285 feet of pipeline was installed by 26 producers to convey water to center pivot irrigation systems or to gated pipe that replaced open ditches. Twenty-four center-pivot sprinkler systems were installed to replace existing surface irrigation.

Grazing/riparian areas were improved significantly within the watershed. Approximately 38,000 feet of pipeline, 19 watering facilities, and 30,000 feet of cross fence were installed using 319 dollars to provide off-stream livestock water and improve grazing distribution. These projects involved 5 producers improving approximately 3,000 riparian acres. New conservation plans were written for over 126,000 acres of grazing lands and follow up was conducted on over 48,000 acres.

Approximately 43 public education and outreach events were completed during this project segment. Outreach activities were in the form of public meetings, informational booths, website maintenance, radio sound bites, rainfall simulator demonstrations, and watershed tours. It is estimated that outreach and education efforts reached at least 16,000 people. A soil quality demonstration trailer was purchased by the BFRWP in 2009 to demonstrate the effects of erosion on soils and how they relate to TSS. The trailer was used at several events sponsored by the BFRWP. The Butte County, Lawrence County, and Elk Creek Conservation Districts each sent out newsletters which included project updates. The BFRWP hosted 10 meetings to provide updates on project work and progress being made. The BFRWP website continues to be updated with happenings and project status and is located at <*www.bellefourchewatershed.org*>. Outreach activities have helped increase participation and support in the BFRWP and also gave the BFRWP several contacts for BMP installation. Several informative sound bites were broadcasted on local radio to increase public awareness of water quality issues and to promote involvement with the project.

Preliminary estimates based on BMP installation indicate that TSS load was reduced by 55,278 tons per year in this segment, which is 11,144 tons per year greater than what was estimated to be accomplished in this project segment. This brings the cumulative TSS load reduction to 161,211 tons per year towards the goal 289,910 tons per acre identified in the TMDL. Currently, the project is in the seventh year of implementation.

ACKNOWLEDGEMENTS

The Belle Fourche River Watershed Partnership would like to thank all those involved with this segment of the implementation of practices recommended from the Belle Fourche River Watershed Total Maximum Daily Load. The efforts of all those involved from the following organizations are greatly appreciated and have been essential to the success of this project:

Belle Fourche Irrigation District

Butte County Conservation District

Crook County Conservation District

Elk Creek Conservation District

Individual ranchers, farmers, and landowners within the watershed

Lawrence County

Lawrence County Conservation District

Natural Resources Conservation Service

South Dakota Association of Conservation Districts

South Dakota Conservation Commission

South Dakota Department of Agriculture

South Dakota Department of Environment and Natural Resources

South Dakota Game Fish and Parks

South Dakota Grassland Coalition

South Dakota School of Mines and Technology

South Dakota State University

United States Army Corp of Engineers

United States Bureau of Reclamation

United States Environmental Protection Agency

United States Fish and Wildlife Service

United States Geological Survey

Wyoming Department of Environmental Quality.

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1.0 INTRODUCTION

The Belle Fourche River is a natural stream that drains parts of Butte, Lawrence, and Meade Counties in South Dakota. The headwaters are located in Wyoming. The river flows into the Cheyenne River in southern Meade County and ultimately to the Missouri River. The watershed is shown in Figure 1-1. The Belle Fourche River Watershed encompasses approximately 2,100,000 acres (3,300 square miles) in South Dakota and includes Hydraulic Units 10120201, 10120202, 10120203. The city of Spearfish (population 8,606) is the largest municipality located in the South Dakota portion of the watershed. Other South Dakota communities in the watershed include Deadwood (population 1,380), Lead (3,027), Sturgis (4,442), Belle Fourche (4,565), Fruitdale (62), Nisland (204), and Newell (646).

Land in the watershed is used primarily for grazing with some cropland and a few urban areas. Wheat, alfalfa, native and tame grasses, and hay are the main crops. Some corn is grown in the Belle Fourche Irrigation District (BFID). Gold mining, while reduced in scope from the past and silviculture occur in the Black Hills portion of the watershed. Approximately 15 percent of the watershed is federally owned. Of this, 11 percent is managed by the U.S. Forest Service and 4 percent by the Bureau of Land Management.

The Belle Fourche River is identified in the 1998 and 2002 *South Dakota 303(d) Waterbody Lists* and the 2004 and 2006 *Integrated Report for Surface Water Quality Assessment* (IR) as impaired because of elevated total suspended solids (TSS) concentrations. According to the 2006 IR, the Belle Fourche River, from the Wyoming border to the Cheyenne River, South Dakota, failed to support its assigned uses because of high TSS concentrations. In the report, agricultural activities were listed as a likely source of occasional impairment. This report also states that a natural source of TSS may be the erosion of exposed shale beds that lie along the river and its tributaries. The 2008 IR shows all segments of the Belle Fourche River, with the exception of the reach from the Wyoming border to Fruitdale, South Dakota, were delisted after water-quality standards for TSS were met. The 2010 IR once again showed some of the segments impaired. Table 1-1 contains a summary of 15 impaired TMDL segments within the Belle Fourche River Watershed. The table also lists the impaired beneficial use, impairment parameter, water-quality criteria, and possible source.

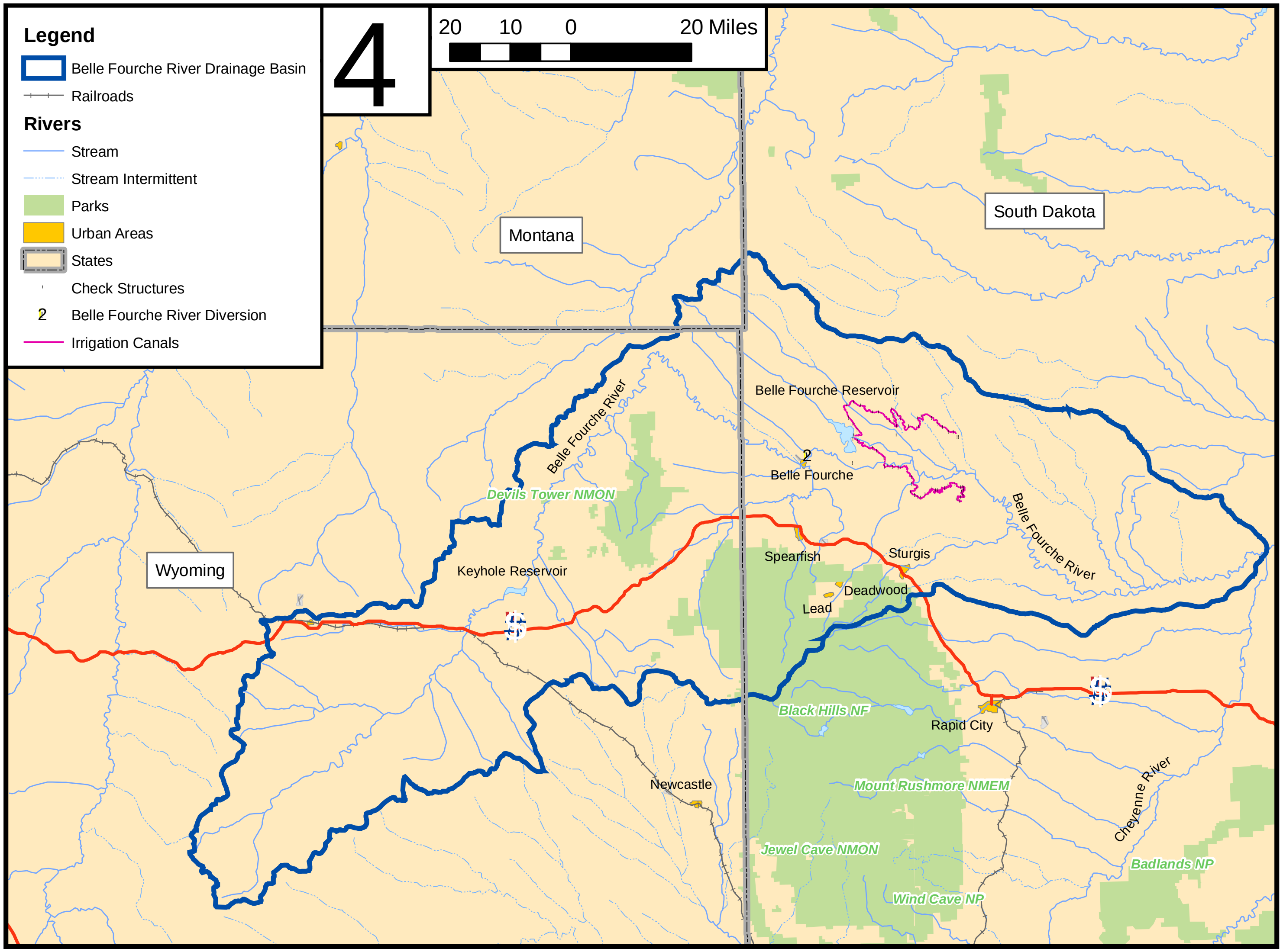

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Figure 1-1. Belle Fourche River Watershed.

Table 1-1. Summary of Belle Fourche River Watershed Exceedance Water-Quality Data (Page 1 of 2)

Stream	Stream Reach	Beneficial Use	Impairment Parameter	Water Quality Criteria	Source
Bear Butte Creek	Headwaters to Strawberry Creek	Cold-Water Permanent Fish Life	Water Temperature (°F)	<65°F	Natural Source
Bear Butte Creek	Strawberry Creek to Mouth	Cold-Water Permanent Fish Life	Water Temperature (°F)	<65°F	Natural Source
Belle Fourche River	Wyoming Border to Redwater River, South Dakota	Immersion Recreation	Fecal Coliform (per/100 mL)	200[a]/400[b]	Riparian Grazing/ Wildlife
		Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	Crop Production/ Livestock
Belle Fourche River	Whitewood Creek to Willow Creek	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	NA
Belle Fourche River	Willow Creek to Alkali Creek	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	NA
Belle Fourche River	Alkali Creek to Mouth	Immersion Recreation	Fecal Coliform (per/100 mL)	200[a]/400[b]	NA
		Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	NA
Horse Creek	Indian Creek to Mouth	Irrigation Waters	Conductivity (mohms/cm @ 25°C)	2,500[a]/4,375[b]	NA
Redwater River	Wyoming Border to US HWY 85	Cold-Water Permanent Fish Life	Water Temperature (°F)	<65°F	Natural Source
Strawberry Creek	Bear Butte Creek to S5, T4N, R4E	Fish/Wildlife Prop. Rec. Stock Waters	Cadmium (mg/L)	(c)	Mining Impacts
West Strawberry Creek[m]	Headwaters to Mouth	Limited Contact Recreation	Fecal Coliform (per/100 mg/L)	1,000[a]/2,000[b]	NA

Table 1-1. Summary of Belle Fourche River Watershed Exceedance Water-Quality Data (Page 2 of 2)

Stream	Stream Reach	Beneficial Use	Impairment Parameter	Water Quality Criteria	Source
Whitewood Creek	Deadwood Creek to Spruce Gulch	Immersion Recreation	Fecal Coliform (per/100 mg/L) Escherichia coli (E. coli)	200[a]/400[b]	Combined Sewers/Grazing/ Wildlife
Whitewood Creek	Sandy Creek to I-90	Cold-Water Marginal Fish Life	pH	6.5–8.8	Natural Sources
Whitewood Creek	I-90 to Crow Creek	Warm-Water Permanent Fish Life	pH	6.5–9.0	Natural Sources
Whitewood Creek	Crow Creek to Mouth	Warm-Water Permanent Fish Life	TSS (mg/L)	90[a]/158[b]	NA
Willow Creek	Near Vale, South Dakota	Irrigation Waters	Conductivity (mohms/cm @ 25^{o}C)	2,500[a]/4,375[b]	NA

(a) 30-day average.

(b) Daily maximum.

(c) Cadmium Concentration < (1.136672 – ((ln(hardness) × 0.041838) × exp(1.128 × (ln(hardness)) – 3.828).

Horse Creek was listed in the 1998 impaired waterbody list for total dissolved solids (TDS) that was later determined to be a listing error. The Horse Creek listing was corrected to conductivity during 2002. During this assessment, approximately 10 percent of the samples collected from Horse Creek exceeded the water-quality standard for TSS. The 2008 IR lists Horse Creek as nonsupporting for conductivity and delisted for TSS. Similar results were shown on the 2010 IR. The TMDL report for Horse Creek includes both TSS and conductivity.

The Belle Fourche River Watershed Partnership (BFRWP) completed a water-quality assessment project which led to development of a TSS Total Maximum Daily Load (TMDL) for the Belle Fourche River and Horse Creek. The project period extended from April 2001 through 2003. Six TMDLs were approved by the U.S. Environmental Protection Agency (EPA) for the Belle Fourche River and Horse Creek in 2005. Based on the results of the watershed study, the main sources of TSS were determined to be rangeland erosion, irrigation return flows, free cattle access to streams, riparian degradation, natural geologic processes, hydraulic alteration by irrigation, and reduced stream miles. The *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005] developed to implement the TMDL includes recommendations for reducing TSS concentrations using practices that include irrigation water management, riparian rehabilitation, and grazing management. As part of the Segment 4 implementation project, the fecal coliform TMDL has been developed for Whitewood Creek.

During the winter 2004, the BFRWP applied for and received a Clean Water Act Section 319 Grant to begin implementation of the Best Management Practices (BMPs) recommended in the TMDLs for the Belle Fourche River. Currently, the BFRWP is in its seventh year of implementing BMPs in the watershed and has been funded through Fiscal Year 2013 with the Segment 5 proposal. The project is supported by agricultural organizations, federal and state agencies, local governments, South Dakota State University (SDSU), and the South Dakota School of Mines & Technology (SDSM&T).

Funding for the project included support from local ranchers and farmers, BFRWP, South Dakota Department of Environment and Natural Resources (SD DENR), U.S. Fish and Wildlife Service (USFWS), Lawrence County, BFID, Wyoming Department of Environmental Quality (WYDEQ), Natural Resources Conservation Service (NRCS), Corps of Engineers, Bureau of Reclamation, U.S. Geological Survey (USGS), and the Clean Water Act Section 319 Grant. Products of the first implementation project segment were the *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005] and the *Belle Fourche Irrigation District Water Conservation Plan* [Rolland and Hoyer, 2005]. These plans outline BMP installation activities to be completed in this project for a 10-year time frame, and associated TSS and nonused water savings are presented for each action planned. BMPs recommended by the TMDLs and the 10-year plan installed during this project segment include flow automation units, real-time stage/flow-measuring devices, upgraded water card and water ordering system, updated canal operational model, replacing open irrigation ditches with pipeline, lining open irrigation ditches, installing pipelines to deliver water from the BFID system to the fields, installation of irrigation sprinkler systems within the BFID, and managed grazing. These BMPs were installed in the South Dakota portion of the Belle Fourche River Watershed (Figure 1-1).

2.0 PROJECT GOALS AND OBJECTIVES

The goal of the Belle Fourche River Watershed Management Project is to bring the Belle Fourche River and Horse Creek into compliance with TSS water-quality standards within 10 years. To accomplish the goal, a reduction of 55 percent (289,910 tons/year) in TSS is required. A reduction of 41 percent (2,033 tons/year) in TSS is required for Horse Creek.

In this project segment, the load reduction goal is 44,134 tons per year. To accomplish this goal, this project segment had three objectives:

1. Continue implementation of BMPs in the watershed to reduce TSS 21.5 milligrams per liter (mg/L) reduction below the Belle Fourche Reservoir; 33 mg/L reduction above the Belle Fourche Reservoir.
2. Conduct public education and outreach to stakeholders within the Belle Fourche River Watershed.
3. Track progress toward meeting TMDL goals to help ensure that the BMPs are effective and that the proper BMPs are being implemented.

2.1 PLANNED AND ACTUAL MILESTONES, PRODUCTS, AND COMPLETION DATES

Objective 1. Implement BMPs Recommended to Reduce TSS. This objective was comprised of two tasks: improving irrigation water management and implementing riparian vegetation improvements. The products of this objective included 11 real-time stage control units; replacement of canals, laterals, and/or ditches with 6,718 feet of pipelines; 1,300 feet of inlet canal lining; 54,285 feet of pipeline installed to convey water to center-pivot irrigation systems or to gated pipe that replaced open ditches; installing of 24 sprinkler irrigation systems to replacing existing flood irrigation; rangeland implementation projects benefiting 3,000 riparian acres; and range planning and follow up on 174,146 acres. Implementation of the BMPs is discussed further in Chapter 3.0.

Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit. There were approximately 45 outreach activities that involved approximately 16,705 participants; 3 Grant Tracking and Reporting System (GRTS) reports as well is this final report. These activities are further discussed in Chapter 5.0 of this report.

Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development. Water-quality samples were collected by USGS at real-time stream gauging sites and SD DENR at several water-quality monitoring (WQM) sites in the watershed. A detailed statistical analysis is included in Chapter 4.0 of this report. The Whitewood Creek TMDL for fecal coliform and *E. coli* bacteria was also completed.

Table 2-1 lists the project objectives along with their products, planned milestone completion date, and actual milestone completion date. An extension of time from June 2011 to December 2011 was requested from and granted by the SD DENR. The extension of time was needed by agricultural producers to complete installation of BMPs because of alignment of other funding sources, including Environmental Quality Incentives Program (EQIP), and wet conditions throughout the 2011 season.

Table 2-1. Planned Versus Actual Milestone Completion Dates

Belle Fourche River Watershed Partnership Implementation	Planned Completion	Actual Completion
Objective 1. Implement BMPs Recommended to Reduce TSS		
Product 1. Improve Irrigation Delivery and Application	June 2011	December 2011
Product 2. Complete and Install Riparian Area BMPs	June 2011	December 2011
Objective 2. Conduct Public Education and Outreach		
Product 3. Public Outreach, Report Writing, Federal Audit	June 2011	June 2011
Objective 3. Tracking Progress Toward Meeting Goals		
Product 5. GRTS and Final Reports	June 2011	December 2011

2.2 EVALUATION OF GOAL ATTAINMENT

Project success was evaluated by comparing project outputs and outcomes with the planned milestones. All objectives established for this project were reached:

- Implementation of several BMPs recommended within the Phase I Watershed Assessment Final Report and TMDL [Hoyer and Larson, 2004].
- Load reductions, estimated as a result of BMP installation, of 55,278 tons per year which is 11,144 tons per year greater than the goal for this project segment.
- Completion of approximately 45 successful education and outreach activities which led to greater public participation in the project, completion of annual GRTS reports along with this final report, and 2 required federal audits.
- Completion of essential water-quality monitoring and Whitewood Creek fecal coliform and *E. coli* TMDL study.

This project was very successful in that project goals were exceeded for all of the objectives. BMPs were implemented that are estimated to reduce TSS in the Belle Fourche River by 55,278 tons per year.

3.0 BEST MANAGEMENT PRACTICES

Installation of the BMPs recommended in the Belle Fourche River TMDL was continued during this project segment. The BMP installation included funding from local ranchers and farmers, BFID, Bureau of Reclamation, USFWS, and NRCS as well as financial assistance from the 319 project.

The BMPs installed included the following:

- 11 real-time stage control units.
- 6,718 feet of pipeline replaced open irrigation canals and laterals.
- 1,300 feet of canal lining.
- 54,285 feet of pipeline installed by individual irrigators to convey water to center-pivot irrigation systems or to gated pipe that replaced open ditches.
- 24 irrigation sprinkler systems to replace flood irrigation.
- Approximately 38,000 feet of pipeline, 19 watering facilities, and 30,000 feet of cross fence to provide off-stream livestock water and improve grazing distribution involving five producers in 3,000 acres of riparian vegetation improvements.
- Completed conservation plans for over 174,000 acres of grazing lands.

Table 3-1 provides a track of BMP implementation planned and implemented to date.

3.1 REDUCING NONUSED IRRIGATION WATER AND IMPROVING EFFICIENCY

To reduce return flows of nonused irrigation waters, the project installed BMPs that will improve precision in water quantity delivered to irrigators. The installation of 37 units to measure and control flow within the BFID delivery system, enables water levels to be measured, monitored, and adjusted from the BFID office in Newell, South Dakota. Figure 3-1 shows where the automated sites are located within the Belle Fourche Irrigation District. These automated units provide continual oversight of canal water levels and the ability to immediately adjust levels when necessary, thereby reducing waste and improving efficiency. Water-level data at each site are recorded every 10 minutes and stored in a database. This allows for easy summation of the total volume of water delivered during any given time period and calculation of efficiencies. Figure 3-2 shows an automated site within the Belle Fourche Irrigation District.

Table 3-1. Best Management Practices Implemented

Best Management Practice	10-Year Plan	Planned This Segment	Installed This Segment	Installed to Date
Flow Automation Units	42	3	11	37
Real-time Stage/Flow-Measuring Devices	15	0	0	24
Canal Operational Model	2	0	0	2
Water Card Ordering System	1	0	0	1
Line Open Canals and Laterals (Feet of Lining)	26,560	7,780	1,300	10,360
Replace Open Canals and Laterals With Pipeline (Feet of Pipeline)	25,000	4,000	6,718	14,514
Sprinkler Irrigation Systems	36	18	24	47
Managed Riparian Grazing (Acres)	34,000	500	3,000	22,638

An upgraded water card ordering system was also implemented. The system allows BFID personnel to enter the timing and amount of water ordered for individual farmers on a given ride (or section of the irrigation district). Once this information is entered, the upgraded water card ordering system generates daily water delivery cards for the ditch riders that deliver the water to the fields. It also calculates the amount of lag time that it takes for the water to travel from the dam to all fields within the BFID and provides a daily estimate of the amount of water to release from the dam to meet the water order demands. This system eliminates mathematical and transcription errors from manual data entry and improves the overall efficiency of the system.

Currently, the entire north canal is set up in the **Storm Water Management Model** (**SWMM**), an EPA model capable of simulating all the conditions within the north canal. The model was calibrated and validated using data collected at automated checks and portable stage-measuring devices as well as manual field measurements collected during the summers of 2006 through 2008. The hydraulic model is capable of assisting with irrigation delivery system settings and improving irrigation

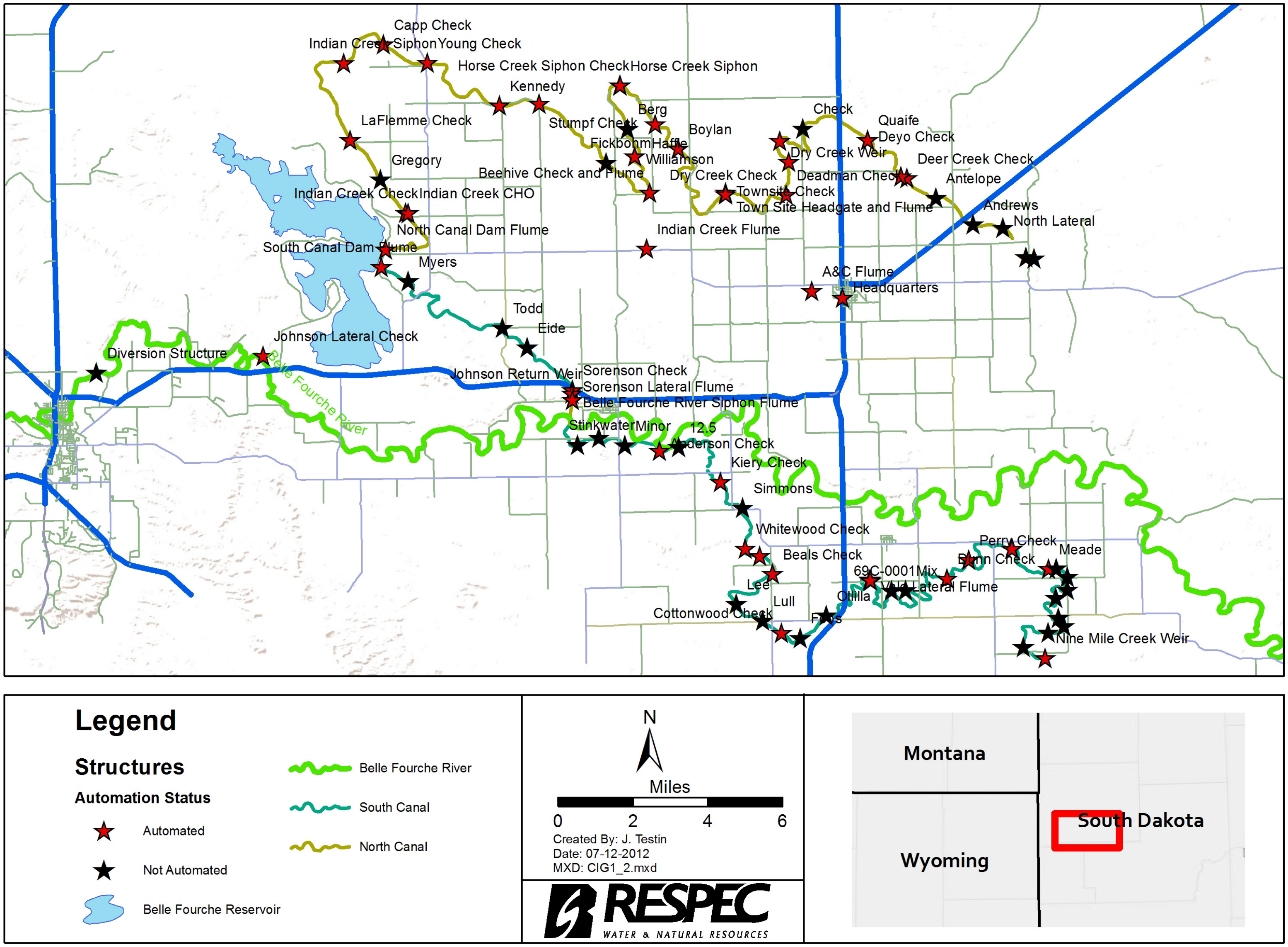

Figure 3-1. Location of Automated Sites in the Belle Fourche Irrigation District.

efficiency during future irrigation season. To help validate the SWMM model, operational curves, charts, and spreadsheets were developed for five automated check structures within the BFID. These tools provide BFID personnel with a better understanding of how to optimally operate automated check structures and offer flow measurements based on the check settings and upstream water levels. Using the operational curves, charts, and spreadsheets along with the developed SWMM model will help BFID personnel understand the dynamic irrigation system. This understanding will reduce irrigation return flows and, in turn, TSS levels in the Belle Fourche River.

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Figure 3-2. Gate Automation Unit Installed in the Belle Fourche Irrigation District.

A total of 54,285 feet of pipeline was installed by 26 irrigators during this segment to convey water to center-pivot irrigation systems or to gated pipe that replaced open ditches. Twenty Four center-pivot sprinkler systems were installed to replace existing surface irrigation. Figure 3-3 shows a center pivot irrigation system that was partially funded by the project. Locations of producer irrigation BMPs are shown in Figure 3-4.

Figure 3-3. Center Pivot Installed in the Belle Fourche Irrigation District.

Approximately 1,300 feet of inlet canal lining was completed by the BFID during this segment. It was originally estimated that the BFID would line approximately 7,780 feet of the inlet canal. After further study of the project it was determined by the BFID along with BOR to allocate the additional lining to other parts of the BFID in order to receive maximum benefit. The lining has been purchased and plans are being made to utilize it on other sections of the canals or laterals in subsequent years. This will be tracked and reported in future segments. The inlet canal lining is shown in Figure 3-5. A total of 6,718 feet of canal and open laterals within the BFID were replaced with pipeline. This was above the goal of 4,000 feet for this segment. Installation of pipeline eliminated water losses from infiltration and evaporation along these sections.

3.2 MANAGED GRAZING

Information from resource inventories of several ranches located in the watershed were used to plan and install BMPs that significantly improved grazing/riparian areas within the watershed. Approximately 38,000 feet of

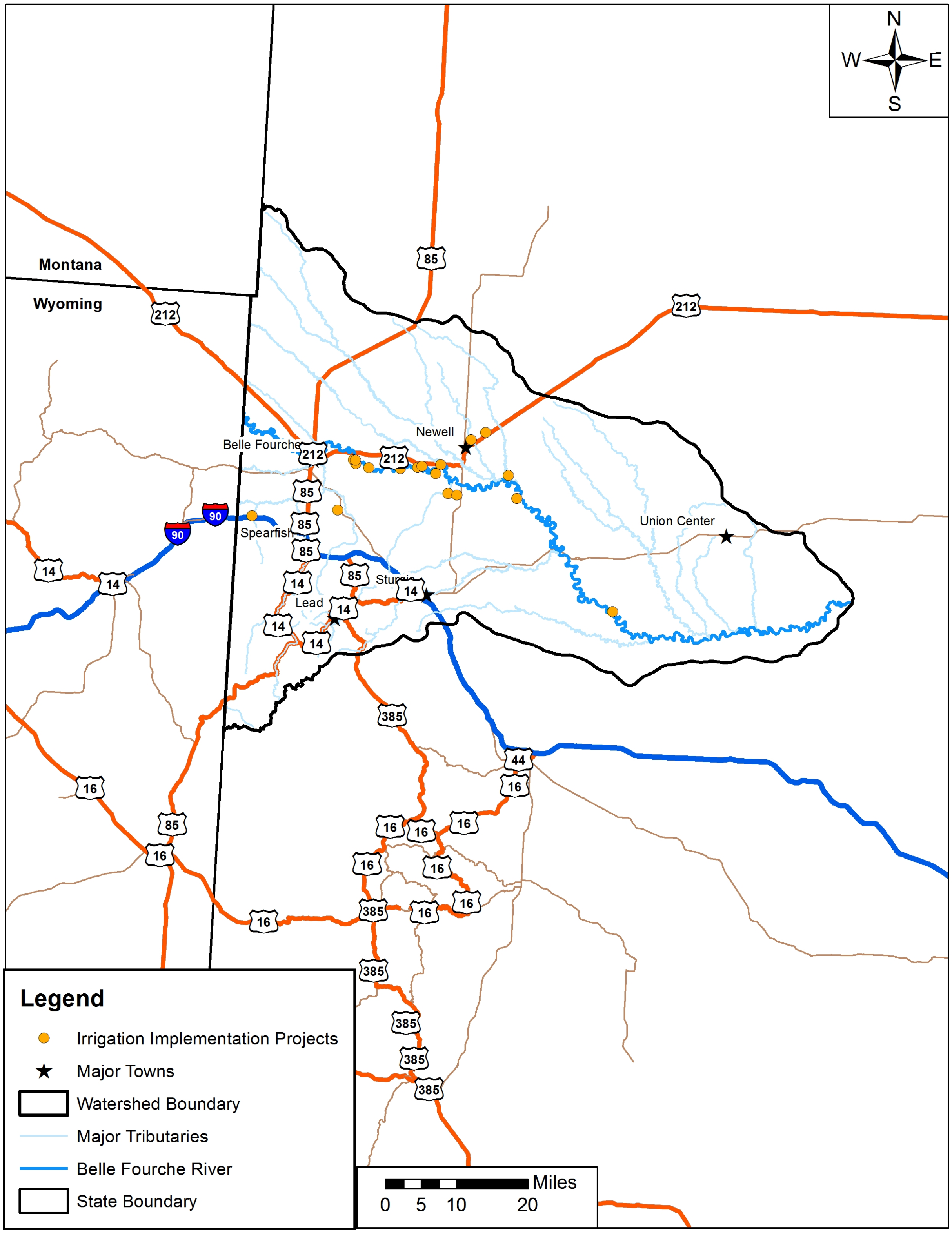

Figure 3-4. Location of Producer Irrigation Implementation Project in Segment 4.

pipeline, 19 watering facilities, and 30,0000 feet of cross fence were installed using 319 dollars to provide off-stream livestock water and improve grazing distribution. Improved grazing distribution maintains or improves the integrity of the riparian corridor of the watershed. Healthy riparian areas are integral to trapping sediment from rangeland runoff, reducing TSS entering the Belle Fourche River. These projects involved five producers resulting in an estimated 3,000 acres of riparian vegetation improvements Figure 3-6 shows the location of the riparian vegetation improvement projects funded with Segment 4 funds. In addition to practices installed, conservation plans and follow ups to those plans were written for over 174,000 acres of grazing lands in the watershed. This was done in cooperation with the South Dakota Grassland Coalition (SDGLC) and their 319 project titled Grassland Management and Planning Project Implementation Plan. The continued success of this partnership between the SDGLC and BFRWP has provided a solution to reduce TSS coming from range riparian sites as well as adjacent uplands. Figure 3-7 and 3-8 show a photo monitoring effort as part of range riparian BMP implementation project on a ranch in the watershed. Figure 3-7 was taken in 2008 before BMP implementation and Figure 3-8 was taken in 2010 after implementation. You can visually note an increase of over all stream bank stabilization. This was accomplished by developing off stream water, fencing, and improving livestock grazing practices that limit the time cattle spend on the creek.

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Figure 3-5. Lining of the Inlet Canal.

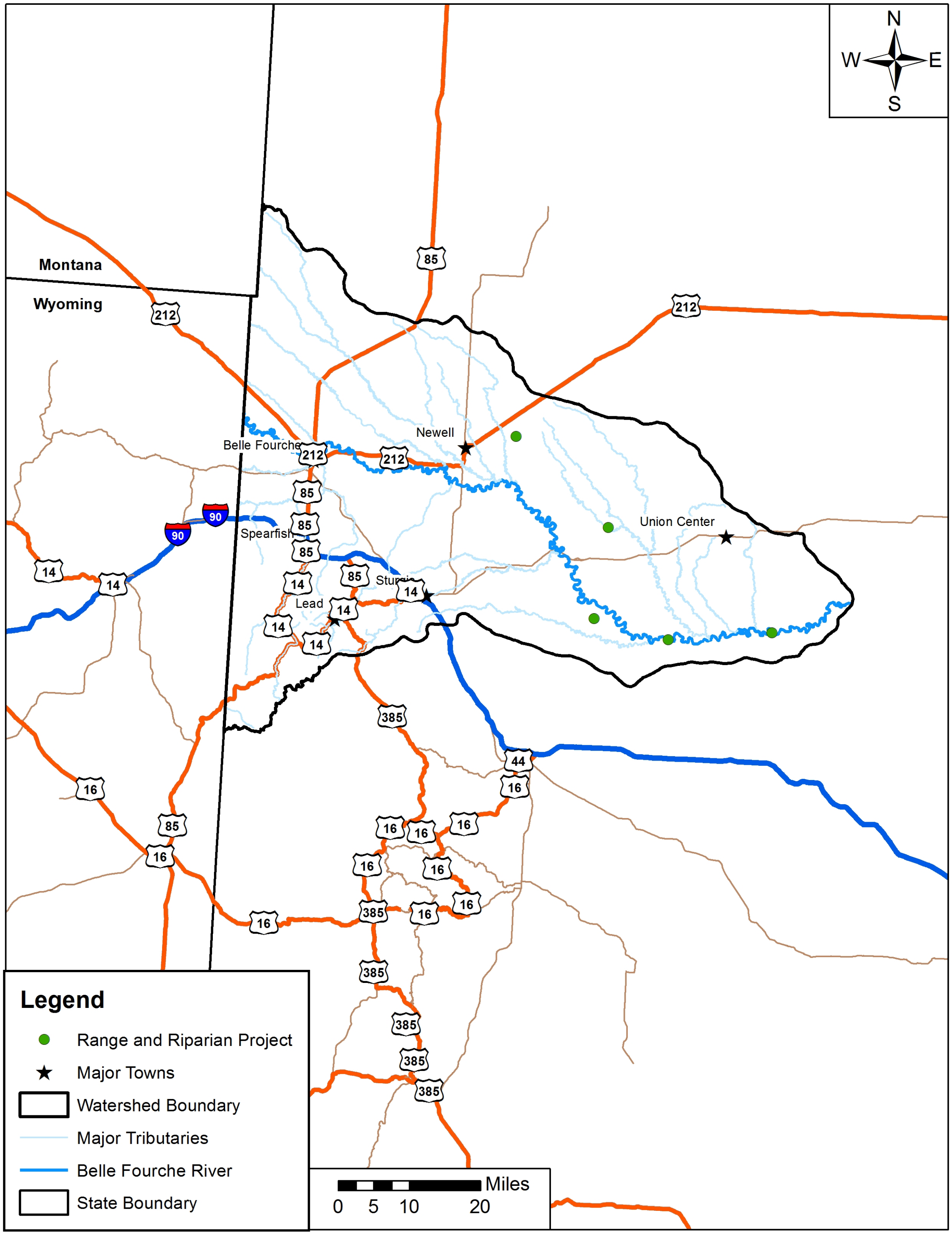

Figure 3-6. Location of Producer Range Implementation Projects in Segment 4.

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Figure 3-7. Photograph of a Monitoring Site Before Planned Grazing Best Management Practice Installation in 2008.

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Figure 3-8. Photograph Monitoring Site After Planned Grazing Best Management Practice Installation in 2010.

4.0 SUMMARY OF PUBLIC PARTICIPATION AND OUTREACH

Approximately 45 public education and outreach events were completed during this project segment. The outreach activities are shown in Table 4-1. Outreach activities were in the form of public meetings, informational booths, Web site, radio sound bites, watershed tours, range riparian workshops, and youth range camps. It is estimated that outreach and education efforts reached over 16,000 people. The Butte County, Lawrence County, and Elk Creek Conservation Districts each sent out newsletters which included project updates. The BFRWP hosted 10 meetings to provide updates on project work and progress being made. The BFRWP Web site, located at <*www.bellefourchewatershed.org*>, continues to be updated with events and project status. Sound bites were used on local radio stations provide overviews of BFRWP happenings and lead listeners to the website for additional information. The BFRWP used their soil quality demonstration trailer to educate audiences of all ages about the importance of good stewardship on soil health. Figure 4-1 shows a soil quality demonstration at one of the BFRWP's tours.

The BFRWP sponsored/cosponsored seven tours in the watershed during Segment 4. These tours included local producers; state and federal agency staff; local, state, and federal government officials; and the interested public. Partners in these tours included Butte, Lawrence, and Elk Creek Conservation Districts, South Dakota Association of Conservation Districts, South Dakota State University Cooperative Extension, South Dakota Society for Range Management, NRCS, and Bureau of Reclamation. These tours showcased projects sponsored by the BFRWP, including irrigation demonstrations in the BFID and rangeland demonstrations on ranches in the watershed. These outreach activities helped increase participation and support for the BFRWP and also gave the BFRWP several contacts for BMP installation.

The BFRWP conducted range riparian monitoring workshops educating producers about proper management and monitoring techniques. The BFRWP also sponsored range youth camps in the watershed educating high school age students about proper range management techniques. Figure 4-2 shows a range camp taking place near Sturgis in June 2010.

Table 4-1. Summary of Public Outreach and Education During Segment 4 (Page 1 of 2)

Type of Education and Outreach	Date	Number of Participants
Belle Fourche River Watershed Partnership Meetings (10 Meetings)	June 2009–May 2011	200
Riparian Management Training Workshop	2009	25
Butte/Lawrence County Fair Booth	2009, 2010	400
Legislative Watershed Tour	2009	35
SDACD Annual Meeting, Booth and Watershed Tour	2009	250
SRM Range Tour	2009	25
House and Senate Ag and Natural Resource Tour	2009	60
Grazing Lands Conservation Initiative Conference Poster Presentation	2009	150
Vale Ag Show	2010, 2011	300
Black Hills Stock Show Rainfall Simulator Demo	2010, 2011	60
Sturgis Key City Pen of 3	2010, 2011	600
Sturgis High Career Fair	2010, 2011	1,000
Two SDSU Small Acreage workshops Rainfall Simulator Demonstrations	2010	100
Cammack Ranch Supply Open House Booth and Rainfall Simulator	2010	300
Hydrology Conference Presentation	2010	200
Belle Fourche Tri State Expo Booth	2010, 2011	600
South Dakota High School Range Camp	2009, 2010	80
Rapid City Ag Appreciation Day Rainfall Simulator Demonstration	2010	500
Ag Lenders Range Camp Tour and Rainfall Simulator	2010	25

Table 4-1. Summary of Public Outreach and Education During Segment 4 (Page 2 of 2)

Type of Education and Outreach	Date	Number of Participants
American Indian and Native Alaskan NRCS Tour and Rainfall Simulator Demonstration	2010	85
NRCS Organic Producer Tour Rainfall Simulator Demo	2010	60
Elk Creek Conservation District Tour Rainfall Simulator Demonstration	2010	60
Range Monitoring Workshop	2010	40
Rainfall Simulator Demonstration, Mud Butte	2010	40
DENR Watershed Tour	2011	10
Informational Radio Sound Bites	2010, 2011	10,000
Website	2009–2011	1,500

RSI-1870-12-010

Figure 4-1. Soil Quality Demonstration During a Watershed Tour.

RSI-1870-12-011

Figure 4-2. Youth Range Camp Near Sturgis. The Belle Fourche River Watershed Partnership help sponsor this activity by providing cash and in-kind contributions.

5.0 MONITORING RESULTS

5.1 WHITEWOOD CREEK FECAL COLIFORM TMDL SUMMARIES

The Whitewood Creek fecal coliform and *E. coli* TMDL studies were completed as part of Segment 4. The summaries are attached in Appendix A.

5.2 WATER-QUALITY ANALYSIS

To gain insight as to the effectiveness of the current implementation plan, a rigorous statistical analysis was performed on multiple aspects of data that were collected at five WQM sites located within the South Dakota portion of the Belle Fourche River Watershed). Figure 5-1 shows the location of the five water-quality monitoring sites within the South Dakota portion of the Belle Fourche River Watershed. The data collected at the five WQM sites on the main stem of the Belle Fourche River consist of *E. coli* concentrations, fecal coliform concentrations, and TSS concentrations. The sites are listed in order from upstream to downstream. The data were grouped into two categories: Pre-BMP and post-BMP implement-tation. Pre-BMP implementation refers to data collected before the Year 2005, while post-BMP implementation refers to data collected after, and including the Year 2005.

Tables 5-1 through 5-3 display the basic summary statistics for *E. coli*, fecal coliform, and TSS data collected and analyzed for the five WQM sites. Let it be noted that for the *E. coli* data analyzed in Table 5-1, no record of data exists before the Year 2009. As no previous or pre- BMP data is available, no comparison for *E. coli* reduction can be made within this segment of the implementation plan and the summary provided will be used as a comparison for future BMP implementation progress. It should also be noted that BMP implementation to-date has focused on TSS reductions rather than bacteria, although many of the practices will have a positive impact on the loadings for both constituents.

The mean concentrations of fecal coliforms at all but one site dropped after significant BMP implementation began in 2005 (post-BMP). The largest percent reduction was observed at WQM 21 with a reduction of 87.5 percent. The smallest percent reduction was observed at WQM 76, showing that the site increased with a rather significant gain of over 300 percent. This very well may have been an error in sampling or a heavy storm event, as it appears an outlier within the dataset exists. This value, occurring in July of 2009, ranges over three times larger than that of the next highest observed value.

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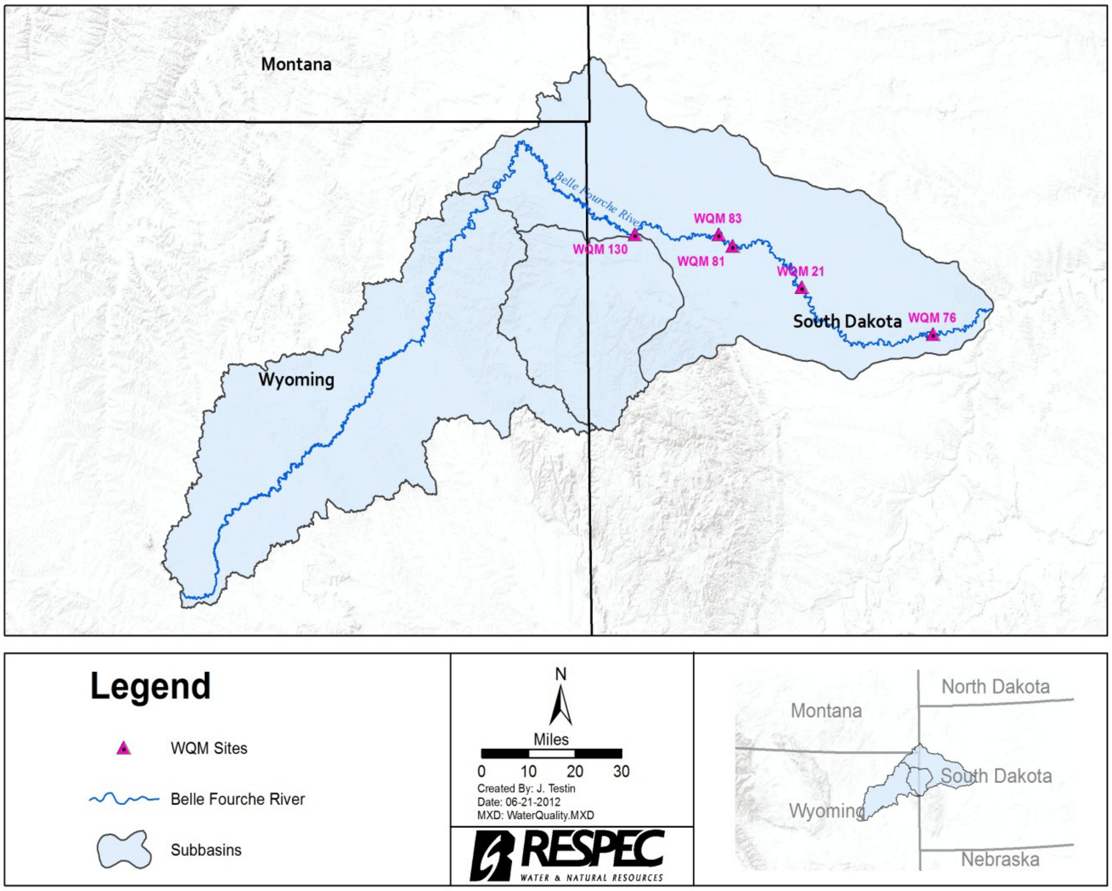

Figure 5-1. Location of the Five Water-Quality Monitoring Sites within the South Dakota Portion of the Belle Fourche River Watershed.

The mean concentrations of TSS at all but one site dropped after significant BMP implementation began in 2005 (post-BMP). As with the fecal coliform concentrations, WQM 76 was the only site to show an increase in mean values of TSS. This increase was observed to be 65.3 percent. The largest percent reduction was observed at WQM 21 with a reduction of 84.5 percent.

When analyzing the mean of a dataset, it should be noted that an unusually high value may skew the set of samples. This would result from an unusually high concentration observed within the data, such as was seen within the fecal coliform data for WQM 76 in July of 2009. This outlier within the data could easily have

Table 5-1. Summary *E. coli* Statistics for Mainstream Water-Quality Monitoring Sites on the Belle Fourche River

Site	BMP Status	Mean (cfu/100 mL)	Standard Deviation	Q1	Median	Q3	Min	Max	n
WQM130	Post-BMP	301.9	757	45	96	164	17	3,020	15
WQM 81	Post-BMP	53.2	24.4	36.5	42.5	75	32	96	6
WQM 83	Post-BMP	42.3	23.5	24.3	35.5	62	19	83	6
WQM 21	Post-BMP	77.5	121.4	14.8	26.5	125.8	14	323	6
WQM 76	Post-BMP	1,514.2	2,861.4	16	42	2,910	4	9,678	15

Table 5-2. Summary Fecal Coliform Statistics for Mainstream Water-Quality Monitoring Sites on the Belle Fourche River

Site	BMP Status	Mean (cfu/100 mL)	Standard Deviation	Q1	Median	Q3	Min	Max	n
WQM130	Pre-BMP	599.3	972.8	150	305	517.5	60	3,800	14
WQM130	Post-BMP	363.4	891.7	78	150	320	2	5,300	35
WQM 81	Pre-BMP	453.3	665.8	130	225	675	60	1,800	6
WQM 81	Post-BMP	128.2	78.2	67.5	110	160	60	310	11
WQM 83	Pre-BMP	297.9	680.6	24	70	160	2	3,315	31
WQM 83	Post-BMP	60.2	31.4	33	62	92.5	12	100	10
WQM 21	Pre-BMP	768	2473.4	10	40	307.5	0	24,000	170
WQM 21	Post-BMP	96	110.4	35.5	47	130	24	390	10
WQM 76	Pre-BMP	964	5,584.3	7.8	43.5	147.5	0	52,400	92
WQM 76	Post-BMP	4,265.9	22,246.6	45.5	79	220	2	130,000	34

Table 5-3. Summary Total Suspended Solids Statistics for Mainstream Water-Quality Monitoring Sites on the Belle Fourche River

Site	BMP Status	Mean (mg/L)	Standard Deviation	Q1	Median	Q3	Min	Max	n
WQM130	Pre-BMP	245.2	781.7	5	8	87	1	4,520	37
WQM130	Post-BMP	203.4	457.6	5	22	170	1	2,800	79
WQM 81	Pre-BMP	192.1	890.8	7	18	44	1	6,885	105
WQM 81	Post-BMP	80.3	143.5	5	22	63.5	1	640	30
WQM 83	Pre-BMP	77.6	154.6	9.8	34.5	68.8	1	885	104
WQM 83	Post-BMP	62	129.2	5.5	19	54	1	680	30
WQM 21	Pre-BMP	527.1	1,517.7	11	41.5	255.8	0	1,4977	198
WQM 21	Post-BMP	81.8	143.8	12	25.5	76.5	1	700	28
WQM 76	Pre-BMP	349.7	1,280.9	8.5	35	110	1	1,1000	135
WQM 76	Post-BMP	578.1	1,855.1	8	38	145	1	1,3000	85

thrown off the mean calculated and misconstrue the dataset; therefore, it is useful to analyze the population medians to see if a similar trend exists. This analysis was performed using a hypothesis test known as The Mann-Whitney test, which tests the equality of two population medians. The Mann-Whitney test provides a safeguard against drawing wrong conclusions from analysis from data that cannot be determined to be normally distributed.

Figures 5-2 and 5-3 display the median concentration values at each WQM site, pre- and post-BMP implementation for fecal coliform concentrations and TSS concentrations on The Belle Fourche River. Again, let it be noted that no record of *E. coli* concentrations exist before the Year 2009. Therefore any comparison for *E. coli* reduction cannot be made within this segment of the implementation plan.

To gain understanding of the statistical significance of any of the changes in median values, whether they are positive or negative, a Mann-Whitney Test was performed. Datasets were separated into two categories: pre-BMP (η_1) and post-BMP (η_2) at each of the sites. The Null hypothesis (H_o) is that the median concentrations at each of the sites pre-BMP implementation was equal to the median concentrations at each of the sites post-BMP implementation. The alternate hypothesis (H_1) is that the median concentrations at each of the sites pre-BMP implementation were not equal to the median concentrations at each of the sites post-BMP implementation. The Null and alternate hypothesis's are represented mathematically as follows:

$$\begin{aligned} H_o &: \eta_1 = \eta_2 \\ H_1 &: \eta_1 \neq \eta_2. \end{aligned} \tag{5-1}$$

The results of the Mann-Whitney tests performed for the five WQM sites indicate that at the 95th percentile confidence interval a difference between the population medians do exist. Therefore, the WQM data obtained are sufficiently adequate for the analysis that was performed. Although there appears to be a difference between the population medians throughout the WQM sites, the lack of sampling either Pre- or post-BMP implementation, does not allow us to declare that this difference is statistically significant.

The overall goal for the Belle Fourche River Watershed is to have all waterbodies within the watershed come into compliance with water-quality standards as set forth by the Clean Water Act. The Belle Fourche River has been assigned the

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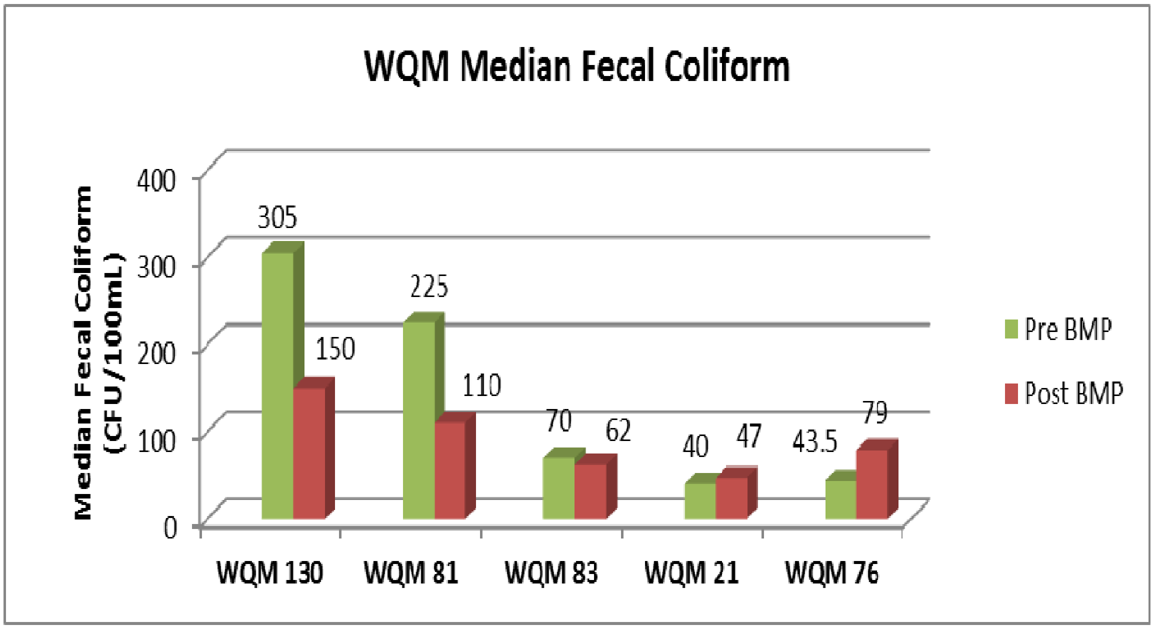

Figure 5-2. Median Fecal Coliform Concentrations Observed at Water-Quality Monitoring sites on the Belle Fourche River in South Dakota, Pre- and Post-BMP Implementation.

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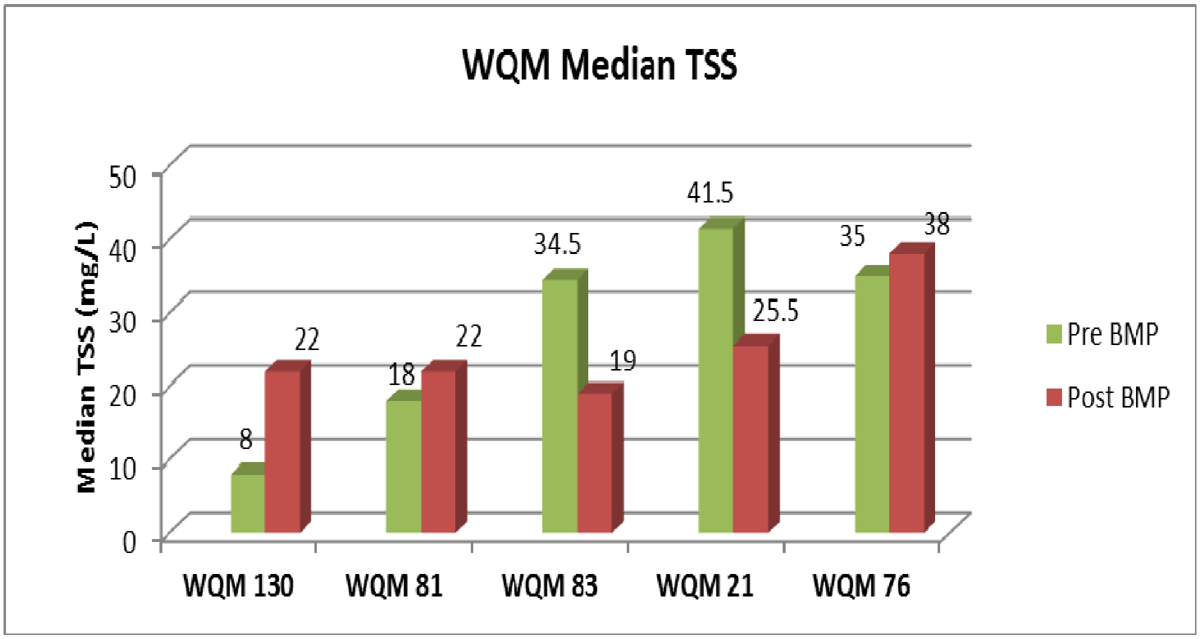

Figure 5-3. Median Total Suspended Solids Concentrations Observed at Water-Quality Monitoring sites on the Belle Fourche River in South Dakota, Pre- and Post-BMP Implementation.

following beneficial uses: Limited Contact Recreation Waters, Immersion Recreation Waters, and Warm-Water Fish Life Propagation. Under this segment of the implementation plan, the goal was to reduce the impairment parameters *E. coli*, fecal coliform, and TSS that are respectively, hindering the beneficial uses listed above.

The impairment parameter *E. coli* has an immersion recreation water-quality standard of 235 mpn/100 mL. Again, noting that no data exist before 2009, the percent exceedances for each site give a baseline comparison for data that were collected within this segment of the implementation plan. WQM 81 and WQM 83 show that no samples collected exceeded the water-quality standard within the monitoring period, and WQM 76 showed the highest percent exceedance at 26.7 percent.

The impairment parameter fecal coliform has an immersion recreation water-quality standard of 400 cfu/100 mL. Figure 5-4 displays the percent exceedances of the water-quality-standard for fecal coliform at each of the five WQM sites on the Belle Fourche River before and after BMP implementation. All but one of the sites show a decrease in percent exceedances for fecal coliform. WQM Sites 81, 83, and 21 show that no samples collected within the monitoring period exceed the water-quality standard. The highest percent exceedance was observed at WQM 76, which actually increased in percent exceedances from pre- to post-BMP, with 14.7 percent of the samples exceeding the water-quality standard.

The impairment parameter TSS has a warm-water fish life propagation water-quality standard of 158 mg/L. Figure 5-5 displays the percent exceedances of the water-quality standard for TSS at each of the five WQM sites on The Belle Fourche River before and after BMP implementation. All sites but one, WQM 21, show an increase in percent exceedances from pre- to post-BMP implementation. Of the post-BMP data, WQM 130 shows the highest percent exceedance at 25.3 percent with WQM 76 a close second, at 24.7 percent. This increase from pre-BMP to post-BMP could be caused by a number of factors. Heavy rainfall that occurred several times during this segment during times of sampling will undoubtedly elevate TSS concentrations.

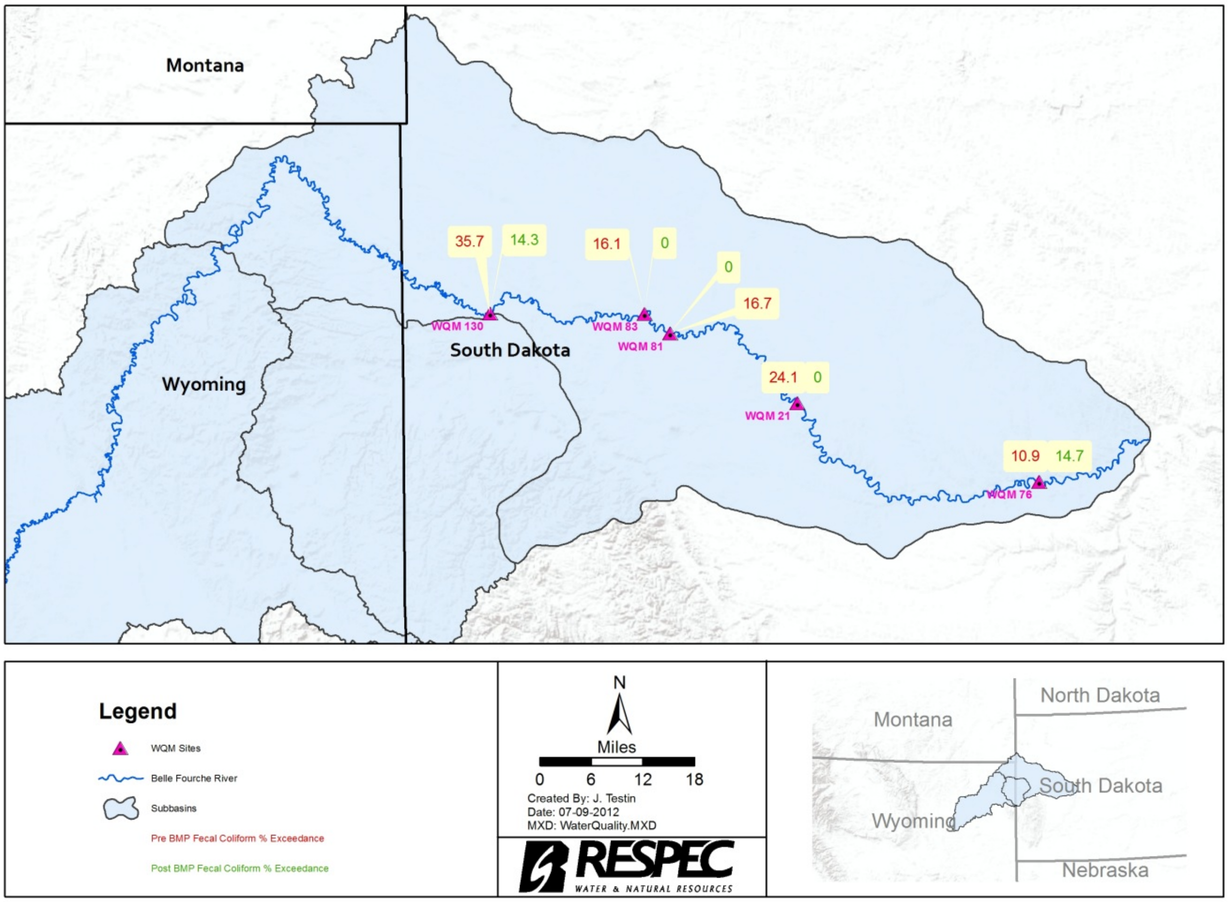

Figure 5-4. Percent Exceedances of the Fecal Coliform Water Quality Standard for Pre- (Red) and Post- (Green) BMP Implementation at Five Water-Quality Monitoring Sites on The Belle Fourche River.

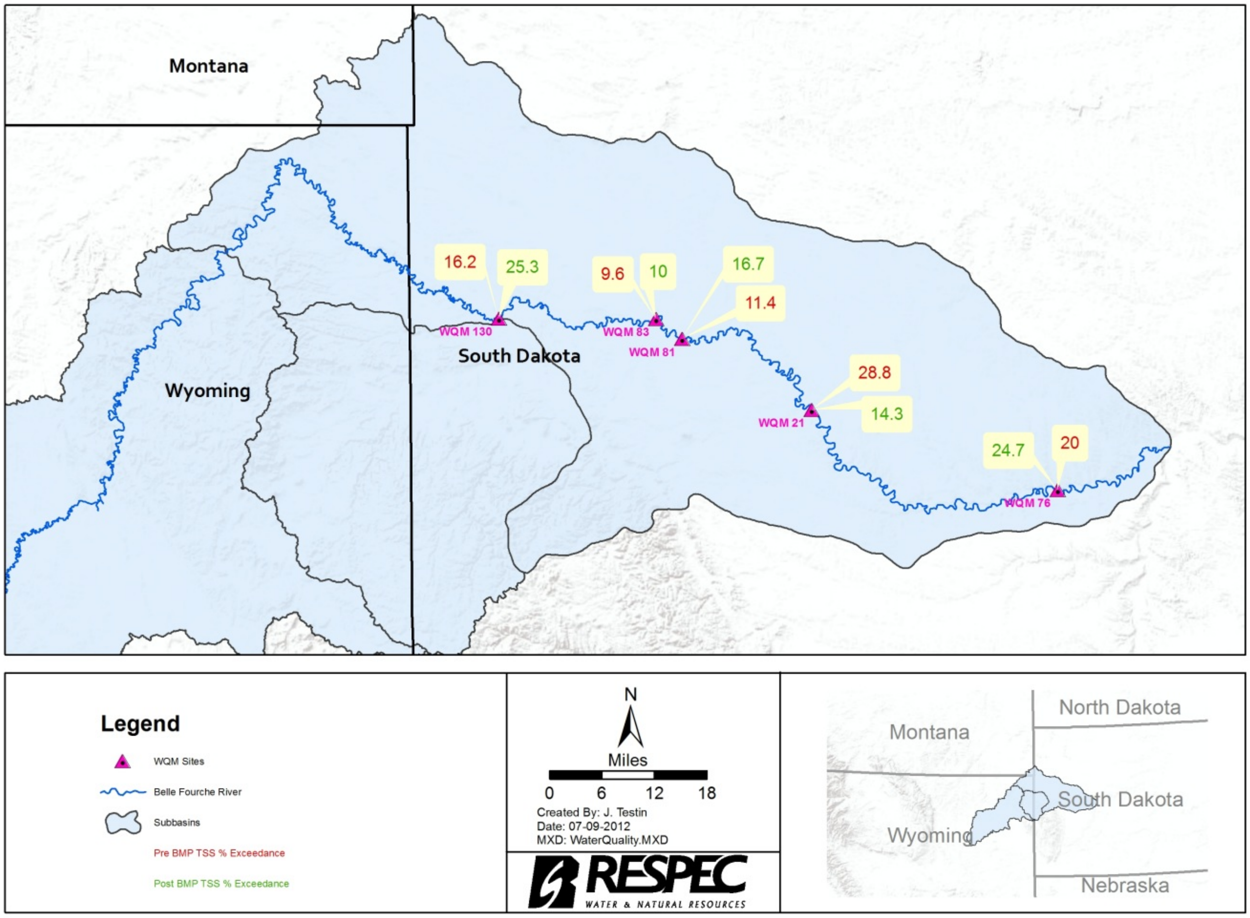

Figure 5-5. Percent Exceedances of the TSS Water Quality Standard for Pre- (Red) and Post- (Green) BMP Implementation at Five Water-Quality Monitoring Sites on The Belle Fourche River.

5.2.1 Horse Creek Flow Analysis

Real-time discharge data collected by the USGS at Horse Creek was analyzed over a period of record that spans from October of 1981 to October of 2011. Horse Creek is an irrigation dominated tributary, as it delivers overland return flows from fields within the BFID delivery system, back to the Belle Fourche River. BMPs implemented within the Belle Fourche Irrigation District delivery system, along with on-farm improvements, are designed to reduce the volume of sediment-laden return flows impacting Horse Creek and ultimately the Belle Fourche River. Figure 5-6 shows the relation of Horse Creek to the delivery system and fields located within the BFID.

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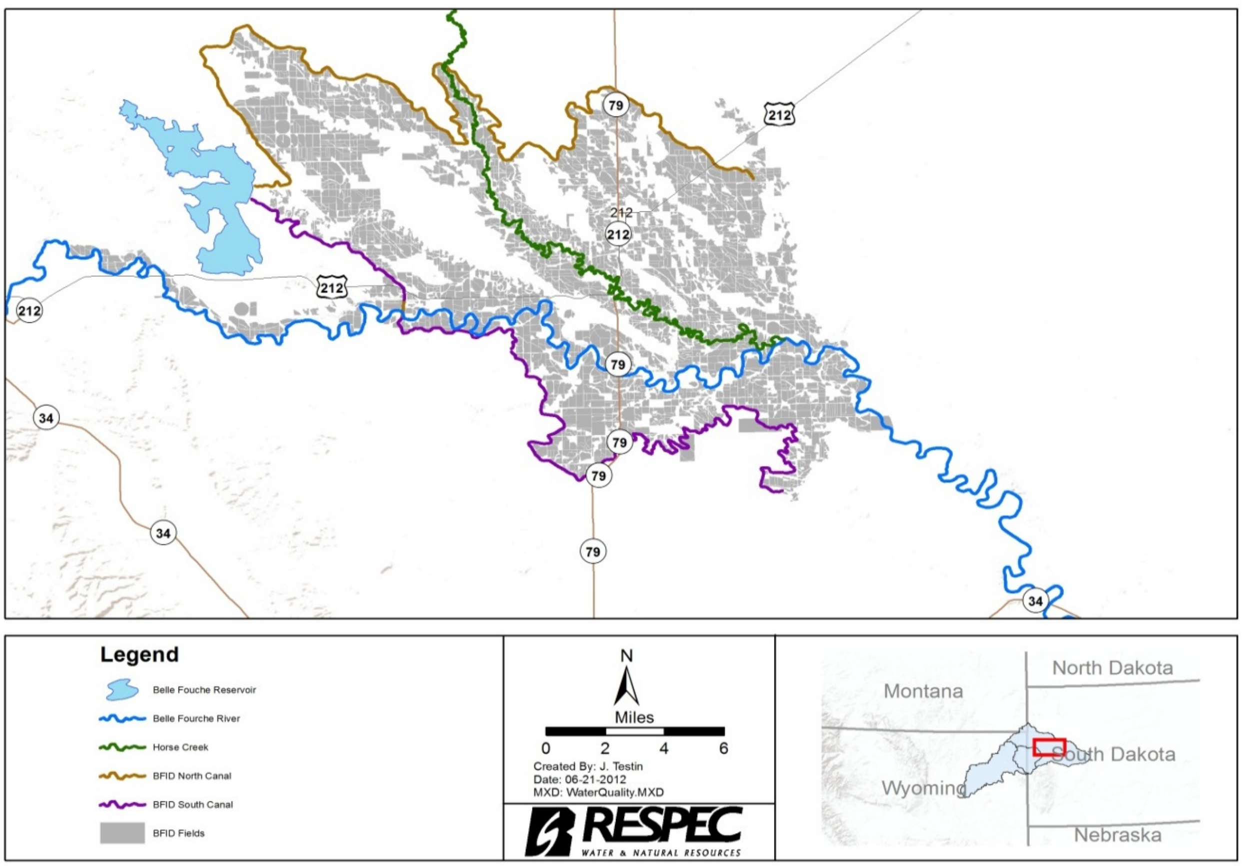

Figure 5-6. Location of Horse Creek in Relation to the Fields and Main Delivery System Within the Belle Fourche Irrigation District.

The influence that waste from the BFID delivery system and fields has on flows in Horse Creek is evident when observing a boxplot of historic monthly flows at the sight shown in Figure 5-7.. The boxplot shows 95 percent of the data (the highest and lowest 2.5 percent of values are considered outliers and therefore are eliminated). Median values of the average daily flow are labeled in blue, the boxes delineate the inner quartile range (the range bounded by the 1st and 3rd quartiles), and the whiskers mark the extents of 95 percent of the data. The typical irrigation season in the BFID begins in June and lasts until the end of September. This is demonstrated in the boxplot as the median flow jumps from 15 cfs in May to 32 cfs in June. The median flow increases to a maximum flow of 52 cfs in September and drastically drops over one order of magnitude lower in October reporting a median value of 4.2 cfs. Since the region receives very little precipitation during the irrigation season, nearly all of the increase in flow can be attributed to losses or waste within the irrigation system.

The BMPs are continuing to show that they are achieving their implementation goals. The BMPs used within the BFID to date include automated gate controls and flow monitoring, the replacement of open ditches with pipeline, the lining of open canals and laterals, the replacement of flood irrigation techniques with sprinkler irrigation, and a more efficient irrigation scheduling system. Along with the implementation of physical BMPs, BMPs in the form of public meetings and project tours have helped extend public outreach and awareness as well. Figure 5–8 displays a boxplot of the median flows during the irrigation season in Horse Creek pre- and post-BMP implementation. The plot shows that the flows are being reduced significantly, especially within July and August, which are typically months with the greatest demand and subsequent amount of irrigation deliveries.

5.3 EVALUATION OF GOAL ATTAINMENT

Project success was evaluated by comparing planned versus actual project outputs and outcomes. The goal was attained by reaching the objectives as follows:

- Implementation of several BMPs from the 10-year BFRWP Strategic Implementation Plan.
- Load reductions, estimated as a result of BMP installation, of 55,178 tons per year which is 11,144 tons/year greater than the goal for the project.

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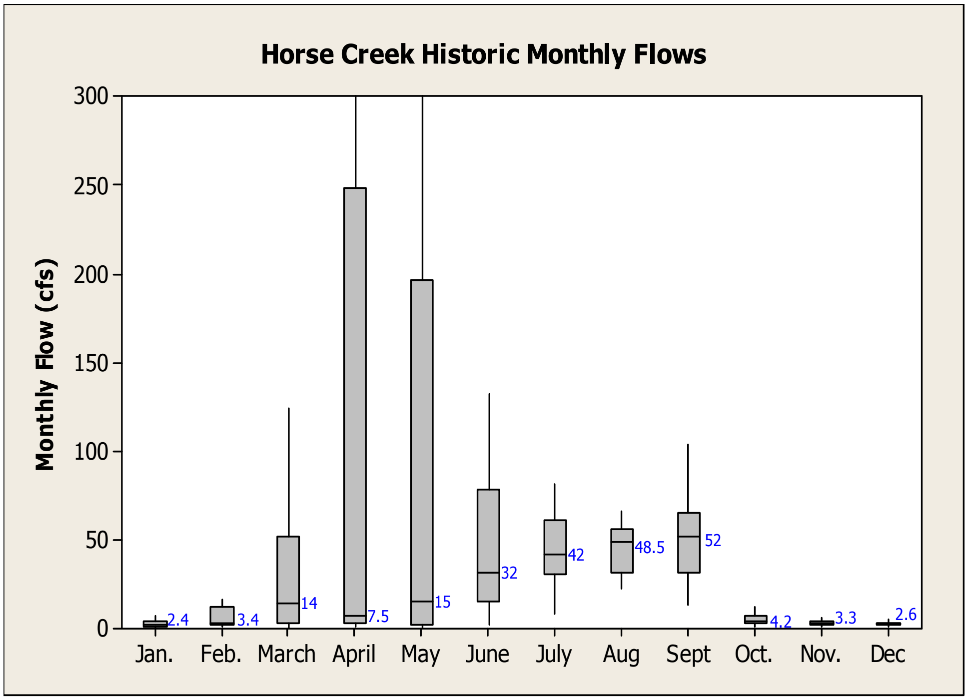

Figure 5-7. Box Plot of Historic Monthly Flows at the Mouth of Horse Creek.

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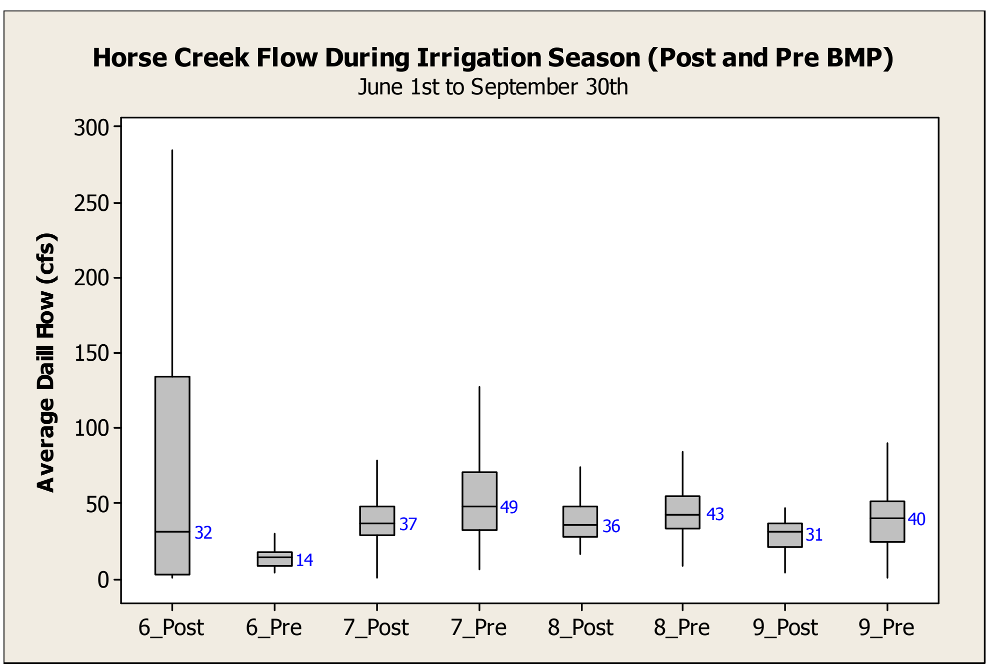

Figure 5-8. Box Plot of Average Daily Flows on Horse Creek during the Belle Fourche Irrigation District Irrigation Season; Before and After Best Management Practice Implementation.

- Completion of nearly 45 successful education and outreach activities which led to greater public participation in the project.
- Completion of midyear and annual Grant Reporting and Tracking System (GRTS) reports along with this final report.

This project was successful in that project goals were attained and BMPs were implemented that are estimated to reduce total suspended solids in the Belle Fourche River and Horse Creek.

6.0 SUCCESSES OF THE PROJECT AND ASPECTS OF THE PROJECT THAT DID NOT WORK WELL

Continued public awareness of this ongoing project greatly enhances the effort being put into improved water quality in the watershed. Combined efforts of radio advertisements, brochures, outreach booths, tours, the BFRWP Website, and the soil quality demonstration trailer were measured as a success. Many comments and questions were received from the public mentioning they heard about the BFRWP from radio advertisements and sound bites. These activities increased interest and awareness from the general public in addition to the producers directly involved in an implementation project. Buy in from the general public is a huge asset when making watershed wide improvements in water quality.

The BFRWP had two ongoing U.S. Department of Agriculture (USDA) NRCS grants during the Segment 4 funding round that augment efforts being made to achieve project goals set out in the 10-year plan. The Conservation Innovation Grant (CIG) provided irrigators in the watershed with an on-line irrigation scheduling software program to assist with irrigation scheduling. The purpose of the project was to provide producers with a reliable, easy-to-use means to monitor and schedule irrigations that will conserve water and reduce the amount of sediment-laden irrigation return flows discharged into the adjacent Belle Fourche River. This was a 3-year project that created a tool that farmers in the watershed have used beyond the end of the project. 319 project funds have been used to provide continued technical support for farmers that have chosen to use the tool to reduce return flows from their fields.

The other USDA grant that was continued was the Cooperative Conservation Partnership Initiative Grant (CCPI). CCPI is part of NRCS' existing EQIP program that provides targeted funds for rangeland improvement practices in the watershed. These range improvement practices include off stream water development and cross fencing for better livestock distribution that in turn lead to sediment reduction in the Belle Fourche River. CCPI provided nearly $1.4 million for these types of improvement projects during this segment. Currently, CCPI grant is in its fifth and final year of funding.

Some challenges that caused the project timeline to be extended were extremely wet weather and timing of EQIP funding. To get the most benefit out of the irrigation funds, the BFRWP typically “piggy backs” 319 funds on top of EQIP funds. EQIP funding announcements are made in March so when the 319 implementation grant is scheduled to be done by June 1, the deadline is often unrealistic. With the allowed extension from June 1, 2011, to December 31, 2011, all projects were able to be completed as planned.

7.0 PROJECT BUDGET/EXPENDITURES

The BFRWP received a $1,296,150 EPA section 319 Grant through DENR to continue installation of the BMPs recommended in the *Phase I Watershed Assessment Final Report and TMDL* [Hoyer and Larson, 2004]. Tables 7-1a, 7-2a, and 7-3a show the budgets of 319, 319/matching funds and nonmatching funds respectively. The budgets were the final budgets after the approval of the Segment 4 amendment and the additional documented changes to the budget after the Segment 4 amendment. Tables 7-1b, 7-2b and 7-3b are the final expenditure budgets for 319, 319/matching funds and nonmatching funds, respectively.

7.1 319 BUDGET

The total 319 budget remained the same with some changes between tasks. From Task 1 Product 1b Install 18 Sprinkler Systems $65,440 was transferred to other tasks, including Task 2 Product 2 Riparian BMPs $37,440 to cover increased demand for riparian BMP implementation; Task 3 Product 3 $19,000 to cover expensed incurred from federally mandated audit; and $9,000 to Task 4 Product 4 to cover additional analysis requested by EPA for the Whitewood Creek Fecal Coliform TMDL Summary. No other changes were made to the 319 budget.

7.2 MATCHING FUNDS BUDGET

All federal match requirements were met in this project. Final match dollars were not as high as originally estimated. Match from Product 1a was under estimated largely because it was not known at the time of the proposal. Producer cash match for Product 1b was not as high as originally estimated; it was not known at the time of the proposal what the actual cost share to producer match would be. Match on Product 2 was under estimated largely because additional BMP funds were allocated to that product. Minor differences also occurred in Product 5.

7.3 NONMATCHING FEDERAL FUNDS BUDGET

Overall nonmatching funds were under estimated for project by approximately $100,000. Federal dollars, including NRCS EQIP, can be variable from year to year depending on the demand making it a challenge to estimate actual numbers. Changes occurred in all areas of the nonmatching budget to reflect what was actually spent.

Table 7-1a. Planned Budget of 319 Funds

Project Description	Consultants ($)	USGS ($)	Producer ($)	BFID ($)	Butte Conservation District ($)	BFRWP ($)	Totals ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL							
Task 1. Reduce Nonused Water							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Line and Pipe Open Canals and Laterals	–	–	–	–			–
1b. Install 18 Sprinkler Systems	–	–	605,000				605,000
1c. Install 3 Stage Control Automation Units				50,000			50,000
Task 2. Riparian Area BMP Implementation							
Product 2. Implement Riparian BMPs			50,000				50,000
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit							
Task 3. Project Management							
Product 3. Public Outreach, and Education Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit	487,650	–	–		20,000	20,000	527,650
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development							
Task 4. Whitewood Creek Fecal Coliform TMDL Summaries							
Product 4. Whitewood Creek Fecal Coliform TMDL Summary	13,500						13,500
Task 5. Water-Quality Monitoring to Assess BMPs							
Product 5. Compile Water-Quality Monitoring Data	15,375	34,625	–				50,000
Other Watershed Improvement Projects	–	–	–				–
Total	**516,525**	**34,625**	**655,000**	**50,000**	**20,000**	**20,000**	**1,296,150**

Table 7-1b. Actual Budget of 319 Funds

Project Description	Consultants ($)	USGS ($)	Producer ($)	BFID ($)	Butte Conservation District ($)	BFRWP ($)	Totals ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL							
Task 1. Reduce Nonused Water							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Line and Pipe Open Canals and Laterals	–	–	–	–			–
1b. Install 18 Sprinkler Systems	–	–	539,560				539,560
1c. Install 3 Stage Control Automation Units				50,000			50,000
Task 2. Riparian Area BMP Implementation							
Product 2. Implement Riparian BMPs			87,440				87,440
Objective 2. Conduct Public Outreach and Education, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit							
Task 3. Project Management							
Product 3. Public Outreach, and Education Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit	487,727	–	–		26,000	32,923	546,650
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development							
Task 4. Whitewood Creek Fecal Coliform TMDL Summaries							
Product 4. Whitewood Creek Fecal Coliform TMDL Summary	22,500						22,500
Task 5. Water-Quality Monitoring to Assess BMPs							
Product 5. Compile Water-Quality Monitoring Data	15,375	34,625	–				50,000
Other Watershed Improvement Projects	–	–	–				–
Total	**525,602**	**34,625**	**627,000**	**50,000**	**26,000**	**32,923**	**1,296,150**

Table 7-2a. Planned U.S. Environmental Protection Agency 319 and Matching Funds Budget

EPA 319 and Matching Funds Budget	EPA 319 ($)	Matching Funds ($)				Sum of Matching Funds ($)
		Producer (Cash and In-kind) ($)	Lawrence County (Cash) ($)	BFID (Cash and In-kind) ($)	WY DEQ (Cash)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL						
Task 1. Reduce Nonused Water						
Product 1. Improved Irrigation Water Delivery and Application						
1a. Line and Pipe Open Canals and Laterals						
1b. Install 18 Sprinkler Systems	605,000	2,285,000				2,285,000
1c. Install 3 Stage Control Automation Units	50,000					
Task 2. Riparian Area BMP Implementation						
Product 2. Implement Riparian BMPs	50,000	17,000				17,000
Objective 2. Conduct Public Education and Outreach, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit						
Task 3. Project Management						
Product 3. Public Outreach and Education, Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit	527,650					
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development						
Task 4. Whitewood Creek Fecal Coliform TMDL Summary						
Product 4. Whitewood Creek Fecal Coliform TMDL Summary	13,500					
Task 5. Water-Quality Monitoring to Assess BMPs						
Product 5. Compile Water-Quality Monitoring Data	50,000		28,900	10,726	14,300	53,926
Other Water-Quality Improvements						
Total	**1,296,150**	**2,302,000**	**28,900**	**10,726**	**14,300**	**2,355,926**

Table 7-2b. Actual U.S. Environmental Protection Agency 319 and Matching Funds Budget

EPA 319 and Matching Funds Budget	EPA 319 ($)	Matching Funds ($)				Sum of Matching Funds ($)
		Producer (Cash and In-kind) ($)	Lawrence County (Cash) ($)	BFID (Cash and In-kind) ($)	WY DEQ (Cash)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL						
Task 1. Reduce Nonused Water						
Product 1. Improved Irrigation Water Delivery and Application						
1a. Line and Pipe Open Canals and Laterals						
1b. Install 18 Sprinkler Systems	539,560	1,384,944		172,042		1,556,986
1c. Install 3 Stage Control Automation Units	50,000					
Task 2. Riparian Area BMP Implementation						
Product 2. Implement Riparian BMPs	87,440	59,075				59,075
Objective 2. Conduct Public Education and Outreach, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit						
Task 3. Project Management						
Product 3. Public Outreach and Education, Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit	546,650					
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development						
Task 4. Whitewood Creek Fecal Coliform TMDL Summary						
Product 4. Whitewood Creek Fecal Coliform TMDL Summary	22,500					
Task 5. Water-Quality Monitoring to Assess BMPs						
Product 5. Compile Water-Quality Monitoring Data	50,000		14,900	10,500	14,000	39,400
Other Water-Quality Improvements						
Total	**1,296,150**	**1,444,019**	**14,900**	**182,542**	**14,000**	**1,655,461**

Table 7-3a. Planned Nonmatching Funds Budget

EPA 319 and Nonmatching Funds Budget	Nonmatching Funds						Sum of Nonmatching Funds ($)
	SD DENR (Federal) ($)	NRCS CIG Grant (Federal) ($)	NRCS EQIP (Federal) ($)	COE (Federal) ($)	BOR (Federal) ($)	USGS (Federal) ($)	
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL							
Task 1. Reduce Nonused Water							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Line and Pipe Open Canals and Laterals					300,000		300,000
1b. Install 18 Sprinkler Systems			412,500				412,500
1c. Install 3 Stage Control Automation Units							
Task 2. Riparian Area BMP Implementation							
Product 2. Implement Riparian BMPs							
Objective 2. Conduct Public Education and Outreach, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit							
Task 3. Project Management							
Product 3. Public Outreach and Education, Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit			1,400,000				1,400,000
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development							
Task 4. Whitewood Creek Fecal Coliform TMDL Summary							
Product 4. Whitewood Creek Fecal Coliform TMDL Summary							
Task 5. Water-Quality Monitoring to Assess BMPs							
Product 5. Compile Water-Quality Monitoring Data	71,500			14,300	7,148	169,852	262,800
Other Water-Quality Improvements		300,000					300,000
Total	**71,500**	**300,000**	**1,812,500**	**14,300**	**307,148**	**169,852**	**2,675,300**

Table 7-3b. Actual Nonmatching Funds Budget

EPA 319 and Nonmatching Funds Budget	Nonmatching Funds: SD DENR (Federal) ($)	NRCS CIG Grant (Federal) ($)	NRCS EQIP (Federal) ($)	COE (Federal) ($)	BOR (Federal) ($)	USGS (Federal) ($)	Sum of Nonmatching Funds ($)
Objective 1. Implement BMPs Recommended in the Belle Fourche River Watershed TMDL							
Task 1. Reduce Nonused Water							
Product 1. Improved Irrigation Water Delivery and Application							
1a. Line and Pipe Open Canals and Laterals					205,295		205,295
1b. Install 18 Sprinkler Systems			805,945				805,945
1c. Install 3 Stage Control Automation Units							
Task 2. Riparian Area BMP Implementation							
Product 2. Implement Riparian BMPs							
Objective 2. Conduct Public Education and Outreach, Implementation Record Keeping, Report Writing, Writing Future Grants, and Federal Audit							
Task 3. Project Management							
Product 3. Public Outreach and Education, Implementation Record Keeping, Report and Future Grant Writing, and Federal Audit			1,319,036				1,319,036
Objective 3. Complete Essential Water-Quality Monitoring and TMDL Development							
Task 4. Whitewood Creek Fecal Coliform TMDL Summary							
Product 4. Whitewood Creek Fecal Coliform TMDL Summary							
Task 5. Water-Quality Monitoring to Assess BMPs							
Product 5. Compile Water-Quality Monitoring Data	70,000			14,000	7,000	173,400	264,400
Other Water-Quality Improvements		184,000					184,000
Total	**71,500**	**184,000**	**2,124,981**	**14,000**	**212,295**	**173,400**	**2,778,676**

8.0 FUTURE ACTIVITY RECOMMENDATIONS

During the next 3 years, additional project segments are planned to finish installing the BMPs outlined in the *Phase I Watershed Assessment Final Report and TMDL* [Hoyer and Larson, 2004] and the *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan* [Hoyer, 2005]. This will ensure that the overall goal for the watershed is met, which is to bring the Belle Fourche River and Horse Creek into compliance with state TSS standards. As additional TMDLs are completed for other lakes and tributaries in the watershed, implementation of TMDLs developed should be added to the Belle Fourche River Watershed project.

9.0 REFERENCES

Hoyer, D. P. and A. Larson, 2004. *Phase I Watershed Assessment Final Report and TMDL*, prepared for the state of South Dakota, Pierre, SD.

Hoyer, D. P., 2005. *Ten-Year Belle Fourche River Watershed Strategic Implementation Plan*, RSI-1821, prepared by RESPEC, Rapid City, SD, for Belle Fourche Irrigation District, Newell, SD.

Rolland, C. and D. P. Hoyer, 2005. *Belle Fourche Irrigation District Water Conservation Plan*, RSI-1824, prepared by RESPEC, Rapid City, SD, for Belle Fourche Irrigation District, Newell, SD.

APPENDIX A

E. COLI TOTAL MAXIMUM DAILY LOAD FOR WHITEWOOD CREEK

APPENDIX B

FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD FOR WHITEWOOD CREEK

FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD FOR WHITEWOOD CREEK

Topical Report RSI-2118

prepared for

South Dakota Department of Environment
and Natural Resources
523 East Capitol
Joe Foss Building
Pierre, South Dakota 57501

August 2010

RESPEC
CONSULTING & SERVICES

FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD
FOR WHITEWOOD CREEK

Topical Report RSI-2118

by

Cindie M. McCutcheon

RESPEC
P.O. Box 725
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prepared for

South Dakota Department of Environment
and Natural Resources
523 East Capitol
Joe Foss Building
Pierre, South Dakota 57501

August 2010

Total Maximum Daily Load Summary Table

Waterbody Name/Description	Whitewood Creek (from Deadwood Creek to Spruce Gulch)
Assessment Unit I.D.	SD-BF-R-WHITEWOOD_03
Size of Impaired Waterbody	Approximately 1.8 miles (2.9 kilometers) in length
Size of Watershed	105 square miles (273 square kilometers)
Location	Hydrologic Unit Codes (12-digit HUC): 101202020207 and 101202020208
Impaired Designated Use(s)	Immersion Recreation
Cause(s) of Impairment	Fecal coliform bacteria
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points	Indicator Name: Fecal coliform bacteria Threshold Values: Maximum daily concentration of 400 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 200 cfu/ 100 mL. These criteria apply from May through September.
Analytical Approach	Load Duration Curve, **Bacterial Indicator Tool** and **Hydrological Simulation Program – FORTRAN** (**HSPF**) modeling

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1.0 INTRODUCTION

The intent of this document is to clearly identify the components of a Total Maximum Daily Load (TMDL), support adequate public participation, and facilitate the U.S. Environmental Protection Agency (EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the fecal coliform bacteria impairment on Whitewood Creek (SD-BF-R-WHITEWOOD_03), which was assigned an EPA assessment category of 5 (water is impaired or threatened and a TMDL is needed) in the 2008 and 2010 Impaired Waterbodies Lists [South Dakota Department of Environment and Natural Resources, 2008; 2010a].

1.1 WATERSHED CHARACTERIZATION

The Whitewood Creek Watershed is approximately 105 square miles (273 square kilometers). The creek flows through both Lawrence and Meade Counties, with its headwaters located near the base of Deer Mountain. The creek flows to the Belle Fourche River near Vale, South Dakota. The watershed drains much of the central portion of Lawrence County in South Dakota. Figure 1-1 shows the Whitewood Creek study area. The impaired (Section 303(d) listed) segment of Whitewood Creek has a length of approximately 1.8 miles (2.9 kilometers), beginning at Deadwood Creek and ending at Spruce Gulch.

Average annual precipitation for Lead, South Dakota, and Deadwood, South Dakota, is 29 inches and 28 inches, respectively. Over 50 percent of the annual precipitation occurs between the months of April and June. The highest rainfall totals occur during May while the lowest rainfall totals occur during January. Snowmelt significantly contributes to flow during March, April, and May. Average annual snowfall in Lead and Deadwood is 169 inches and 112 inches, respectively [Carter, 2002].

Watershed land use above the TMDL endpoint is mainly forestland (71 percent) and grasslands (16 percent). The type of land use, acreage, and percentage of area is given in Table 1-1. Urban areas above the TMDL endpoint (5.6 percent of the study area) can be found near Lead, Central City, and Deadwood, South Dakota. The remaining portion of the study area consists of agricultural land, shrubs, and wetlands. A majority of the impaired reach is located within the city of Deadwood.

1.2 CLEAN WATER ACT SECTION 303(D) LISTING INFORMATION

Whitewood Creek was first listed in South Dakota's 1998 303(d) list [South Dakota Department of Environment and Natural Resources, 1998] as impaired because of sample concentrations of fecal coliform bacteria that exceeded the criterion for the protection of the

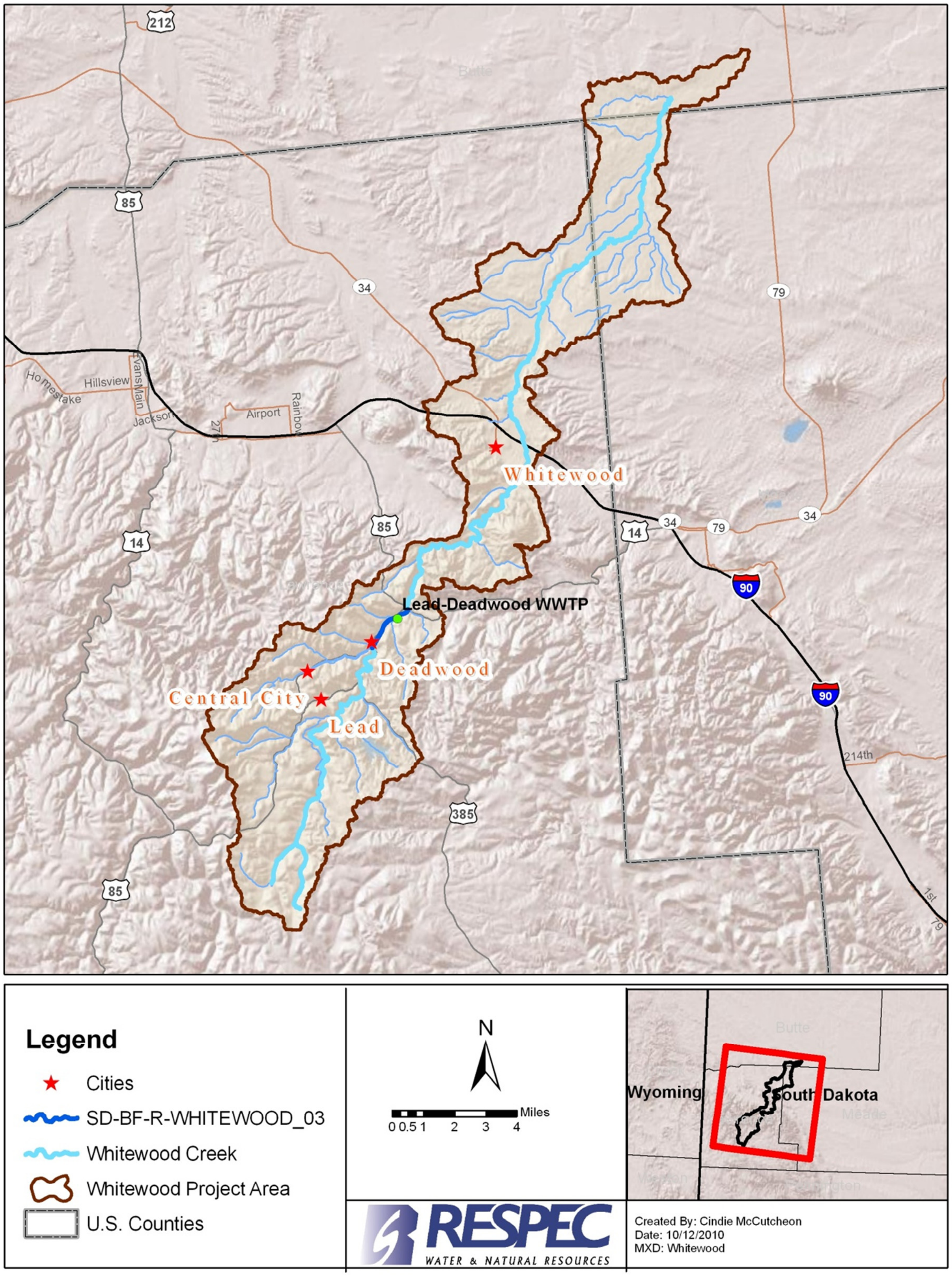

Figure 1-1. Whitewood Creek Study Area.

immersion recreation use. Currently, Whitewood Creek from Deadwood Creek to Spruce Gulch is listed in South Dakota's 2010 303(d) list [South Dakota Department of Environment and Natural Resources, 2010a] as impaired because of sample concentrations of both fecal coliform and *E. coli* bacteria that exceeded the acute criterion for the protection of the immersion recreation use. The double listing for fecal coliform and *E. coli* is because of a new *E. coli* standard that was adopted in 2010. For a parameter to be included as a cause of impairment on the 303(d) impaired waters list, greater than 10 percent of the samples collected during the previous 5-year period must exceed water-quality criteria.

Table 1-1. Watershed Land Use in the Whitewood Creek Watershed Above the Total Maximum Daily Load Reach Endpoint

Land Uses	Area (acres)	% of Area
Evergreen Forest	19,938	71.0
Grassland/Herbaceous	4,532	16.1
Shrub/Scrub	1,121	4.0
Developed, Low Intensity	743	2.6
Developed, Open Space	718	2.6
Barren Land (Rock/Sand/Clay)	478	1.7
Open Water	175	0.6
Mixed Forest	134	0.5
Deciduous Forest	124	0.4
Developed, Medium Intensity	99	0.4
Pasture/Hay	8	0.0
Emergent Herbaceous Wetlands	3	0.0
Woody Wetlands	1	0.0
Total	**28,074**	**100.0**

1.3 AVAILABLE WATER-QUALITY AND FLOW DATA

The South Dakota Department of Environment and Natural Resources (SD DENR) collected bacteria samples at the Whitewood Creek ambient water-quality monitoring (WQM) Station 123 near Deadwood since 1991 (see Figure 1-2). Fecal coliform bacteria concentration data collected

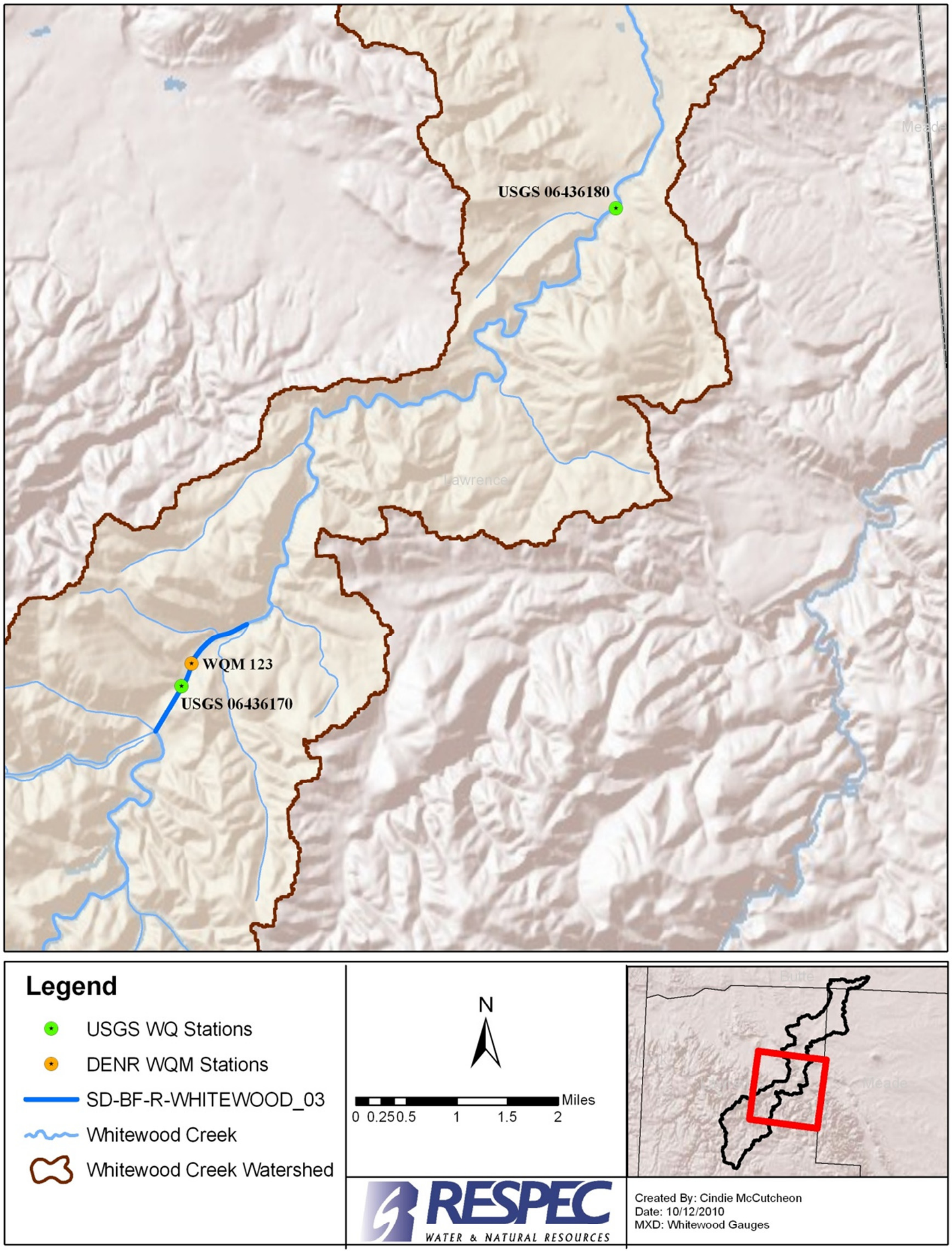

Figure 1-2. Water-Quality Stations in the Whitewood Creek Watershed Used for Total Maximum Daily Load Development.

at WQM 123 show that 52 out of 106 samples (49 percent) collected during the recreation season from May 1 to September 30 exceeded the acute fecal coliform bacteria criterion of 400 colony-forming units per 100 milliliters (cfu/100 mL) from 1991 through 2009. Concentrations ranged from < 10 cfu/100 mL to 6,700 cfu/100 mL. *E. coli* bacteria concentration data collected at WQM 123 (1998 through 2009) show that 14 out of 34 samples (41 percent) collected during the recreation season exceeded the acute fecal coliform bacteria criterion of 235 cfu/100 mL. Concentrations ranged from < 10 cfu/100 mL to 770 cfu/100 mL.

Whitewood Creek flow data were available from U.S. Geological Survey (USGS) Station 06436170 at Deadwood, South Dakota, near WQM 123 from 1981 through 1995, while flow data were available from USGS Station 06436180 above Whitewood, South Dakota, from 1982 through 2009. Flow at USGS Station 06436170 was considered representative of flow at WQM 123. Because recent flow data were required for construction of a load duration curve, a linear regression analysis was completed comparing historical flow (1982 through 1995) from the two stations; the equation of the linear regression analysis line ($r^2 = 0.88$) was used with the data from USGS Station 06436180 (1998 through 2009) to calculate more recent flow values for USGS Station 06436170. SD DENR WQM stations and USGS stations used for TMDL development are shown in Table 1-2 and Figure 1-2. Bacteria sample data are presented in Appendix A.

Table 1-2. Water-Quality Stations in the Whitewood Creek Watershed Used for Total Maximum Daily Load Development

Water-Quality Stations	Period of Record	Fecal Coliform Samples	*E. coli* Samples	Flow Samples
Whitewood Creek near Deadwood, SD (WQM 123)	1991–2009	106	34	0
Whitewood Creek at Deadwood, SD (USGS 06436170)	1981–1995	0	0	5,113
Whitewood Creek above Whitewood, SD (USGS 06436180)	1982–2009	2	0	9,719

Boxplots shown in Figure 1-3 were constructed for the water-quality monitoring sites shown in Figure 1-4 using data that were used for the 2008 and 2010 integrated reports (2003 through 2009). This dataset was used because requirements for stream listings state that data must be less than 5 years old. Boxplots are shown from upstream to downstream. A watershed schematic, illustrated in Figure 1-5, shows median concentrations, percent exceedance, and number of samples at each water-quality monitoring site from upstream to downstream for this time period. The only water-quality monitoring site within the impaired reach is Whitewood Creek below Deadwood (460123). West Strawberry Creek (460675), which flows into Reach SD-BF-R-WHITEWOOD_01, is impaired for fecal coliform with a median concentration of nearly two times that of Whitewood Creek below Deadwood. Currently, a TMDL document is approved for West Strawberry Creek suggesting the bacteria load sources are approximately 43 percent human and 57 percent wildlife [South Dakota Department of Environment and Natural Resources, 2010b]. Whitewood Creek above Gold Run (460686), Gold Run Creek (460659), Whitewood Creek near Deadwood (460122), and Deadwood Creek (460127) are unimpaired. Using only data from 2003 through 2009, the impaired reach, SD-BF-R-WHITEWOOD_03, has 22 percent exceedance of the acute criteria and 50 percent exceedance of the geometric mean criteria. The Whitewood Creek near Deadwood site (460685), following the impaired reach, actually exceeds the acute criteria 15 percent of the time. However, this site is not listed because it does not meet the sample requirements for impairment which state, “at least 20 samples for any one parameter are usually required at any site. The sample threshold was reduced to 10 samples if greater than 25 percent of samples exceed water standards [South Dakota Department Environment and Natural Resources, 2008].”

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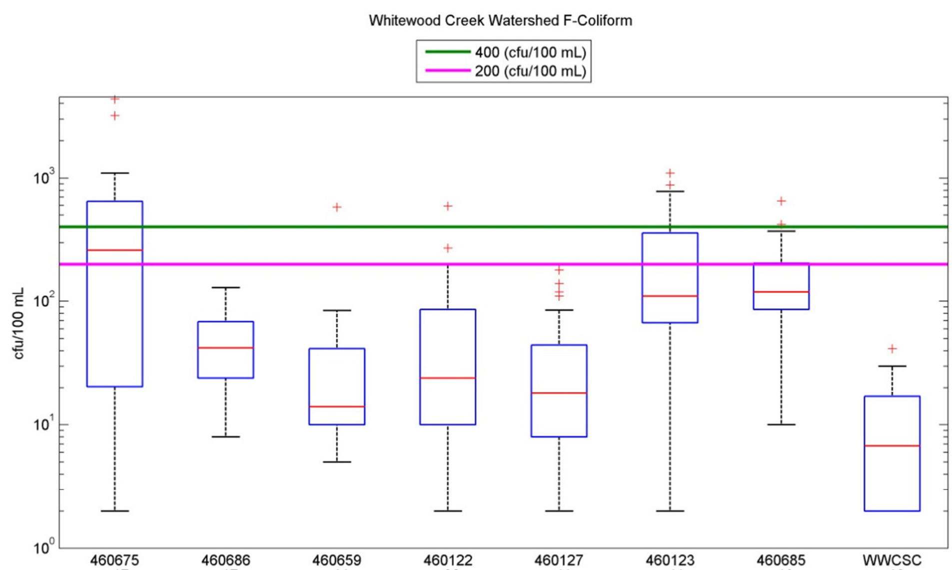

	460675	460686	460659	460122	460127	460123	460685	WWCSC
n	17	17	11	30	41	41	13	10
Min	2	8	5	2	2	2	10	2
Max	4350	130	580	590	180	1100	650	41.5
q1	20.5	24	10	10	8	67.25	86	2
Median	260	42	14	24	18	110	120	6.75
q3	642.5	68.5	41.5	86	44.5	357.5	205	17
Mean	716.9	49.4	73.7	68.9	34.9	251.8	182	12.2
90th%	2780	107	282	160	95	712	466	35.8
95th%	3948	123	555	270	129	825	615	41.5
% Exceeded	41	0	9.1	3.3	0	22	15	0
% Exceed30	59	0	0	NaN	0	50	NaN	0
n 30	17	17	12	0	22	22	0	10

Figure 1-3. Boxplots of 2003 Through 2009 Fecal Coliform Data for Sites Upstream, Within, and Downstream of the Impaired Reach.

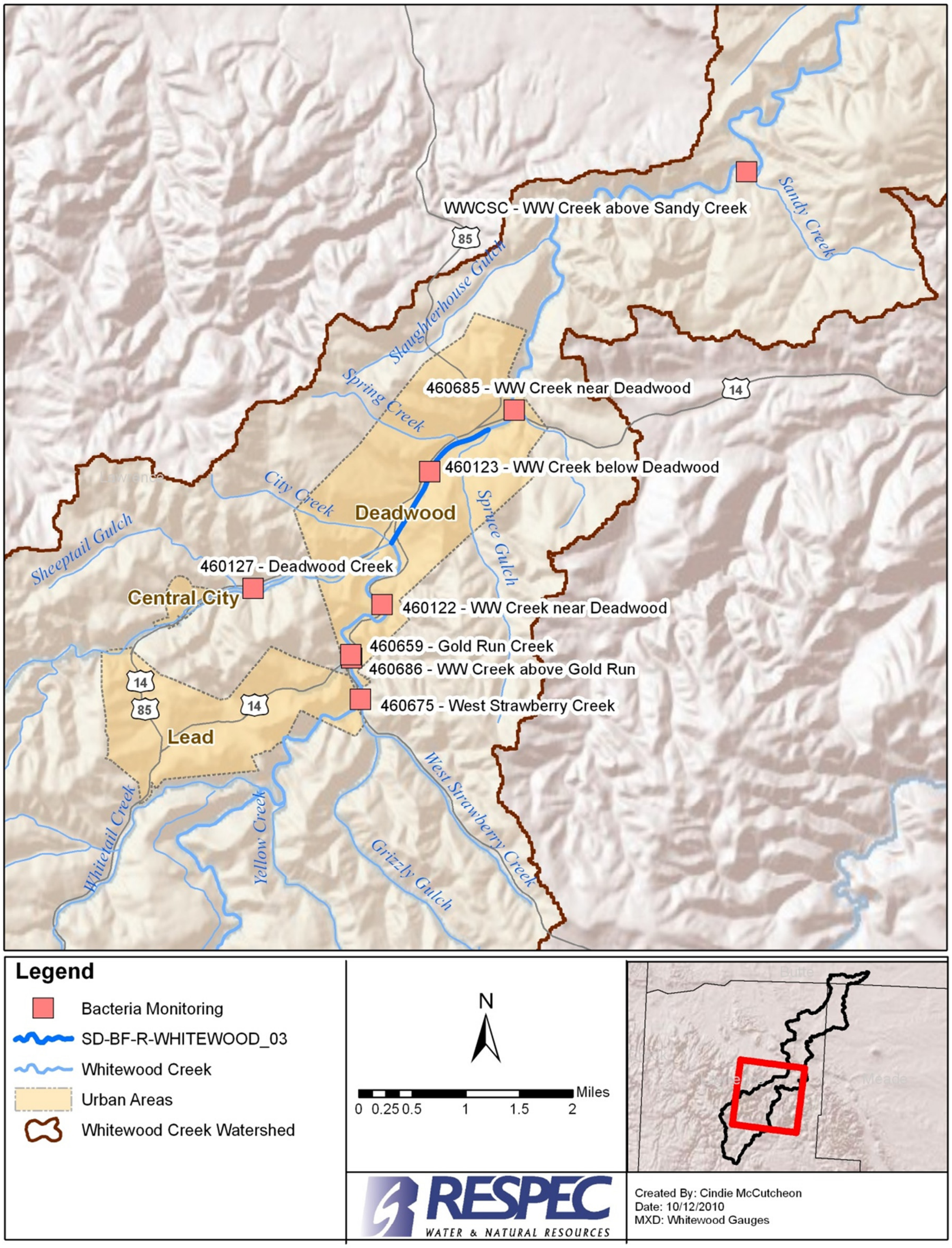

Figure 1-4. Whitewood Creek Monitoring Sites Upstream, Downstream, and Within Impaired Reach.

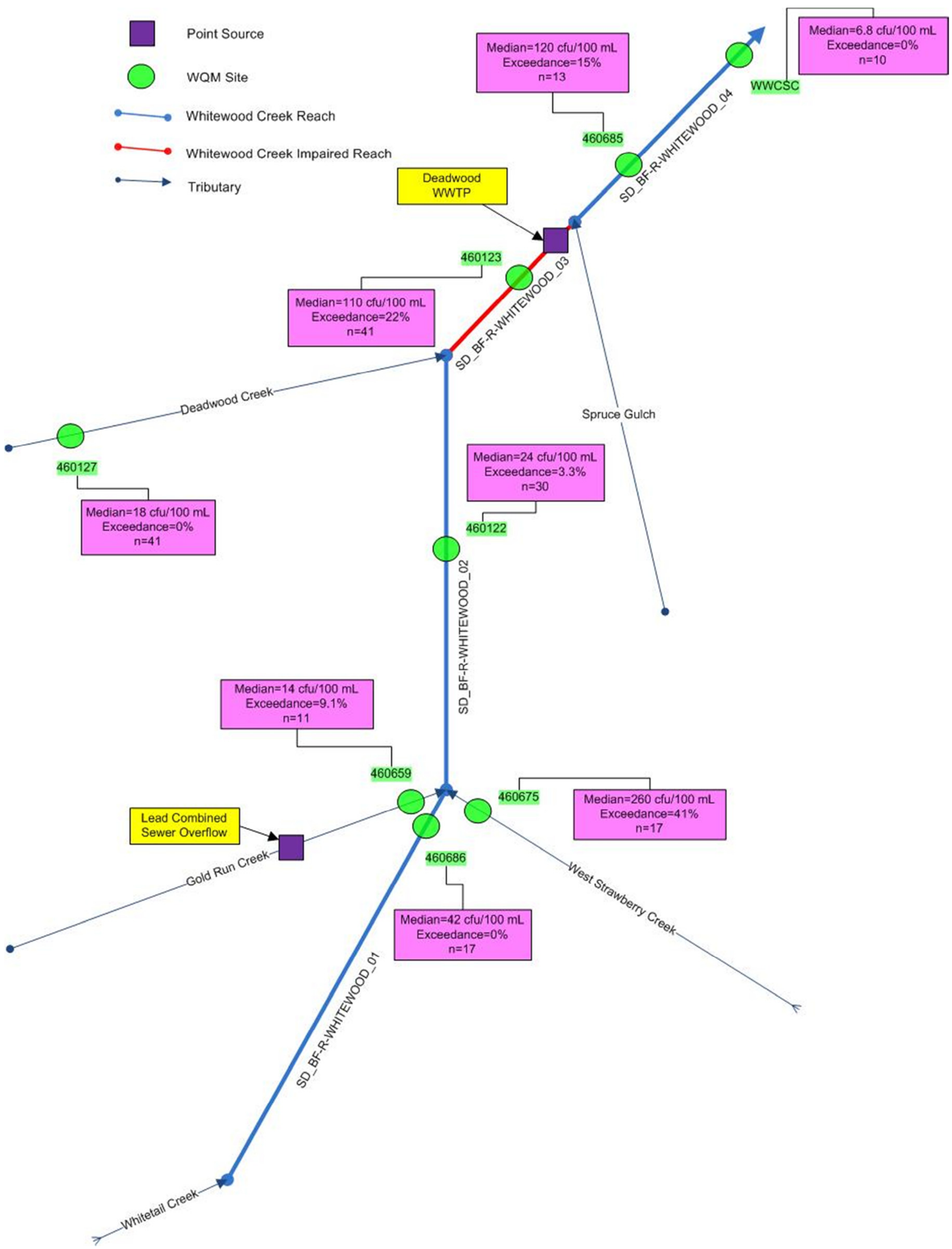

Figure 1-5. Whitewood Creek Watershed Schematic Showing Reaches Upstream and Downstream of Impaired Reach.

Although West Strawberry Creek is impaired for bacteria, there is zero exceedance at Whitewood Creek above Gold Run (460686) downstream of the confluence of West Strawberry Creek with Whitewood Creek. Even though some loading from West Strawberry Creek occurs, the overall contribution of West Strawberry Creek appears to be diluted by the time it gets to Whitewood Creek above Gold Run (460686). Besides West Strawberry Creek, none of the monitoring sites upstream of the impairment have consistently high bacteria concentrations, and the upstream contribution is relatively negligible compared to the Whitewood Creek site below Deadwood (460123). Deadwood sources could consist of sanitary sewer cross connections with the storm sewer, cracked or broken sanitary sewer lines draining into the storm sewer or directly to the stream, stormwater discharge from Deadwood or a combination of the above. An investigation should be completed upstream, within, and downstream of the impaired reach, throughout Deadwood and Lead, to pinpoint the bacterial sources. With implementation of Best Management Practices (BMPs) in Deadwood such as reduction of on-site wastewater treatment system failures and leaking sewer lines and stormwater treatment programs, loads from the city of Deadwood downstream of the impaired reach in Whitewood Creek near Deadwood (Site 460685) would likely be reduced as well.

2.0 WATER-QUALITY STANDARDS AND TOTAL MAXIMUM DAILY LOAD TARGETS

South Dakota waterbodies are all assigned beneficial uses based on the regulations of the EPA Clean Water Act. All streams are designated with the use of fish and wildlife propagation, recreation, stock watering, and irrigation. Additional uses are assigned by the state based on a beneficial use analysis of each waterbody. Water-quality standards are defined in South Dakota state statutes in support of these uses. These standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed (Administrative Rules of South Dakota (ARSD) 74:51:01–74:51:03). Additional narrative standards that may apply can be found in the ARSD § 74:51:01:05, 06, 08, 09, and 12. These contain language that generally prohibit the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, and pollutants impacting biological integrity.

Whitewood Creek Segment SD-BF-F-WHITEWOOD_03 was assigned the following beneficial uses: cold-water permanent fish life propagation, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 2-1 lists water-quality criteria that must be met to support the beneficial uses currently assigned to the Whitewood Creek.

Current fecal coliform criteria for the immersion recreation and limited contact recreation use require that (1) no sample exceeds 400 cfu/100 mL and 2,000 cfu/100 mL, respectively, and (2) the geometric mean of a minimum of five samples collected during separate 24-hour periods for any 30-day period must not exceed 200 cfu/100 mL and 1,000 cfu/100 mL, respectively. The current *E. coli* criteria for the immersion recreation and limited contact recreation use require that (1) no sample exceeds 235 cfu/100 mL and 1,178 cfu /100 mL, respectively, and (2) the geometric mean of a minimum of five samples collected during separate 24-hour periods for any 30-day period must not exceed 126 cfu/100 mL and 630 cfu/100 mL, respectively. Since generally only one or two water samples were collected during any 30-day period, compliance with the chronic criterion was evaluated using the **Hydrological Simulation Program – FORTRAN** (**HSPF**) model-predicted, daily concentrations from a recalibrated version of a model created by Carter [2002]. The geometric mean, as defined in ARSD § 74:51:01:01, is the *n*th root of a product of *n* factors. The fecal coliform and *E. coli* criteria are applicable from May 1 through September 30.

A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still support its designated beneficial uses; it is the sum of allowable loads of a single pollutant from all contributing point and nonpoint sources. The numeric TMDL target established for the Whitewood Creek's immersion recreation beneficial use, which is more stringent than the limited contact beneficial use, was determined for each of five flow conditions or zones and based on either the acute (400 cfu/100 mL) or chronic (200 cfu/100 mL) fecal coliform bacteria criterion, depending on which criterion required the greatest load reduction.

Table 2-1. State Surface Water-Quality Standards for Whitewood Creek From Deadwood Creek to Spruce Gulch (SD-BF-R-WHITEWOOD_03) [South Dakota Department of Environment and Natural Resources, 2008] (Page 1 of 2)

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate[(a)]	≤ 750	mg/L	30-day average
	≤ 1,313	mg/L	Daily maximum
Total dissolved solids[(a)]	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	Daily maximum
Total petroleum hydrocarbon[(a)]	≤ 10	mg/L	Daily maximum
Oil and grease[(a)]	≤ 10	mg/L	Daily maximum
Nitrogen, nitrates as N[(a)]	≤ 50	mg/L	30-day average
	≤ 88	mg/L	Daily maximum
Chloride[(b)]	≤ 100	mg/L	30-day average
	≤ 175	mg/L	Daily maximum
Chlorine, total residual[(b)]	≤ 0.011	mg/L	Chronic
	≤ 0.019	mg/L	Acute
Dissolved oxygen[(c), (d)]	≥ 5.0	mg/L	Daily minimum
Total suspended solids[(b)]	≤ 30	mg/L	30-day average
	≤ 53	mg/L	Daily maximum
Temperature[(b)]	≤ 65	°F	Daily maximum
pH[(b)]	6.6 and ≤ 8.6	Standard units	
Undisassociated hydrogen sulfide[(b)]	≤ 0.002	mg/L	Daily maximum
Total ammonia nitrogen as N[(b)]	Equation-based limit	mg/L	30-day average (March 1–October 31)
	Equation-based limit	mg/L	30-day average (November 1–February 29)
	Equation-based limit	mg/L	Daily maximum
Fecal coliform[(d), (e)]	≤ 200	cfu/100 mL	Geometric mean (May 1–September 30)
	≤ 400	cfu/100 mL	Daily maximum (May 1–September 30)
E. coli[(d), (e)]	≤ 126	cfu/100 mL	Geometric mean (May 1–September 30)
	≤ 235	cfu/100 mL	Daily maximum (May 1–September 30)

Table 2-1. State Surface Water-Quality Standards for Whitewood Creek From Deadwood Creek to Spruce Gulch (SD-BF-R-WHITEWOOD_03) [South Dakota Department of Environment and Natural Resources, 2008] (Page 2 of 2)

Parameter	Criteria	Unit of Measure	Special Conditions
Conductivity at 25°C[f]	≤ 2,500	micromhos/cm	30-day average
	≤ 4,375	micromhos/cm	Daily maximum
Sodium adsorption ratio[f]	≤ 10		Daily maximum

(a) Criteria for fish and wildlife propagation, recreation, and stock watering use.
(b) Criteria for cold-water permanent fish life propagation.
(c) Criteria for limited contact recreation use.
(d) Criteria for immersion recreation use.
(e) Geometric means must be based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period.
(f) Criteria for irrigation use.

3.0 SIGNIFICANT SOURCES

3.1 POINT SOURCES

The permitted Lead/Deadwood wastewater treatment plant (WWTP) located in Deadwood discharges its effluent into Whitewood Creek. The monthly average discharge from 1997 to 2009 from the facility ranged from 0.8 million gallons per day (mgd) to 3.6 mgd. The mean monthly average discharge over this range was 1.4 mgd, and the median monthly average discharge was also 1.4 mgd. The Lead/Deadwood WWTP has been in operation since 1979. According to the WWTP, the geometric mean of the fecal coliform bacteria in the effluent for any 30-day period should not exceed 200 cfu/100 mL and the daily maximum should not exceed 400 cfu/100 mL. These fecal coliform criteria are the same as the criteria for Whitewood Creek. Thus as long as the WWTP meets the criteria of its discharge permit, it should not cause exceedances of the fecal coliform concentration criteria of Whitewood Creek [Carter, 2002].

One combined sewer outfall (CSO) remains in the city of Lead. It was constructed in the late 1890s. When the sewer lines for the Lead/Deadwood Sanitation District were constructed, they collected sewage from all but two of the sewer outfalls that discharged to Whitewood Creek. The discharge that overflowed to Whitewood Creek near the Lead/Deadwood WWTP was eliminated from the sewer system in 2001; therefore, only one CSO remains in the city of Lead. Under normal conditions, a 10-inch weir located in the sewer keeps wastewater from flowing out of the CSO in Lead. However, during some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The wastes that flow over the weir travel down a concrete channel and flow into Gold Run Creek and eventually into Whitewood Creek. A collection container is anchored to the downstream side of the weir. If there is an overflow, some of the water is collected in the container, and the container is checked daily to determine if there has been an overflow. The water from the overflow in the container is tested and the state is notified of the discharge. From 1991 to 1998, the geometric mean of the overflow concentrations of fecal coliform bacteria was 51,746 cfu/100 mL. The maximum concentration during this period was 2.1×10^6 cfu/100 mL. Overflows were reported in 44 of the 96 months from 1991 to 1998. The overflow that discharged to Whitewood Creek near the Lead/Deadwood WWTP only had discharges reported in 8 months from 1991 to 1998. The geometric mean of the concentrations of fecal coliform bacteria was 265,556 cfu/100 mL and the maximum was 721,000 cfu/100 mL [Carter, 2002].

When an overflow occurs, the city is required to contact SD DENR and to collect a sample of the overflow. Additionally, at the end of each month, the city submits a report to SD DENR that includes the geometric mean and maximum concentrations of fecal coliforms from the overflow samples. This information was obtained from SD DENR and used to estimate loadings from the combined sewer overflows. Because of the age of the data, the exact dates of the overflows were not available for this assessment. To determine when overflows likely occurred, the daily precipitation data for Lead was compared to the record of reported combined sewer overflows. It was assumed that each of the overflows was the result of a precipitation event. By comparing these two records, it was estimated that any storm event yielding over 0.33 inch of precipitation could cause the combined sewer to overflow. An "average" overflow resulting from approximately 1 inch of rain per hour likely results in an overflow of 250,000 gallons. Most overflows last for 2 hours or less [Carter, 2002].

3.2 NONPOINT SOURCES

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of bacteria within the Whitewood Creek Watershed include livestock, wildlife, aging on-site wastewater treatment and sewer systems, and the CSO in Lead. Using the best-available information, loadings were estimated from each of these sources using the EPA's **Bacterial Indicator Tool (BIT)** based on the density and distribution of animals (livestock and wildlife) and failing on-site wastewater treatment systems in the watershed [U.S. Environmental Protection Agency, 2001a].

3.2.1 Agriculture

Manure from livestock is a potential source of bacteria to the stream. Livestock population densities in the watershed, shown in Table 3-1, were estimated using 1997 Census of Agriculture data [U.S. Department of Agriculture, 1997]. Livestock contribute bacteria loads to the Whitewood Creek by defecating directly into the stream while wading and defecating on rangelands that are washed off during precipitation events. Both the indirect and direct defecation bacteria loads from livestock were represented in the modeling applications.

Table 3-1. Approximate Livstock Population Densities for Lawrence County

Species	Population Density (per mi^2)
Beef Cattle	6.68
Dairy Cattle	0.10
Hogs/Pigs	0.00
Sheep	1.53
Bison	0.00
Horses	0.84
Chickens	1.10

3.2.2 Human

The bacterial source tracking tests identified the presence of human fecal coliform bacteria in Whitewood Creek. The watershed contains one centralized wastewater collection and treatment facility for Deadwood and Lead, South Dakota, as well as the CSO for Lead that is currently being eliminated. Besides the Deadwood/Lead WWTP, the watershed is mainly rural. Thus on-site wastewater treatment systems and leaks in sewer lines are also assumed to be human sources of bacteria loads to Whitewood Creek. Densities of on-site wastewater treatment systems in the watershed were derived from the 2000 U.S. Census statistics [Carter, 2002]. Discharge from the Deadwood/Lead WWTP and the Lead CSO is considered a point source while any on-site wastewater treatment systems and leaks in sewer lines are considered nonpoint sources.

The retired director of the Environmental Health Office of Lawrence County, Mr. Roger Marshall, believes that less than 15 percent of the on-site wastewater treatment systems in the Lead and Deadwood areas are failing [Marshall, 2002]. SD DENR estimates that there are approximately 351 on-site wastewater treatment systems in use in the study area [Sawyer, 2002].

Because of leaks in sewer lines, raw sewage may bypass the wastewater treatment plant and flow directly into surface water or groundwater. Raw sewage could have high levels of pathogenic bacteria, protozoans, and viruses [U.S. Environmental Protection Agency, 2001b], in addition to elevated levels of fecal coliforms [Carter, 2002]. There are approximately 55 to 60 miles of sewer lines in Lead. Much of the existing sewer lines were constructed from clay tiles in the 1890s. Some of the clay tile sewer lines are in poor condition. Approximately 90 percent of the sewer lines in Deadwood have been replaced. The remaining 10 percent of the sewer lines that have not yet been replaced were constructed of clay tiles; however, the city of Deadwood plans to replace these remaining lines [Renner, 2002].

3.2.3 Natural Background/Wildlife

Wildlife within the watershed is a natural background source of fecal coliform bacteria. For watershed modeling purposes, wildlife population density estimates in Table 3-2 were obtained from the South Dakota Department of Game, Fish and Parks [1982]. Turkeys and whitetail deer were shown to be the most dense wildlife species in the Whitewood Creek Watershed. Avian species are a large source of fecal coliform counts at each watershed, throughout almost all types of flows. Through discussions at public meetings with ranchers in the area, it was determined that wild turkeys in the area were a probable source of fecal coliform. It was suggested that the number of wild turkeys in the watershed is large and the turkeys use the riparian areas adjacent to the stream.

Table 3-2. Approximate Wildlife Population Densities for Lawrence County in 2001

Species	Population Density (per mi^2)
Whitetail Deer	12.55
Turkeys	11.29
Mule Deer	3.76
Raccoons	1.25
Beaver	0.76
Elk	n/a
Ducks	n/a
Canadian Geese	n/a
Grouse	n/a

3.3 BACTERIAL SOURCE TRACKING

Bacteria samples (n = 257) were collected and analyzed in 2003 on a weekly basis from May 29 through September 10 for bacterial source tracking to determine sources of fecal coliform bacteria within the watershed. A ribotyping test was used to link bacteria from samples to known sources. Ribotyping uses a DNA fingerprint of *E. coli* which shows differences among members of the same species of *E. coli* that have adapted to live in different host species. Because of differences in the intestinal environments of different species, these genes can be used to distinguish animal sources.

The source tracking assessment was completed at three separate locations: Whitewood Creek above Gold Run, Gold Run Creek at the junction with Whitewood Creek, and Whitewood Creek below Deadwood. These locations are illustrated in Figure 3-1. Total fecal coliform values were highest at Whitewood Creek below Deadwood. Categories used for the assessment include wild animals (avian, bear, deer/elk, rabbit, raccoon, rodent), domestic animals (canine and feline), livestock (bovine and horse), and human.

Each of the three locations (Whitewood Creek above Gold Run, Whitewood Creek below Deadwood, and Gold Run Creek) was analyzed collectively and separately. Figure 3-2 shows the ribotyping results by category for all locations combined, and Table 3-3 shows the percent of contributions by source during all flows and high flows [Kenner, 2009].

Source tracking results from all flows and from high flows (Table 3-3) were fairly similar. Wild animals made up the majority of the bacterial counts, with numbers decreasing from source tracking results from all flows and from high flows (Table 3-3) were fairly similar. Wild

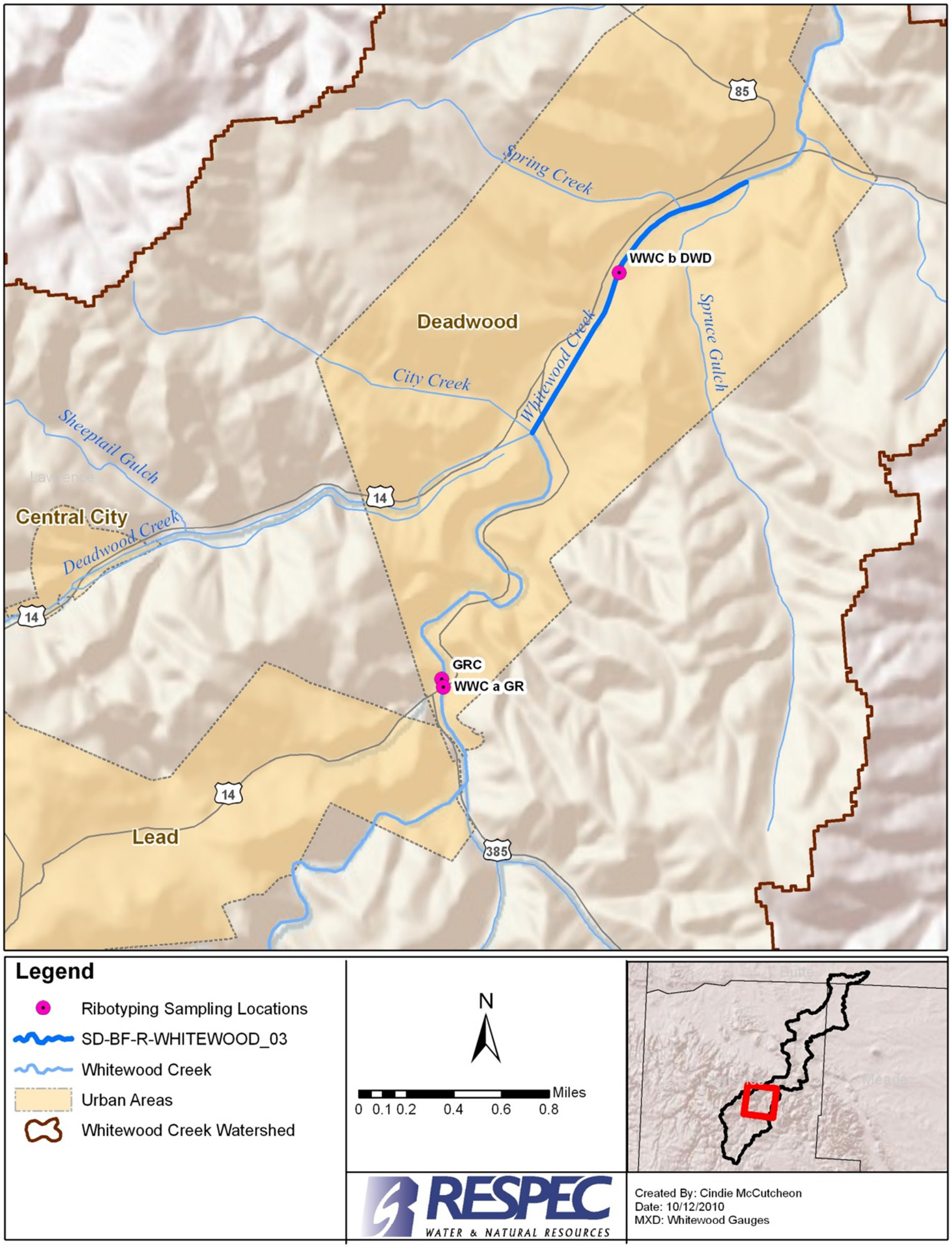

Figure 3-1. Ribotyping Locations.

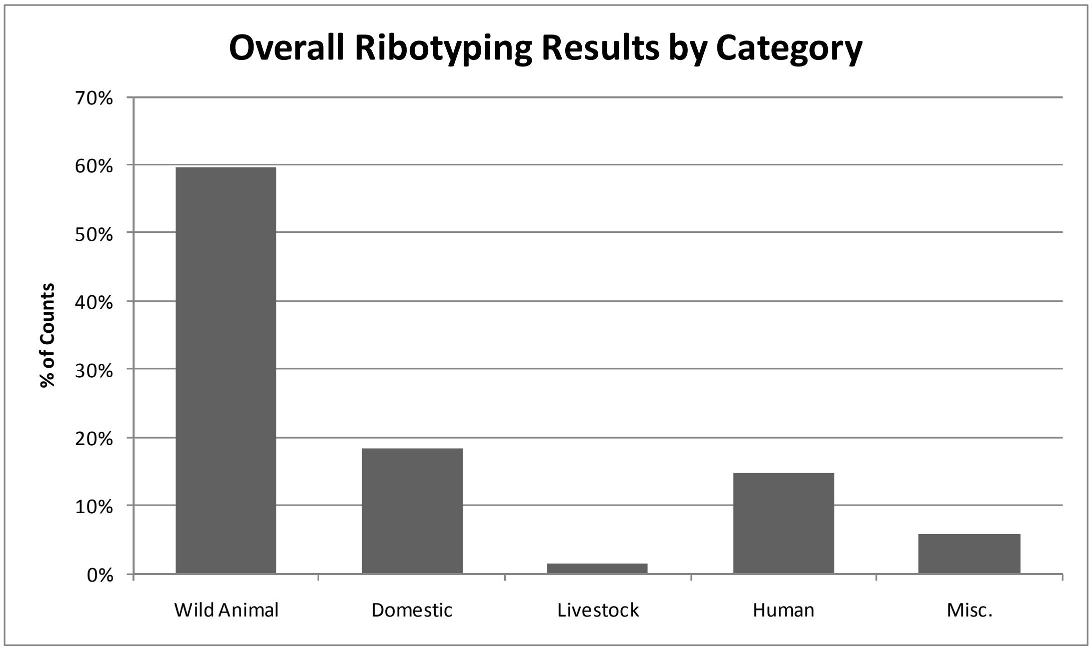

Figure 3-2. Ribotyping Results by Category for All Sampling Locations Combined.

Table 3-3. Total Fecal Coliform Contributions to Whitewood Creek From Each of Three Sampling Locations During All Flows and High Flows [Kenner, 2009]

Location	Source	Total Contribution (%) All Flows	Total Contribution (%) High Flows
Whitewood Creek above Gold Run	Agricultural livestock	2	0
	Domestic animals	15	19
	Wild animals	67	71
	Human	6	5
	Unknown	10	5
Gold Run Creek at the Junction with Whitewood Creek	Agricultural livestock	0	0
	Domestic animals	18	20
	Wild animals	63	65
	Human	13	15
	Unknown	5	0
Whitewood Creek below Deadwood	Agricultural livestock	3	0
	Domestic animals	20	24
	Wild animals	51	51
	Human	21	25
	Unknown	5	0

animals made up the majority of the bacterial counts, with numbers decreasing from upstream to downstream. Domestic animals and humans made up the second highest bacterial counts, with numbers increasing from upstream to downstream. Agricultural livestock made up the smallest percentages at all locations [Kenner, 2009]. These results seem logical, as population also increases from Whitewood Creek above Gold Run (the most upstream bacterial source tracking location), to Gold Run Creek at the junction with Whitewood Creek (influenced by Lead), to Whitewood Creek below Deadwood (influenced by Deadwood).

Source tracking results during high flows at the Whitewood Creek below Deadwood location, which is located within the impaired reach, had wild animals (avians, rodents, and a small amount of deer/elk) accounting for approximately half of the fecal coliform counts and domestic (canine) and human each accounting for a quarter of the counts [Kenner, 2009]. The percent of human counts from the site downstream of Lead and the site just above Lead were 10 and 20 percent lower, respectively, than counts from the site below Deadwood. The increase in human counts from the reach upstream of Lead to the reach downstream of Lead to the reach within and downstream of Deadwood may indicate that human sources in the impaired reach during high flows are not only from the Lead CSO and sewer lines, but could also be from sanitary sewer cross connections with Deadwood storm sewers and/or stormwater discharge from Deadwood, and/or washoff from overland flow.

3.4 HYDROLOGIC MODEL

The **HSPF** model application, developed by Carter for the years of 1991 through 1998, was used to simulate the sources of loads in the watershed. Direct sources modeled include the Lead/Deadwood WWTP, the CSO, leaking sewers and septic systems, and wildlife/livestock direct defecation. The permit for the CSOs does not have a set bacteria limit and requires ultimate elimination of the CSO. Indirect sources modeled throughout the watershed that were represented include washoff from urban/built-up land, rangeland, forestland, and agricultural land.

The **HSPF** model application was also used to simulate the implementation of BMPs and to evaluate their effectiveness in reducing bacteria loads in the Whitewood Creek Watershed. The nonpoint sources in the study area were represented in **HSPF** with per-acre fecal coliform accumulation rates and maximum fecal coliform storage rates for each source estimated by the **BIT**. The buildup and washoff of fecal coliform was simulated based on these rates, precipitation, and predicted runoff. The **BIT** was also used to calculate fecal coliform bacteria loadings that represent livestock in streams and human sources, which were then used as inputs to the **HSPF** model.

It was determined that the wasteload allocation for the Lead/Deadwood WWTP be based on its discharge permit; the fecal coliform concentration, geometric mean is to be less than 200 cfu/100 mL and the daily maximum is not to exceed 400 cfu/100 mL. Carter's **HSPF** model application used a wasteload allocation for the Lead/Deadwood WWTP of approximately 1×10^{11} cfu/day [Carter, 2002].

One of the two combined sewer outfalls was removed in 2001. However, because the modeling period was from 1991 to 1998 (before removal occurred), point sources were modeled to represent both outfalls. A BMP representing the removal of one outfall in 2001 was simulated to account for the removal of the outfall. Most overflows last 2 hours or less [Carter, 2002]. To create time series for both of the combined sewer outfalls, it was assumed that overflows only occurred in the months that they were reported. The precipitation records were reviewed and whenever the precipitation exceeded 0.33 inch in those months when overflows were reported, a discharge and fecal coliform load were added to the appropriate time series. When it was assumed that a discharge occurred, a daily flow of 0.39 cubic square feet (cfs) was added to the flow time series. This discharge rate represents an overflow of 250,000 gallons for that day. The fecal coliform loading for that day was assumed to be equal to the product of the discharge and the reported geometric mean of the fecal coliform samples collected and reported for that month. Based on these estimates, the combined sewer outfall that discharges to Gold Run Creek overflowed 148 times from 1991 to 1998. The outfall that discharged to Whitewood Creek overflowed 39 times.

The fecal coliform model inputs were adjusted from Carter's initial estimates to match observed fecal coliform concentrations at five monitoring locations upstream of the TMDL endpoint. The inputs were classified as either indirect or direct sources and adjusted simultaneously within their respective classes. This method allowed for the original estimates to maintain their weight in their respective classes while also allowing flexibility to accurately represent indirect and direct sources. The model performance was evaluated visually using concentration duration curves which show the statistical distribution of the observed data compared to all simulated and paired simulated data, as shown in Figure 3-3 through Figure 3-7. The duration curves also show the water-quality standard which compares the observed and simulated exceedance percentages. Overall, the figures show the model performed very well and adequately represents direct and indirect sources accurately.

Figure 3-8 shows boxplots of sites in the vicinity of the impaired reach from upstream to downstream which were constructed for water-quality monitoring sites using only data from the Carter's modeling period (1991 through 1998). The main difference between these boxplots and the 2003 through 2009 boxplots presented in Section 1.3 is a large increase at the West Strawberry Creek site. The West Strawberry Creek loads are likely negligible within the impaired reach because of decay and dilution. A pie chart of the load influences above Deadwood and at the TMDL reach endpoint, presented in Figure 3-9, shows that only 1 percent of the load in the impaired reach comes from upstream of the impaired reach. Three percent of the loads at the TMDL reach endpoint are from Deadwood Creek, and the remainder of the load at the TMDL endpoint is from the Deadwood Area. Flow contributions from upstream of the impaired reach are approximately 50 percent of the total flow, and flow contributions from the Deadwood Area are approximately 30 percent of the total flow. Because the impaired reach receives over one-third of the flow contribution from the Deadwood area having observed concentrations of more than seven times any upstream observed concentrations, there is reasonable assurance that the Whitewood Creek model predictions, which show that 96 percent of the loads being from the Deadwood area, adequately represents BMP reductions.

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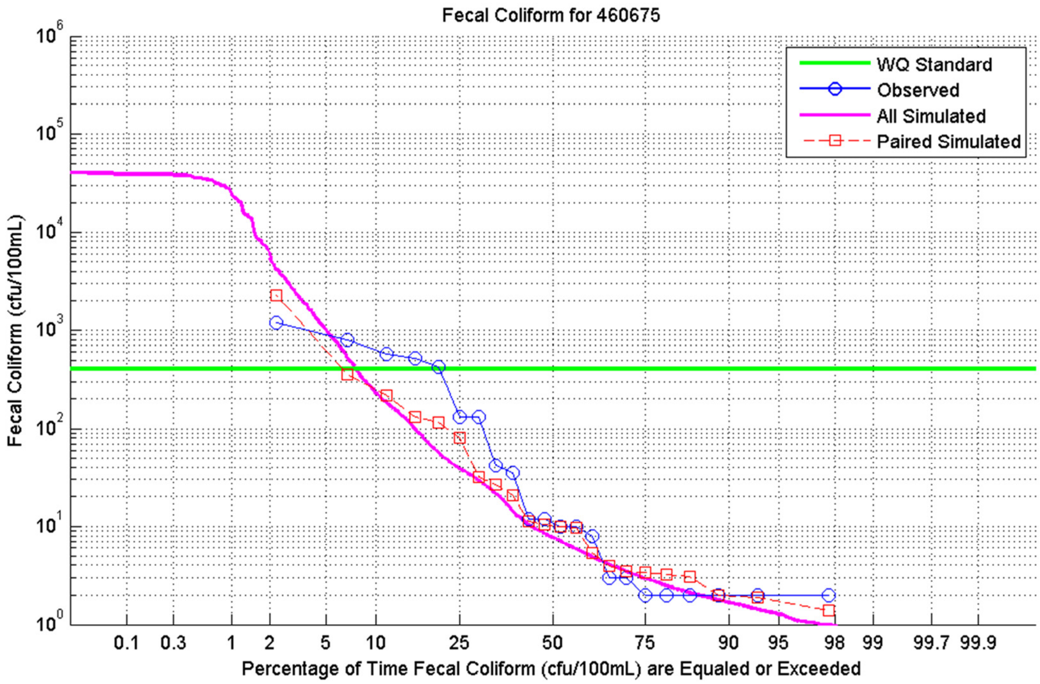

Figure 3-3. Concentration Duration Curve for West Strawberry Creek (460675).

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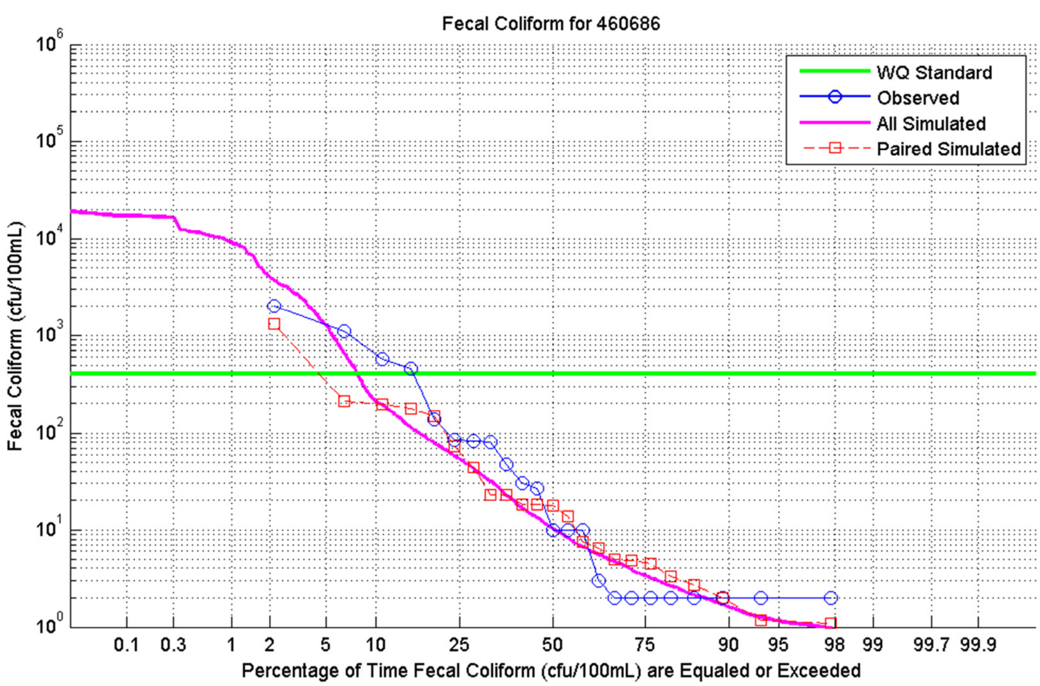

Figure 3-4. Concentration Duration Curve for Whitewood Creek Above Gold Run (460686).

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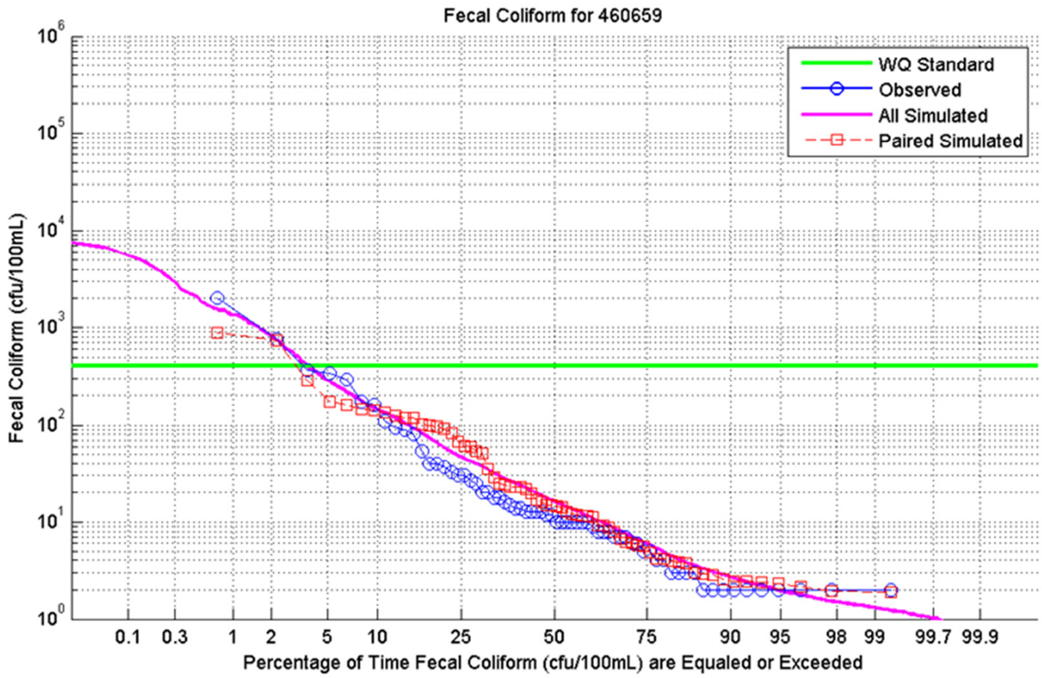

Figure 3-5. Concentration Duration Curve for Gold Run Creek (460659).

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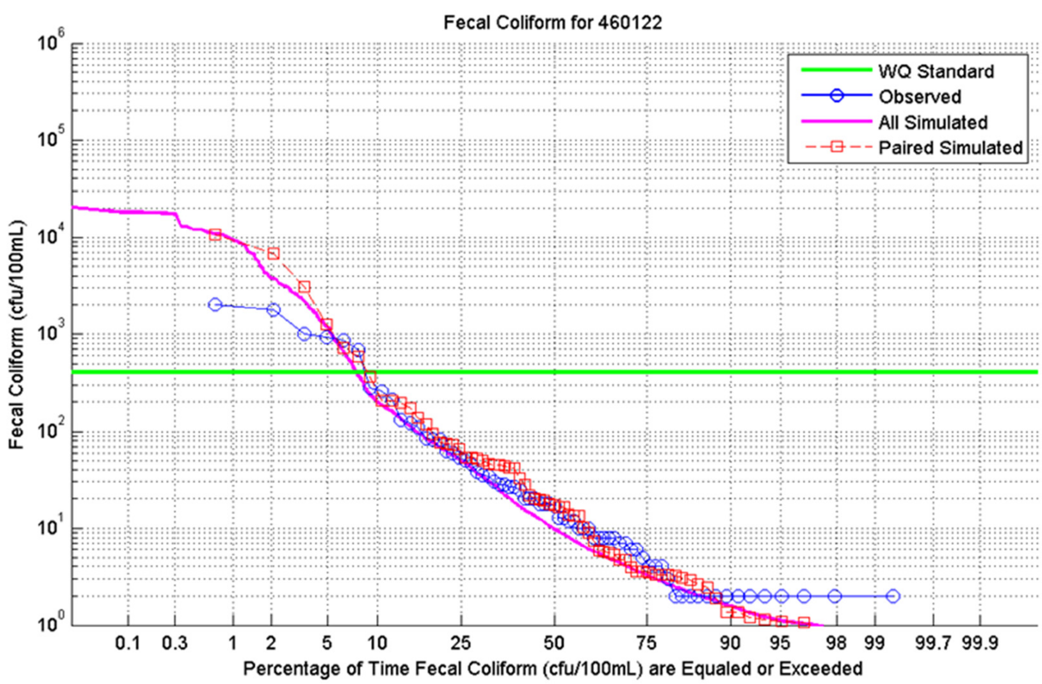


Figure 3-6. Concentration Duration Curve for Whitewood Creek Near Deadwood (460122).

RSI-1870-11-030

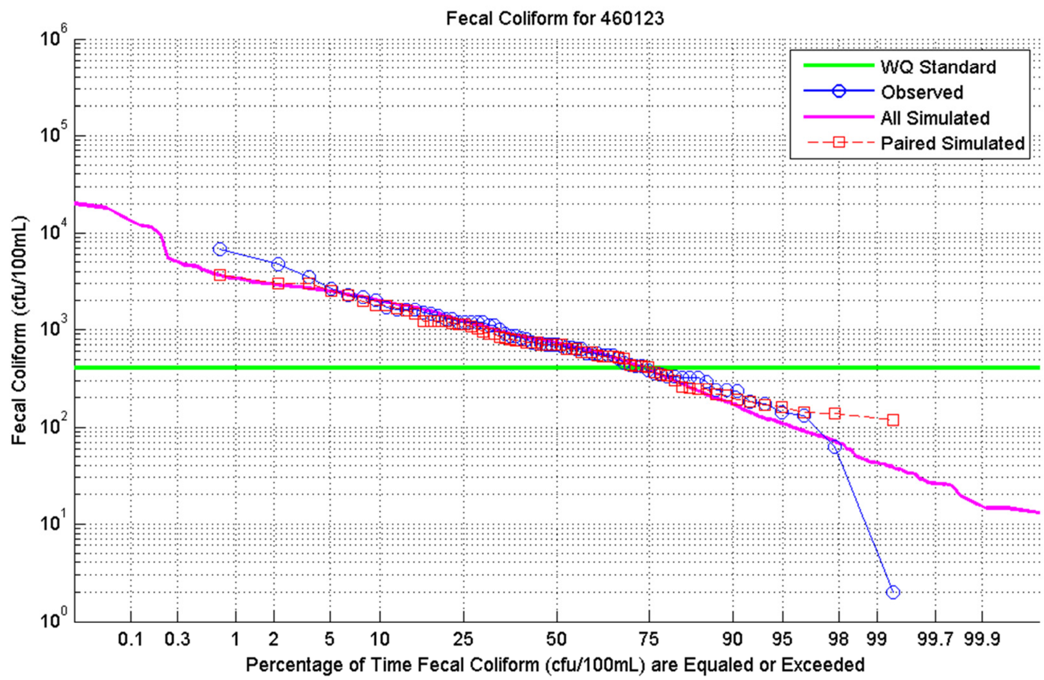
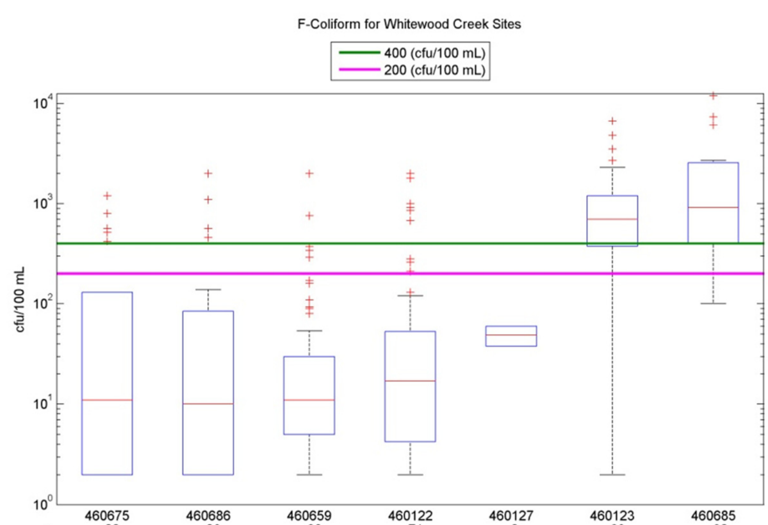


Figure 3-7. Concentration Duration Curve for Whitewood Creek Below Deadwood (460123).

RSI-1870-11-031



	460675	460686	460659	460122	460127	460123	460685
n	22	23	68	71	2	69	32
Min	2	2	2	2	38	2	100
Max	1200	2000	2000	2000	60	6700	12000
q1	2	2	5	4.25	38	375	410
Median	11	10	11	17	49	700	920
q3	130	84.5	30	53	60	1200	2550
Mean	178	203	76.12	133.6	49	997.9	2250.6
90th%	2	2	2	2	38	139.5	205
95th%	960	1415	343	917	60	2740	7400
% Exceeded	23	17	2.9	8.5	0	74	75
Geo30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
%Excd	0	0	0	0	0	0	0
Geo30 n							

Figure 3-8. Boxplots of 1991 through 1998 (Modeling Period) Fecal Coliform Data for Sites Upstream, Within, and Downstream of the Impaired Reach.

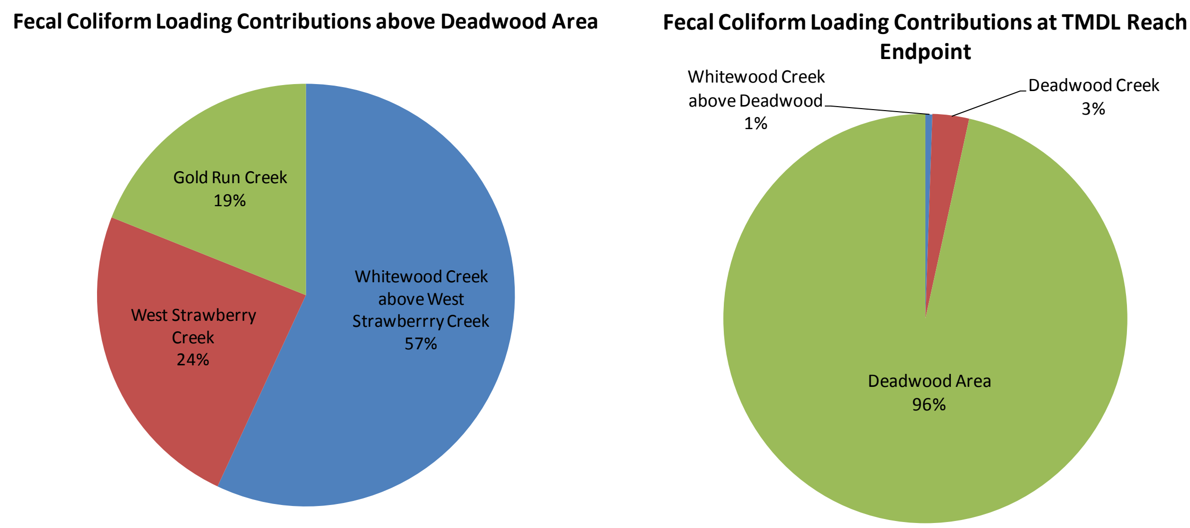


Figure 3-9. Pie Charts of Fecal Coliform Load Contributions Upstream of the Deadwood Area (Left) and at the Endpoint of the Impaired TMDL Reach (Right).

The city of Lead has already explored several options for treating the overflows from the combined sewer. To alleviate the problems associated with the combined sewer overflow, the city has decided to separate the sanitary and storm sewers. Approximately 40 percent of the sewer lines have already been separated [Thomas, 2010]. As the combined sewer is separated, the existing clay tile sewer lines will also be replaced [Carr, 2002]. During the separation process, urban stormwater-quality control measures should be implemented. Urban stormwater management systems, such as storm sewers, ponds, and detention basins, are commonly used for pollutant reduction as well as flood control. To simulate this remediation effort, the point sources representing the combined sewer overflow in Lead were turned off in the model application, which resulted in a 17 percent load reduction.

To simulate the removal of failing on-site wastewater treatment systems and leaking sewer lines, it was assumed that approximately half of the failing on-site wastewater treatment systems and leaking sewer lines could be located and repaired or replaced. The removal of 50 percent of failing on-site wastewater treatment systems and leaking sewer lines resulted in a 38 percent load reduction.

It was assumed that a stormwater treatment program would be effective within the cities, so the effectiveness of these programs was only simulated for the urban land downstream of Gold Run Creek and Lead. To evaluate the effectiveness of these practices, the fecal coliform accumulation rates for the commercial and services, mixed urban or built-up, and residential land uses were reduced by 50 percent. The implementation of stormwater treatment in the model reduced loads by 6 percent.

The simulation of buffer/filter strips, avian control; direct defecation reduction; and overland load reduction from forest, pasture, and cropland was estimated to have a 50 percent efficiency on reducing bacteria loads from overland washoff and in-stream defecation. To simulate this BMP, the overland bacteria load and the load from in-stream defecation was reduced by 50 percent. The implementation of buffer/filter strips; avian control; direct defecation reduction; and overland load reduction from forest, pasture, and cropland in the model reduced the load by 2 percent.

4.0 LOAD DURATION CURVE ANALYSIS

This TMDL was developed using the Load Duration Curve (LDC) approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1–September 30). The LDC is a dynamic expression of the allowable load for any given flow within the recreation season. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10 percent), moist conditions (10–40 percent), midrange flows (40–60 percent), dry conditions (60–90 percent), and low flows (90–100 percent) according to the U.S. Environmental Protection Agency [2007].

Instantaneous loads were calculated by multiplying the fecal coliform sample concentrations from SD DENR WQM 123 by the measured flow at the time the water sample was collected and by a unit conversion factor (0.0245) which converts the product of concentration and flow to a daily cfu load (product of flow cfs), concentration (cfu/100 mL), 86,400 seconds per day (sec/day), 28.32 liters per cubic feet (L/ft^3), and 1,000 milliliters per liter (mL/L). Recent flow data were not available for the closest USGS station (USGS 06436170); thus, a regression analysis was completed comparing flow at a downstream location (USGS 06436180). The analysis correlation between the two locations was determined to be significant ($r^2 = 0.88$ and $p < 0.05$) with no lag time between stations; therefore, discharge values from the downstream location were used with the regression equation (upstream station = downstream station × 0.8265 + 3.1156) to calculate the flow near Deadwood. These calculated discharge values for the upstream location were used for the upstream load calculation.

Two bacteria LDCs were constructed for the impaired reach using data from 1991 through 2009. The first LDC (constructed using the acute criteria), shown in Figure 4-1, used observed bacteria data and observed flow data from within the reach (Figure 4-1). This plot includes observed loads calculated using observed instantaneous daily bacteria data and observed instantaneous daily flow data from monitoring stations. The second LDC (constructed using geometric mean criteria), illustrated in Figure 4-2, for the impaired reach used simulated geometric mean bacteria data and observed geometric mean flow data.

Loads that plot above the solid curve exceed the acute water-quality criterion while loads below the curve are in compliance. Both LDCs show fecal coliform samples collected from Whitewood Creek WQM 123 exceeding the criterion during high, moist, midrange, dry, and low flow conditions. Loads exceeding the criteria in the low flow zone indicate point source load contributions or sources near the stream, such as failing on-site wastewater treatment systems or livestock in the stream channel. Loads within the high flow and moist conditions commonly indicate potential nonpoint source contributions from stormwater runoff [U.S. Environmental Protection Agency, 2007]. The LDCs shown in Figures 4-1 and Figure 4-2 represent dynamic expressions of the fecal coliform bacteria TMDLs for the impaired reach of Whitewood Creek that are based on the acute and chronic fecal coliform criterion. These LDCs result in unique loads that correspond to average daily flows.

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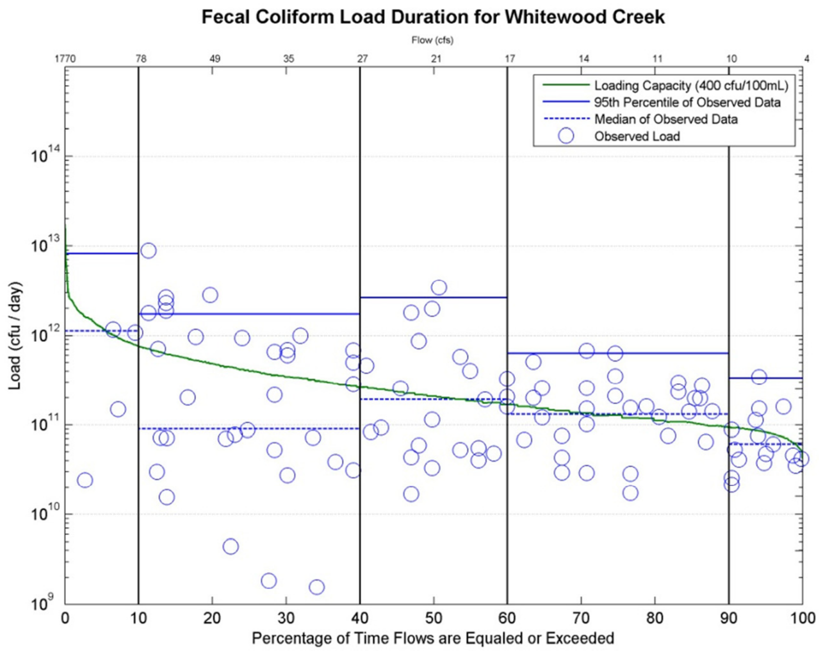

Figure 4-1. Load Duration Curve Representing Allowable Loads of Daily Fecal Coliform Based on Acute Fecal Coliform Criteria (≤ 400 cfu/100 mL) and Calculated Stream Flow From May to September.

RSI-1870-11-034

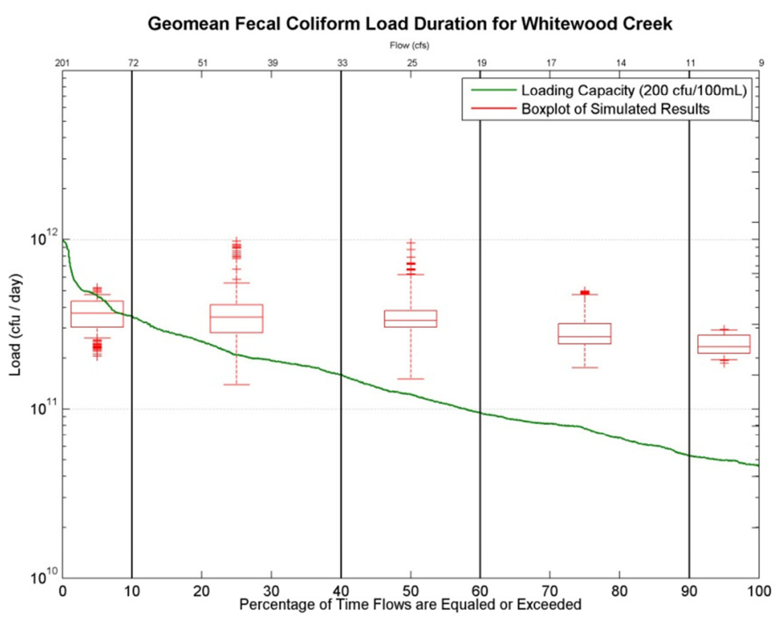

Figure 4-2. Load Duration Curve Representing Allowable Loads of Geometric Mean Fecal Coliform Based on Chronic Fecal Coliform Criteria (≤ 200 cfu/100 mL) and Calculated Stream Flow From May to September.

5.0 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

To ensure that all applicable fecal coliform criteria are met and aid in the implementation of the TMDL, load allocations were calculated for each of the five flow zones using both the acute and chronic criteria. The criterion requiring the greatest load reduction from baseline conditions, which varies by flow zone, was used to establish the TMDL allocations. Methods used to calculate the TMDL allocations are discussed in more detail below.

The TMDL is in effect from May 1 through September 30, as the fecal coliform criteria are applicable only during this period. In addition, only data from this time period were used to develop the TMDL allocations and load reduction goals.

5.1 LOAD ALLOCATION

To develop the fecal coliform bacteria load allocation (LA), the loading capacity was first determined. Both the acute criterion (400 cfu/100 mL) and the chronic criterion (200 cfu/ 100 mL) were used for the calculation of the loading capacity. The loading capacity for Whitewood Creek based on the acute criterion was calculated by multiplying the acute fecal coliform bacteria criterion by the calculated USGS daily average flow. The loading capacity based on the chronic criterion was calculated by multiplying the chronic criterion by the monthly average USGS flows.

For each of the five flow zones, the 95th percentile of the range of loading capacities within a zone was set as the flow zone goal. Bacteria loads experienced during the largest stream flows (e.g., top 5 percent) cannot be feasibly controlled by practical management practices. Thus setting the flow zone goal at the 95th percentile of the range of loading capacities will protect the immersion recreation beneficial use and allow for the natural variability of the system.

The TMDL (and loading capacity) is the sum of waste load allocation (WLA), LA, and margin of safety (MOS). Portions of the loading capacity were allocated to nonpoint sources as an LA, WLA, and MOS to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed in Section 6.1. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was, therefore, determined by multiplying the WWTP average design flow by 200 cfu/100 mL for the geometric mean TMDL and by 400 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. The overall LA was determined by subtracting the WLA and the MOS from the loading capacity. Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero.

5.2 BASELINE CONDITIONS

Measured sample concentrations and flow data were used to compute current daily loads (cfu × 10^9/day) by calculating the product of fecal coliform sample concentrations (cfu/100 mL) from SD DENR WQM 123, the calculated average daily flow (cfs), and a unit conversion factor (0.0245). Observed load estimates were calculated for WQM 123 from 1991 through 2009. The 95th percentile of the range of these estimates within each flow zone was defined as the baseline daily load.

Baseline conditions for the 30-day geometric mean period were calculated similarly to the daily averaging period. The monthly fecal coliform geometric mean loads (cfu × 10^9/month) were estimated by calculating the products of the geometric mean simulated fecal coliform concentrations (cfu/100 mL), the calculated geometric mean of average daily stream flows (cfs), and a unit conversion factor (0.0245). The 95th percentile of the range of these estimates within each flow zone was defined as the baseline geometric mean load.

Table 5-1 presents allocations and load reductions required based on the acute criterion for each flow zone, showing that load reductions are required for every flow zone except the high flow zone to meet the acute criterion. Table 5-2 lists monthly allocations based on the chronic criterion, showing that load reductions of the monthly mean loads are required for every flow zone except the high flow zone to meet the chronic criterion. The moist and midrange flow zone allocations based on the acute criterion require slightly greater reductions than the allocations based on the chronic criterion, while the dry and low flow zone allocations based on the chronic criterion require greater reductions than the allocations based on the acute criterion. Thus the allocations listed for the moist and midrange flow zones in Table 5-1 (acute criterion) and the allocations listed for high, dry, and low flow zones in Table 5-2 (chronic criterion) represent the TMDL goals to attain compliance with water-quality standards.

5.3 WASTE LOAD ALLOCATION

One point source (Deadwood WWTP) of fecal coliform bacteria discharges directly to the impaired segment of Whitewood Creek, so the WLA was assigned values 3.79 × 10^{10} cfu/day for the daily maximum TMDL value and 1.89 × 10^{10} cfu/day for the geometric mean TMDL value, which was calculated using the maximum permitted daily maximum and geometric mean concentrations from the point source during the effective criterion period. The Lead/Deadwood WWTP has reported flows of 2.5 mgd. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was, therefore, determined by multiplying the WWTP reported flows by 200 cfu/100 mL for the geometric mean TMDL and by 400 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. A WLA for the Lead CSO was set to zero because the Lead CSO permit requires its elimination. No permitted concentrated animal feeding operations currently exist within the Whitewood Creek Watershed.

Table 5-1. Whitewood Creek Fecal Coliform Bacteria Total Maximum Daily Load Based on the Acute Criterion

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 78 cfs	77–27 cfs	26–17 cfs	16–10 cfs	9–4 cfs
LA	2,450	520	182	89	15
WLA	38	38	38	38	38
MOS	455	136	38	33	41
TMDL	2,943	694	257	160	94
Current Load[(a)]	1,170	2,802	2,492	636	289
Load Reduction	0	2,108	2,235	476	195
Load Reduction	0%	75%	90%	75%	68%

(a) Current load is the 95th percentile of the observed fecal coliform bacteria load for each flow zone.

Table 5-2. Whitewood Creek Fecal Coliform Bacteria Total Maximum Daily Load Based on the Chronic Criterion

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	>73 cfs	71–33 cfs	31–19 cfs	18–11 cfs	9–9 cfs
LA	818	259	107	50	30
WLA	19	19	19	19	19
MOS	111	49	27	24	4
TMDL	948	327	153	92	52
Current Load[(a)]	481	571	624	476	292
Load Reduction	0	244	471	384	239
Load Reduction	0%	43%	76%	81%	82%

(a) Current load is the 95th percentile of the simulated geometric mean fecal coliform bacteria load for each flow zone.

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 MARGIN OF SAFETY

An explicit MOS identified using a duration curve framework is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit MOS was calculated as the difference between the loading capacity at the midpoint of each of the five flow zones and the loading capacity at the minimum flow in each zone. A substantial MOS is provided using this method because the loading capacity is typically much less at the minimum flow of a zone as compared to the midpoint. Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS.

6.2 SEASONALITY

Stream flows and fecal coliform concentrations in Whitewood Creek displayed seasonal variation. Available recreational season daily (actual and calculated) flow and fecal coliform data were used to calculate the maximum and minimum average monthly flows and bacteria concentrations for the impaired reach and are shown in Table 6-1. Monthly average stream flows ranged considerably, with the lowest monthly average stream flow occurring in September (14 cfs) and the highest monthly average stream flow occurring in May (84 cfs). A large range of fecal coliform concentrations also occurred, with the lowest monthly average recreational season fecal coliform concentration occurring in May (418 cfu/100 mL) and the highest recreational season monthly average fecal coliform concentration occurring in July (1,140 cfu/100 mL).

Table 6-1. Whitewood Creek Average Monthly Recreational Season Flows and Fecal Coliform Concentrations

Month	Average Monthly Fecal Coliform Concentration (cfu/100 mL)	Average Monthly Flow (cfs)
May	417.7	83.7
June	625.4	52.1
July	1,139.9	21.3
August	739.4	15.9
September	548.2	13.7

The highest bacteria concentrations generally occur during the midsummer months. Short-duration, high-intensity rainstorms are common during the summer months. These localized summer storms can cause significant runoff and increased bacteria concentrations for a relatively short period of time while only slightly increasing stream flows. However, by using the LDC approach to develop TMDL allocations, seasonal variability in flow and fecal coliform loads is taken into account, as stream flow and bacteria delivery to the stream is related to seasonal changes in precipitation.

In addition, this fecal coliform TMDL is seasonal, as it is effective only during the period of May 1 through September 30. Since the criteria for fecal coliform concentrations are in effect from May 1 through September 30, the TMDL is also applicable only during this time period.

Critical conditions occur during the midrange flow conditions as the greatest load reductions are required during this flow regime. Summer is also a critical time period because of seasonal differences in precipitation patterns and land uses. Typically, livestock are allowed to graze along the streams during the summer months. Also, Black Hills tourism peaks during the summer months. Combined with the peak in bacteria sources, high-intensity rainstorm events are common during the summer and produce a significant amount of fecal coliform load because of bacterial washoff from the watershed. Similarly, loads from the CSO would be at their peak during summer months.

7.0 PUBLIC PARTICIPATION

Efforts taken to gain public education, review, and comment during development of the Whitewood Creek fecal coliform bacteria TMDL involved presentations to local groups in the watershed on the findings of the assessment and a 30-day public notice period for public review and comment. The findings from these public meetings and comments were taken into consideration in development of the TMDL. The public notice was published in the *Meade County Times-Tribune*, the *Rapid City Journal*, and the *Lawrence County Journal*. The document was made available through the SD DENR's website.

It was desired to hold informational meetings, provide news releases on a quarterly basis for the public, and inform the involved parties of progress on the study. Public meetings were held at Herford, Sturgis, Belle Fourche, Newell, Vale, and Spearfish in 2002. In addition, the project information and results were presented at various conservation district meetings (Butte, Lawrence, and Elk Creek). A special stakeholders meeting was also held to discuss the number of cattle below Lead and Deadwood.

8.0 MONITORING STRATEGY

During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDL. Stream water-quality monitoring will be accomplished through SD DENR's WQM 123 on Whitewood Creek, which is sampled on a monthly basis during the effective criteria period.

Additional monitoring and evaluation efforts should be targeted toward the effectiveness of implemented BMPs. Monitoring locations should be based on the location and type of BMPs installed.

SD DENR may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that develop during the implementation phase of the TMDL. New information generated during TMDL implementation may include monitoring data, BMP effectiveness information, and land use information. SD DENR will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity. The adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable water-quality standards, and any adjusted WLA will be supported by a demonstration that load allocations are practicable. SD DENR will notify EPA of any adjustments to this TMDL within 30 days of their adoption. Adjustment of the LA and WLA will only be made following an opportunity for public participation.

9.0 RESTORATION STRATEGY

A variety of BMPs could be considered in the development of a water-quality management implementation plan for the impaired portion of the Whitewood Creek Watershed. While several types of control measures are available for reducing fecal coliform bacteria loads, the practicable control measures listed and discussed below are recommended to address the identified sources. Based on water-quality monitoring, bacterial source tracking, and **HSPF** model results, there is reasonable assurance that the recommended control measures to be implemented in South Dakota will achieve the required load reductions and attain the TMDL goal.

The combined flow-weighted percent reductions required to meet the TMDL based on acute and chronic water-quality criterion were 44 and 36 percent, respectively. Required percent reductions for the five flow zones, either acute or chronic, ranged from 0 percent for the acute high flow zone to 90 percent for the acute midrange flow zone (Table 5-1 and 5-2). In addition to the TMDL prepared, the following BMPs were simulated within the **HSPF** model framework:

- Complete replacement of the CSO system in Lead, South Dakota.
- Reduction of on-site wastewater treatment system failures and leaking sewer lines.
- Stormwater treatment/urban litter control programs for urban areas.
- Riparian buffers and filter strips; avian management practices; reduction of direct defecation; and reduction of overland load from forest, pasture, and cropland.

The combination of these BMPs showed a 63 percent reduction of the daily load. Therefore, there is reasonable assurance that the TMDL can be attained considering inherent modeling error and the applied MOS. Implementation progress to date includes 40 percent replacement of the CSO system in Lead, South Dakota [Thomas, 2010] and replacement of over 90 percent of sewer lines in Deadwood [Renner, 2002]. Completion of the CSO replacement project is a part of a 10-year plan [Thomas, 2010].

The calibration results of the **HSPF** model application showed higher fecal coliform concentrations in low flows which indicates an influence from direct sources. Direct sources contribute to the bacteria loading similarly at all flows, causing higher concentrations during low flows. The direct sources in the Whitewood Creek Watershed above the TMDL endpoint primarily include septic system failures and leaking sewer lines. Indirect sources require high runoff to influence in-stream fecal coliform loads. High amounts of runoff also cause higher stream flows which result in lower concentrations. The indirect sources in the Whitewood Creek Watershed include landscape fecal coliform accumulation and washoff from wildlife and livestock. The model BMP simulation indicates that complete removal of the CSO, reduction of on-site wastewater treatment facilities and leaking sewer lines, and a Deadwood stormwater treatment/urban litter control program should be the primary target for future BMP implementation. It is recommended that an in-depth BMP scenario analysis be performed before developing a future BMP implementation plan.

There is reasonable assurance that the goals of this TMDL established for Whitewood Creek can be met with proper planning between state and local regulatory agencies, organizations, and stakeholders; BMP implementation; and access to adequate financial resources. Funds to implement watershed water-quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low-interest loans and grants for projects that protect and improve water quality in South Dakota, including Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Nonpoint Source program.

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APPENDIX A

BACTERIA SAMPLE DATA

APPENDIX A
BACTERIA SAMPLE DATA

Table A-1. Water-Quality Monitoring Station 123 Fecal Coliform Data (Page 1 of 5)

Type (cfu/100 mL)	Date	Fecal Coliform (cfu/100 mL)	Exceedance (E/NE)
Fecal Coliform	04/08/1991	1,500	E
Fecal Coliform	05/06/1991	700	E
Fecal Coliform	06/11/1991	430	E
Fecal Coliform	07/09/1991	6,700	E
Fecal Coliform	08/12/1991	2,000	E
Fecal Coliform	09/09/1991	180	NE
Fecal Coliform	10/16/1991	2	NE
Fecal Coliform	11/12/1991	320	NE
Fecal Coliform	12/09/1991	140	NE
Fecal Coliform	01/14/1992	1,200	E
Fecal Coliform	02/04/1992	660	E
Fecal Coliform	03/11/1992	2,700	E
Fecal Coliform	04/13/1992	540	E
Fecal Coliform	05/18/1992	440	E
Fecal Coliform	06/08/1992	1,100	E
Fecal Coliform	07/20/1992	550	E
Fecal Coliform	08/10/1992	580	E
Fecal Coliform	09/14/1992	710	E
Fecal Coliform	10/13/1992	4,800	E
Fecal Coliform	11/09/1992	2,200	E
Fecal Coliform	12/07/1992	740	E
Fecal Coliform	01/20/1993	580	E
Fecal Coliform	02/09/1993	1,600	E

Table A-1. Water-Quality Monitoring Station 123 Fecal Coliform Data (Page 2 of 5)

Type (cfu/100 mL)	Date	Fecal Coliform (cfu/100 mL)	Exceedance (E/NE)
Fecal Coliform	03/08/1993	1,200	E
Fecal Coliform	04/14/1993	240	NE
Fecal Coliform	05/26/1993	1,200	E
Fecal Coliform	06/15/1993	550	E
Fecal Coliform	07/21/1993	1,460	E
Fecal Coliform	08/16/1993	510	E
Fecal Coliform	09/22/1993	660	E
Fecal Coliform	10/25/1993	320	NE
Fecal Coliform	11/10/1993	710	E
Fecal Coliform	12/08/1993	1,300	E
Fecal Coliform	01/10/1994	330	NE
Fecal Coliform	02/14/1994	640	E
Fecal Coliform	03/24/1994	330	NE
Fecal Coliform	04/18/1994	360	NE
Fecal Coliform	05/16/1994	1,700	E
Fecal Coliform	06/20/1994	1,300	E
Fecal Coliform	07/20/1994	1,100	E
Fecal Coliform	08/16/1994	870	E
Fecal Coliform	09/12/1994	1,600	E
Fecal Coliform	10/24/1994	170	NE
Fecal Coliform	11/08/1994	290	NE
Fecal Coliform	12/13/1994	1,400	E
Fecal Coliform	01/10/1995	3,500	E
Fecal Coliform	02/22/1995	350	NE
Fecal Coliform	03/14/1995	680	E
Fecal Coliform	04/19/1995	460	E

Table A-1. Water-Quality Monitoring Station 123 Fecal Coliform Data (Page 3 of 5)

Type (cfu/100 mL)	Date	Fecal Coliform (cfu/100 mL)	Exceedance (E/NE)
Fecal Coliform	05/03/1995	1,200	E
Fecal Coliform	06/27/1995	730	E
Fecal Coliform	07/18/1995	240	NE
Fecal Coliform	08/28/1995	870	E
Fecal Coliform	09/27/1995	230	NE
Fecal Coliform	05/16/1996	1,000	E
Fecal Coliform	06/18/1996	900	E
Fecal Coliform	07/29/1996	1,200	E
Fecal Coliform	08/20/1996	380	NE
Fecal Coliform	09/17/1996	320	NE
Fecal Coliform	05/27/1997	63	NE
Fecal Coliform	06/25/1997	730	E
Fecal Coliform	07/21/1997	2,300	E
Fecal Coliform	08/18/1997	420	E
Fecal Coliform	09/23/1997	1,600	E
Fecal Coliform	05/12/1998	800	E
Fecal Coliform	06/16/1998	130	NE
Fecal Coliform	07/14/1998	1,000	E
Fecal Coliform	08/18/1998	700	E
Fecal Coliform	09/22/1998	440	E
Fecal Coliform	05/26/1999	145	NE
Fecal Coliform	06/22/1999	5,000	E
Fecal Coliform	07/20/1999	730	E
Fecal Coliform	08/03/1999	3,800	E
Fecal Coliform	09/20/1999	490	E
Fecal Coliform	05/15/2000	10	NE

Table A-1. Water-Quality Monitoring Station 123 Fecal Coliform Data (Page 4 of 5)

Type (cfu/100 mL)	Date	Fecal Coliform (cfu/100 mL)	Exceedance (E/NE)
Fecal Coliform	06/06/2000	90	NE
Fecal Coliform	07/11/2000	3,200	E
Fecal Coliform	08/14/2000	86	NE
Fecal Coliform	09/19/2000	2,000	E
Fecal Coliform	05/15/2001	46	NE
Fecal Coliform	06/11/2001	220	NE
Fecal Coliform	07/18/2001	780	E
Fecal Coliform	08/16/2001	760	E
Fecal Coliform	09/17/2001	440	E
Fecal Coliform	05/13/2002	30	NE
Fecal Coliform	06/17/2002	260	NE
Fecal Coliform	07/15/2002	290	NE
Fecal Coliform	08/22/2002	520	E
Fecal Coliform	09/23/2002	170	NE
Fecal Coliform	05/07/2003	2	NE
Fecal Coliform	06/03/2003	2	NE
Fecal Coliform	07/08/2003	120	NE
Fecal Coliform	08/20/2003	680	E
Fecal Coliform	09/15/2003	110	NE
Fecal Coliform	05/11/2004	58	NE
Fecal Coliform	06/07/2004	92	NE
Fecal Coliform	07/13/2004	780	E
Fecal Coliform	08/19/2004	230	NE
Fecal Coliform	09/13/2004	320	NE
Fecal Coliform	05/23/2005	54	NE

Table A-1. Water-Quality Monitoring Station 123 Fecal Coliform Data (Page 5 of 5)

Type (cfu/100 mL)	Date	Fecal Coliform (cfu/100 mL)	Exceedance (E/NE)
Fecal Coliform	06/20/2005	110	NE
Fecal Coliform	07/12/2005	380	NE
Fecal Coliform	08/25/2005	350	NE
Fecal Coliform	09/20/2005	230	NE
Fecal Coliform	05/16/2006	460	E
Fecal Coliform	06/19/2006	88	NE
Fecal Coliform	07/25/2006	520	E
Fecal Coliform	08/21/2006	180	NE
Fecal Coliform	09/19/2006	300	NE
Fecal Coliform	05/10/2007	18	NE
Fecal Coliform	06/19/2007	72	NE
Fecal Coliform	07/12/2007	120	NE
Fecal Coliform	08/14/2007	880	E
Fecal Coliform	09/12/2007	310	NE
Fecal Coliform	05/13/2008	6	NE
Fecal Coliform	06/17/2008	46	NE
Fecal Coliform	07/15/2008	78	NE
Fecal Coliform	08/20/2008	82	NE
Fecal Coliform	09/23/2008	96	NE
Fecal Coliform	05/20/2009	4	NE
Fecal Coliform	06/23/2009	32	NE
Fecal Coliform	07/20/2009	110	NE
Fecal Coliform	08/20/2009	150	NE
Fecal Coliform	09/10/2009	210	NE

APPENDIX B

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII TOTAL MAXIMUM DAILY LOAD REVIEW

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**Fecal Coliform Total Maximum Daily Load for Whitewood Creek, Lawrence County, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**August 25, 2010**
Review Date:	**September 9, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final review only):

- ☐ Approve
- ☐ Partial Approval
- ☐ Disapprove
- ☐ Insufficient Information

Approval Notes to Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   - 1.1. TMDL Document Submittal Letter
   - 1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   - 1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   - 4.1. Data Set Description
   - 4.2. Waste Load Allocations (WLA)
   - 4.3. Load Allocations (LA)
   - 4.4. Margin of Safety (MOS)
   - 4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's minimum submission requirements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in the minimum submission requirements denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review template is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal Letter

When a TMDL document is submitted to EPA requesting formal comments or a final review and approval, the submittal package should include a letter identifying the document being submitted and the purpose of the submission.

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek fecal coliform TMDL was submitted to EPA for review during the public notice period via an email from Cheryl Saunders, SD DENR on August 25, 2010. The email included the draft TMDL document and a public notice announcement requesting review and comment.

COMMENTS: None

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Minimum Submission Requirements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map.

☐ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek is a stream located in the Black Hills of western South Dakota. Its headwaters are located near the base of Deer Mountain and it ends at the confluence with the Belle Fourche River near Vale, SD. Whitewood Creek has a contributing drainage area of approximately 105 square miles. It flows to the Belle Fourche River from the Lower Belle Fourche sub-basin (HUC 10120202). The impaired segment of Whitewood Creek begins at Deadwood Creek and ends at Spruce Gulch (1.8 miles; SD-BF-R-WHITEWOOD_03), and is listed as a medium priority for TMDL development.

This segment is identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated fecal coliform and *E. coli* concentrations. The *E. coli* impairment will be addressed in a separate TMDL document.

The designated uses for the listed segment of Whitewood Creek include: coldwater permanent fish life propagation waters, immersion recreation waters, limited-contact recreation waters, irrigation waters, fish and wildlife propagation, recreation, and stock watering.

COMMENTS: None.

SD DENR Comments: Watershed and inches of rain presented in Section 1.1 was rounded to the nearest square mile and inch, respectively. A landuse discussion and percent landuse table was changed from the entire watershed to the watershed above the TMDL endpoint. The phrase "A majority of the impaired reach is located within the City of Deadwood" was added to the last paragraph of the watershed characterization.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g., insufficient data were available to determine if this water quality criterion is being attained).

Minimum Submission Requirements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the significant sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)).

Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek segment addressed by this TMDL is impaired based on fecal coliform concentrations that are impacting the immersion recreation beneficial uses. South Dakota has applicable numeric standards for fecal coliform that may be applied to this river segment. The numeric standards being implemented in this TMDL are: a daily maximum value of fecal coliform of 400 cfu/100mL in any one sample, and a maximum geometric mean of 200 cfu/100mL during a 30-day period. The standards for fecal coliform are applicable from May 1 to September 30. Discussion of additional applicable water quality standards for Whitewood Creek can be found on pages 7 - 10 of the TMDL document.

COMMENTS: Page 7 contains a statement that: "…the fecal coliform bacteria TMDL and associated implementation strategy described in this document are expected to address both the fecal coliform bacteria and *E. coli* impairments to the immersion recreation use of Whitewood Creek." It seems that this statement is not needed in the fecal coliform TMDL because a separate TMDL document was written to address the existing *E. coli* impairments in the impaired segment of Whitewood Creek. We recommend removing the statement in quotes above from the TMDL document.

SD DENR Comments: Because it is no longer relevant to this document, the entire section discussing translation from fecal coliform to E. coli was removed. Any discussion about the translation of fecal coliform data to E. coli data was removed from this document, as it is presented in the E. coli TMDL.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained.

Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.

☐ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water quality targets for this TMDL are based on the numeric water quality standards for fecal coliform established to protect the immersion recreation beneficial uses for the impaired segment of Whitewood Creek. The fecal coliform targets are: daily maximum of $\leq$ 400 cfu/100mL in any one sample, and maximum geometric mean of $\leq$ 200 cfu/100mL during a 30-day period. The fecal coliform standards are applicable from May 1 to September 30.

COMMENTS: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The TMDL document identifies the land uses in the watershed as a mixture of predominately evergreen forest and grasses with a small amount of cropland and other uses. The specific landuse breakdown for the watershed is included in Table 1-1 excerpted from the TMDL below.

Table 1-1. Watershed Land Use in the Whitewood Creek Watershed

Land Uses	Area (acres)	% of Area
Evergreen Forest	30,131	45.1
Grassland/Herbaceous	21,304	31.9
Cultivated Crops	4,915	7.4
Shrub/Scrub	3,977	5.9
Woody Wetlands	2,118	3.2
Developed, Open Space	1,232	1.8
Developed, Low Intensity	1,162	1.7
Barren Land (Rock/Sand/Clay)	513	0.8
Pasture/Hay	432	0.6
Deciduous Forest	321	0.5
Open Water	223	0.3
Emergent Herbaceous Wetlands	208	0.3
Developed, Medium Intensity	173	0.3
Mixed Forest	137	0.2
Developed, High Intensity	9	0.0
Total	**66,855**	**100**

One point source, the permitted Lead/Deadwood wastewater treatment plant located in Deadwood, discharges effluent containing fecal coliform bacteria directly into the impaired segment of Whitewood Creek. No permitted concentrated animal feeding operations currently exist within the Whitewood Creek watershed.

One combined sewer outfall (CSO) remains in the city of Lead. A 10-inch weir located in the sewer keeps wastewater from flowing out of the CSO in Lead under normal conditions. However, during some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The waste that passes over the weir from the overflow travels down a concrete channel and flows into Gold Run Creek and eventually into Whitewood Creek. An average overflow, resulting from approximately 1 inch of rain per hour, likely results in an overflow of 250,000 gallons.

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of bacteria within the Whitewood Creek watershed include livestock, wildlife, aging onsite wastewater treatment and sewer systems, and the CSO in Lead. Using the best-available information, loadings were estimated from each of these sources using the EPA's Bacterial Indicator Tool (BIT) based on the density and distribution of animals (livestock and wildlife) and failing onsite wastewater treatment systems in the watershed.

Manure from livestock is a potential source of fecal coliform to the stream. Livestock population densities in the watershed were estimated using Census of Agriculture data. Livestock contribute bacteria loads to the Whitewood Creek by defecating directly into the stream while wading and indirectly by defecating on rangelands that are washed off during precipitation events. Both the indirect and direct sources of bacteria loads from livestock were represented in the modeling applications.

COMMENTS: On page 11 of the TMDL document it mentions using livestock density populations in the modeling. However, the TMDL does not include a table showing the livestock population densities in the watershed. We recommend adding a table that includes livestock population densities for the Whitewood Creek watershed similar to the table provided for wildlife population densities.

SD DENR Comments: A table of livestock densities was added to Section 3.2.1

This segment is very small and appears to begin in the City of Deadwood and extend to approximately the WWTP. The TMDL does not include specific details on the sub-watershed drainage area for this segment. It may be helpful to review and discuss the water quality data in the segment directly above and below the listed segment for additional clues on what may be causing the bacteria problems in this segment. It seems odd that the segments above and below the listed segment are not impaired for pathogens, yet they also receive loads from many of the same sources (i.e., Lead's CSO, WWTP, failing septic systems, wildlife, livestock). Because the TMDL segment is almost entirely along Main Street in Deadwood we wonder if the source(s) may be more localized. We also wonder how much wildlife (i.e., turkeys or other avian species) or livestock are / are not concentrated in the Deadwood vicinity or immediate drainage area. If wildlife and livestock are not present in significant quantities in the localized drainage area then the sources could be related to sanitary sewer cross connections with the storm sewer, cracked or broken sanitary sewer lines draining into the storm sewer or directly to the stream, stormwater discharge from Deadwood or a combination of the above. We recommend adding information about potential localized sources and plans to investigate additional local sources during the restoration phase.

SD DENR Comments: An analysis of bacteria concentrations from upstream to downstream and information about potential localized sources and plans to investigate additional local sources was added to Section 1.3. Also, detail on on-site wastewater treatment systems, leaks in sewer lines, and the CSO was added to section 3.2.2. Further information on potential localized sources was also added to the ribotyping section discussing bacterial sources. A column showing ribotyping results during high flows was added to Table 3-3. An error was noticed in the mapped ribotyping location WWC b DWD and the map was updated accordingly.

We also recommend checking the location of the WWTP in relation to the listed segment. The TMDL mentions that the WWTP "…discharges directly to the impaired segment of Whitewood Creek…" However, EPA's Enviromapper shows that the WWTP may be in the segment below the listed segment.

SD DENR Comments: The WWTP was added to the map of Whitewood Creek Watershed (Figure 1-1). The location was checked, and the WWTP is located within the impaired segment.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust data set and an appropriate level of technical analysis**.** This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum LAs + \sum WLAs + MOS$$

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments;

chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Whitewood Creek TMDL describes how the fecal coliform loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segment.

The South Dakota Department of Environment and Natural Resources (SD DENR) collected bacteria samples at the Whitewood Creek ambient water-quality monitoring (WQM) station 123 near Deadwood since 1991. Historical data collected from May 1 to September 30 (applicable dates for the fecal coliform water quality standards) from WQM 123 monitoring station were used in the TMDL technical analysis. Whitewood Creek flow data were available from U.S. Geological Survey (USGS) Station 06436170 at Deadwood, South Dakota, near WQM 123 from 1981 through 1995, and flow data were available from USGS Station 06436180 above Whitewood, South Dakota, from 1982 through 2009. Because recent flow data were required for construction of a load duration curve, a linear regression analysis was completed comparing historical flow (1982 through 1995) from the two stations to calculate more recent flow values for USGS Station 06436170.

The Hydrological Simulation Program – FORTRAN (HSPF) model was established to simulate flows within the Whitewood Creek Watershed and the point and nonpoint sources in the watershed. Loadings were estimated from each of the nonpoint sources using the EPA's Bacterial Indicator Tool (BIT) based on the density and distribution of animals (livestock and wildlife) and failing onsite wastewater treatment systems in the watershed.

The TMDLs were developed using the Load Duration Curve (LDC) approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1st – September 30th). The LDC is a dynamic expression of the allowable load for any given day within the recreation season. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10%), moist conditions (10–40%), mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%) according to EPA's LDC guidance.

The LDCs shown in Figures 4-1 and 4-2 in the TMDL document represent dynamic expressions of parameter-specific TMDLs for the impaired segment of the Whitewood Creek that are based on the daily maximum and 30-day geometric mean fecal coliform criteria, resulting in unique loads that correspond to measured and simulated average daily flows.

Two bacteria LDCs were constructed for the bacteria-impaired reach of Whitewood Creek. The curve, which represents loading capacity, within the first LDC was constructed using the product of simulated flow data, the daily maximum bacteria criteria, and a unit conversion factor. Box plots in the second LDC represent the simulated geometric mean bacteria data and simulated geometric mean flow data.

To ensure that all applicable water quality standards are met, TMDL loads were set according to the criterion (either acute or chronic) that required the greatest load reduction percentage by flow zone. The TMDL loading capacities are included in Tables 5-1 and 5-2 of the TMDL document. These loads, when met, will attain compliance with all applicable water quality standards for fecal coliform in the listed segment of Whitewood Creek.

COMMENTS: The TMDL mentions use of the BIT, but does not include a discussion of the results of the loading estimates derived from its use. Also, the Model Results section mentions how the HSPF model was used, but doesn't discuss the results of the modeling. Further, Carter's lack of analysis of Lead's CSO discharge and loading estimates is not sufficient justification for excluding this existing loading source from the technical analysis in the TMDL. The load should not be assumed to be zero until the CSO separation is complete. Carter's thesis was completed in 2002 – what progress has been made in CSO separation since 2002? When is it scheduled to be completed? Is it possible to estimate a WLA, using existing information, to include in the TMDL?

As mentioned in the comments to the Restoration Strategy below, it appears that the TMDL document includes mention that the necessary nonpoint source reductions are achievable or practicable. However, we recommend including more information to address reasonable assurance.

SD DENR Comments: Carter's original watershed model was re-calibrated and concentration curves for the impaired reach as well as for upstream reaches are included in the Hydrologic Model section. A discussion the model results which used loading estimates derived from the BIT was added to Section 3.4. Model results and further detail regarding the CSO, on-site wastewater treatment systems, litter control, buffer zones and filter strips, and leaking sewer lines were also added to Section 3.4. More detail was added to this section regarding the CSO loading assumptions and methods used to model the CSO. The CSO was only assumed zero for the purposes of BMPs. Information was added in Section 9.0 on progress made in CSO separation and plans. Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero. A brief explanation was added to the ends of sections 5.1 and 5.3 describing why the WLA was set to zero (because the CSO permit requires its elimination). The recalibration of the model altered the simulated geometric mean TMDL values slightly, and any relating text was updated. Updated model results were added to Section 9.0, and reasonable assurance was addressed in Section 3.4 and 9.0.

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Minimum Submission Requirements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek TMDL data description and summary are included mostly in the Available Data section and in tables throughout the document. The full data set is in not included in the TMDL. The South Dakota Department of Environment and Natural Resources (SD DENR) collected bacteria samples at the Whitewood Creek ambient water-quality monitoring (WQM) station 123 near Deadwood since 1991. A total of 95 fecal coliform samples were collected at WQM 123 during the recreation season from May 1 to September 30. *E. coli* bacteria concentration data was also collected at WQM 123 (1998 through 2009), and includes a total of 34 samples collected during the recreation season. The data set also includes the flow record on Whitewood Creek that was used to create the load duration curves for the listed segment included in the TMDL document.

COMMENTS: None.

SD DENR Comments: Eleven additional fecal coliform samples from 2003 SDSMT sampling efforts were brought to our attention and added to the analysis. Numbers changed by less than 2 percent in section 1.3 and by less than 1 percent in the actual TMDL tables. The r^2 value of the flow regression analysis was added in the Section 1.3 for detail. Table 1-3 was removed as it added nothing to the document about the impaired reach.

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:

☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: One point source, the permitted Lead/Deadwood wastewater treatment plant located in Deadwood, discharges effluent containing fecal coliform bacteria directly into the impaired segment of Whitewood Creek. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was determined by multiplying the WWTP reported flows by 200 cfu/100 mL for the geometric mean TMDL and by 400 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. The WLA was assigned values 3.79×10^{10} cfu/day for the daily maximum TMDL value and 1.89×10^{10} cfu/day for the geometric mean TMDL value.

No permitted concentrated animal feeding operations currently exist within the Whitewood Creek watershed.

One combined sewer outfall (CSO) remains in the city of Lead. During some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The waste that passes over the weir from the overflow travels down a concrete channel and flows into Gold Run Creek and eventually into Whitewood Creek. An average overflow, resulting from approximately 1 inch of rain per hour, likely results in an overflow of 250,000 gallons.

COMMENTS: As mentioned above in the comments to the Technical Analysis, the CSO discharges from Lead will remain a potential source of fecal coliform loading to the impaired segment of Whitewood Creek until the separation project is complete. Typically, if a point source is not accounted for in an upstream boundary condition or provided a specific WLA, then the discharge is assumed to have a zero WLA which should be reflected in the permit as no discharge of that pollutant. We recommend analyzing the discharges from the Lead CSO and providing accounting for that load in the TMDL document.

SD DENR Comments: Information on CSO separation and discharges was added to sections 3.4. A CSO WLA was set to zero in the TMDL document because the CSO permit requires its eventual elimination and a permitted concentration does not exist. The following statement was added to Section 5.1: Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero. The following statement was added to Section 5.3: A WLA for the Lead CSO was set to zero because the Lead CSO permit requires its elimination.

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Minimum Submission Requirements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: To develop the fecal coliform bacteria load allocation (LA), the loading capacity was first determined using the data sources specified. The daily maximum criterion (400 cfu/100 mL) was used in the calculation of the daily maximum loading capacities, and the geometric mean criterion (200 cfu/100 mL) was used for the calculation of the geometric mean loading capacities. The loading capacities for Whitewood Creek were calculated by multiplying the specified fecal coliform bacteria criterion by the specified flow data. For each of the flow zones, the 95th percentile of the range of loading capacities within a zone was set as the flow zone goal. Bacteria loads experienced during the largest stream flows (e.g., top 5 percent) cannot be feasibly controlled by practical management practices. Thus setting the flow zone goal at the 95th percentile of the range of loading capacities will protect the immersion recreation beneficial use and allow for the natural variability of the system. The TMDL (and loading capacity) is the sum of the waste load allocation (WLA), the LA, and margin of safety (MOS). Portions of the loading capacity were allocated to nonpoint sources as an LA and an MOS to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed below. The overall LA was determined by subtracting the WLA and MOS from the loading capacity. The resulting LA was allocated to the various nonpoint sources identified in the watershed.

COMMENTS: None.

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Minimum Submission Requirements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

☐ <u>If the MOS is implicit</u>, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.

☒ <u>If the MOS is explicit</u>, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ <u>If</u>, rather than an explicit or implicit MOS, the <u>TMDL relies upon a phased approach</u> to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek TMDL includes an explicit MOS derived by calculating the difference between the loading capacity at the mid-point of each of the flow zones and the loading capacity at the minimum flow in each zone. The explicit MOS values are included in Tables 5-1, and 5-2 of the TMDL.

COMMENTS: None.

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Minimum Submission Requirements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: By using the load duration curve approach to develop the TMDL allocations seasonal variability in fecal coliform loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months.

COMMENTS: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Minimum Submission Requirements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:

☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process so far. In particular, the State has encouraged participation through public meetings in the watershed, and a website was developed and maintained throughout the project. The TMDL has been available for a 30-day public notice period prior to finalization.

COMMENTS: The Public Participation section (Section 7.0) generally mentions presentations to "local groups in the watershed." Additional detail on the number of presentations given and the types of stakeholder groups in attendance would provide a more complete description of the public participation process for this TMDL. It would also be helpful to state whether the public notice was published in local newspapers and if it was available on the SD DENR's web site.

SD DENR Comments: Information regarding the number of presentations given, the types of stakeholder groups in attendance, and publishing of public notice was added to Chapter 7.0.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Minimum Submission Requirements:

☒ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☒ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The impaired segment of Whitewood Creek will continue to be monitored through SD DENR's ambient water quality monitoring stations in the Whitewood Creek watershed. Stream water-quality monitoring will be accomplished through SD DENR's ambient water-quality monitoring stations which are sampled on a monthly basis during the recreational season. During the recreation season bacterial monitoring should be increased to collect at least 5 samples per month to assess the geometric mean criterion. Additional monitoring and evaluation efforts should be targeted toward designed BMPs to document the effectiveness of implemented BMPs. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

COMMENTS: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Minimum Submission Requirements:

☒ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Restoration Strategy section of the TMDL document says that a variety of BMPs could be considered in the development of a water-quality management implementation plan for the impaired segment of the Whitewood Creek watershed. Several types of control measures are available for reducing fecal coliform bacteria loads, and recommendations to address the identified sources are included in the TMDL document. Based on water-quality monitoring, bacterial source tracking, and HSPF model results, the recommended control measures to be implemented are expected to achieve the required load reductions and attain the TMDL goals. The model results indicate that direct sources should be the primary target for future BMP implementation. It is recommended that an in-depth BMP scenario analysis be performed before developing a future BMP implementation plan. Funds to implement watershed water quality improvements can be obtained through the SD DENR.

COMMENTS: The EPA is working on an updated and expanded reasonable assurance policy for all TMDLs. Until the policy is finalized we are asking that all TMDLs that include both point and nonpoint sources address reasonable assurance to the extent possible. It appears that components of reasonable assurance already exist in the Whitewood Creek TMDL document (e.g., mention of analysis that shows that implementation of a combination of BMPs would reduce the loading to the ranges needed to meet the water quality standards). We recommend including a few paragraphs that use the words "reasonable assurance" and also include general implementation progress to date and any proposed future schedule for NPS implementation.

SD DENR Comments: The words "reasonable assurance" were used in multiple paragraphs, and general implementation progress to date and any proposed future schedule for NPS implementation was included in Chapter 9.0.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Minimum Submission Requirements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek fecal coliform TMDL includes daily loads expressed as colonies forming units (cfu) per day. The daily TMDL loads are included in TMDL Section of the document.

COMMENTS: None.

E. COLI TOTAL MAXIMUM DAILY LOAD FOR WHITEWOOD CREEK

Topical Report RSI-2149

prepared for

South Dakota Department of Environment and Natural Resources
523 East Capitol
Joe Foss Building
Pierre, South Dakota 57501

August 2010

RESPEC
CONSULTING & SERVICES

E. COLI TOTAL MAXIMUM DAILY LOAD FOR WHITEWOOD CREEK

Topical Report RSI-2149

by

Cindie M. McCutcheon

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P.O. Box 725
Rapid City, South Dakota 57709

prepared for

South Dakota Department of Environment
and Natural Resources
523 East Capitol
Joe Foss Building
Pierre, South Dakota 57501

August 2010

Total Maximum Daily Load Summary Table	
Waterbody Name/Description	Whitewood Creek (from Deadwood Creek to Spruce Gulch)
Assessment Unit I.D.	SD-BF-R-WHITEWOOD_03
Size of Impaired Waterbody	Approximately 1.8 miles (2.9 kilometers) in length
Size of Watershed	105 square miles (273 square kilometers)
Location	Hydrologic Unit Codes (12-digit HUC): 101202020207 and 101202020208
Impaired Designated Use(s)	Immersion Recreation
Cause(s) of Impairment	*E. coli*
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points	Indicator Name: Fecal coliform bacteria Threshold Values: Maximum daily concentration of 400 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 200 cfu/ 100 mL. These criteria apply from May through September.
Analytical Approach	Load Duration Curve, **Bacterial Indicator Tool** and **Hydrological Simulation Program – FORTRAN** (**HSPF**) modeling

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1.0 INTRODUCTION

The intent of this document is to clearly identify the components of a Total Maximum Daily Load (TMDL), support adequate public participation, and facilitate the U.S. Environmental Protection Agency (EPA) review. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the *E. coli* bacteria impairment on Whitewood Creek (SD-BF-R-WHITEWOOD_03), which was assigned an EPA assessment category of 5 (water is impaired or threatened and a TMDL is needed) in the 2010 impaired waterbodies list [South Dakota Department of Environment and Natural Resources, 2010a].

1.1 WATERSHED CHARACTERIZATION

The Whitewood Creek Watershed is approximately 105 square miles (273 square kilometers). The creek flows through both Lawrence and Meade Counties, with its headwaters located near the base of Deer Mountain. The creek flows to the Belle Fourche River near Vale, South Dakota. The watershed drains much of the central portion of Lawrence County in South Dakota, as shown in Figure 1-1. The impaired (Section 303(d) listed) segment of Whitewood Creek has a length of approximately 1.8 miles (2.9 kilometers), beginning at Deadwood Creek and ending at Spruce Gulch.

Average annual precipitation for Lead, South Dakota, and Deadwood, South Dakota, is 29 inches and 28 inches, respectively. Over 50 percent of the annual precipitation occurs between the months of April and June. The highest rainfall totals occur during May while the lowest rainfall totals occur during January. Snowmelt significantly contributes to flow during March, April, and May. Average annual snowfall in Lead and Deadwood is 169 inches and 112 inches, respectively [Carter, 2002].

Watershed land use above the TMDL endpoint is mainly forestland (71 percent) and grasslands (16 percent). Urban areas above the TMDL endpoint (5.6 percent of the study area) can be found near Lead, Central City, and Deadwood, South Dakota. The remaining portion of the study area consists of agricultural land, shrubs, and wetlands. Table 1-1 lists the land use in the Whitewood Creek Watershed above the TMDL endpoint. A majority of the impaired reach is located within the city of Deadwood.

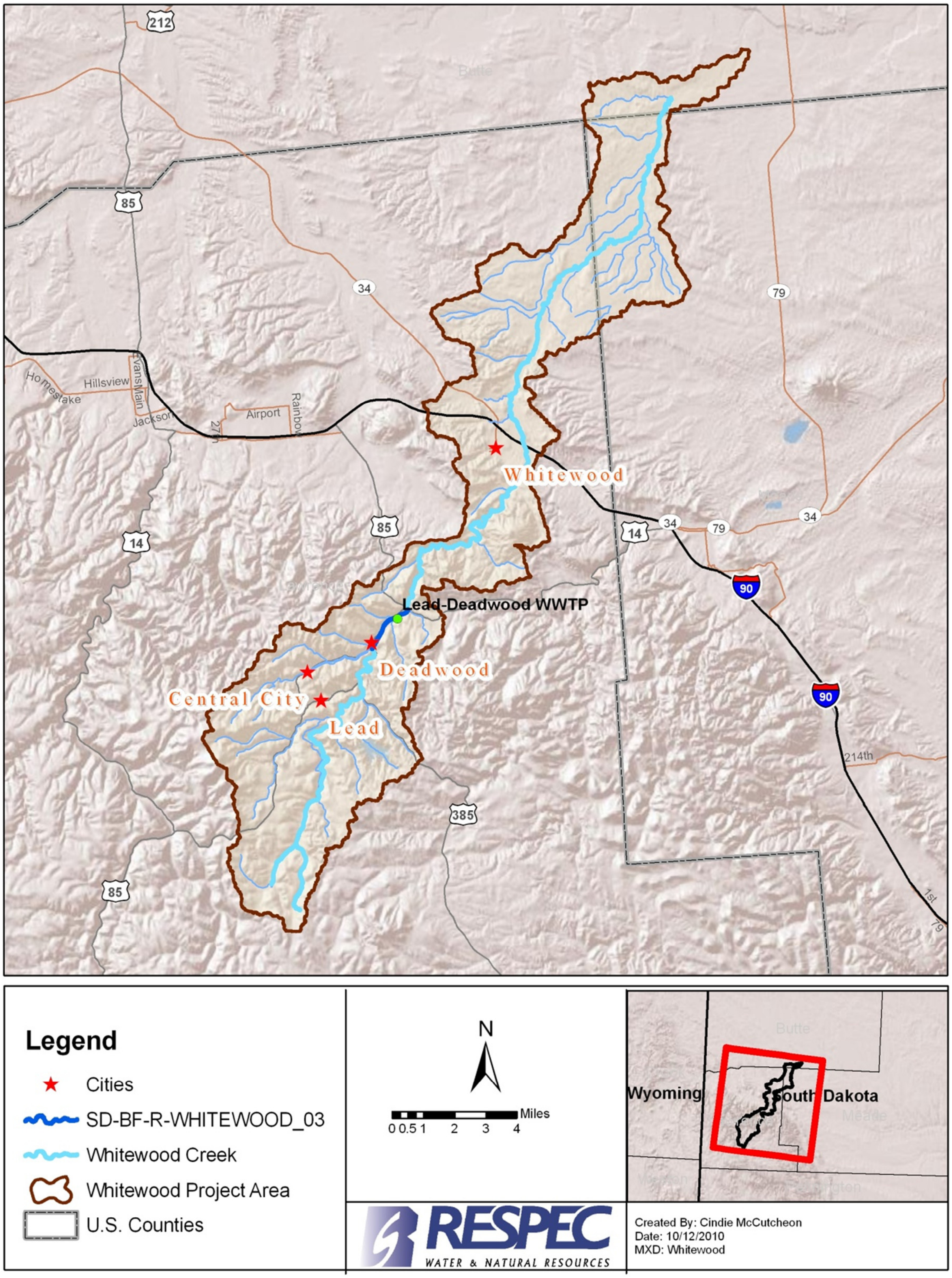

Figure 1-1. Whitewood Creek Study Area.

Table 1-1. Watershed Land Use in the Whitewood Creek Watershed Above the TMDL Reach Endpoint

Land Uses	Area (acres)	% of Area
Evergreen Forest	19,938	71.0%
Grassland/Herbaceous	4,532	16.1%
Shrub/Scrub	1,121	4.0%
Developed, Low Intensity	743	2.6%
Developed, Open Space	718	2.6%
Barren Land (Rock/Sand/Clay)	478	1.7%
Open Water	175	0.6%
Mixed Forest	134	0.5%
Deciduous Forest	124	0.4%
Developed, Medium Intensity	99	0.4%
Pasture/Hay	8	0.0%
Emergent Herbaceous Wetlands	3	0.0%
Woody Wetlands	1	0.0%
Total	28,074	100.0%

1.2 CLEAN WATER ACT SECTION 303(D) LISTING INFORMATION

Whitewood Creek was first listed in South Dakota's 2010 303(d) list [South Dakota Department of Environment and Natural Resources, 2010a] because of sample concentrations of *E. coli* bacteria that exceeded the criterion for the protection of the immersion recreation use. Because South Dakota did not adopt the *E. coli* criteria for the protection of the immersion recreation and limited contact uses until 2010, Segment SD-BF-R-WHITEWOOD_03 (from Deadwood Creek to Spruce Gulch) was not listed as impaired for *E. coli* until 2010. For a parameter to be included as a cause of impairment on the 303(d) impaired waterbodies list, greater than 10 percent of samples collected during the previous 5-year period must exceed water-quality criteria.

1.3 AVAILABLE WATER-QUALITY AND FLOW DATA

The South Dakota Department of Environment and Natural Resources (SD DENR) collected *E. coli* samples since 1998 at the Whitewood Creek ambient Water-Quality Monitoring (WQM) Station 123 near Deadwood and fecal coliform samples since 1991. *E. coli* bacteria concentration data collected at WQM 123 (1998 through 2009) show that 14 out of 34 samples (41 percent) collected during the recreation season from May 1 to September 30 exceeded the acute *E. coli* bacteria criterion of 235 colony-forming units per 100 milliliters (cfu/100 mL). *E. coli* concentrations ranged from < 10 cfu/100 mL to 770 cfu/100 mL.

Bacteria sample data collected to date in Whitewood Creek near Deadwood at WQM 123 show a statistically significant correlation (Spearman $r_s = 0.71$; $p < 0.05$) between fecal coliform bacteria and *E. coli* concentrations. Because the two indicators are closely related, the paired fecal coliform and *E. coli* were used to develop a site-specific translator function ($r^2 = 0.55$) to convert fecal coliform loading estimates to *E. coli* loading estimates to address impairments to the immersion recreation impairment of Whitewood Creek. The mean ratio of *E. coli* to fecal coliform was calculated to be 1.21 cfu *E. coli*/cfu fecal coliform. Figure 1-2 shows the plot of *E. coli* versus fecal coliform. The translation requires the regression analysis equation (Equation 1-1) to convert fecal coliform concentration to *E. coli* concentrations:

$$E = 0.7681(F) + 74.592 \quad (1\text{-}1)$$

where:

E = E. *coli* concentration (cfu/100 mL)

F = fecal coliform concentration (cfu/100 mL).

Fecal coliform bacteria concentration data collected at WQM 123 and transformed to *E. coli* concentrations show that 67 out of 106 samples (63 percent) collected during the recreation season from May 1 to September 30 exceeded the acute *E. coli* bacteria criterion of 235 cfu/100 mL from 1991 through 2009. Calculated concentrations ranged from 76 cfu/100 mL to 5,221 cfu/100 mL.

Whitewood Creek flow data were available from U.S. Geological Survey (USGS) Station 06436170 at Deadwood, South Dakota, near WQM 123 from 1981 through 1995, while flow data were available from USGS Station 06436180 above Whitewood, South Dakota, from 1982 through 2009. Because recent flow data were required for construction of a load duration curve, a linear regression analysis was completed comparing historical flow (1982 through 1995) from the two stations; the equation of the linear regression analysis line ($r^2 = 0.88$) was used with the data from USGS Station 06436180 (1998 through 2009) to calculate more recent flow values for USGS Station 06436170. SD DENR WQM stations and USGS stations used for TMDL development are shown in Table 1-2 and Figure 1-3.

Boxplots shown in Figure 1-4 were constructed for the water-quality monitoring sites shown in Figure 1-5 using data which would have been used for the 2008 and 2010 integrated reports

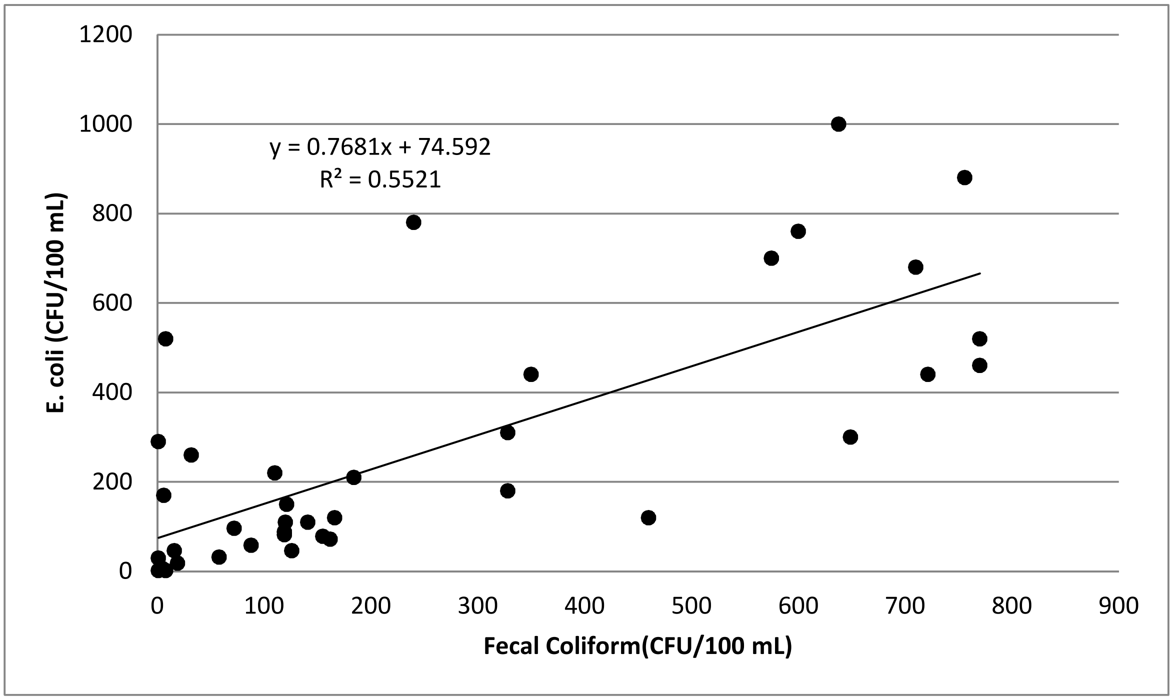

Figure 1-2. Plot of Fecal Coliform Versus *E. coli* for South Dakota Department of Environment and Natural Resources Water-Quality Monitoring Station WQM 123.

Table 1-2. Water-Quality Stations in the Whitewood Creek Watershed Used for Total Maximum Daily Load Development

Water Quality Stations	Period of Record	Calculated *E. coli* Samples	Actual *E. coli* Samples	Flow Samples
Whitewood Creek near Deadwood, SD (WQM 123)	1991–2009	106	39	0
Whitewood Creek at Deadwood, SD (USGS 06436170)	1981–1995	0	0	5,113
Whitewood Creek above Whitewood, SD (USGS 06436180)	1982–2009	2	0	9,719

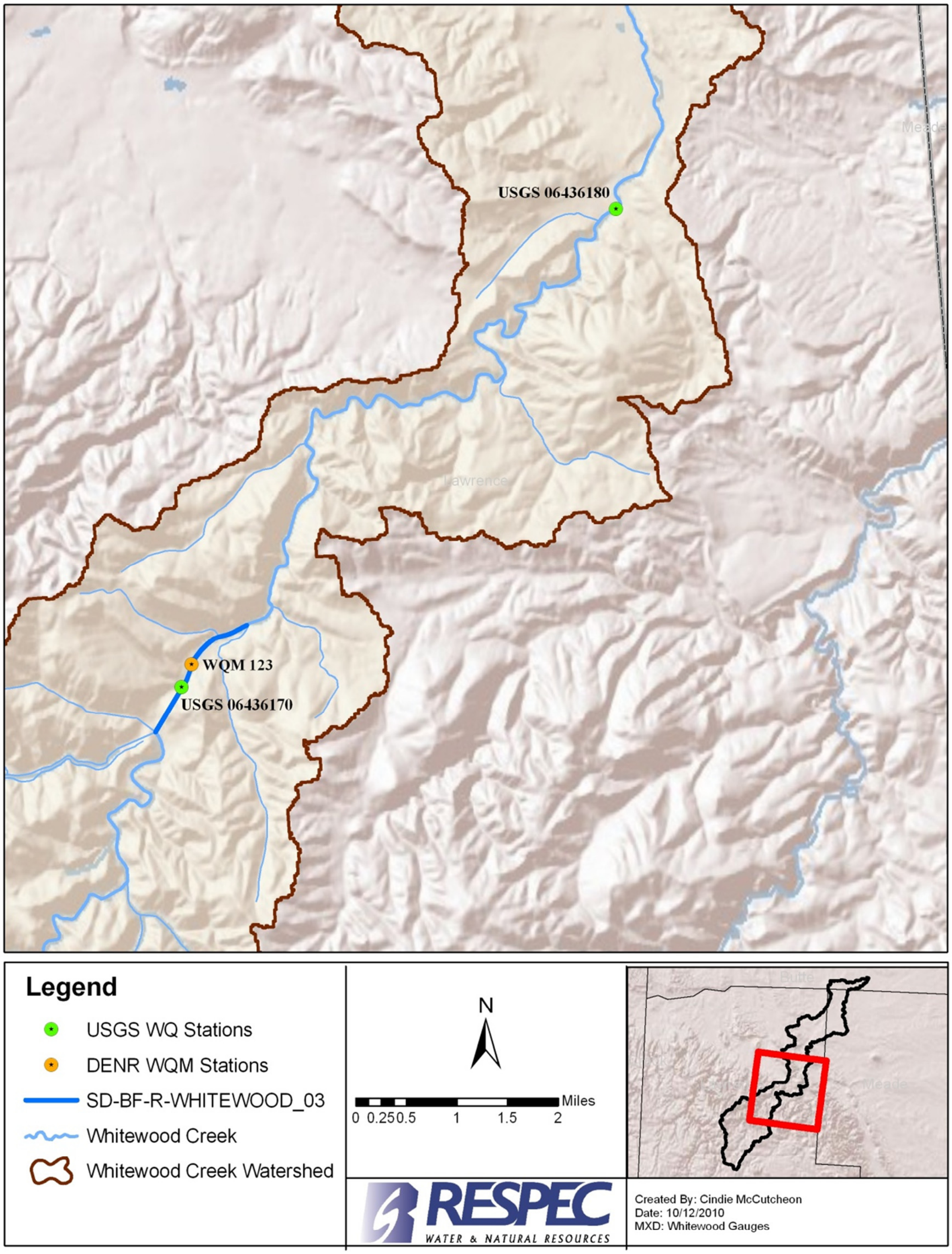

Figure 1-3. Water-Quality Stations in the Whitewood Creek Watershed Used for Total Maximum Daily Load Development.

(2003 through 2009). This dataset was used because requirements for stream listings state that data must be less than 5 years old. Boxplots are shown from upstream to downstream. A watershed schematic, as illustrated in Figure 1-6, shows median concentrations, percent exceedance, and number of samples at each water quality monitoring site from upstream to downstream for this time period. The only water-quality monitoring site within the impaired reach is Whitewood Creek below Deadwood (460123). West Strawberry Creek (460675), which flows into Reach SD-BF-R-WHITEWOOD_01 is impaired for fecal coliform with a median concentration of nearly two times that of Whitewood Creek below Deadwood. There is a TMDL document approved for West Strawberry Creek which suggests the bacteria load sources are approximately 43 percent human and 57 percent wildlife [South Dakota Department of Environment and Natural Resources, 2010b]. Whitewood Creek above Gold Run (460686), Gold Run Creek (460659), Whitewood Creek near Deadwood (460122), and Deadwood Creek (460127) are unimpaired. Using only data from 2003 through 2009, the impaired reach, SD-BF-R-WHITEWOOD_03, has 22 percent exceedance of the acute criteria and 50 percent exceedance of the geometric mean criteria. The Whitewood Creek near Deadwood site (460685) following the impaired reach actually exceeds the acute criteria 15 percent of the time. However, this site is not listed because it does not meet the sample requirements for impairment which state, "at least 20 samples for any one parameter are usually required at any site. The sample threshold was reduced to 10 samples if greater than 25 percent of samples exceed water standards [South Dakota Department Environment and Natural Resources, 2008]."

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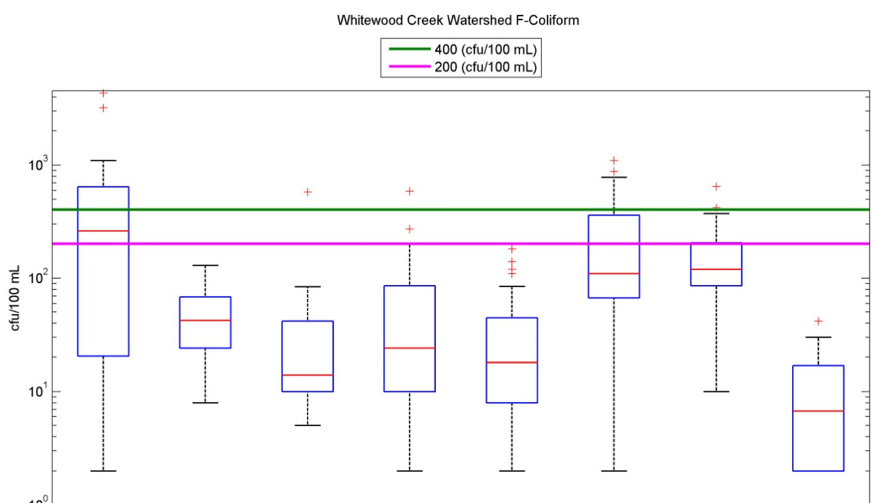

	460675	460686	460659	460122	460127	460123	460685	WWCSC
n	17	17	11	30	41	41	13	10
Min	2	8	5	2	2	2	10	2
Max	4350	130	580	590	180	1100	650	41.5
q1	20.5	24	10	10	8	67.25	86	2
Median	260	42	14	24	18	110	120	6.75
q3	642.5	68.5	41.5	86	44.5	357.5	205	17
Mean	716.9	49.4	73.7	68.9	34.9	251.8	182	12.2
90th%	2780	107	282	160	95	712	466	35.8
95th%	3948	123	555	270	129	825	615	41.5
% Exceeded	41	0	9.1	3.3	0	22	15	0
% Exceed30	59	0	0	NaN	0	50	NaN	0
n 30	17	17	12	0	22	22	0	10

Figure 1-4. Boxplots of 2003 Through 2009 Fecal Coliform Data for Sites Upstream, Within, and Downstream of the Impaired Reach.

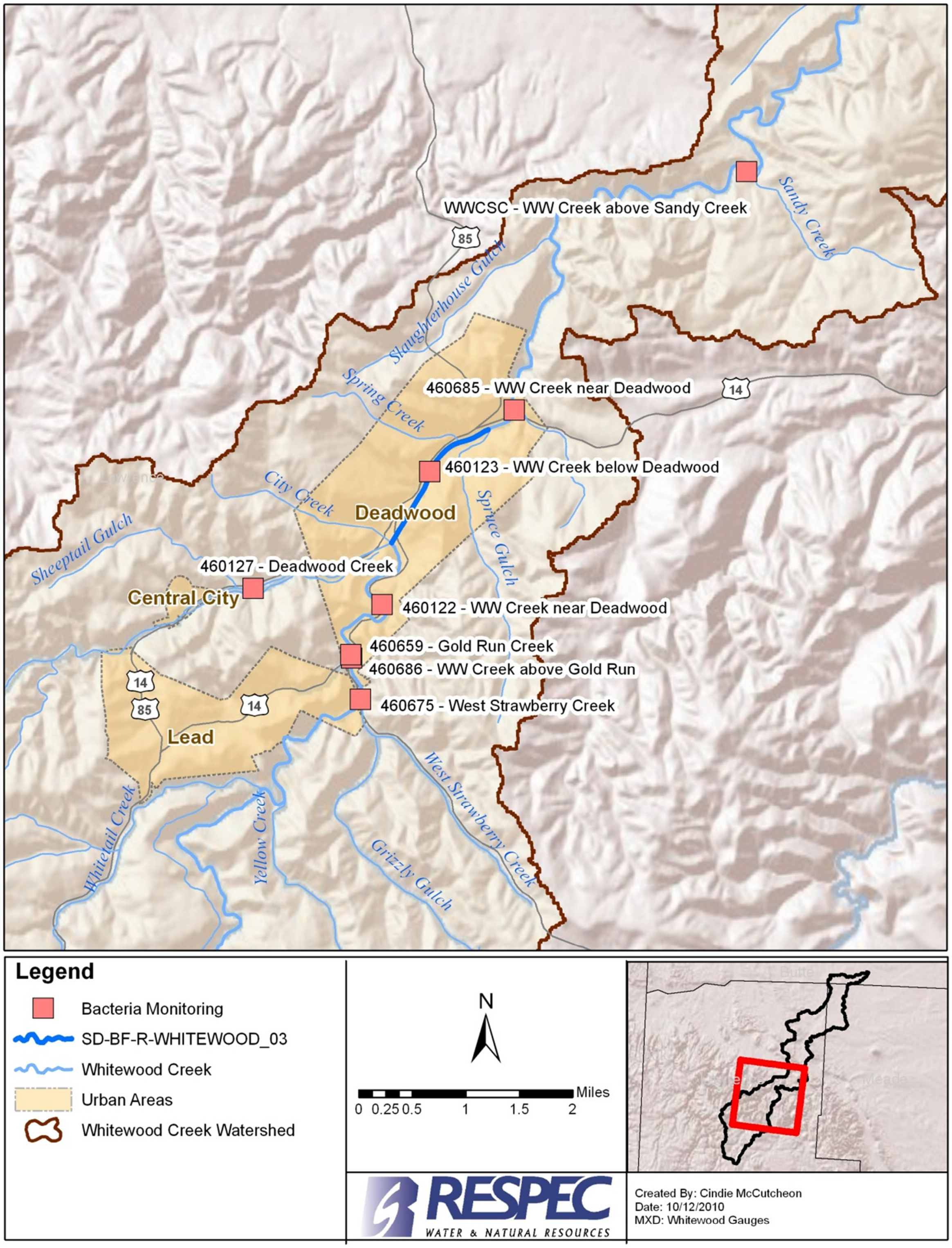

Figure 1-5. Whitewood Creek Monitoring Sites Upstream, Downstream, and Within Impaired Reach.

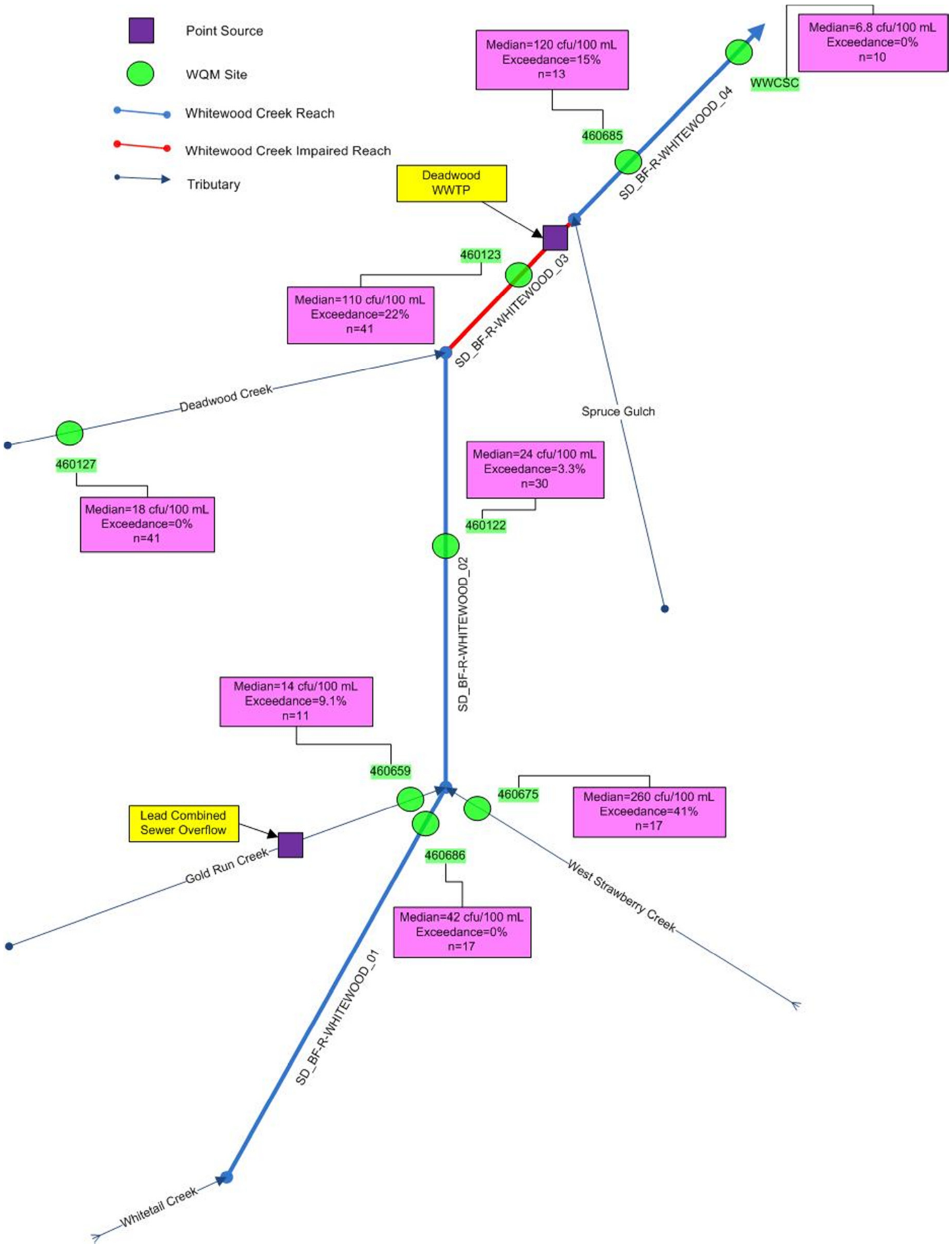

Figure 1-6. Whitewood Creek Watershed Schematic Showing Reaches Upstream and Downstream of Impaired Reach.

Although West Strawberry Creek is impaired for bacteria, there is zero exceedance at Whitewood Creek above Gold Run (460686) downstream of the confluence of West Strawberry Creek with Whitewood Creek. Even though some loading from West Strawberry Creek occurs, the overall contribution of West Strawberry Creek appears to be diluted by the time it gets to Whitewood Creek above Gold Run (460686). Besides West Strawberry Creek, none of the monitoring sites upstream of the impairment have consistently high bacteria concentrations, and the upstream contribution is relatively negligible compared to the Whitewood Creek site below Deadwood (460123). Deadwood sources could consist of sanitary sewer cross connections with the storm sewer, cracked or broken sanitary sewer lines draining into the storm sewer or directly to the stream, stormwater discharge from Deadwood or a combination of the above. An investigation should be completed upstream, within, and downstream of the impaired reach, throughout Deadwood and Lead, to pinpoint the bacterial sources. With implementation of Best Management Practices (BMPs) in Deadwood, such as reduction of on-site wastewater treatment system failures and leaking sewer lines and stormwater treatment programs, loads from the city of Deadwood downstream of the impaired reach in Whitewood Creek near Deadwood site 460685 would likely be reduced as well.

2.0 WATER-QUALITY STANDARDS AND TOTAL MAXIMUM DAILY LOAD TARGETS

South Dakota waterbodies are all assigned beneficial uses based on the regulations of the EPA Clean Water Act. All streams are designated with the use of fish and wildlife propagation, recreation, stock watering, and irrigation. Additional uses are assigned by the state based on a beneficial use analysis of each waterbody. Water-quality standards are defined in South Dakota state statutes in support of these uses. These standards consist of suites of criteria that provide physical and chemical benchmarks from which management decisions can be developed (Administrative Rules of South Dakota (ARSD) 74:51:01–74:51:03). Additional narrative standards that may apply can be found in the ARSD § 74:51:01:05, 06, 08, 09, and 12. These articles contain language that generally prohibit the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, and pollutants impacting biological integrity.

Whitewood Creek Segment SD-BF-F-WHITEWOOD_03 was assigned the following beneficial uses: cold-water permanent fish life propagation, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 2-1 lists water-quality criteria that must be met to support the beneficial uses currently assigned to the Whitewood Creek.

South Dakota recently adopted *E. coli* criteria for the protection of the limited contact and immersion recreation uses. Current *E. coli* criteria for the immersion recreation and limited contact recreation use require that (1) no sample exceeds 235 cfu/100 mL and 1,178 cfu/100 mL, respectively, and (2) the geometric mean of a minimum of five samples collected during separate 24-hour periods for any 30-day period must not exceed 126 cfu/100 mL and 630 cfu/100 mL, respectively. Since only one or two water samples were collected during any 30-day period, compliance with the geometric mean criterion was evaluated using the **Hydrological Simulation Program – FORTRAN** (**HSPF**) model-predicted daily concentrations from a recalibrated version of a model created by Carter [2002]. The geometric mean, as defined in ARSD § 74:51:01:01, is the *n*th root of a product of *n* factors. The *E. coli* criteria are applicable from May 1 through September 30 (recreational season). A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still support its designated beneficial uses; it is the sum of allowable loads of a single pollutant from all contributing point and nonpoint sources. The numeric TMDL target established for Whitewood Creek's immersion recreation use impairment was determined for each of five flow conditions or zones and based on either the daily maximum (235 cfu/100 mL) or 30-day average (126 cfu/100 mL) *E. coli* bacteria criterion, depending on which criterion required the greatest load reduction.

Table 2-1. State Surface Water-Quality Standards for Whitewood Creek From Deadwood Creek to Spruce Gulch (SD-BF-R-WHITEWOOD_03) [South Dakota Department of Environment and Natural Resources, 2008] (Page 1 of 2)

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate[a]	≤ 750	mg/L	30-day average
	≤ 1,313	mg/L	Daily maximum
Total dissolved solids[a]	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	Daily maximum
Total petroleum hydrocarbon[a]	≤ 10	mg/L	Daily maximum
Oil and grease[a]	≤ 10	mg/L	Daily maximum
Nitrogen, nitrates as N[a]	≤ 50	mg/L	30-day average
	≤ 88	mg/L	Daily maximum
Chloride[b]	≤ 100	mg/L	30-day average
	≤ 175	mg/L	Daily maximum
Chlorine, total residual[b]	≤ 0.011	mg/L	Chronic
	≤ 0.019	mg/L	Acute
Dissolved oxygen[c, d]	≥ 5.0	mg/L	Daily minimum
Total suspended solids[b]	≤ 30	mg/L	30-day average
	≤ 53	mg/L	Daily maximum
Temperature[b]	≤ 65	°Φ	Daily maximum
pH[b]	6.6 and ≤ 8.6	Standard units	
Undisassociated hydrogen sulfide[b]	≤ 0.002	mg/L	Daily maximum
Total ammonia nitrogen as N[b]	Equation-based limit	mg/L	30-day average (March 1–October 31)
	Equation-based limit	mg/L	30-day average (November 1–February 29)
	Equation-based limit	mg/L	Daily maximum
Fecal coliform[d, e]	< 200	cfu/100 mL	Geometric mean (May 1–September 30)
	< 400	cfu/100 mL	Daily maximum (May 1–September 30)
E. coli[d, e]	< 126	cfu/100 mL	Geometric mean (May 1–September 30)
	< 235	cfu/100 mL	Daily maximum (May 1–September 30)

Table 2-1. State Surface Water-Quality Standards for Whitewood Creek From Deadwood Creek to Spruce Gulch (SD-BF-R-WHITEWOOD_03) [South Dakota Department of Environment and Natural Resources, 2008] (Page 2 of 2)

Parameter	Criteria	Unit of Measure	Special Conditions
Conductivity at 25°C[f]	< 2,500	micromhos/cm	30-day average
	< 4,375	micromhos/cm	Daily maximum
Sodium adsorption ratio[f]	< 10		Daily maximum

(a) Criteria for fish and wildlife propagation, recreation, and stock watering use.
(b) Criteria for cold-water permanent fish life propagation.
(c) Criteria for limited contact recreation use.
(d) Criteria for immersion recreation use.
(e) Geometric means must be based on a minimum of five samples obtained during separate 24-hour periods for any 30-day period.
(f) Criteria for irrigation use.

3.0 SIGNIFICANT SOURCES

3.1 POINT SOURCES

The permitted Lead/Deadwood wastewater treatment plant (WWTP) located in Deadwood discharges its effluent into Whitewood Creek. The monthly average discharge from 1997 to 2009 from the facility ranged from 0.8 million gallons per day (mgd) to 3.6 mgd. The mean monthly average discharge over this range was 1.4 mgd, and the median monthly average discharge was also 1.4 mgd. The Lead/Deadwood WWTP has been in operation since 1979. According to the WWTP, the geometric mean of the fecal coliform bacteria in the effluent for any 30-day period should not exceed 200 cfu/100 mL and the daily maximum should not exceed 400 cfu/100 mL. These fecal coliform criteria are the same as the criteria for Whitewood Creek. Thus as long as the WWTP meets the criteria of its discharge permit, it should not cause exceedances of the fecal coliform concentration criteria of Whitewood Creek [Carter, 2002]. However, using the translator function discussed in Section 1.3 to calculate *E. coli* loads from the WWTP effluent limits yields a 30-day average maximum *E. coli* concentration of 228 cfu/100 mL and a daily maximum *E. coli* concentration of 382 cfu/100 mL, surpassing the recently adopted *E. coli* standards. The current permit for the Lead/Deadwood WWTP is up for renewal, and an *E. coli* limit will be added to the renewed permit. The WWTP will have at least 1 year to meet the new limit, during which time, the fecal coliform limit will continue to be regulated [Buscher, 2010].

One combined sewer outfall (CSO) remains in the city of Lead. It was constructed in the late 1890s. When the sewer lines for the Lead/Deadwood Sanitation District were constructed, they collected sewage from all but two of the sewer outfalls that discharged to Whitewood Creek. The discharge that overflowed to Whitewood Creek near the Lead/Deadwood WWTP was eliminated from the sewer system in 2001; therefore, only one CSO remains in the city of Lead. Under normal conditions, a 10-inch weir located in the sewer keeps wastewater from flowing out of the combined sewer overflow in Lead. However, during some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The wastes that flow over the weir travel down a concrete channel and flow into Gold Run Creek and eventually into Whitewood Creek. A collection container is anchored to the downstream side of the weir. If there is an overflow, some of the water is collected in the container; the container is checked daily to determine if there has been an overflow. The water in the container from the overflow is tested and the state is notified of the discharge. From 1991 to 1998, the geometric mean of the overflow concentrations of fecal coliform bacteria was 51,746 cfu/100 mL. The maximum concentration during this period was 2.1×10^6 cfu/100 mL. Overflows were reported in 44 of the 96 months from 1991 to 1998. The overflow that discharged to Whitewood Creek near the Lead/Deadwood WWTP only had discharges reported in 8 months from 1991 to 1998. The geometric mean of the concentrations of fecal coliform bacteria was 265,556 cfu/100 mL and the maximum was 721,000 cfu/100 mL [Carter, 2002].

When an overflow occurs, the city of Lead is required to contact SD DENR and to collect a sample of the overflow. Additionally, at the end of each month, the city of Lead submits a report to SD DENR including the geometric mean and maximum concentrations of fecal coliforms from the overflow samples. This information was obtained from SD DENR and used to estimate loadings from the combined sewer overflows. Because of the age of the data, the exact dates of the overflows were not available for this assessment. To determine when overflows likely occurred, the daily precipitation data for Lead was compared to the record of reported combined sewer overflows. It was assumed that each of the overflows was the result of a precipitation event. By comparing these two records, it was estimated that any storm event yielding over 0.33 inch of precipitation could cause the combined sewer to overflow. An "average" overflow resulting from approximately 1 inch of rain per hour likely results in an overflow of 250,000 gallons. Most overflows last for 2 hours or less [Carter, 2002].

3.2 NONPOINT SOURCES

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of bacteria within the Whitewood Creek Watershed include livestock, wildlife, aging on-site wastewater treatment and sewer systems, and the CSO in Lead. Using the best-available information, loadings were estimated from each of these sources using the EPA's **Bacterial Indicator Tool** (**BIT**) based on the density and distribution of animals (livestock and wildlife) and failing on-site wastewater treatment systems in the watershed [U.S. Environmental Protection Agency, 2001a].

3.2.1 Agriculture

Manure from livestock is a potential source of bacteria to the stream. Livestock population densities in the watershed, shown in Table 3-1, were estimated using 1997 Census of Agriculture data [U.S. Department of Agriculture, 1997]. Livestock contribute bacteria loads to the Whitewood Creek by defecating directly into the stream while wading and defecating on rangelands that are washed off during precipitation events. Both the indirect and direct defecation bacteria loads from livestock were represented in the modeling applications.

3.2.2 Human

The bacterial source tracking tests identified the presence of human bacteria in Whitewood Creek. The watershed contains one centralized wastewater collection and treatment facility for Deadwood and Lead, South Dakota, as well as the CSO for Lead that is currently being eliminated. Besides the Deadwood/Lead WWTP, the watershed is mainly rural. Thus on-site wastewater treatment systems and leaks in sewer lines are also assumed to be human sources of bacteria loads to Whitewood Creek. Densities of on-site wastewater treatment systems in the watershed were derived from the 2000 U.S. Census statistics [Carter, 2002]. Discharge from the Deadwood/Lead WWTP and the Lead CSO is considered a point source while any on-site wastewater treatment systems and leaks in sewer lines are considered nonpoint sources.

Table 3-1. Approximate Livestock Population Densities for Lawrence County

Species	Population Density (per mi^2)
Beef Cattle	6.68
Dairy Cattle	0.10
Hogs/Pigs	n/a
Sheep	1.53
Bison	n/a
Horses	0.84
Chickens	1.10

The retired director of the Environmental Health Office of Lawrence County, Mr. Roger Marshall, believes that less than 15 percent of the on-site wastewater treatment systems in the Lead and Deadwood areas are failing [Marshall, 2002]. SD DENR estimates that there are approximately 351 on-site wastewater treatment systems in use in the study area [Sawyer, 2002].

Because of leaks in sewer lines, raw sewage may bypass the wastewater treatment plant and flow directly into surface water or groundwater. Raw sewage could have high levels of pathogenic bacteria, protozoans, and viruses [U.S. Environmental Protection Agency, 2001b] in addition to elevated levels of fecal coliforms [Carter, 2002]. There are approximately 55 to 60 miles of sewer lines in Lead. Much of the existing sewer lines were constructed from clay tiles in the 1890s. Some of the clay tile sewer lines are in poor condition. Approximately 90 percent of the sewer lines in Deadwood have been replaced. The remaining 10 percent of the sewer lines that had not yet been replaced were constructed of clay tiles; however, the city of Deadwood plans to replace these remaining lines [Renner, 2002].

3.2.3 Natural Background/Wildlife

Wildlife within the watershed is a natural background source of bacteria. For watershed modeling purposes, wildlife population density estimates in Table 3-2 were obtained from the South Dakota Department of Game, Fish and Parks [1982]. Turkeys and whitetail deer were shown to be the most dense wildlife species in the Whitewood Creek Watershed. Avian species are a large source of bacterial counts at each watershed, throughout almost all types of flows. Through discussions at public meetings with ranchers in the area, it was determined that wild turkeys in the area were a probable source of bacteria. It was suggested that the number of wild turkeys in the watershed is large and the turkeys use the riparian areas adjacent to the stream.

Table 3-2. Approximate Wildlife Population Densities for Lawrence County in 2001

Species	Population Density (per mi^2)
Whitetail Deer	12.55
Turkeys	11.29
Mule Deer	3.76
Raccoons	1.25
Beaver	0.76
Elk	n/a
Ducks	n/a
Canadian Geese	n/a
Grouse	n/a

3.3 BACTERIAL SOURCE TRACKING

Bacteria samples (n = 257) were collected and analyzed in 2003 on a weekly basis from May 29 through September 10 for bacterial source tracking to determine sources of fecal coliform bacteria within the watershed. A ribotyping test was used to link bacteria from samples to known sources. Ribotyping uses a DNA fingerprint of *E. coli* which shows differences among members of the same species of *E. coli* that have adapted to live in different host species. Because of differences in the intestinal environments of different species, these genes can be used to distinguish animal sources.

The source tracking assessment was completed at three separate locations: Whitewood Creek above Gold Run (WWC a GR), Gold Run Creek at the junction with Whitewood Creek (GRC), and Whitewood Creek below Deadwood (WWC b DWD). These locations are illustrated in Figure 3-1. Total fecal coliform values were highest at WWC b DWD. Categories used for the assessment include wild animals (avian, bear, deer/elk, rabbit, raccoon, rodent), domestic animals (canine and feline), livestock (bovine and horse), and human.

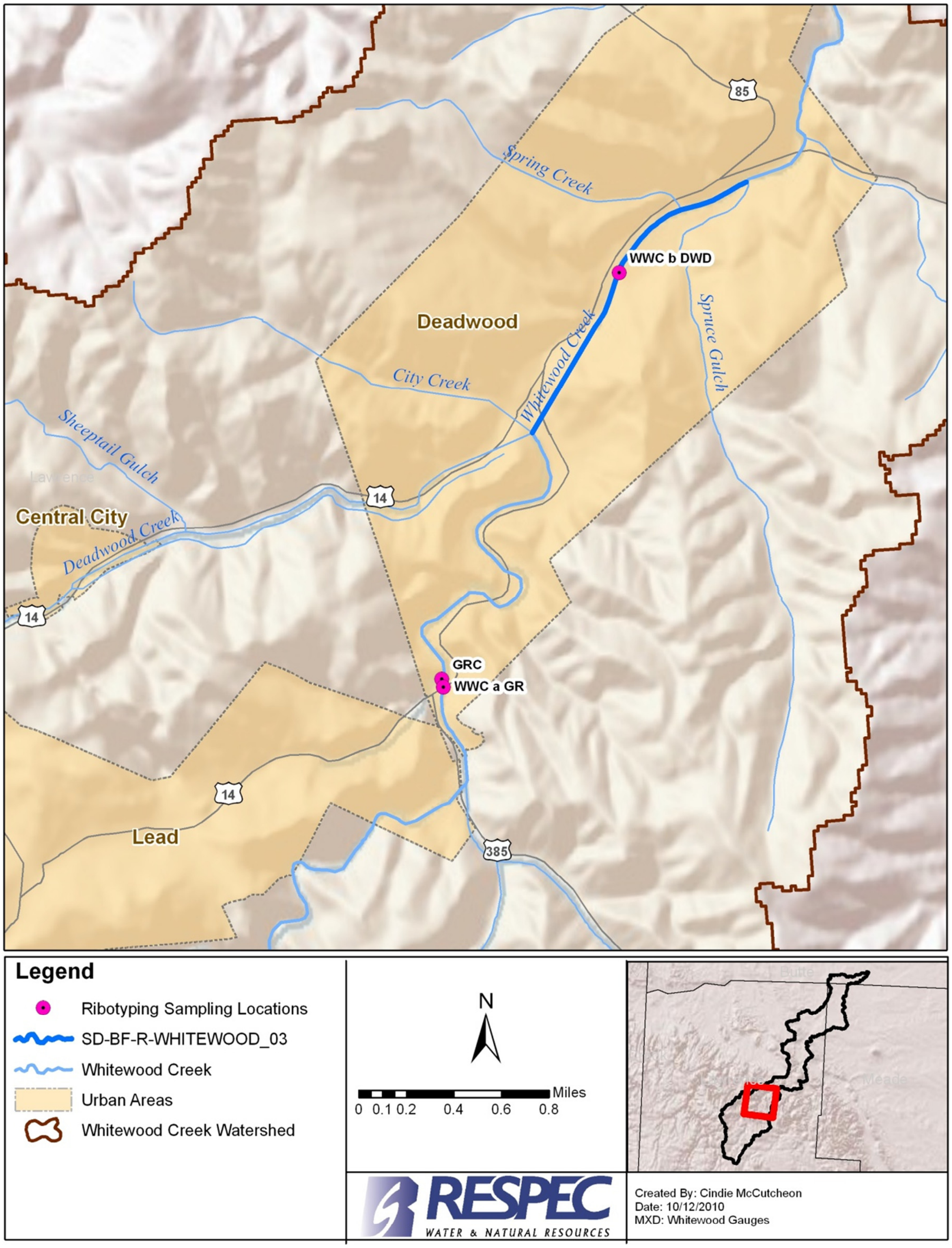

Figure 3-1. Ribotyping Locations.

Each of the three locations (Whitewood Creek above Gold Run, Whitewood Creek below Deadwood, and Gold Run Creek) were analyzed collectively and separately. Figure 3-2 shows the ribotyping results by category for all locations combined, and Table 3-3 shows the percent of contributions by source during all flows and high flows.

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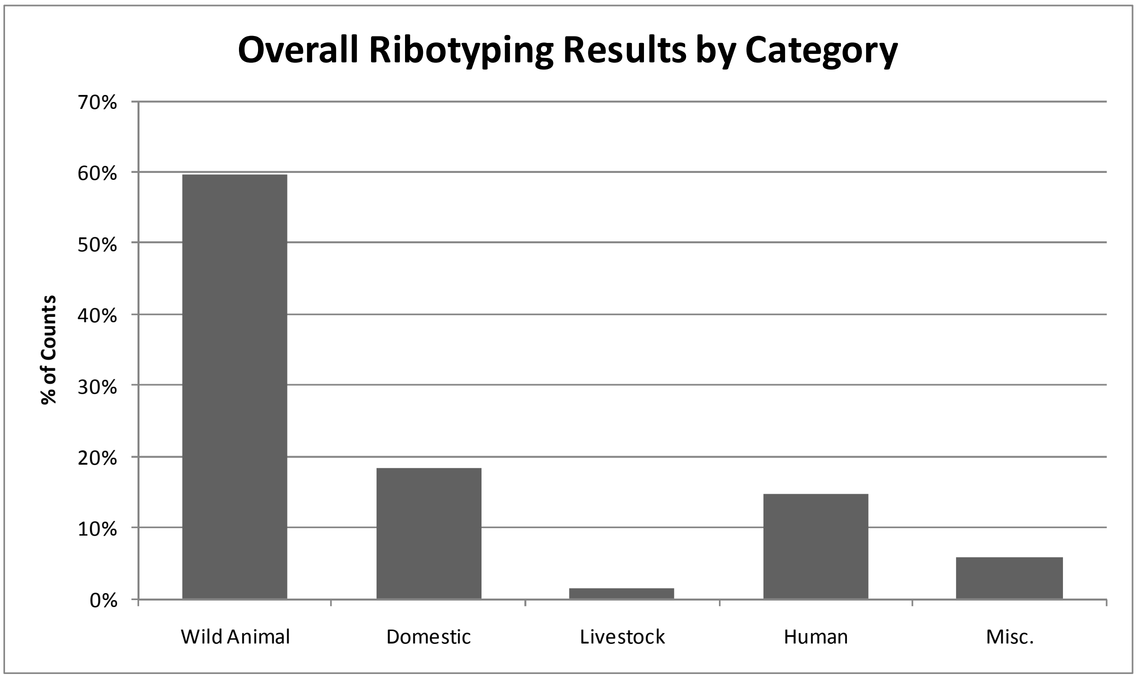

Figure 3-2. Ribotyping Results by Category for All Sampling Locations Combined.

Source tracking results from all flows and from high flows (Table 3-3) were fairly similar. Wild animals made up the majority of the bacterial counts, with numbers decreasing from upstream to downstream. Domestic animals and humans made up the second highest bacterial counts, with numbers increasing from upstream to downstream. Agricultural livestock made up the smallest percentages at all locations [Kenner, 2009]. These results seem logical, as population also increases from WWC a GR (the most upstream bacterial source tracking location), to GRC (influenced by Lead), to WWC b DWD (influenced by Deadwood).

Source tracking results during high flows at the WWC b DWD location, which is located within the impaired reach, had wild animals (avians, rodents, and a small amount of deer/elk) accounting for approximately half of the fecal coliform counts and domestic (canine) and human each accounting for a quarter of the counts [Kenner, 2009]. The percent of human counts from the site downstream of Lead and the site just above Lead were 10 and 20 percent lower, respectively, than counts from the site below Deadwood. The increase in human counts from the reach upstream of Lead to the reach downstream of Lead to the reach within and downstream of Deadwood may indicate that human sources in the impaired reach during high flows are not only from the Lead CSO and sewer lines, but could also be from sanitary sewer cross connections with Deadwood storm sewers and/or stormwater discharge from Deadwood and/or washoff from overland flow.

Table 3-3. Total Fecal Coliform Contributions to Whitewood Creek From Each of Three Sampling Locations During All Flows and High Flows [Kenner, 2009]

Location	Source	Total Contribution (%) All Flows	Total Contribution (%) High Flows
Whitewood Creek above Gold Run	Agricultural livestock	2	0
	Domestic animals	15	19
	Wild animals	67	71
	Human	6	5
	Unknown	10	5
Gold Run Creek at the Junction with Whitewood Creek	Agricultural livestock	0	0
	Domestic animals	18	20
	Wild animals	63	65
	Human	13	15
	Unknown	5	0
Whitewood Creek below Deadwood	Agricultural livestock	3	0
	Domestic animals	20	24
	Wild animals	51	51
	Human	21	25
	Unknown	5	0

3.4 HYDROLOGIC MODEL

The HSPF model application, developed by Carter for the years of 1991 through 1998, was used to simulate the sources of loads in the watershed. Direct sources modeled include the Lead/Deadwood WWTP, the CSO, leaking sewers and septic systems, and wildlife/livestock direct defication. The permit for the CSOs does not have a set bacteria limit, and requires ultimate elimination of the CSO. Indirect sources modeled throughout the watershed that were represented include washoff from urban/built-up land, rangeland, forestland, and agricultural land.

The HSPF model application was also used to simulate the implementation of BMPs and evaluate their effectiveness in reducing bacteria loads in the Whitewood Watershed. The nonpoint sources in the study area were represented in HSPF with per-acre fecal coliform accumulation rates and maximum fecal coliform storage rates for each source estimated by the BIT. The buildup and washoff of fecal coliform was simulated based on these rates, precipitation, and predicted runoff. The BIT was also used to calculate fecal coliform bacteria loadings that represent livestock in streams and human sources, which were then used as inputs to the HSPF model.

It was determined that the wasteload allocation for the Lead/Deadwood WWTP be based on its discharge permit; the fecal coliform concentration, geometric mean is to be less than 200 cfu/100 mL and the daily maximum is not to exceed 400 cfu/100 mL. Carter's HSPF model application used a wasteload allocation for the Lead/Deadwood WWTP of approximately 1×10^{10} cfu/day [Carter, 2002].

One of the two combined sewer outfalls was removed in 2001. However, because the modeling period was from 1991 to 1998 (before removal occurred), point sources were modeled to represent both outfalls. A best management practice representing the removal of one outfall in 2001 was simulated to account for the removal of the outfall. Most overflows last 2 hours or less [Carter, 2002]. To create time series for both of the combined sewer outfalls, it was assumed that overflows only occurred in the months that they were reported. The precipitation records were reviewed and whenever the precipitation exceeded 0.33 inch in those months when overflows were reported, a discharge and fecal coliform load were added to the appropriate time series. When it was assumed that a discharge occurred, a daily flow of 0.39 cfs was added to the flow time series. This discharge rate represents an overflow of 250,000 gallons for that day. The fecal coliform loading for that day was assumed to be equal to the product of the discharge and the reported geometric mean of the fecal coliform samples collected and reported for that month. Based on these estimates, the CSO that discharges to Gold Run Creek overflowed 148 times from 1991 to 1998. The outfall that discharged to Whitewood Creek overflowed 39 times.

The fecal coliform model inputs were adjusted from Carter's initial estimates to match observed fecal coliform concentrations at five monitoring locations upstream of the TMDL endpoint. The inputs were classified as either indirect or direct sources and adjusted simultaneously within their respective classes. This method allowed for the original estimates to maintain their weight in their respective classes while also allowing flexibility to accurately represent indirect and direct sources. The model performance was evaluated visually using concentration duration curves which show the statistical distribution of the observed data compared to all simulated and paired simulated data, as shown in Figure 3-3 through Figure 3-7. The duration curves also show the water-quality standard which compares the observed and simulated exceedance percentages. Overall, the figures show the model performed very well and adequately represents direct and indirect sources accurately.

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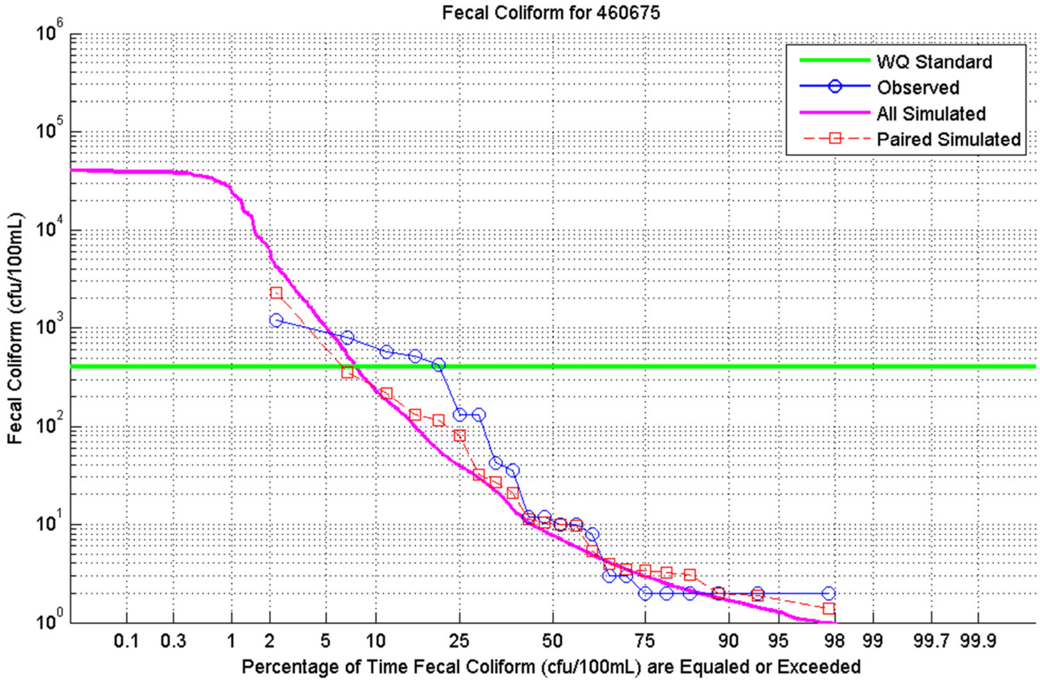

Figure 3-3. Concentration Duration Curve for West Strawberry Creek (460675).

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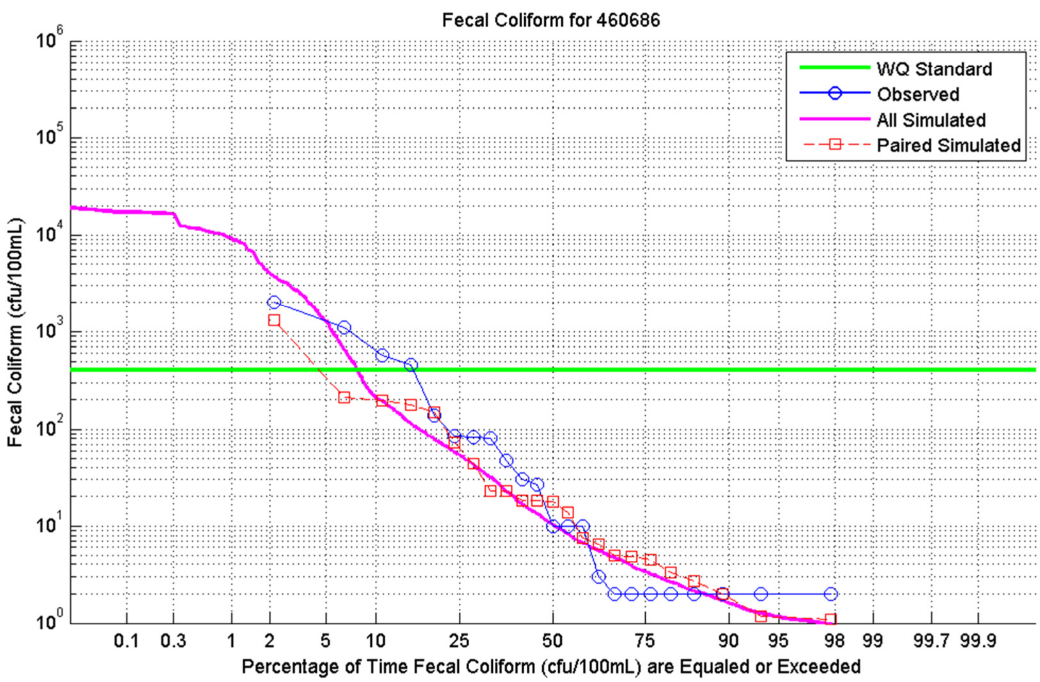

Figure 3-4. Concentration Duration Curve for Whitewood Creek Above Gold Run (460686).

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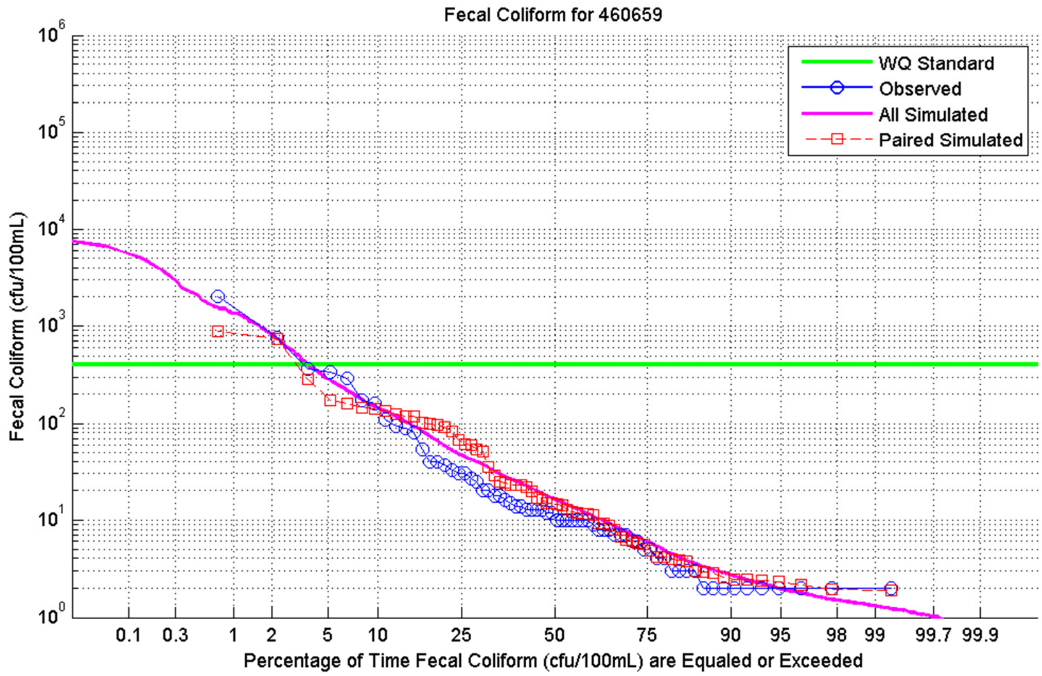

Figure 3-5. Concentration Duration Curve for Gold Run Creek (460659).

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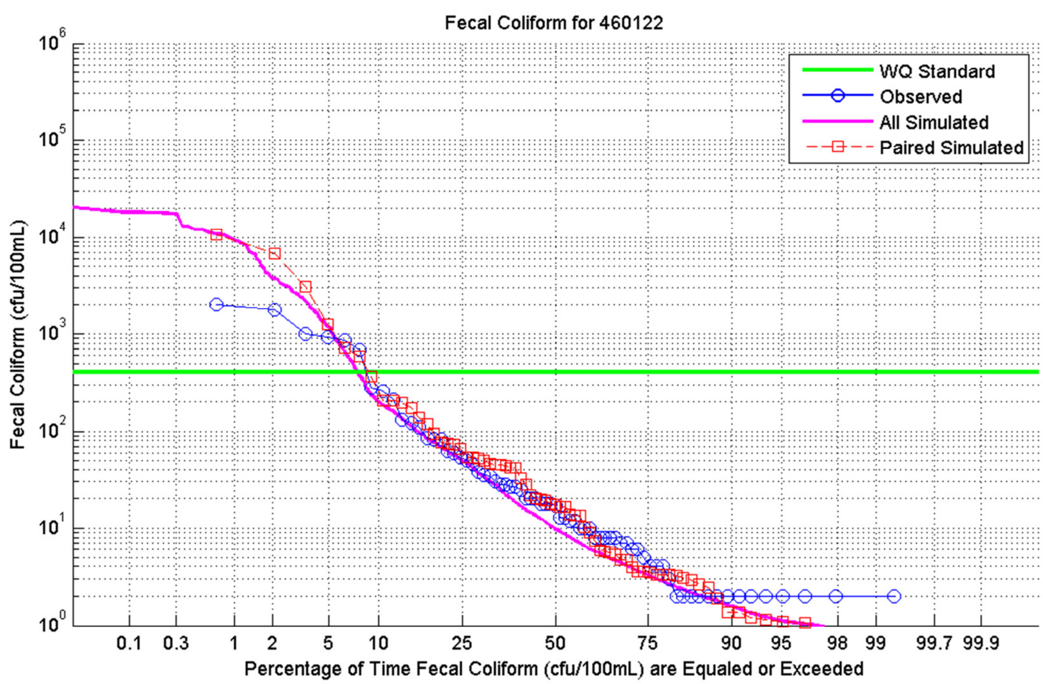

Figure 3-6. Concentration Duration Curve for Whitewood Creek Near Deadwood (460122).

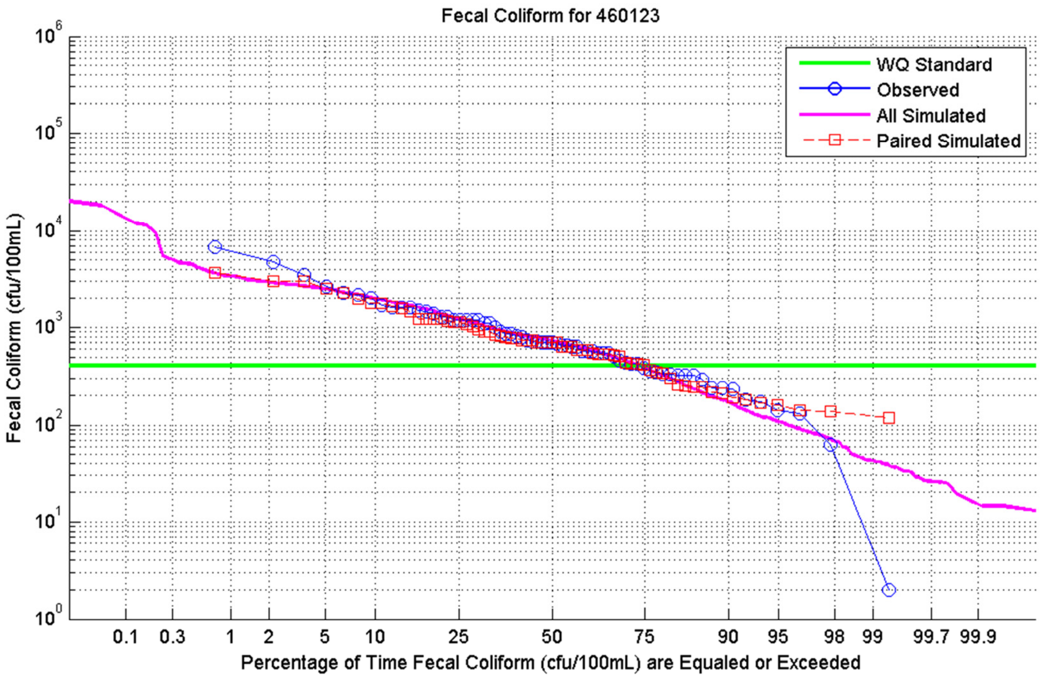

Figure 3-7. Concentration Duration Curve for Whitewood Creek Below Deadwood (460123).

Figure 3-8 shows boxplots of sites in the vicinity of the impaired reach from upstream to downstream which were constructed for water-quality monitoring sites using only data from the Carter's modeling period (1991 through 1998). The main difference between these boxplots and the 2003 through 2009 boxplots presented in Section 1.3 is a large increase at the West Strawberry Creek site. The West Strawberry Creek loads are likely negligible within the impaired reach because of decay and dilution. A pie chart of the load influences above Deadwood and at the TMDL reach endpoint, presented in Figure 3-9, shows that only 1 percent of the load in the impaired reach comes from upstream of the impaired reach. Three percent of the loads at the TMDL reach endpoint are from Deadwood Creek, and the remainder of the load at the TMDL endpoint is from the Deadwood Area. Flow contributions from upstream of the impaired reach are approximately 50 percent of the total flow, and flow contributions from the Deadwood area are approximately 30 percent of the total flow. Because the impaired reach receives over one third of the flow contribution from the Deadwood area, having observed concentrations of more than seven times any upstream observed concentrations, there is reasonable assurance that the Whitewood Creek model predictions, which show that 96 percent of the loads being from the Deadwood area, adequately represents BMP reductions.

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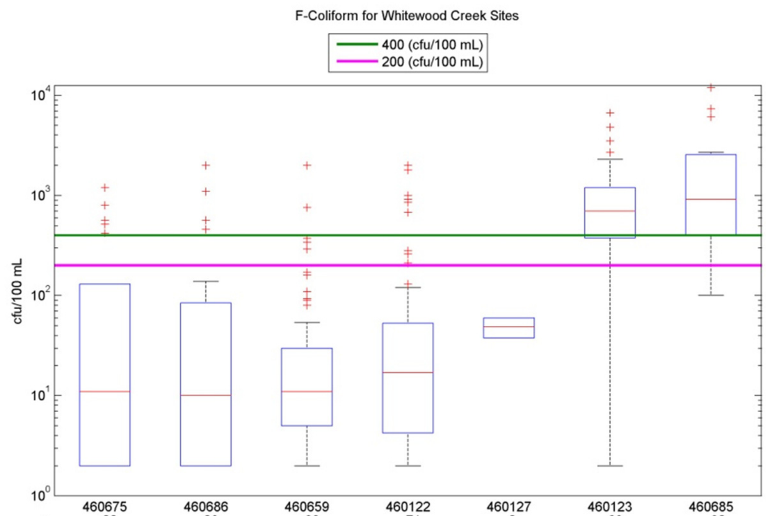

	460675	460686	460659	460122	460127	460123	460685
n	22	23	68	71	2	69	32
Min	2	2	2	2	38	2	100
Max	1200	2000	2000	2000	60	6700	12000
q1	2	2	5	4.25	38	375	410
Median	11	10	11	17	49	700	920
q3	130	84.5	30	53	60	1200	2550
Mean	178	203	76.12	133.6	49	997.9	2250.6
90th%	2	2	2	2	38	139.5	205
95th%	960	1415	343	917	60	2740	7400
% Exceeded	23	17	2.9	8.5	0	74	75
Geo30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
%Excd	0	0	0	0	0	0	0
Geo30 n							

Figure 3-8. Boxplots of 1991 Through 1998 (Modeling Period) Fecal Coliform Data for Sites Upstream, Within, and Downstream of the Impaired Reach.

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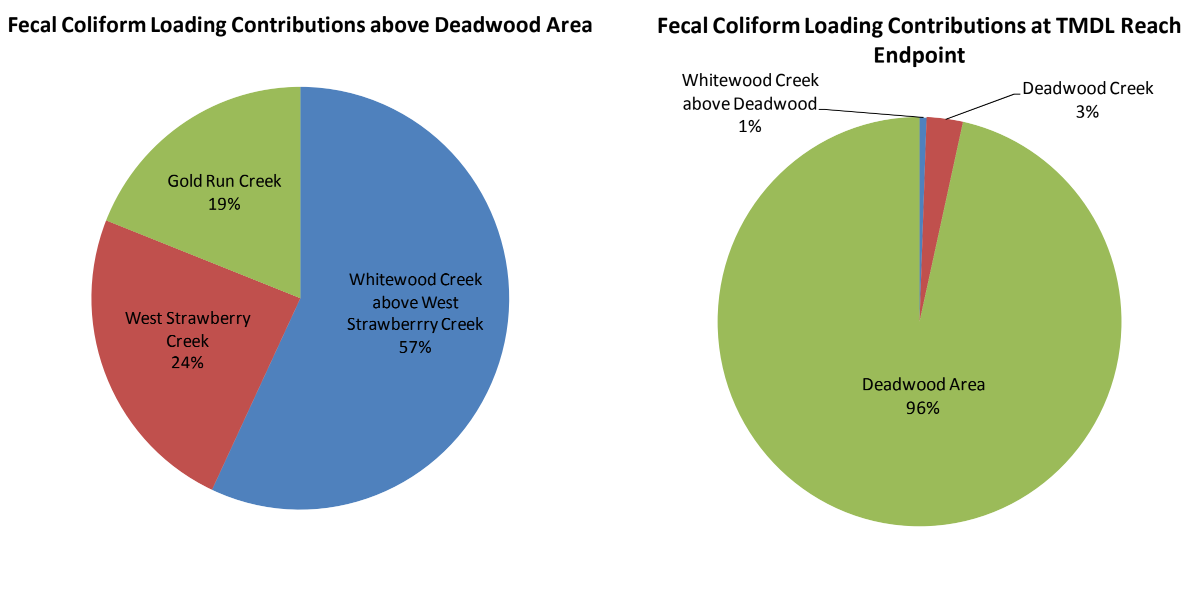

Figure 3-9. Pie Charts of Fecal Coliform Load Contributions Upstream of the Deadwood Area (Left) and at the Endpoint of the Impaired TMDL Reach (Right).

The city of Lead has already explored several options for treating the overflows from the combined sewer. To alleviate the problems associated with the combined sewer overflow, the city has decided to separate the sanitary and storm sewers. Approximately 40 percent of the sewer lines have already been separated [Thomas, 2010]. As the combined sewer is separated, the existing clay tile sewer lines will also be replaced [Carr, 2002]. During the separation process, urban stormwater-quality control measures should be implemented. Urban stormwater management systems such as storm sewers, ponds, and detention basins, are commonly used for pollutant reduction was well as flood control. To simulate this remediation effort, the point sources representing the combined sewer overflow in Lead were turned off in the model application, which resulted in a 17 percent load reduction.

To simulate the removal of failing on-site wastewater treatment systems and leaking sewer lines, it was assumed that approximately half of the failing on-site wastewater treatment systems and leaking sewer lines could be located and repaired or replaced. The removal of 50 percent of failing on-site wastewater treatment systems and leaking sewer lines resulted in a 38 percent load reduction.

It was assumed that a stormwater treatment program would be effective within the cities, so the effectiveness of these programs was only simulated for the urban land downstream of Gold Run Creek and Lead. To evaluate the effectiveness of these practices, the fecal coliform accumulation rates for the Commercial and Services, Mixed Urban or Built-up, and Residential land uses were reduced by 50 percent. The implementation of stormwater treatment in the model reduced loads by 6 percent.

The simulation of buffer/filter strips, avian control, direct defecation reduction, and overland load reduction from forest, pasture, and cropland was estimated to have a 50 percent efficiency on reducing bacteria loads from overland washoff and in-stream defecation. To simulate this BMP, the overland bacteria load and the load from in-stream defecation was reduced by 50 percent. The implementation of buffer/filter strips, avian control, direct defecation reduction, and overland load reduction from forest, pasture, and cropland in the model reduced the load by 2 percent.

4.0 LOAD DURATION CURVE ANALYSIS

This TMDL was developed using the Load Duration Curve (LDC) approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1–September 30). The LDC is a dynamic expression of the allowable load for any given flow within the recreation season. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10 percent), moist conditions (10–40 percent), midrange flows (40–60 percent), dry conditions (60–90 percent), and low flows (90–100 percent) according to the U.S. Environmental Protection Agency [2007].

Instantaneous loads were calculated by multiplying the fecal coliform sample concentrations from SD DENR WQM 123 by the measured flow at the time the water sample was collected and by a unit conversion factor (0.0245) which converts the product of concentration and flow to a daily cfu load (product of flow (cubic feet per second (cfs)), concentration (cfu/100 mL), 86,400 seconds per day (sec/day), 28.32 liters per cubic feet (L/ft^3), and 1,000 milliliters per liter (mL/L). Recent flow data were not available for the closest USGS station (USGS 06436170); thus, a regression analysis was completed comparing flow at a downstream location (USGS 06436180). The analysis correlation between the two locations was determined to be significant ($r^2 = 0.88$ and $p < 0.05$) with no lag time between stations; therefore, discharge values from the downstream location were used with the regression equation (upstream station = downstream station × 0.8265 + 3.1156) to calculate the flow near Deadwood. These calculated discharge values for the upstream location were used for the upstream load calculation.

Two bacteria LDCs were constructed for the impaired reach using data from 1991 through 2009. The first LDC (constructed using the acute criteria), as shown in Figure 4-1, used observed bacteria data and observed flow data from within the reach. This plot includes observed loads calculated using observed instantaneous daily bacteria data and observed instantaneous daily flow data from monitoring stations. The second LDC (constructed using geometric mean criteria), shown in Figure 4-2) for the impaired reach used simulated geometric mean bacteria data and observed geometric mean flow data.

Loads that plot above the solid curve exceed the acute water-quality criterion while loads below the curve are in compliance. Both LDCs show *E. coli* samples collected from Whitewood Creek WQM 123 exceeding the criterion during high, moist, midrange, dry, and low flow conditions. Loads exceeding the criteria in the low flow zone indicate point source load contributions or sources near the stream, such as failing on-site wastewater treatment systems or livestock in the stream channel. Loads within the high flow and moist conditions commonly indicate potential nonpoint source contributions from stormwater runoff [U.S. Environmental Protection Agency, 2007]. The LDCs shown in Figures 4-1 and Figure 4-2 represent dynamic expressions of the *E. coli* bacteria TMDLs for the impaired reach of Whitewood Creek that are based on the acute and chronic *E. coli* criterion. These LDCs result in unique loads that correspond to average daily flows.

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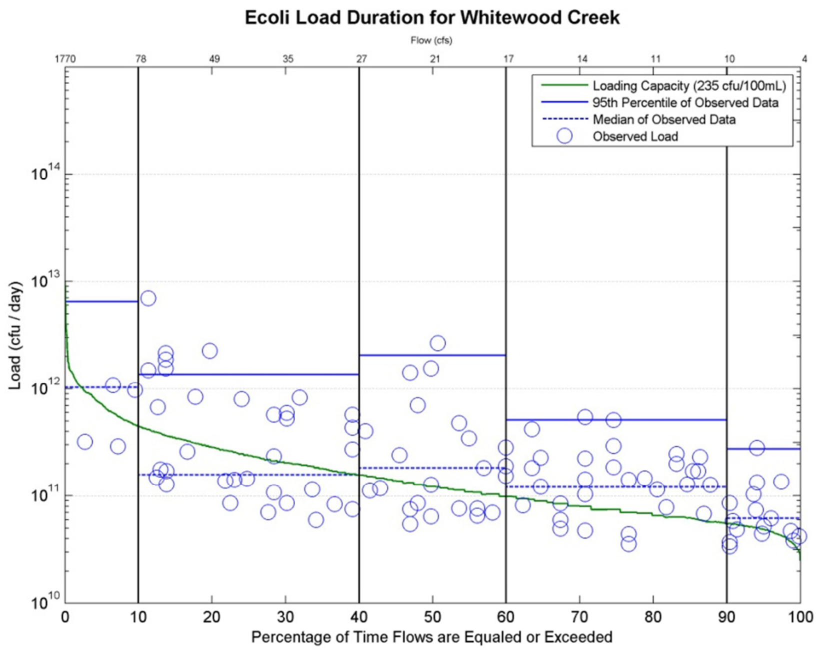

Figure 4-1. Load Duration Curve Representing Allowable Loads of Daily *E. coli* Based on Acute *E. coli* Criteria (≤ 235 cfu/100 mL) and Calculated Stream Flow From May to September.

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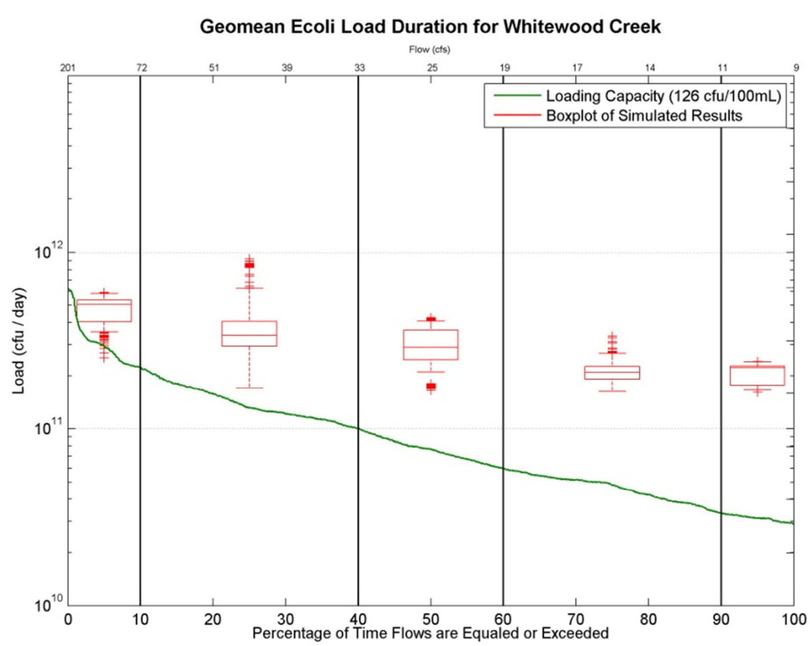

Figure 4-2. Load Duration Curve Representing Allowable Loads of Geometric Mean *E. coli* Based on Chronic *E. coli* Criteria (≤ 126 cfu/100 mL) and Calculated Stream Flow From May to September.

5.0 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

To ensure that all applicable *E. coli* criteria are met and aid in the implementation of the TMDL, load allocations were calculated for each of the five flow zones using both the acute and chronic criteria. The criterion requiring the greatest load reduction from baseline conditions, which varies by flow zone, was used to establish the TMDL allocations. Methods used to calculate the TMDL allocations are discussed in more detail below.

The TMDL is in effect from May 1 through September 30, as the *E. coli* criteria are applicable only during this period. In addition, only data from this time period were used to develop the TMDL allocations and load reduction goals.

5.1 LOAD ALLOCATION

To develop the *E. coli* bacteria load allocation (LA), the loading capacity was first determined. Both the acute criterion (235 cfu/100 mL) and the chronic criterion (126 cfu/ 100 mL) were used for the calculation of the loading capacity. The loading capacity for Whitewood Creek based on the acute criterion was calculated by multiplying the acute *E. coli* bacteria criterion by the calculated USGS daily average flow. The loading capacity based on the chronic criterion was calculated by multiplying the chronic criterion by the monthly average USGS flows.

For each of the five flow zones, the 95th percentile of the range of loading capacities within a zone was set as the flow zone goal. Bacteria loads experienced during the largest stream flows (e.g., top 5 percent) cannot be feasibly controlled by practical management practices. Thus setting the flow zone goal at the 95th percentile of the range of loading capacities will protect the immersion recreation beneficial use and allow for the natural variability of the system.

The TMDL (and loading capacity) is the sum of waste load allocation (WLA), LA, and margin of safety (MOS). Portions of the loading capacity were allocated to nonpoint sources as an LA, a WLA, and an MOS to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed in Section 6.1. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was, therefore, determined by multiplying the WWTP average design flow by 126 cfu/100 mL for the geometric mean TMDL and by 235 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. The overall LA was determined by subtracting the WLA and MOS from the loading capacity. Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero.

5.2 BASELINE CONDITIONS

Measured sample concentrations and flow data were used to compute current daily loads (cfu × 10^9/day) by calculating the product of calculated *E. coli* sample concentrations (cfu/100 mL) from SD DENR WQM 123, the calculated average daily flow (cfs), and a unit conversion factor (0.0245). Observed load estimates were calculated for WQM 123 from 1991 through 2009. The 95th percentile of the range of these estimates within each flow zone was defined as the baseline daily load.

Baseline conditions for the 30-day geometric mean period were calculated similarly to the daily averaging period. The monthly *E. coli* geometric mean loads (cfu × 10^9/month) were estimated by calculating the products of the geometric mean-simulated calculated *E. coli* concentrations (cfu/100 mL), the calculated geometric mean of average daily stream flows (cfs), and a unit conversion factor (0.0245). The 95th percentile of the range of these estimates within each flow zone was defined as the baseline geometric mean load.

Table 5-1 presents allocations and load reductions required based on the acute criterion for each flow zone, showing that load reductions are required for every flow zone except the high flow zone to meet the acute criterion. Table 5-2 lists monthly allocations based on the chronic criterion, showing that load reductions of the monthly mean loads are required for every flow zone except the high flow zone to meet the chronic criterion. The moist and midrange flow zone allocations based on the acute criterion require slightly greater reductions than the allocations based on the chronic criterion, while the dry and low flow zone allocations based on the chronic criterion require greater reductions than the allocations based on the acute criterion. Thus the allocations listed for the moist and midrange flow zones in Table 5-1 (acute criterion) and the allocations listed for high, dry, and low flow zones in Table 5-2 (chronic criterion) represent the TMDL goals to attain compliance with water-quality standards.

5.3 WASTE LOAD ALLOCATION

One point source (Deadwood WWTP) of *E. coli* bacteria discharges directly to the impaired segment of Whitewood Creek, so the WLA was assigned values 2.22 × 10^{10} cfu/day for the daily maximum TMDL value and 1.19 × 10^{10} cfu/day for the geometric mean TMDL value, which was calculated using the maximum permitted daily maximum and geometric mean concentrations from the point source during the effective criterion period. The Lead/Deadwood WWTP has reported flows of 2.5 mgd. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was therefore determined by multiplying the WWTP-reported flows by 126 cfu/100 mL for the geometric mean TMDL and by 235 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. A WLA for the Lead CSO was set to zero because the Lead CSO permit requires its elimination. No permitted concentrated animal feeding operations currently exist within the Whitewood Creek Watershed.

Table 5-1. Whitewood Creek *E. coli* Bacteria Total Maximum Daily Load Based on the Acute Criterion

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 78 cfs	77–27 cfs	26–17 cfs	16–10 cfs	9–4 cfs
LA	1,439	305	107	52	9
WLA	22	22	22	22	22
MOS	267	80	22	19	24
TMDL	1,729	408	151	94	55
Current Load[(a)]	1,088	2,247	1,953	512	237
Load Reduction	0	1,840	1,802	418	182
Load Reduction	0%	82%	92%	82%	77%

(a) Current load is the 95th percentile of the observed fecal coliform bacteria load for each flow zone.

Table 5-2. Whitewood Creek *E. coli* Bacteria Total Maximum Daily Load Based on the Chronic Criterion

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	>73 cfs	71–33 cfs	31–19 cfs	18–11 cfs	9–9 cfs
LA	516	163	67	31	19
WLA	12	12	12	12	12
MOS	70	31	17	15	2
TMDL	597	206	96	58	33
Current Load[(a)]	590	638	544	402	243
Load Reduction	0	432	448	344	210
Load Reduction	0%	68%	82%	86%	86%

(a) Current load is the 95th percentile of the simulated geometric mean fecal coliform bacteria load for each flow zone.

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 MARGIN OF SAFETY

An explicit MOS identified using a duration curve framework is basically unallocated assimilative capacity intended to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit MOS was calculated as the difference between the loading capacity at the midpoint of each of the five flow zones and the loading capacity at the minimum flow in each zone. A substantial MOS is provided using this method because the loading capacity is typically much less at the minimum flow of a zone as compared to the midpoint. Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS.

6.2 SEASONALITY

Stream flows, as well as actual and calculated *E. coli* concentrations in Whitewood Creek, displayed seasonal variation. Available recreational season daily (actual and calculated) flow, actual *E. coli* concentrations, and calculated *E. coli* concentrations were used to calculate the maximum and minimum average monthly flows and bacteria concentrations for the impaired reach (see Table 6-1). Monthly average stream flows ranged considerably, with the lowest monthly average stream flow occurring in September (14 cfs) and the highest monthly average stream flow occurring in May (84 cfs). A large range of calculated and actual *E. coli* concentrations also occurred. The lowest monthly average recreational season actual and calculated *E. coli* concentration occurred in May (129 and 395 cfu/100 mL, respectively). The highest recreational season monthly average actual *E. coli* concentration occurred in August (442 cfu/100 mL), and the highest monthly average calculated *E. coli* concentration occurred in July (950 cfu/100 mL).

Table 6-1. Whitewood Creek Average Monthly Recreational Season Flows and *E. coli* Concentrations

Month	Average Actual Monthly *E. coli* Concentration (cfu/100mL)	Average Calculated Monthly *E. coli* Concentration (cfu/100mL)	Average Monthly Flow (cfs)
May	128.6	395.4	83.7
June	92.8	554.9	52.1
July	347.1	950.1	21.3
August	442.3	642.5	15.9
September	320.9	495.7	13.7

The highest bacteria concentrations generally occur during the midsummer months. Short-duration, high-intensity rainstorms are common during the summer months. These localized summer storms can cause significant runoff and increased bacteria concentrations for a relatively short period of time while only slightly increasing stream flows. However, by using the LDC approach to develop TMDL allocations, seasonal variability in flow and *E. coli* loads is taken into account, as stream flow and bacteria delivery to the stream is related to seasonal changes in precipitation.

In addition, this *E. coli* bacteria TMDL is seasonal, as it is effective only during the period of May 1 through September 30. Since the criteria for *E. coli* bacteria concentrations are in effect from May 1 through September 30, the TMDL is also applicable only during this time period.

Critical conditions occur during the midrange flow conditions as the greatest load reductions are required during this flow regime. Summer is also a critical time period because of seasonal differences in precipitation patterns and land uses. Typically, livestock are allowed to graze along the streams during the summer months. Also, Black Hills tourism peaks during the summer months. Combined with the peak in bacteria sources, high-intensity rainstorm events are common during the summer and produce a significant amount of *E. coli* load because of bacterial washoff from the watershed. Similarly, loads from the CSO would be at their peak during summer months.

7.0 PUBLIC PARTICIPATION

Efforts taken to gain public education, review, and comment during development of the Whitewood Creek fecal coliform bacteria TMDL involved presentations to local groups in the watershed on the findings of the assessment and a 30-day public notice period for public review and comment. The findings from these public meetings and comments were taken into consideration in development of the TMDL. The public notice was published in the *Meade County Times-Tribune*, the *Rapid City Journal*, and the *Lawrence County Journal*. The document was made available through the SD DENR's website.

It was desired to hold informational meetings, provide news releases on a quarterly basis for the public, and inform the involved parties of progress on the study. Public meetings were held at Herford, Sturgis, Belle Fourche, Newell, Vale, and Spearfish in 2002. In addition, the project information and results were presented at various conservation district meetings (Butte, Lawrence, and Elk Creek). A special stakeholders meeting was also held to discuss the number of cattle below Lead and Deadwood.

8.0 MONITORING STRATEGY

During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDL. Stream water-quality monitoring will be accomplished through SD DENR's WQM 123 on Whitewood Creek, which is sampled on a monthly basis during the effective criteria period.

Additional monitoring and evaluation efforts should be targeted toward the effectiveness of implemented BMPs. Monitoring locations should be based on the location and type of BMPs installed.

SD DENR may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that develop during the implementation phase of the TMDL. New information generated during TMDL implementation may include monitoring data, BMP effectiveness information, and land use information. SD DENR will propose adjustments only in the event that any adjusted LA or WLA will not result in a change to the loading capacity. The adjusted TMDL, including its WLAs and LAs, will be set at a level necessary to implement the applicable water-quality standards, and any adjusted WLA will be supported by a demonstration that load allocations are practicable. SD DENR will notify EPA of any adjustments to this TMDL within 30 days of their adoption. Adjustment of the LA and WLA will only be made following an opportunity for public participation.

9.0 RESTORATION STRATEGY

A variety of BMPs could be considered in the development of a water-quality management implementation plan for the impaired portion of the Whitewood Creek Watershed. While several types of control measures are available for reducing *E. coli* bacteria loads, the practicable control measures listed and discussed below are recommended to address the identified sources. Based on water-quality monitoring, bacterial source tracking, and **HSPF** model results, there is reasonable assurance that the recommended control measures to be implemented in South Dakota will achieve the required load reductions and attain the TMDL goal.

The combined flow-weighted percent reductions required to meet the TMDL based on acute and chronic water-quality criterion were 60 and 59 percent, respectively. Required percent reductions for the five flow zones, either acute or chronic, ranged from 0 percent for the acute high flow zone to 92 percent for the acute midrange flow zone (Table 5-1 and 5-2). In addition to the TMDL prepared, the following BMPs were simulated within the **HSPF** model framework:

- Complete replacement of the CSO system in Lead, South Dakota.
- Reduction of on-site wastewater treatment system failures and leaking sewer lines.
- Stormwater treatment programs for urban areas.
- Riparian buffers and filter strips, avian management practices, reduction of direct defecation, and reduction of overland load from forest, pasture, and cropland.

The combination of these BMPs showed a 63 percent reduction of the daily load. Therefore, there is reasonable assurance that the TMDL can be attained considering inherent modeling error and the applied MOS. Implementation progress to date includes 40 percent replacement of the CSO system in Lead, South Dakota [Thomas, 2010] and replacement of over 90 percent of sewer lines in Deadwood [Renner, 2002]. Completion of the CSO replacement project is a part of a ten year plan [Thomas, 2010].

The calibration results of the **HSPF** model application showed higher *E. coli* concentrations in low flows which indicates an influence from direct sources. Direct sources contribute to the bacteria loading similarly at all flows causing higher concentrations during low flows. The direct sources in the Whitewood Creek Watershed above the TMDL endpoint primarily include, septic system failures and leaking sewer lines. Indirect sources require high runoff to influence in-stream *E. coli* loads. High amounts of runoff also cause higher stream flows which result in lower concentrations. The indirect sources in the Whitewood Creek Watershed include landscape *E. coli* accumulation and washoff from wildlife and livestock. The model BMP simulation indicates that complete removal of the CSO, reduction of on-site wastewater treatment facilities and leaking sewer lines, and a Deadwood stormwater treatment/urban litter control program should be the primary target for future BMP implementation. It is recommended that an in-depth BMP scenario analysis be performed before developing a future BMP implementation plan.

There is reasonable assurance that the goals of this TMDL established for Whitewood Creek can be met with proper planning between state and local regulatory agencies, organizations and stakeholders, BMP implementation, and access to adequate financial resources. Funds to implement watershed water-quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota, including Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Nonpoint Source program.

10.0 REFERENCES

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APPENDIX A

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII TOTAL MAXIMUM DAILY LOAD REVIEW

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	**E. coli Total Maximum Daily Load for Whitewood Creek, Lawrence County, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**August 25, 2010**
Review Date:	**September 9, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final review only):

☐ Approve
☐ Partial Approval
☐ Disapprove
☐ Insufficient Information

Approval Notes to Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the minimum submission requirements and TMDL elements identified in the following 8 sections:

1. Problem Description
   1.1. TMDL Document Submittal Letter
   1.2. Identification of the Waterbody, Impairments, and Study Boundaries
   1.3. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   4.1. Data Set Description
   4.2. Waste Load Allocations (WLA)
   4.3. Load Allocations (LA)
   4.4. Margin of Safety (MOS)
   4.5. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered "impaired." When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's minimum submission requirements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in the minimum submission requirements denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review template is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal Letter

When a TMDL document is submitted to EPA requesting formal comments or a final review and approval, the submittal package should include a letter identifying the document being submitted and the purpose of the submission.

Minimum Submission Requirements.

☒ A TMDL submittal letter should be included with each TMDL document submitted to EPA requesting a formal review.

☒ The submittal letter should specify whether the TMDL document is being submitted for initial review and comments, public review and comments, or final review and approval.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek *E. coli* TMDL was submitted to EPA for review during the public notice period via an email from Cheryl Saunders, SD DENR on August 25, 2010. The email included the draft TMDL document and a public notice announcement requesting review and comment.

COMMENTS: None

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included.

Minimum Submission Requirements:

☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s).

☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map.

☐ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity_ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek is a stream located in the Black Hills of western South Dakota. Its headwaters are located near the base of Deer Mountain and it ends at the confluence with the Belle Fourche River near Vale, SD. Whitewood Creek has a contributing drainage area of approximately 105 square miles. It flows to the Belle Fourche River from the Lower Belle Fourche sub-basin (HUC 10120202). The impaired segment of Whitewood Creek begins at Deadwood Creek and ends at Spruce Gulch (1.8 miles; SD-BF-R-WHITEWOOD_03), and is listed as a medium priority for TMDL development.

This segment is identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated *E. coli* and fecal coliform concentrations. The fecal coliform impairment will be addressed in a separate TMDL document.

The designated uses for the listed segment of Whitewood Creek include: coldwater permanent fish life propagation waters, immersion recreation waters, limited-contact recreation waters, irrigation waters, fish and wildlife propagation, recreation, and stock watering.

COMMENTS: None.

SD DENR Comments: Watershed and inches of rain presented in Section 1.1 was rounded to the nearest square mile and inch, respectively. A land use discussion and percent land use table was changed from the entire watershed to the watershed above the TMDL endpoint. The phrase "A majority of the impaired reach is located within the City of Deadwood" was added to the last paragraph of the watershed characterization.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g., insufficient data were available to determine if this water quality criterion is being attained).

Minimum Submission Requirements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the significant sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)).

Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek segment addressed by this TMDL is impaired based on *E. coli* concentrations that are impacting the immersion recreation beneficial uses. South Dakota has applicable numeric standards for *E. coli* that may be applied to this river segment. The numeric standards being implemented in this TMDL are: a daily maximum value of *E. coli* of 235 cfu/100mL in any one sample, and a maximum geometric mean of 126 cfu/100mL during a 30-day period. The standards for *E. coli* are applicable from May 1 to September 30. Discussion of additional applicable water quality standards for Whitewood Creek can be found on pages 8 - 10 of the TMDL document.

COMMENTS: None.

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddeness, stream morphology, up-slope conditions and a measure of biota).

Minimum Submission Requirements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained.

Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.

☐ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The water quality targets for this TMDL are based on the numeric water quality standards for *E. coli* established to protect the immersion recreation beneficial uses for the impaired segment of Whitewood

Creek. The *E. coli* targets are: daily maximum of ≤ 235 cfu/100mL in any one sample, and maximum geometric mean of ≤ 126 cfu/100mL during a 30-day period. The *E. coli* standards are applicable from May 1 to September 30.

COMMENTS: None.

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each significant source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each significant source (or source category) should be identified and quantified to the maximum practical extent. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Minimum Submission Requirements:

☒ The TMDL should include an identification of all potentially significant point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified, characterized, and properly quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The TMDL document identifies the land uses in the watershed as a mixture of predominately evergreen forest and grasses with a small amount of cropland and other uses. The specific landuse breakdown for the watershed is included in Table 1-1 excerpted from the TMDL below.

Table 1-1. Watershed Land Use in the Whitewood Creek Watershed

Land Uses	Area (acres)	% of Area
Evergreen Forest	30,131	45.1
Grassland/Herbaceous	21,304	31.9
Cultivated Crops	4,915	7.4
Shrub/Scrub	3,977	5.9
Woody Wetlands	2,118	3.2
Developed, Open Space	1,232	1.8
Developed, Low Intensity	1,162	1.7
Barren Land (Rock/Sand/Clay)	513	0.8
Pasture/Hay	432	0.6
Deciduous Forest	321	0.5
Open Water	223	0.3
Emergent Herbaceous Wetlands	208	0.3
Developed, Medium Intensity	173	0.3
Mixed Forest	137	0.2
Developed, High Intensity	9	0.0
Total	**66,855**	**100**

One point source, the permitted Lead/Deadwood wastewater treatment plant located in Deadwood, discharges effluent containing *E. coli* bacteria directly into the impaired segment of Whitewood Creek. No permitted concentrated animal feeding operations currently exist within the Whitewood Creek watershed.

One combined sewer outfall (CSO) remains in the city of Lead. A 10-inch weir located in the sewer keeps wastewater from flowing out of the CSO in Lead under normal conditions. However, during some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The waste that passes over the weir from the overflow travels down a concrete channel and flows into Gold Run Creek and eventually into Whitewood Creek. An average overflow, resulting from approximately 1 inch of rain per hour, likely results in an overflow of 250,000 gallons.

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of bacteria within the Whitewood Creek watershed include livestock, wildlife, aging onsite wastewater treatment and sewer systems, and the CSO in Lead. Using the best-available information, loadings were estimated from each of these sources using the EPA's Bacterial Indicator Tool (BIT) based on the density and distribution of animals (livestock and wildlife) and failing onsite wastewater treatment systems in the watershed.

Manure from livestock is a potential source of *E. coli* to the stream. Livestock population densities in the watershed were estimated using Census of Agriculture data. Livestock contribute bacteria loads to the Whitewood Creek by defecating directly into the stream while wading and indirectly by defecating on rangelands that are washed off during precipitation events. Both the indirect and direct sources of bacteria loads from livestock were represented in the modeling applications.

COMMENTS: On page 12 of the TMDL document it mentions using livestock density populations in the modeling. However, the TMDL does not include a table showing the livestock population densities in the watershed. We recommend adding a table that includes livestock population densities for the Whitewood Creek watershed similar to the table provided for wildlife population densities.

SD DENR Comments: A table of livestock densities was added to Section 3.2.1

This segment is very small and appears to begin in the City of Deadwood and extend to approximately the WWTP. The TMDL does not include specific details on the sub-watershed drainage area for this segment. It may be helpful to review and discuss the water quality data in the segment directly above and below the listed segment for additional clues on what may be causing the bacteria problems in this segment. It seems odd that the segments above and below the listed segment are not impaired for pathogens, yet they also receive loads from many of the same sources (i.e., Lead's CSO, WWTP, failing septic systems, wildlife, livestock). Because the TMDL segment is almost entirely along Main Street in Deadwood we wonder if the source(s) may be more localized. We also wonder how much wildlife (i.e., turkeys or other avian species) or livestock are / are not concentrated in the Deadwood vicinity or immediate drainage area. If wildlife and livestock are not present in significant quantities in the localized drainage area then the sources could be related to sanitary sewer cross connections with the storm sewer, cracked or broken sanitary sewer lines draining into the storm sewer or directly to the stream, stormwater discharge from Deadwood or a combination of the above. We recommend adding information about potential localized sources and plans to investigate additional local sources during the restoration phase.

SD DENR Comments: An analysis of bacteria concentrations from upstream to downstream and information about potential localized sources and plans to investigate additional local sources was added to Section 1.3. Also, detail on on-site wastewater treatment systems, leaks in sewer lines, and the CSO was added to section 3.2.2. Further information on potential localized sources was also added to the ribotyping section discussing bacterial sources. A column showing ribotyping results during high flows was added to Table 3-3. An error was noticed in the mapped ribotyping location WWC b DWD and the map was updated accordingly.

We also recommend checking the location of the WWTP in relation to the listed segment. The TMDL mentions that the WWTP "…discharges directly to the impaired segment of Whitewood Creek…" However, EPA's Enviromapper shows that the WWTP may be in the segment below the listed segment.

SD DENR Comments: The WWTP was added to the map of Whitewood Creek Watershed (Figure 1-1). The location was checked, and the WWTP is located within the impaired segment.

4. TMDL Technical Analysis

TMDL determinations should be supported by a robust data set and an appropriate level of technical analysis**.** This applies to **<u>all</u>** of the components of a TMDL document. It is vitally important that the technical basis for **<u>all</u>** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor $\rightarrow$ response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum LAs + \sum WLAs + MOS$$

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

MOS = The portion of the Load Capacity allocated to the Margin of safety.

Minimum Submission Requirements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Whitewood Creek TMDL describes how the *E. coli* loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segment.

The South Dakota Department of Environment and Natural Resources (SD DENR) collected bacteria samples at the Whitewood Creek ambient water-quality monitoring (WQM) station 123 near Deadwood since 1991. Historical data collected from May 1 to September 30 (applicable dates for the *E. coli* water quality standards) from WQM 123 monitoring station were used in the TMDL technical analysis. Whitewood Creek flow data were available from U.S. Geological Survey (USGS) Station 06436170 at Deadwood, South Dakota, near WQM 123 from 1981 through 1995, and flow data were available from USGS Station 06436180 above Whitewood, South Dakota, from 1982 through 2009. Because recent flow data were required for construction of a load duration curve, a linear regression analysis was completed comparing historical flow (1982 through 1995) from the two stations to calculate more recent flow values for USGS Station 06436170.

The Hydrological Simulation Program – FORTRAN (HSPF) model was established to simulate flows within the Whitewood Creek Watershed and the point and nonpoint sources in the watershed. Loadings were estimated from each of the nonpoint sources using the EPA's Bacterial Indicator Tool (BIT) based on the density and distribution of animals (livestock and wildlife) and failing onsite wastewater treatment systems in the watershed.

The TMDLs were developed using the Load Duration Curve (LDC) approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1st – September 30th). The LDC is a dynamic expression of the allowable load for any given day within the recreation season. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10%), moist conditions (10–40%), mid-range flows (40–60%), dry conditions (60–90%), and low flows (90–100%) according to EPA's LDC guidance.

The LDCs shown in Figures 4-1 and 4-2 in the TMDL document represent dynamic expressions of parameter-specific TMDLs for the impaired segment of the Whitewood Creek that are based on the daily maximum and 30-day geometric mean *E. coli* criteria, resulting in unique loads that correspond to measured and simulated average daily flows.

Two bacteria LDCs were constructed for the bacteria-impaired reach of Whitewood Creek. The curve, which represents loading capacity, within the first LDC was constructed using the product of simulated flow data, the daily maximum bacteria criteria, and a unit conversion factor. Box plots in the second LDC represent the simulated geometric mean bacteria data and simulated geometric mean flow data.

To ensure that all applicable water quality standards are met, TMDL loads were set according to the criterion (either acute or chronic) that required the greatest load reduction percentage by flow zone. The TMDL loading capacities are included in Tables 5-1 and 5-2 of the TMDL document. These loads, when met, will attain compliance with all applicable water quality standards for *E. coli* in the listed segment of Whitewood Creek.

COMMENTS: The TMDL mentions use of the BIT, but does not include a discussion of the results of the loading estimates derived from its use. Also, the Model Results section mentions how the HSPF model was used, but doesn't discuss the results of the modeling. Further, Carter's lack of analysis of Lead's CSO discharge and loading estimates is not sufficient justification for excluding this existing loading source from the technical analysis in the TMDL. The load should not be assumed to be zero until the CSO separation is complete. Carter's thesis was completed in 2002 – what progress has been made in CSO separation since 2002? When is it scheduled to be completed? Is it possible to estimate a WLA, using existing information, to include in the TMDL?

As mentioned in the comments to the Restoration Strategy below, it appears that the TMDL document includes mention that the necessary nonpoint source reductions are achievable or practicable. However, we recommend including more information to address reasonable assurance.

SD DENR Comments: Carter's original watershed model was re-calibrated and concentration curves for the impaired reach as well as for upstream reaches are included in the Hydrologic Model section. A discussion the model results which used loading estimates derived from the BIT was added to Section 3.4. Model results and further detail regarding the CSO, on-site wastewater treatment systems, litter control, buffer zones and filter strips, and leaking sewer lines were also added to Section 3.4. More detail was added to this section regarding the CSO loading assumptions and methods used to model the CSO. The CSO was only assumed zero for the purposes of BMPs. Information was added in Section 9.0 on progress made in CSO separation and plans. Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero. A brief explanation was added to the ends of sections 5.1 and 5.3 describing why the WLA was set to zero (because the CSO permit requires its elimination). The recalibration of the model altered the simulated geometric mean TMDL values slightly, and any relating text was updated. Updated model results were added to Section 9.0, and reasonable assurance was addressed in Section 3.4 and 9.0.

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Minimum Submission Requirements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek TMDL data description and summary are included mostly in the Available Data section and in tables throughout the document. The full data set is in not included in the TMDL. The South Dakota Department of Environment and Natural Resources (SD DENR) collected bacteria samples at the Whitewood Creek ambient water-quality monitoring (WQM) station 123 near Deadwood since 1991. A total of 34 *E. coli* samples were collected at WQM 123 during the recreation season from May 1 to September 30. Fecal coliform bacteria concentration data was also collected at WQM 123, and includes a total of 95 samples collected during the recreation season. Bacteria sample data collected to date in Whitewood Creek near Deadwood at WQM 123 show a statistically significant correlation between fecal coliform bacteria and *E. coli* concentrations. Because the two indicators are closely related, the paired fecal coliform and *E. coli* were used to develop a site-specific translator function to convert fecal coliform loading estimates to *E. coli* loading estimates to address impairments to the immersion recreation impairment of Whitewood Creek. The mean ratio of *E. coli* to fecal coliform was calculated to be 1.21 cfu *E. coli* / cfu fecal coliform. The data set also includes the flow record on Whitewood Creek that was used to create the load duration curves for the listed segment included in the TMDL document.

COMMENTS: None.

SD DENR Comments: Eleven additional fecal coliform samples from 2003 SDSMT sampling efforts were brought to our attention and added to the analysis. Numbers changed by less than 2 percent in section 1.3 and by less than 1 percent in the actual TMDL tables. The r^2 value of the flow regression analysis was added in the Section 1.3 for detail. Table 1-3 was removed as it added nothing to the document about the impaired reach.

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Minimum Submission Requirements:

☒ EPA regulations require that a TMDL include WLAs for all significant and/or NPDES permitted point sources of the pollutant. TMDLs must identify the portion of the loading capacity allocated to individual existing and/or future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☒ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: One point source, the permitted Lead/Deadwood wastewater treatment plant located in Deadwood, discharges effluent containing *E. coli* bacteria directly into the impaired segment of Whitewood Creek. The WLA for the Lead/Deadwood WWTP was based on its discharge permit and was determined by multiplying the WWTP reported flows by 126 cfu/100 mL for the geometric mean TMDL and by 235 cfu/100 mL for the daily maximum TMDL and converting this value to cfu/day with a conversion factor. The WLA was assigned values 2.22×10^{10} cfu/day for the daily maximum TMDL value and 1.19×10^{10} cfu/day for the geometric mean TMDL value.

No permitted concentrated animal feeding operations currently exist within the Whitewood Creek watershed.

One combined sewer outfall (CSO) remains in the city of Lead. During some storm and snowmelt events, the flow in the combined sewer exceeds the capacity of the sewer line and overflows the weir. The waste that passes over the weir from the overflow travels down a concrete channel and flows into Gold Run Creek and eventually into Whitewood Creek. An average overflow, resulting from approximately 1 inch of rain per hour, likely results in an overflow of 250,000 gallons.

COMMENTS: As mentioned above in the comments to the Technical Analysis, the CSO discharges from Lead will remain a potential source of *E. coli* loading to the impaired segment of Whitewood Creek until the separation project is complete. Typically, if a point source is not accounted for in an upstream boundary condition or provided a specific WLA, then the discharge is assumed to have a zero WLA which should be reflected in the permit as no discharge of that pollutant. We recommend analyzing the discharges from the Lead CSO and providing accounting for that load in the TMDL document.

SD DENR Comments: Information on CSO separation and discharges was added to sections 3.4. A CSO WLA was set to zero in the TMDL document because the CSO permit requires its eventual elimination and a permitted concentration does not exist. The following statement was added to Section 5.1: Because the CSO permit requires ultimate elimination and does not have a permitted discharge, its WLA was set to zero. The following statement was added to Section 5.3: A WLA for the Lead CSO was set to zero because the Lead CSO permit requires its elimination.

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Minimum Submission Requirements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that all significant anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: To develop the *E. coli* bacteria load allocation (LA), the loading capacity was first determined using the data sources specified. The daily maximum criterion (235 cfu/100 mL) was used in the calculation of the daily maximum loading capacities, and the geometric mean criterion (126 cfu/100 mL) was used for the calculation of the geometric mean loading capacities. The loading capacities for Whitewood Creek were calculated by multiplying the specified *E. coli* bacteria criterion by the specified flow data. For each of the flow zones, the 95th percentile of the range of loading capacities within a zone was set as the flow zone goal. Bacteria loads experienced during the largest stream flows (e.g., top 5 percent) cannot be feasibly controlled by practical management practices. Thus setting the flow zone goal at the 95th percentile of the range of loading capacities will protect the immersion recreation beneficial use and allow for the natural variability of the system. The TMDL (and loading capacity) is the sum of the waste load allocation (WLA), the LA, and margin of safety (MOS). Portions of the loading capacity were allocated to nonpoint sources as an LA and an MOS to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed below. The overall LA was determined by subtracting the WLA and MOS from the loading capacity. The resulting LA was allocated to the various nonpoint sources identified in the watershed.

COMMENTS: None.

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Minimum Submission Requirements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

☐ <u>If the MOS is implicit</u>, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.

☒ <u>If the MOS is explicit</u>, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ <u>If</u>, rather than an explicit or implicit MOS, the <u>TMDL relies upon a phased approach</u> to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek TMDL includes an explicit MOS derived by calculating the difference between the loading capacity at the mid-point of each of the flow zones and the loading capacity at the minimum flow in each zone. The explicit MOS values are included in Tables 5-1, and 5-2 of the TMDL.

COMMENTS: None.

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Minimum Submission Requirements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: By using the load duration curve approach to develop the TMDL allocations seasonal variability in *E. coli* loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months.

COMMENTS: None.

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Minimum Submission Requirements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The State's submittal includes a summary of the public participation process that has occurred which describes the ways the public has been given an opportunity to be involved in the TMDL development process so far. In particular, the State has encouraged participation through public meetings in the watershed, and a website was developed and maintained throughout the project. The TMDL has been available for a 30-day public notice period prior to finalization.

COMMENTS: The Public Participation section (Section 7.0) generally mentions presentations to "local groups in the watershed." Additional detail on the number of presentations given and the types of stakeholder groups in attendance would provide a more complete description of the public participation process for this TMDL. It would also be helpful to state whether the public notice was published in local newspapers and if it was available on the SD DENR's web site.

SD DENR Comments: Information regarding the number of presentations given, the types of stakeholder groups in attendance, and publishing of public notice was added to Chapter 7.0.

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Minimum Submission Requirements:

☒ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☒ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The impaired segment of Whitewood Creek will continue to be monitored through SD DENR's ambient water quality monitoring stations in the Whitewood Creek watershed. Stream water-quality monitoring will be accomplished through SD DENR's ambient water-quality monitoring stations which are sampled on a monthly basis during the recreational season. During the recreation season bacterial monitoring should be increased to collect at least 5 samples per month to assess the geometric mean criterion. Additional monitoring and evaluation efforts should be targeted toward designed BMPs to document the effectiveness of implemented BMPs. Post-implementation monitoring will be necessary to assure the TMDL has been reached and maintenance of the beneficial use occurs.

COMMENTS: None.

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Minimum Submission Requirements:

☒ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable). A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Restoration Strategy section of the TMDL document says that a variety of BMPs could be considered in the development of a water-quality management implementation plan for the impaired segment of the Whitewood Creek watershed. Several types of control measures are available for reducing *E. coli* bacteria loads, and recommendations to address the identified sources are included in the TMDL document. Based on water-quality monitoring, bacterial source tracking, and HSPF model results, the recommended control measures to be implemented are expected to achieve the required load reductions and attain the TMDL goals. The model results indicate that direct sources should be the primary target for future BMP implementation. It is recommended that an in-depth BMP scenario analysis be performed before developing a future BMP implementation plan. Funds to implement watershed water quality improvements can be obtained through the SD DENR.

COMMENTS: The EPA is working on an updated and expanded reasonable assurance policy for all TMDLs. Until the policy is finalized we are asking that all TMDLs that include both point and nonpoint sources address reasonable assurance to the extent possible. It appears that components of reasonable assurance already exist in the Whitewood Creek TMDL document (e.g., mention of analysis that shows that implementation of a combination of BMPs would reduce the loading to the ranges needed to meet the water quality standards). We recommend including a few paragraphs that use the words "reasonable assurance" and also include general implementation progress to date and any proposed future schedule for NPS implementation.

SD DENR Comments: The words "reasonable assurance" were used in multiple paragraphs, and general implementation progress to date and any proposed future schedule for NPS implementation was included in Chapter 9.0.

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Minimum Submission Requirements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The Whitewood Creek *E. coli* TMDL includes daily loads expressed as colonies forming units (cfu) per day. The daily TMDL loads are included in TMDL Section of the document.

COMMENTS: None.