

**FECAL COLIFORM TOTAL MAXIMUM DAILY LOAD FOR  
THE CHEYENNE RIVER, PENNINGTON COUNTY  
SOUTH DAKOTA**

Topical Report RSI-2120

*prepared for*

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

June 2010



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*by*

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RESPEC

P.O. Box 725

Rapid City, South Dakota 57709

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### Total Maximum Daily Load Summary

<b>Waterbody Name/Description</b>	Cheyenne River (Fall River to Cedar Creek)
<b>Assessment Unit I.D.</b>	SD-CH-R-CHEYENNE_03
<b>Size of Impaired Waterbody</b>	57.1 miles (91.9 kilometers)
<b>Size of Watershed (Incremental)</b>	1,000 square miles (2,589 square kilometers)
<b>Size of Watershed (Cumulative)</b>	8,920 square miles (23,102 square kilometers)
<b>Location</b>	10-digit Hydrologic Unit Codes (HUC): 1012010903, 1012010905, 1012010907
<b>Impaired Designated Use(s)</b>	Immersion Recreation
<b>Cause(s) of Impairment</b>	Fecal coliform bacteria
<b>Cycle Most Recently Listed</b>	2010
<b>Total Maximum Daily Load End Points End Points</b>	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.
<b>Analytical Approach</b>	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

### Total Maximum Daily Load Summary

<b>Waterbody Name/Description</b>	Cheyenne River (Cedar Creek to Belle Fourche River)
<b>Assessment Unit I.D.</b>	SD-CH-R-CHEYENNE_04
<b>Size of Impaired Waterbody</b>	87.3 miles (140.5 kilometers)
<b>Size of Watershed (Incremental)</b>	3,423 square miles (8,866 square kilometers)
<b>Size of Watershed (Cumulative)</b>	12,343 square miles (31,968 square kilometers)
<b>Location</b>	10-Digit Hydrologic Unit Codes (HUC): 1012010911, 1012011105, 1012011109, 1012011102, and 1012010907
<b>Impaired Designated Use(s)</b>	Immersion Recreation
<b>Cause(s) of Impairment</b>	Fecal coliform bacteria
<b>Cycle Most Recently Listed</b>	2010
<b>Total Maximum Daily Load End Points</b>	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.
<b>Analytical Approach</b>	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

### **Total Maximum Daily Load Summary**

<b>Waterbody Name/Description</b>	Cheyenne River (Belle Fourche River to Bull Creek)
<b>Assessment Unit I.D.</b>	SD-CH-R-CHEYENNE_05
<b>Size of Impaired Waterbody</b>	44.6 miles (71.8 kilometers)
<b>Size of Watershed (Incremental)</b>	843 square miles (2,184 square kilometers)
<b>Size of Watershed (Cumulative)</b>	13,186 square miles (34,151 square kilometers)
<b>Location</b>	10-digit Hydrologic Unit Codes (HUC): 1012011202 and 1012011206
<b>Impaired Designated Use(s)</b>	Immersion Recreation
<b>Cause(s) of Impairment</b>	Fecal coliform bacteria
<b>Cycle Most Recently Listed</b>	2010
<b>Total Maximum Daily Load End Points</b>	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.
<b>Analytical Approach</b>	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

### **Total Maximum Daily Load Summary**

<b>Waterbody Name/Description</b>	Cheyenne River (Bull Creek to mouth)
<b>Assessment Unit I.D.</b>	SD-CH-R-CHEYENNE_06
<b>Size of Impaired Waterbody</b>	37.9 miles (70.0 kilometers)
<b>Size of Watershed (Incremental)</b>	2,563 square miles (3,369 square kilometers)
<b>Size of Watershed (Cumulative)</b>	15,749 square miles (40,790 square kilometers)
<b>Location</b>	10-digit Hydrologic Unit Codes (HUC): 1012011207 and 1012011211
<b>Impaired Designated Use(s)</b>	Limited Contact Recreation and Immersion Recreation
<b>Cause(s) of Impairment</b>	Fecal coliform bacteria
<b>Cycle Most Recently Listed</b>	2010
<b>Total Maximum Daily Load End Points</b>	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.
<b>Analytical Approach</b>	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

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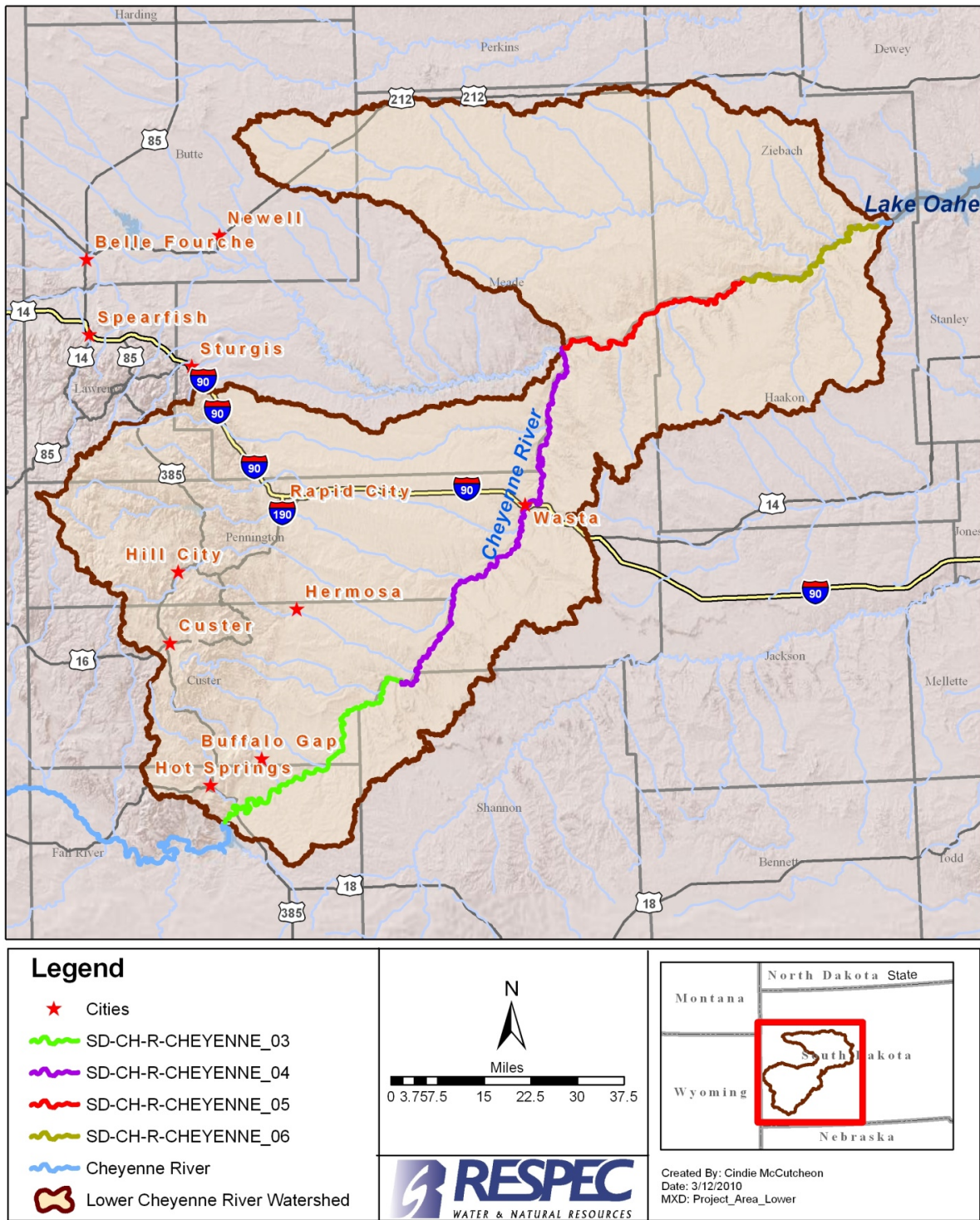
## 1.0 INTRODUCTION

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 the EPA. This TMDL document addresses fecal coliform bacteria impairments on the Cheyenne River within the Lower Cheyenne River Watershed (Segments SD-CH-R-CHEYENNE\_03, SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, SD-CH-R-CHEYENNE\_06), which were assigned to priority category 1 (high priority) in the Draft 2010 Impaired Waterbodies List [South Dakota Department of Environment and Natural Resources, 2010]. Segments listed as impaired in the most recently approved Impaired Waterbodies List (2008) include SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, and SD-CH-R-CHEYENNE\_06 [South Dakota Department of Environment and Natural Resources, 2008].

### 1.1 WATERSHED CHARACTERISTICS

The Cheyenne River is the largest western tributary to the Missouri River in South Dakota with a contributing drainage area of approximately 24,240 square miles. The Cheyenne River drains northeasterly to Lake Oahe, a reservoir located in central South Dakota on the Missouri River just north of Pierre, South Dakota. The Cheyenne River Watershed can be broken into three main areas: the Upper Cheyenne River Watershed above Angostura Reservoir (7,920 square miles); the Belle Fourche River Watershed, the largest contributing tributary drainage area (7,220 square miles); and the Lower Cheyenne River Watershed below Angostura Reservoir (7,930 square miles). Figure 1-1 shows the impaired (Section 303(d) listed) segments on the Cheyenne River located within the Lower Cheyenne River Watershed [South Dakota Department of Environment and Natural Resources, 2010]. This assessment focused on bacteria impairments in the Lower Cheyenne River Watershed below Angostura Reservoir, which drains approximately 33 percent of the total Cheyenne River Watershed. The impaired watershed drains portions of Fall River, Custer, Shannon, Meade, Haakon, Ziebach, and Pennington counties in South Dakota.

Segment SD-CH-R-CHEYENNE\_03 (57.1 miles) begins at the confluence with Fall River and ends at the confluence with Cedar Creek. Segment SD-CH-R-CHEYENNE\_04 (87.3 miles) begins at the confluence with Cedar Creek and ends at the confluence with the Belle Fourche River. Segment SD-CH-R-CHEYENNE\_05 (44.6 miles) begins at the confluence with the Belle Fourche River and ends at the confluence with Bull Creek, and Segment SD-CH-R-CHEYENNE\_06 (37.9 miles) begins at the confluence with Bull Creek and ends at the mouth of the Cheyenne River at the confluence with Lake Oahe of the Missouri River.



**Figure 1-1.** Lower Cheyenne River Watershed Fecal Coliform Impaired Reaches.

According to historical data from BASINS (1990–2006) and High Plains Regional Climate Center [2009], average precipitation in the Lower Cheyenne Watershed ranges from 15 to 33 inches (Figure 1-2). Figure 1-3 shows that approximately 68 percent of the precipitation occurs during the months of April through August and approximately 47 percent occurs during the months of May through July. Watershed land use is predominantly rangeland (75.5 percent). A complete list of watershed land uses and percent areas is shown in Table 1-1.

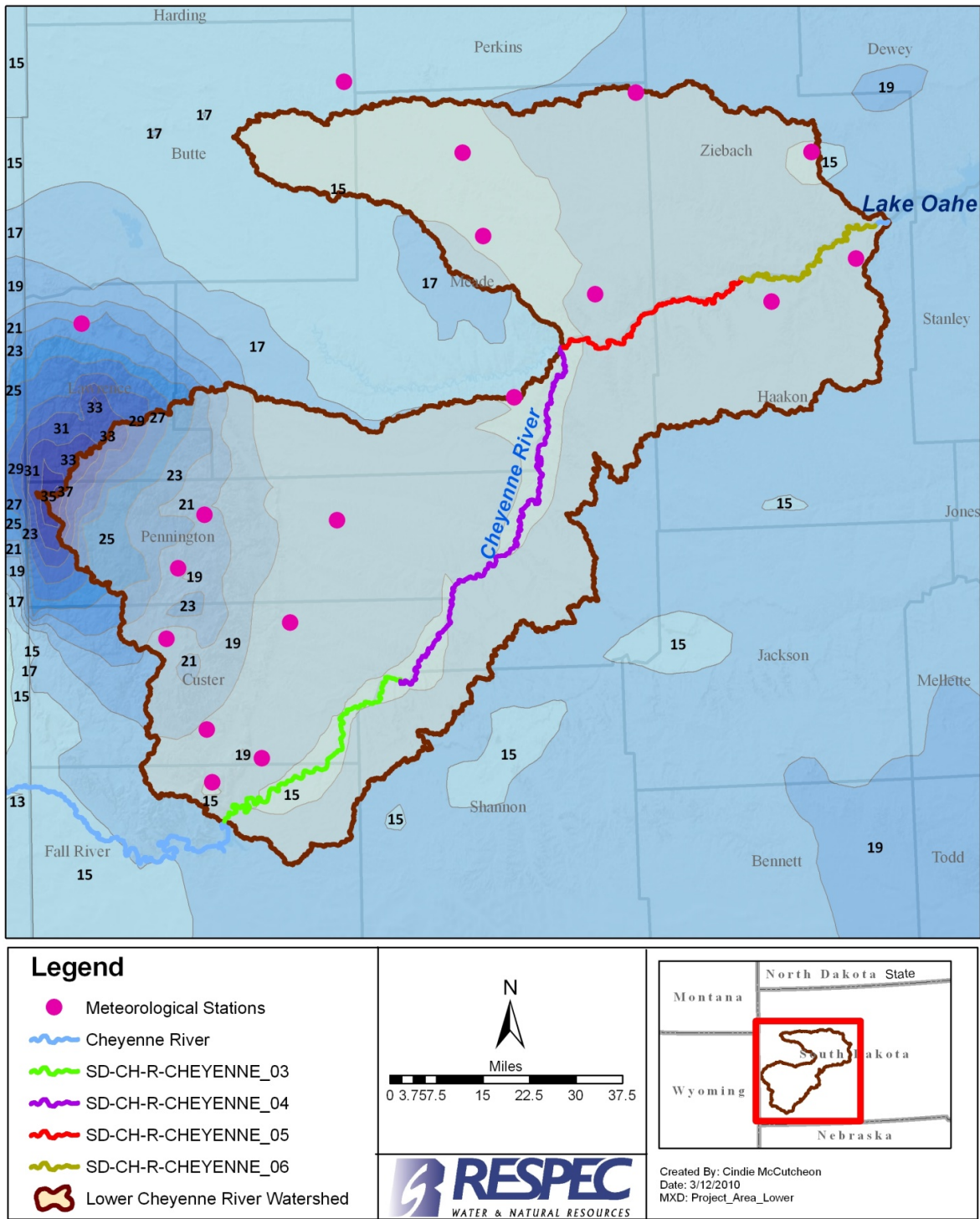
## **1.2 CLEAN WATER ACT SECTION 303(D) LISTING INFORMATION**

Four Cheyenne River Segments (SD-CH-R-CHEYENNE\_03, SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, and SD-CH-R-CHEYENNE\_06) within the Lower Cheyenne River Watershed were listed as impaired in South Dakota's 2010 303(d) list [South Dakota Department of Environment and Natural Resources, 2010] because of sample concentrations of fecal coliform bacteria that exceeded the daily maximum criterion for the protection of the immersion recreation use and the limited recreation use. Immersion recreation use criteria are more stringent than the limited contact recreation use criteria. Cheyenne River Segments SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, and SD-CH-R-CHEYENNE\_06 were first listed as impaired in South Dakota's 2004 303(d) list, while SD-CH-R-CHEYENNE\_03 was first listed as impaired in South Dakota's 2010 303(d) list [South Dakota Department of Environment and Natural Resources, 2010].

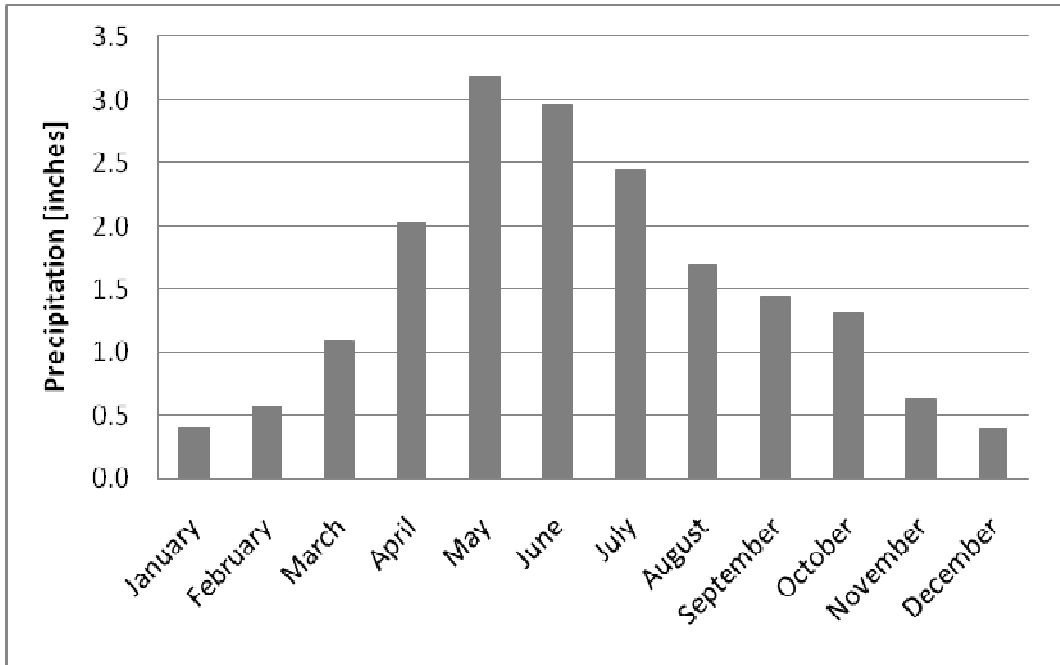
## **1.3 AVAILABLE WATER-QUALITY DATA**

The South Dakota Department of Environment and Natural Resources (SD DENR) and the United States Geological Service (USGS) have been collecting fecal coliform data from multiple sites within the Lower Cheyenne River Watershed dating back to 1967. For the purposes of this TMDL summary, data were used from stations (listed in Table 1-2) located along the Cheyenne River near Buffalo Gap (CHR04), Redshirt (CHR05), Scenic (CHR08), near Wasta (CHR10), near Smithville (CHR16), near Plainview (CHR14), and near Eagle Butte (CHR13). Figure 1-4 also shows the monitoring stations used in collecting data.

Historical data collected from May 1 to September 30 (effective criterion period) from each project site were used to calculate percent exceedance of the daily maximum fecal coliform bacteria criterion of 400 colony-forming units per 100 milliliters (cfu/100 mL) and to find fecal coliform concentration ranges (Table 1-3).



**Figure 1-2.** Lower Cheyenne River Watershed Precipitation (in Inches).



**Figure 1-3.** Historical Average Monthly Precipitation From 1984 Through 2008 for the Lower Cheyenne Watershed.

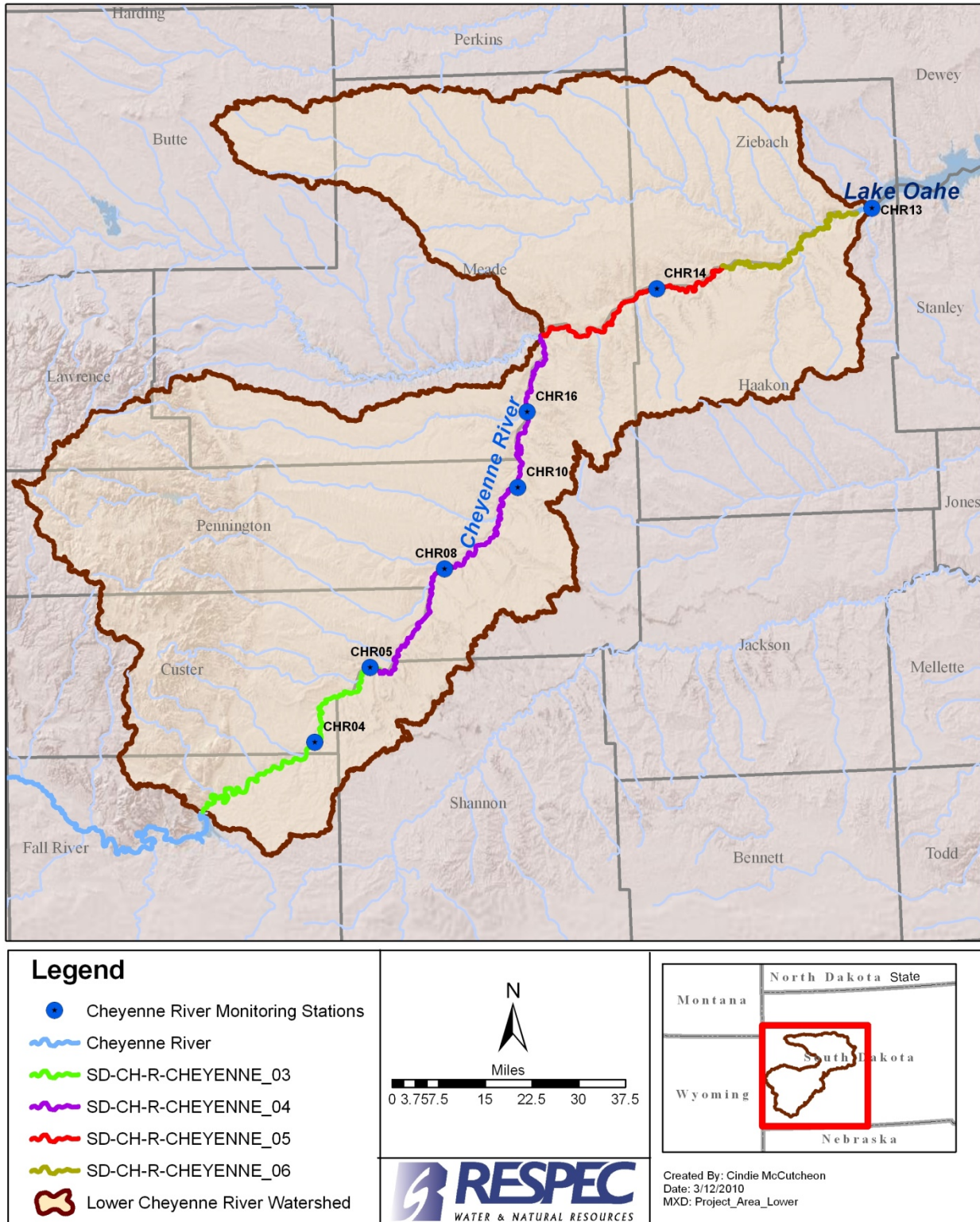
**Table 1-1. Watershed Land Use in the Lower Cheyenne River Watershed**

<b>Model Land Use</b>	<b>Total Area (%)</b>
Urban/EIA	1.2
Forest	10.3
Cropland	6.4
Rangeland	75.5
Barren	2.3
Groundwater Recharge	3.6
Open Water	0.6

**Table 1-2. Water-Quality Stations in the Lower Cheyenne River Watershed Used for Fecal Coliform Total Maximum Daily Load Development**

<b>Fecal Coliform Monitoring Stations</b>	<b>Project</b>	<b>Segment</b>	<b>Data Available</b>	<b>Number of Data Points</b>
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007–2009	18
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999–2009	123
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007–2009	21
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967–2009	196
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008–2009	8
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968–2009	250
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999–2009	63





**Figure 1-4.** Monitoring Stations Used Within the Lower Cheyenne River Watershed.

**Table 1-3. Percent Exceedance of Fecal Coliform Concentration Criteria and Fecal Coliform Concentration Ranges for Project Sites Within the Lower Cheyenne River Watershed**

<b>Fecal Coliform Monitoring Stations</b>	<b>Project</b>	<b>Number of Samples Exceeding Criterion</b>	<b>Total Number of Samples</b>	<b>Percent Exceedance</b>	<b>Concentration Range (cfu/100 mL)</b>
Cheyenne River near Buffalo Gap, SD	CHR04	5	18	28%	14–1,000
Cheyenne River at Redshirt, SD	CHR05	25	123	20%	<10–46,000
Cheyenne River near Wasta, SD	CHR10	74	196	38%	<10–210,000
Cheyenne River at Scenic, SD	CHR08	14	21	67%	42–41,000
Cheyenne River near Smithville, SD	CHR16	2	8	25%	20–510
Cheyenne River near Plainview, SD	CHR14	97	250	39%	<10–92,000
Cheyenne River near Eagle Butte, SD	CHR13	20	63	32%	<10–24,000

## 2.0 WATER-QUALITY STANDARDS AND TOTAL MAXIMUM DAILY LOAD TARGETS

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated with the use of fish and wildlife propagation, recreation, and stock watering. All streams are assigned the use of irrigation. Additional uses may be 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) [Administrative Rules of South Dakota, 2010].

Additional “narrative” standards that may apply can be found in ARSD Articles 74:51:01:05, 06, 08, and 09 [Administrative Rules of South Dakota, 2010]. These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, and nuisance aquatic life.

The Cheyenne River Segments SD-CH-R-CHEYENNE\_03 and SD-CH-R-CHEYENNE\_04 were assigned the following beneficial uses: warm-water semipermanent fish life propagation, immersion recreation, limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Cheyenne River Segments SD-CH-R-CHEYENNE\_05 and SD-CH-R-CHEYENNE\_06 were assigned the same beneficial uses with exception to warm-water semipermanent fish life propagation which was designated as warm-water permanent fish life propagation for these downstream reaches. Table 2-1 lists water-quality criteria that must be met to support the beneficial uses currently assigned to the Cheyenne River. All listed segments must meet the more stringent standards of immersion recreation since it is listed as impaired for both immersion recreation and limited contact recreation.

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. 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. The geometric mean, as defined in ARSD Article 74:51:01:01, is the *n*th root of a product of *n* factors. The fecal coliform criteria are applicable from May 1 through September 30.

**Table 2-1. State Surface Water-Quality Standards for the Cheyenne River (Page 1 of 2)**

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate <sup>(a)</sup>	≤ 750	mg/L	30-day average
	≤ 1313	mg/L	Daily maximum
Total dissolved solids <sup>(a)</sup>	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	Daily maximum
Total petroleum hydrocarbon <sup>(a)</sup>	≤ 10	mg/L	Daily maximum
Oil and grease <sup>(a)</sup>	≤ 10	mg/L	Daily maximum
Nitrates as N <sup>(a)</sup>	≤ 50	mg/L	30-day average
	≤ 88	mg/L	Daily maximum
Dissolved oxygen <sup>(b,c)</sup>	≥ 5.0	mg/L	Daily minimum
Total suspended solids <sup>(b,c)</sup>	≤ 90	mg/L	30-day average
	≤ 158	mg/L	Daily maximum
Temperature <sup>(b)</sup>	≤ 90	°F	Daily maximum
Temperature <sup>(c)</sup>	≤ 80	°F	Daily maximum
pH <sup>(b,c)</sup>	6.5 and ≤ 9.0	Standard units	
Undissociated hydrogen sulfide <sup>(b,c)</sup>	≤ 0.002	mg/L	Daily maximum
Total ammonia nitrogen as N <sup>(b,c)</sup>	Equation-based limit	mg/L	30-day average (Mar 1–Oct 31)
			30-day average (Nov 1–Feb 29)
	Equation-based limit	mg/L	Daily maximum
Fecal coliform <sup>(d,e)</sup>	< 200	cfu /100 mL	Geometric mean (May 1–Sep 30)
	< 400	cfu /100 mL	Daily maximum (May 1–Sep 30)
<i>E. coli</i> <sup>(d,e)</sup>	≤ 126	cfu /100 mL	Geometric mean (May 1–Sep 30)
	≤ 235	cfu /100 mL	Daily maximum (May 1–Sep 30)

**Table 2-1. State Surface Water-Quality Standards for the Cheyenne River (Page 2 of 2)**

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

- (a) Criteria for fish and wildlife propagation, recreation, and stock watering use.
- (b) Criteria for warm-water semipermanent fish life propagation use.
- (c) Criteria for warm-water permanent fish life propagation use.
- (d) Criteria for immersion recreation use.
- (e) Geometric mean 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.

South Dakota recently adopted *E. coli* criteria for the protection of the limited contact and immersion recreation uses. Cheyenne River Segment SD-CH-R-CHEYENNE\_05 requires an *E. coli* TMDL because the parameter is listed as a cause of impairment to this stream in the draft 2010 South Dakota Integrated Report [South Dakota Department of Environment and Natural Resources, 2010]. Out of 44 total samples, 11 samples (25 percent) exceeded the acute *E. coli* criterion (235 cfu/100 mL). Greater than 10 percent of the samples must exceed water-quality criteria for that parameter to be included as a cause of impairment on the 303(d) Impaired Waters List. Also, for a parameter to be considered representative of actual conditions, at least 20 samples of the parameter are required. The sample threshold is reduced to ten samples if three or more samples exceed daily maximum water-quality standards. Because less than ten samples are available for Cheyenne River Segments SD-CH-R-CHEYENNE\_03, SD-CH-R-CHEYENNE\_04, and SD-CH-R-CHEYENNE\_06 during the recreational season, *E. coli* is not included as a cause of impairment for these reaches.

A total of 114 paired fecal coliform and *E. coli* samples existed along the Cheyenne River throughout the study area; 26 were located within Reach SD-CH-R-CHEYENNE\_03, 27 were located within Reach SD-CH-R-CHEYENNE\_04, 55 were located within Reach SD-CH-R-CHEYENNE\_05, and 6 were located within Reach SD-CH-R-CHEYENNE\_06. The *E. coli* samples from all monitoring stations combined were in exceedance of the daily maximum criteria 20 percent of the time. Bacteria sample data for the Cheyenne River impaired reaches show a statistically significant correlation (*Spearman*  $r_s = 0.84$ ) between fecal coliform bacteria and *E. coli* concentrations. The paired fecal coliform and *E. coli* data were used to develop a translator function to convert fecal coliform loading estimates to *E. coli* loading estimates. Figure 2-1 shows a plot of *E. coli* versus fecal coliform. The first step for translation requires the regression analysis equation (Equation 2-1) to convert fecal coliform concentration to *E. coli* concentrations. Once concentrations are available, they can be combined with flow data to

compute loading estimates. The mean ratio of *E. coli* to fecal coliform was calculated to be 1.051 cfu *E. coli*/ cfu fecal coliform.

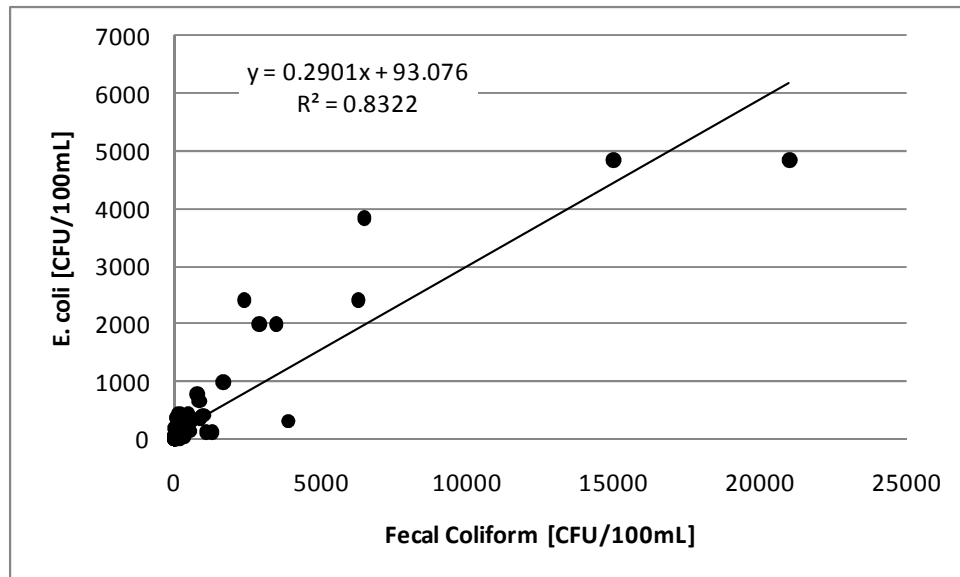
$$(E) = 0.2901(F) + 93.076 \tag{2-1}$$

where:

$F$  = fecal coliform concentration

$E$  = *E. coli* concentration.

RSI-1737-10-005



**Figure 2-1.** Plot of Fecal Coliform Versus *E. coli* for Entire Project Area.

*E. coli* TMDL summaries for all four Lower Cheyenne River segments (SD-CH-R-CHEYENNE\_03, SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, and SD-CH-R-CHEYENNE\_06) will be available in a subsequent document, as all four reaches will likely be listed as impaired once adequate data are available. This is known based on the strong correlation between fecal coliform and *E. coli*.

Impaired segments must meet the more stringent standards of immersion recreation since they are listed as impaired for both immersion recreation and limited contact recreation. The numeric TMDL target established for the Cheyenne River's immersion recreation use impairment was determined for each of five flow conditions or zones and was based on either the daily maximum (400 cfu/100 mL) or 30-day average (200 cfu/100 mL) fecal coliform bacteria criterion, depending on which criterion required the greatest load reduction.

## **3.0 SIGNIFICANT SOURCES**

### **3.1 POINT SOURCES**

No permitted point source dischargers are located in the Lower Cheyenne River Watershed. There are permitted point sources located in upstream tributaries which are addressed by the state of South Dakota as separate stream segments. Bacteria loads from upstream tributaries have been accounted for in boundary conditions.

### **3.2 NONPOINT SOURCES**

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of fecal coliform within the Cheyenne River Watershed include agricultural runoff, as well as wildlife and human sources. 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, 2001].

#### **3.2.1 Agriculture**

Manure from livestock is a potential source of fecal coliform to the stream. Livestock in the basin are predominantly beef cattle, sheep, and horses. Other livestock in the basin include dairy cattle, bison, chickens, and swine. Livestock population densities in the watershed were estimated using Census of Agriculture data and summarized by county shown in Table 3-1. Livestock contribute bacteria loads to the Cheyenne River directly by defecating while wading in the stream 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.

#### **3.2.2 Human**

Human enterococcus bacteria were identified at one site in the Cheyenne River from bacterial source tracking (BST) tests. This site (CHR010) is a short distance downstream of the town of Wasta and near a major Interstate rest area having lagoons located on alluvium. The Cheyenne River Watershed is largely rural, with few centralized wastewater collection and treatment facilities. Thus although no human sources were identified at the time of the BST, it is possible human sources do exist intermittently at sites other than CHR010, and any human bacteria loads other than those identified near Wasta would likely be from on-site wastewater treatment systems.



**Table 3-1. Livestock Densities per 100 Acres by County**

<b>County, State</b>	<b>Beef Cattle</b>	<b>Dairy Cattle</b>	<b>Cattle/ Calves</b>	<b>Hogs/ Pigs</b>	<b>Sheep</b>	<b>Bison</b>	<b>Horses</b>	<b>Chickens</b>
Dawes, NE	3.33	0.02	1.94	0.03	0.19	0.00	0.12	0.08
Sioux, NE	2.43	0.00	4.15	0.00	0.05	0.03	0.09	0.04
Butte, SD	2.37	0.14	1.87	0.04	3.81	0.12	0.16	0.09
Custer, SD	0.00	0.00	0.79	0.01	0.03	0.27	0.17	0.04
Fall River, SD	3.31	0.00	2.07	0.02	0.18	0.00	0.15	0.04
Haakon, SD	3.46	0.00	2.73	0.00	0.00	0.00	0.09	0.02
Lawrence, SD	1.55	0.07	0.89	0.00	0.18	0.04	0.17	0.00
Meade, SD	3.35	0.04	1.98	0.02	0.69	0.03	0.15	0.05
Pennington, SD	2.04	0.02	1.24	0.01	0.07	0.02	0.18	0.04
Shannon, SD	0.00	0.00	1.03	0.00	0.00	0.00	0.18	0.00
Ziebach, SD	2.22	0.00	1.03	0.06	0.34	0.00	0.18	0.01
Crook, WY	2.12	0.01	1.57	0.02	1.15	0.02	0.15	0.04
Niobrara, WY	2.24	0.00	1.39	0.00	0.42	0.00	0.09	0.01
Weston, WY	2.11	0.00	1.17	0.00	0.22	0.00	0.11	0.01

### **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 were obtained from the South Dakota Department of Game, Fish and Parks.

### **3.3 BACTERIAL SOURCE TRACKING**

Bacteria samples were analyzed to determine sources of fecal coliform bacteria within the watershed. Four DNA BST analyses were completed on each sample (Human Enterococcus ID™, Bird Enterococcus ID™, Cow Enterococcus ID™, and Deer (Elk) Enterococcus ID™) to detect fecal contamination using Polymerase Chain Reaction DNA Analytical Technology. Bacterioidetes (short-term survival) and enterococcus (long-term survival) were selected as indicator organisms for identifying the species that are contributing pathogen load. Event flow and base flow were separated for the DNA BST analysis [Mynam, 2009].

DNA BST analyses were completed at the following project sites: CHR08 and CHR10 within Reach SD-CH-R-CHEYENNE\_04, CHR14 within Reach SD-CH-R-CHEYENNE\_05, and CHR13 within Reach SD-CH-R-CHEYENNE\_06. A DNA BST analysis was not completed within Reach SD-CH-R-CHEYENNE\_03 as this reach was not listed as impaired before 2010. The BST locations are illustrated in Figure 3-1. These analyses detected the presence of cow, deer, and bird DNA strains at all locations except CHR13 and the presence of human DNA only at CHR10.

Table 3-2 lists the BST bacteriodetes indicator results (percentage of samples testing positive) at each project site. Project site CHR10 was the only site testing positive for the bacteriodetes indicator. At this site, only avian DNA, which was present in two of four samples, was present.

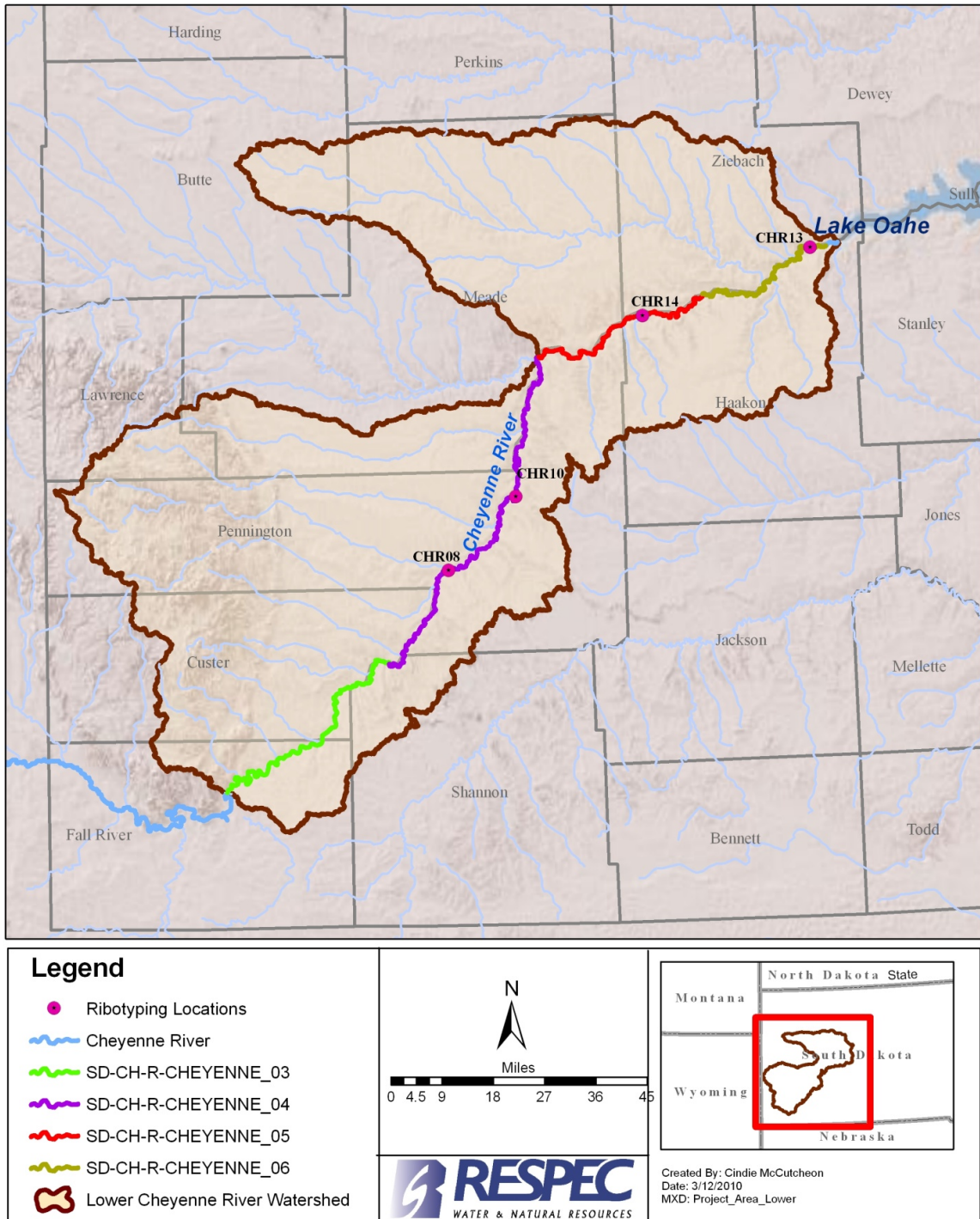
Table 3-3 lists the BST enterococcus indicator results (percentage of samples testing positive) at each project site. The enterococcus indicator showed the presence of cattle, deer, and bird DNA at CHR08; the presence of human, cattle, deer, and avian DNA at CHR10 and the presence of cattle and avian DNA at CHR14 [Mynam, 2009].

The presence of the short-term survival bacteriodetes generally indicates direct defecation (i.e., point sources), and because the presence of these bacteria occurred at only one location, point sources are not a major source of bacterial loading in analyzed segments of the Cheyenne River. Similarly, the higher occurrence of enterococcus during event flows and the lower occurrence during base flows indicate a higher nonpoint source bacterial impact entering the stream through runoff on the analyzed segments of the Cheyenne River.

During runoff events, bacteria are washed into the stream channel from a variety of sources, including cattle, wildlife, and birds. Positive BST results for human sources were only found during storm events, and only at CHR10, a short distance downstream of the town of Wasta and near a major Interstate rest area having lagoons located on alluvium. During high flow events, human sources, probably from Wasta or the rest area, appear to be entering the river system.

### **3.4 SOURCE ASSESSMENT MODELING RESULTS**

The HSPF model was used to determine the contribution of fecal coliform bacteria from identified sources in the Cheyenne River Watershed and to evaluate the implementation of Best Management Practices (BMPs) to control these sources. As shown in Figure 3-2, the Cheyenne River drainage basin was represented in the model using 185 subwatersheds and three boundary conditions which represent the Belle Fourche River, Rapid Creek, and Angostura Reservoir. The nonpoint sources in the study area were modeled in HSPF by estimating per acre fecal coliform accumulation rates and maximum fecal coliform storage rates for each source. The buildup and washoff of fecal coliform was simulated based on these rates and precipitation.



**Figure 3-1.** BST Locations Used Within the Lower Cheyenne River Watershed.

The accumulation and storage rates were calculated using BIT. Failing on-site wastewater treatment systems and livestock in streams are direct sources that were modeled as point sources because the bacteria loads that they produce are independent of rainfall/runoff processes. The BIT was 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.

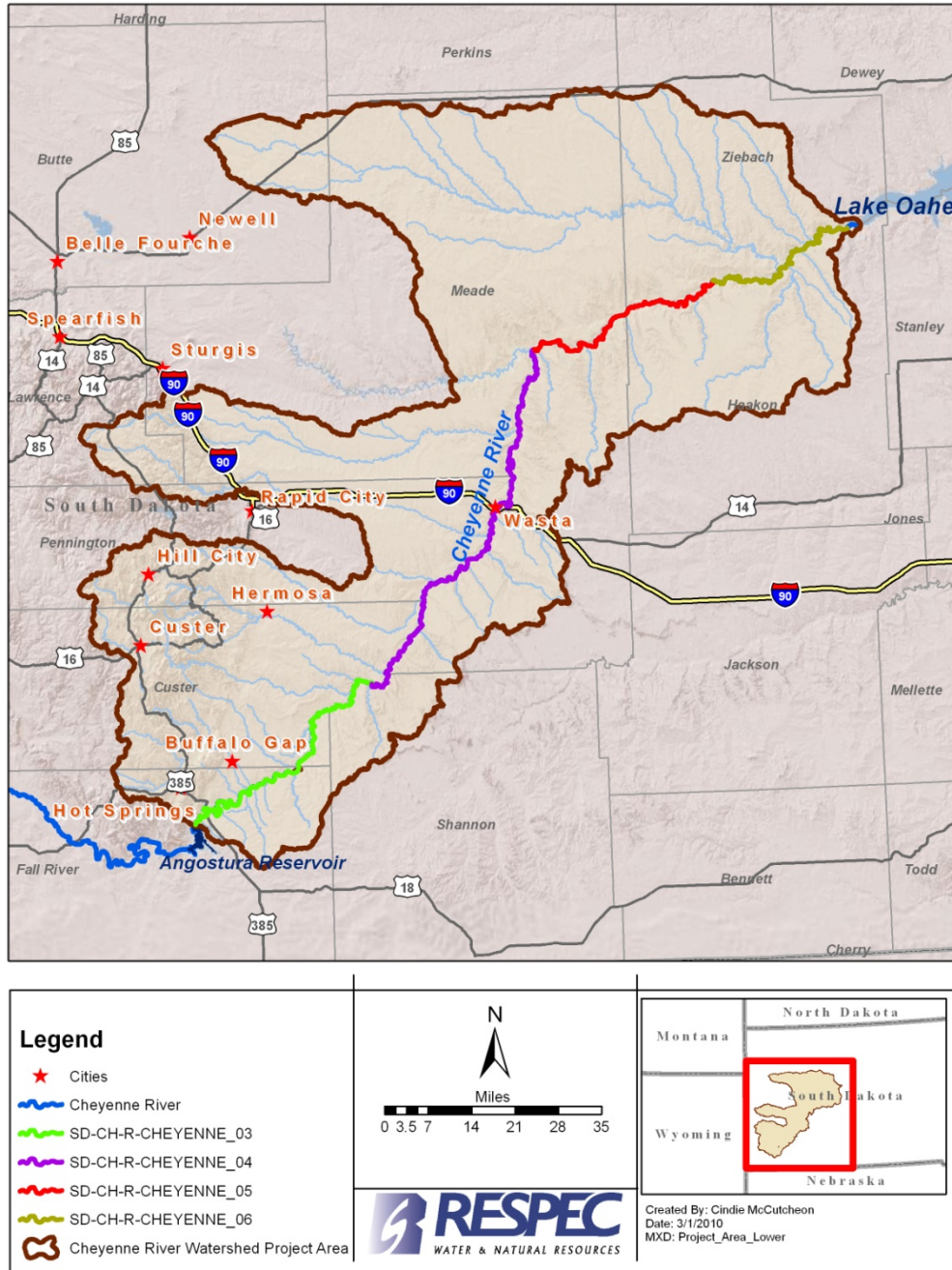
Source assessment modeling results were summarized by land use categories for nonpoint sources and separately for livestock in streams and on-site wastewater treatment tank failures (direct sources). Results show that rangelands contribute the highest proportion (over 98 percent) of the bacteria load to all impaired segments of the Cheyenne River within the Lower Cheyenne River Watershed (Table 3-4).

**Table 3-2. BST Bacterioidetes Indicator Results Showing Percentage of Samples Testing Positive for Each Species, Site, and Flow Condition [Mynam, 2009]**

Indicator Flow Type Site	Bacterioidetes (Short-Term Survival)					
	Event Flow (%)			Base Flow (%)		
	Human	Cattle	Avian	Human	Cattle	Avian
CHR08	0	0	0	0	0	0
CHR10	0	0	50	0	0	0
CHR13	0	0	0	0	0	0
CHR14	0	0	0	0	0	0

**Table 3-3. BST Enterococcus Indicator Results Showing Percentage of Samples Testing Positive for Each Species, Site, and Flow Condition [Mynam, 2009]**

Indicator Flow Type Site	Enterococcus (Long-Term Survival)							
	Event Flow (%)				Base Flow (%)			
	Human	Cattle	Deer	Avian	Human	Cattle	Deer	Avian
CHR08	0	75	50	25	0	0	0	33
CHR10	20	60	60	60	0	0	0	0
CHR13	0	0	0	0	0	0	0	0
CHR14	0	33	0	67	0	33	0	33



**Figure 3-2.** HSPF Modeled Lower Cheyenne River Watershed Fecal Coliform Impaired Reaches.

**Table 3-4. Fecal Coliform Loading Sources by Landuse Based on HSPF Model Results for the Recreational Season**

Source Land Use	Load Contribution (%)			
	SD-CH-R-CHEYENNE_03	SD-CH-R-CHEYENNE_04	SD-CH-R-CHEYENNE_05	SD-CH-R-CHEYENNE_06
<i>Nonpoint Sources</i>				
Rangeland	98.98	99.68	99.73	99.77
Barren	0.25	0.09	0.07	0.05
Impervious Urban	0.13	0.01	0.01	0.01
Forest	0.08	0.00	0.00	0.00
Cropland	0.02	0.16	0.15	0.14
Pervious Urban	0.01	0.00	0.00	0.00
Recharge	0.01	0.00	0.00	0.00
<i>Direct Sources<sup>(a)</sup></i>				
Direct Defecation	0.31	0.03	0.02	0.01
On-Site Wastewater Treatment Tank Failure	0.21	0.02	0.02	0.02

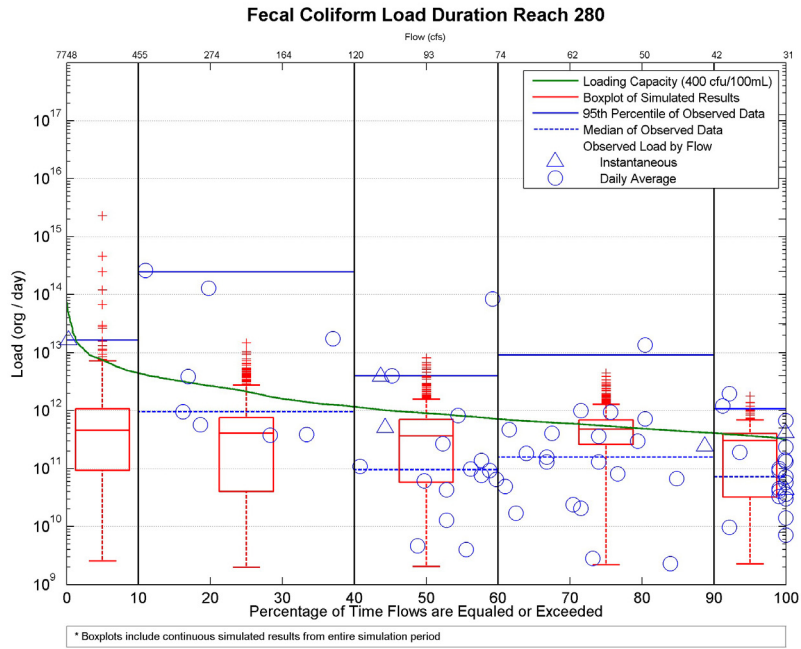
(a) Considered nonpoint source discharges under the Clean Water Act and are not regulated as point sources of pollution.

## 4.0 TECHNICAL ANALYSIS

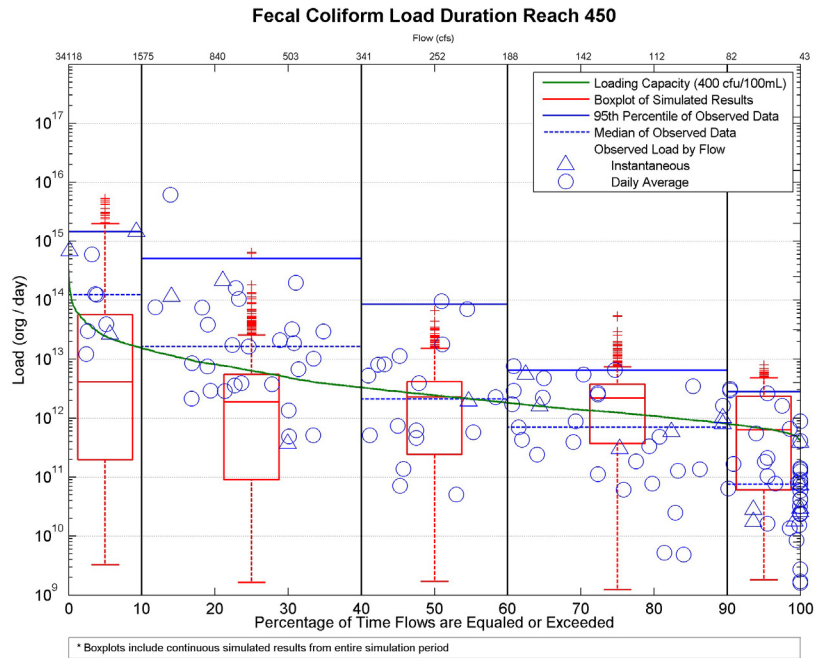
The TMDL was developed using the load duration curve (LDC) approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1–September 30). The LDC is a dynamic expression of the allowable load for any given day within the recreation season. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into five flow zones: high flows (0–10 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].

Two bacteria LDCs were constructed for each bacteria-impaired reaches of the Cheyenne River within the Lower Cheyenne River Watershed (SD-CH-R-CHEYENNE\_03, SD-CH-R-CHEYENNE\_04, SD-CH-R-CHEYENNE\_05, and SD-CH-R-CHEYENNE\_06). The curve, which represents loading capacity, within the first LDC for each reach, was constructed using the product of simulated flow data, the daily maximum bacteria criteria, and a unit conversion factor. Points plotted within the first LDC for each reach include observed loads which were calculated using observed bacteria and flow data from monitoring stations. The first LDCs also includes box plots of simulated average daily loads for each flow zone calculated using simulated bacteria and flow data from reach endpoints. Loading capacity curves for each reach's second LDC were constructed using the product of geometric mean criteria, simulated geometric mean flows, and a unit conversion factor. Box plots in the second LDC for each reach represent the simulated geometric mean bacteria data and simulated geometric mean flow data. The locations of the SD DENR water-quality monitoring sites on the Cheyenne River were shown in Figure 1-4.

When the instantaneous loads are plotted on the LDC, characteristics of the water-quality impairment are shown. Instantaneous loads that plot above the solid curve are exceeding the daily maximum water-quality criterion, while those below the curve are in compliance. As the daily maximum criterion-based LDCs show, fecal coliform samples collected from Segment SD-CH-R-CHEYENNE\_03 (Figure 4-1) exceed the daily maximum criterion during moist, midrange, dry, and low flow conditions, and fecal coliform samples collected from Segments SD-CH-R-CHEYENNE\_04 (Figure 4-2), SD-CH-R-CHEYENNE\_05 (Figure 4-3), and SD-CH-R-CHEYENNE\_06 (Figure 4-4) exceed the daily maximum criterion during high, moist, midrange, dry, and low flow conditions. The geometric mean criterion-based LDCs show similar trends to the daily maximum criterion-based LDCs where fecal coliform samples collected from Segment SD-CH-R-CHEYENNE\_03 (Figure 4-5) exceed the daily maximum criterion during moist, midrange, dry, and low flow conditions, and fecal coliform samples collected from Segments SD-CH-R-CHEYENNE\_04 (Figure 4-6), SD-CH-R-CHEYENNE\_05 (Figure 4-7), and SD-CH-R-CHEYENNE\_06 (Figure 4-8) exceed the daily maximum criterion during these same conditions. Overall, loads exceeding the criteria in the low flow zone indicate potential point source load contributions or sources in close proximity to the stream, such as failing on-site wastewater

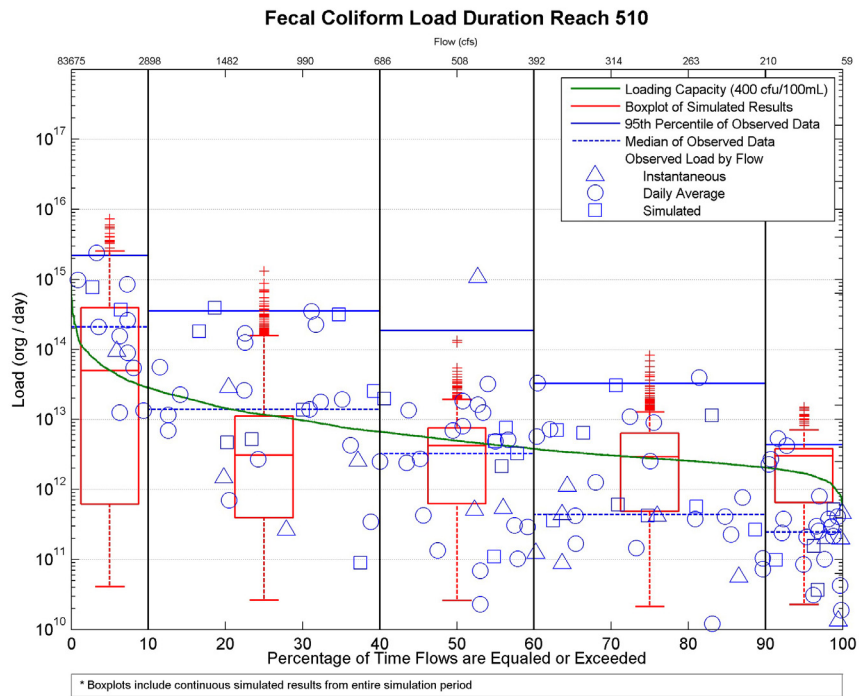


**Figure 4-1.** Reach SD-CH-R-CHEYENNE\_03 Load Duration Curve Representing Allowable Daily Fecal Coliform Loads Based on Daily Maximum Fecal Coliform Criteria.

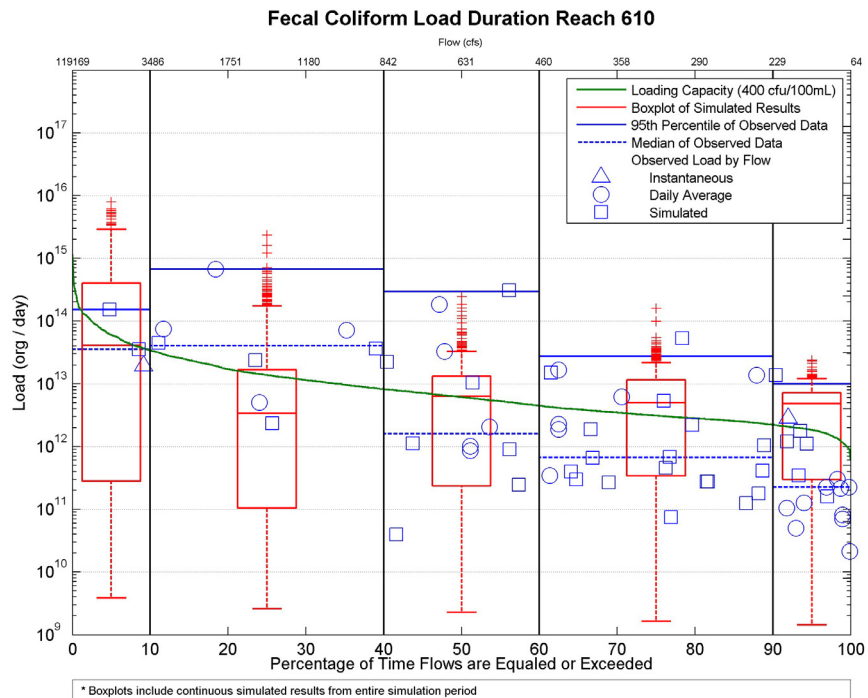


**Figure 4-2.** Reach SD-CH-R-CHEYENNE\_04 Load Duration Curve Representing Allowable Daily Fecal Coliform Loads Based on Daily Maximum Fecal Coliform Criteria.

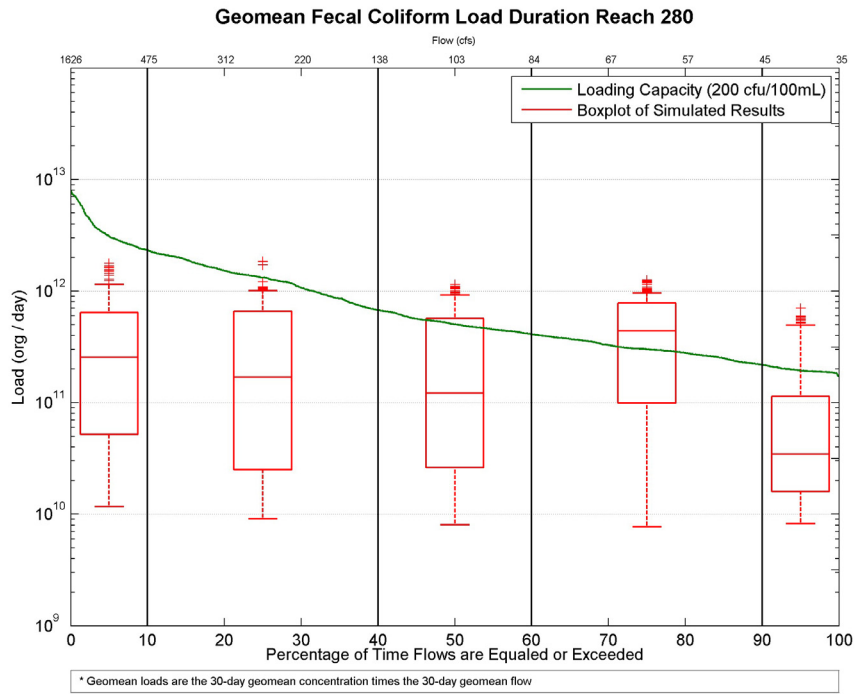




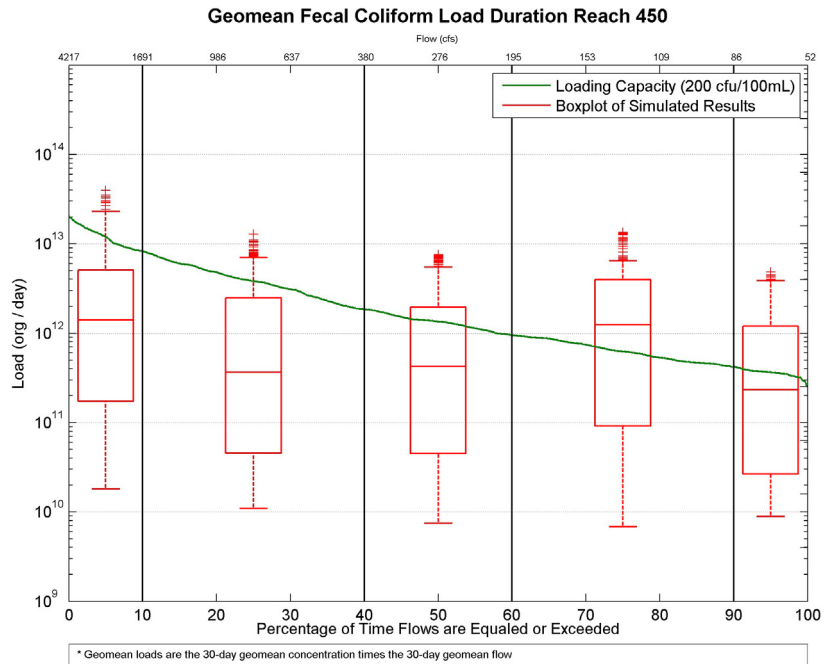
**Figure 4-3.** Reach SD-CH-R-CHEYENNE\_05 Load Duration Curve Representing Allowable Daily Fecal Coliform Loads Based on Daily Maximum Fecal Coliform Criteria.



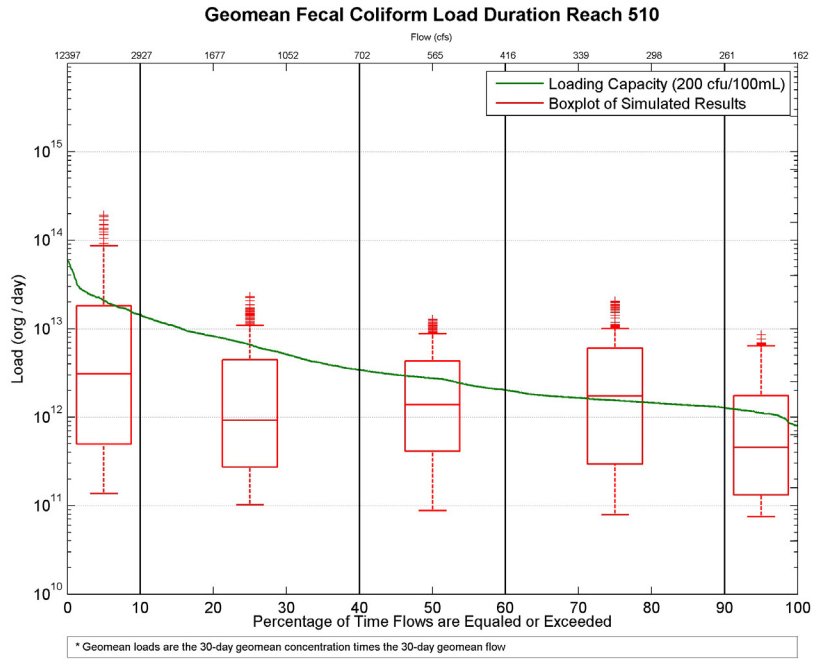
**Figure 4-4.** Reach SD-CH-R-CHEYENNE\_06 Load Duration Curve Representing Allowable Daily Fecal Coliform Loads Based on Daily Maximum Fecal Coliform Criteria.



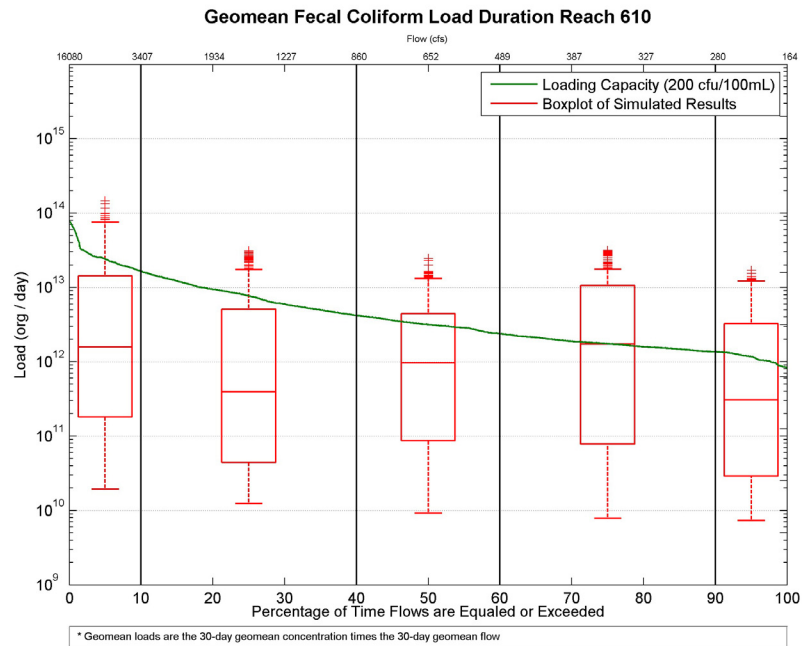
**Figure 4-5.** Reach SD-CH-R-CHEYENNE\_03 Load Duration Curve Representing Allowable Fecal Coliform Loads Based on Geometric Mean Fecal Coliform Criteria.



**Figure 4-6.** Reach SD-CH-R-CHEYENNE\_04 Load Duration Curve Representing Allowable Fecal Coliform Loads Based on Geometric Mean Fecal Coliform Criteria.



**Figure 4-7.** Reach SD-CH-R-CHEYENNE\_05 Load Duration Curve Representing Allowable Fecal Coliform Loads Based on Geometric Mean Fecal Coliform Criteria.



**Figure 4-8.** Reach SD-CH-R-CHEYENNE\_06 Load Duration Curve Representing Allowable Fecal Coliform Loads Based on Geometric Mean Fecal Coliform Criteria.

treatment systems or livestock in the stream channel, while those further left on the plot (i.e., high and moist flow conditions) generally reflect potential nonpoint source contributions from storm water runoff [U.S. Environmental Protection Agency, 2007].

The LDCs shown in Figures 4-1 through Figure 4-8 represent dynamic expressions of the fecal coliform bacteria TMDLs for Cheyenne River segments that are based on the daily maximum and 30-day average fecal coliform criterion. These LDCs result in unique loads that correspond to measured and simulated average daily flows.

## 5.0 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

To ensure that all applicable fecal coliform criteria are met and to aid in the implementation of the TMDL, load allocations were calculated for each of the five flow zones using both the daily maximum and geometric mean 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 in this chapter.

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.

Because of data availability and limitations, three separate TMDL tables were constructed representing different data source combinations for each bacteria-impaired reach of the Cheyenne River within the Lower Cheyenne River Watershed:

1. Observed flows at each reach endpoint with observed bacteria concentrations from water-quality monitoring stations within each reach.
2. Simulated flows at each reach endpoint with simulated bacteria concentrations at each reach endpoint.
3. Simulated geometric mean flows at each reach endpoint with simulated geometric mean bacteria concentrations at each reach endpoint.

For each TMDL summary, an attempt was made to calculate TMDL values using geometric mean flow values and geometric mean bacteria concentrations at actual water-quality monitoring stations for each reach. However, not enough data were available to complete this task. A fourth table is included for each of the four TMDL summaries showing the highest required reduction for each flow zone of the prepared TMDL tables listed earlier.

### 5.1 LOAD ALLOCATION

To develop the fecal coliform bacteria load allocation (LA) for each table, 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 Cheyenne River were calculated by multiplying the specified fecal coliform bacteria criterion by the specified flow data, as listed above.

For each of the five flow zones, the 95<sup>th</sup> 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 95<sup>th</sup> 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 WLA is assigned a zero value, as no point sources of fecal coliform bacteria discharge into the bacteria impaired segments of the Cheyenne River. The overall LA was determined by subtracting the WLA and MOS from the loading capacity.

## 5.2 BASELINE CONDITIONS

Measured sample concentrations and flow data were used to estimate current daily loads ( $\text{cfu} \times 10^9/\text{day}$ ) by calculating the product of fecal coliform sample concentrations ( $\text{cfu}/100 \text{ mL}$ ) from South Dakota monitoring sites, the measured flow (cubic feet per second (cfs)) from the South Dakota monitoring sites, and a unit conversion factor (0.0245). The 95<sup>th</sup> percentile of the range of these estimates within each flow zone was defined as the baseline daily load.

To estimate current monthly geometric mean loads ( $\text{cfu} \times 10^9/\text{month}$ ), the product of the average geometric mean concentrations ( $\text{cfu}/100 \text{ mL}$ ) and monthly average stream flows (cfs) for reach endpoints, calculated from modeled data, was multiplied by a conversion factor (0.0245). The 95<sup>th</sup> percentile of the range of these estimates within each flow zone was defined as the baseline monthly geometric mean load.

Table 5-1 and Table 5-2 present a combination of allocations based on the daily maximum criterion for each flow zone for SD-CH-R-CHEYENNE\_03. Table 5-1 was created using observed fecal coliform data and observed flow data and shows that load reductions are required for all flow zones except the high flow zone (i.e., stream flows greater than 456 cfs). Table 5-2 was created using simulated fecal coliform data and simulated flow data and shows that load reductions are required for all flow zones except the high flow and moist flow zones (i.e., stream flows greater than 133 cfs). Table 5-3 lists monthly allocations based on the geometric mean criterion for SD-CH-R-CHEYENNE\_03, showing that reductions of the geometric mean loads are required in all flow zones, except the high and moist flow zones, to meet the geometric mean criterion (i.e., stream flows greater than 133 cfs). Table 5-3 was created using simulated geometric mean data for both flow and fecal coliform concentration. The allocations based on the observed fecal coliform daily maximum data require slightly greater reductions than the allocations based on simulated and observed daily maximum criterion. Thus the allocations listed for the moist, midrange, dry, and low flow zones in Table 5-1 represent the TMDL goals to attain compliance with all applicable water-quality standards, with the critical conditions occurring during moist and midrange flows, as listed in Table 5-4.

**Table 5-1. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_03 (Observed Flow Data and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	485–133 cfs	132–81 cfs	80–43 cfs	42–33 cfs
LA	42,639	3,532	1,016	548	124
WLA	0	0	0	0	0
MOS	2,496	470	117	157	277
TMDL	45,135	4,002	1,133	705	401
Current Load	16,509	247,931	3,993	9,096	1,069
Load Reduction	0	243,929	2,860	8,391	668
Load Reduction	0%	98%	72%	92%	62%

**Table 5-2. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_03 (Simulated Flow and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	485–133 cfs	132–81 cfs	80–43 cfs	42–33 cfs
LA	29,932	3,131	1,078	596	361
WLA	0	0	0	0	0
MOS	2,890	1,147	199	172	55
TMDL	32,822	4,277	1,277	769	416
Current Load	7,114	2,825	1,566	1,252	731
Load Reduction	0	0	288	483	315
Load Reduction	0%	0%	18%	39%	43%

**Table 5-3. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Geometric Mean Criterion for Reach SD-CH-R-CHEYENNE\_03**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	>487 cfs	486-150 cfs	148-83 cfs	82-44 cfs	43-35 cfs
LA	6,395	1,580	585	314	191
WLA	0	0	0	0	0
MOS	799	641	111	82	21
TMDL	7,194	2,220	697	395	212
Current Load	1,303	1,015	923	969	510
Load Reduction	0	0	226	574	298
Load Reduction	0%	0%	25%	59%	58%

**Table 5-4. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load for Reach SD-CH-R-CHEYENNE\_03 Based on the Greatest Allocations Required for Each Flow Zone From the Previous Three Tables**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	485-133 cfs	132-81 cfs	80-43 cfs	42-33 cfs
LA	42,639	3,532	1,016	548	124
WLA	0	0	0	0	0
MOS	2,496	470	117	157	277
TMDL	45,135	4,002	1,133	705	401
Current Load	16,509	261,172	3,993	9,096	1,069
Load Reduction	0	257,170	2,860	8,391	668
Load Reduction	0%	98%	72%	92%	62%



Table 5-5 and Table 5-6 present a combination of allocations based on the daily maximum criterion for each flow zone for SD-CH-R-CHEYENNE\_04, showing that load reductions are required for all flow zones. Table 5-5 was created using observed fecal coliform data and observed flow data, while Table 5-6 was created using simulated fecal coliform data and simulated flow data. Table 5-7, created using simulated geometric mean data for both flow and fecal coliform concentration, lists monthly allocations based on the geometric mean criterion for SD-CH-R-CHEYENNE\_04, showing that reductions of the geometric mean loads are also required in all flow zones. In the high flow zone, the allocations based on simulated daily maximum bacteria and flow data require the greatest reduction. In the moist and midrange flow zones, the allocations based on observed daily maximum and observed flow data require the greatest reductions. Finally, in the dry and low flow zones, the allocations based on the geometric mean criterion require the greatest reductions. Allocation criteria requiring the greatest reduction for each flow zone will represent the TMDL goals to attain compliance with all applicable water-quality standards, with critical conditions occurring during moist flows as listed in Table 5-8.

**Table 5-5. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_04 (Observed Flow Data and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 1,681 cfs	1,680–386 cfs	385–200 cfs	199–79 cfs	78–43 cfs
LA	86,399	10,980	2,593	1,397	330
WLA	0	0	0	0	0
MOS	9,982	2,721	675	352	443
TMDL	96,381	13,701	3,269	1,749	773
Current Load	1,438,586	512,035	85,660	6,464	2,780
Load Reduction	1,342,205	498,334	82,391	4,715	2,007
Load Reduction	93%	97%	96%	73%	72%

Table 5-9 and Table 5-10 present a combination of allocations based on the daily maximum criterion for each flow zone for SD-CH-R-CHEYENNE\_05, showing that load reductions are required for all flow zones. Table 5-9 was created using observed fecal coliform data and observed flow data, while Table 5-10 was created using simulated fecal coliform data and simulated flow data. Table 5-11 list monthly allocations based on the geometric mean criterion for SD-CH-R-CHEYENNE\_05, showing that reductions of the geometric mean loads are required in all flow zones, except the moist flow zone to meet the geometric mean criterion.

Table 5-11 was created using simulated geometric mean data for both flow and fecal coliform concentration. In the high flow zone, the allocations based on simulated daily maximum bacteria and flow data require the greatest reduction. In the moist, midrange, and dry flow zones, the allocations based on observed daily maximum and observed flow data require the greatest reductions. Finally, in the low flow zone, the allocations based on the geometric mean criterion require the greatest reductions. Allocation criteria requiring the greatest reduction for each flow zone will represent the TMDL goals to attain compliance with all applicable water quality standards, as listed in Table 5-12. Critical conditions for Reach SD-CH-R-CHEYENNE\_05 occur during midrange flow conditions.

**Table 5-6. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_04 (Simulated Flow and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 1,681 cfs	1,680–386 cfs	385–200 cfs	199–79 cfs	78–43 cfs
LA	87,479	11,092	2,852	1,436	530
WLA	0	0	0	0	0
MOS	9,882	3,719	805	423	235
TMDL	97,362	14,811	3,657	1,860	765
Current Load	2,343,325	19,521	10,540	6,916	4,711
Load Reduction	2,245,964	4,710	6,883	5,057	3,946
Load Reduction	96%	24%	65%	73%	84%

Table 5-13 and Table 5-14 present a combination of allocations based on the daily maximum criterion for each flow zone for SD-CH-R-CHEYENNE\_06. Table 5-13 was created using observed fecal coliform data and observed flow data and shows that load reductions are required for all flow zones except the high flow zone. Table 5-14 was created using simulated fecal coliform data and simulated flow data and shows that load reductions are required for all flow zones. Table 5-15 list monthly allocations based on the geometric mean criterion for SD-CH-R-CHEYENNE\_06, showing that reductions of the geometric mean loads are also required in all flow zones. Table 5-16 was created using simulated geometric mean data for both flow and fecal coliform concentration. In the high, moist, and midrange flow zones, the allocations based on simulated daily maximum bacteria and flow data require the greatest reduction. In the dry and low flow zones, the allocations based on the geometric mean criterion require the greatest

**Table 5-7. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Geometric Mean Criterion for Reach SD-CH-R-CHEYENNE\_04**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 1,727 cfs	1,726-392 cfs	391-195 cfs	194-84 cfs	83-52 cfs
LA	14,903	5,779	1,435	718	289
WLA	0	0	0	0	0
MOS	3,818	2,095	440	197	113
TMDL	18,721	7,874	1,875	915	402
Current Load	27,663	7,362	5,416	5,915	3,343
Load Reduction	8,941	0	3,542	4,999	2,941
Load Reduction	32%	0%	65%	85%	88%

**Table 5-8. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load for Reach SD-CH-R-CHEYENNE\_04 Based on the Greatest Allocations Required for Each Flow Zone From the Previous Three Tables**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 1,681 cfs	1,680-386 cfs	385-200 cfs	194-84 cfs	83-52 cfs
LA	87,479	10,980	2,593	718	289
WLA	0	0	0	0	0
MOS	9,882	2,721	675	197	113
TMDL	97,362	13,701	3,269	915	402
Current Load	2,343,325	512,035	85,660	5,915	3,343
Load Reduction	2,245,964	498,334	82,391	4,999	2,941
Load Reduction	96%	97%	96%	85%	88%

**Table 5-9. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_05 (Observed Flow Data and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	225–59 cfs
LA	168,326	21,378	5,275	3,009	910
WLA	0	0	0	0	0
MOS	20,062	4,149	1,233	656	1,086
TMDL	188,388	25,528	6,508	3,665	1,996
Current Load	2,196,584	351,809	186,800	32,663	4,323
Load Reduction	2,008,196	326,281	180,292	28,998	2,327
Load Reduction	91%	93%	97%	89%	54%

**Table 5-10. Cheyenne River Fecal Coliform Bacteria TMDL Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_05 (Simulated Flow and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	225–59 cfs
LA	213,790	21,575	5,567	3,159	860
WLA	0	0	0	0	0
MOS	22,562	5,123	1,393	770	1,319
TMDL	236,352	26,698	6,959	3,929	2,179
Current Load	3,480,344	70,060	15,051	10,504	6,126
Load Reduction	3,243,992	43,362	8,092	6,575	3,947
Load Reduction	93%	62%	54%	63%	64%

**Table 5-11. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Geometric Mean Criterion for Reach SD-CH-R-CHEYENNE\_05**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 3,020 cfs	3,019–743 cfs	742–431 cfs	430–257 cfs	256–162 cfs
LA	42,619	10,002	2,778	1,762	927
WLA	0	0	0	0	0
MOS	6,838	3,372	751	289	319
TMDL	49,457	13,374	3,529	2,051	1,246
Current Load	99,930	11,577	8,890	8,861	6,438
Load Reduction	50,473	0	5,361	6,811	5,192
Load Reduction	51%	0%	60%	77%	81%

**Table 5-12. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load for Reach SD-CH-R-CHEYENNE\_05 Based on the Greatest Allocations Required for Each Flow Zone From the Previous Three Tables**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	256–162 cfs
LA	213,790	21,378	5,275	3,009	927
WLA	0	0	0	0	0
MOS	22,562	4,149	1,233	656	319
TMDL	236,352	25,528	6,508	3,665	1,246
Current Load	3,480,344	351,809	186,800	32,663	6,438
Load Reduction	3,243,992	326,281	180,292	28,998	5,192
Load Reduction	93%	93%	97%	89%	81%

**Table 5-13. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_06 (Observed Flow Data and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 3,632 cfs	3,631–889 cfs	888–479 cfs	478–246 cfs	245–64 cfs
LA	200,866	24,300	6,488	3,601	1,003
WLA	0	0	0	0	0
MOS	20,307	6,038	1,341	773	1,160
TMDL	221,173	30,338	7,829	4,375	2,163
Current Load	161,719	74,376	187,723	145,372	11,610
Load Reduction	0	44,038	179,894	140,997	9,447
Load Reduction	0%	59%	96%	97%	81%

**Table 5-14. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE\_06 (Simulated Flow and Fecal Coliform Data)**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 3,632 cfs	3,631–889 cfs	888–479 cfs	478–246 cfs	245–64 cfs
LA	250,519	26,124	6,661	3,588	994
WLA	0	0	0	0	0
MOS	25,671	6,182	1,790	873	1,385
TMDL	276,190	32,306	8,452	4,461	2,379
Current Load	2,955,114	71,754	27,254	20,360	11,105
Load Reduction	2,678,924	39,448	18,802	15,898	8,726
Load Reduction	91%	55%	69%	78%	79%

**Table 5-15. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load Based on the Geometric Mean Criterion for Reach SD-CH-R-CHEYENNE\_06**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 3,513 cfs	3,512–918 cfs	917–513 cfs	512–278 cfs	277–164 cfs
LA	58,378	11,796	3,567	1,997	998
WLA	0	0	0	0	0
MOS	7,447	3,789	818	414	354
TMDL	65,824	15,586	4,386	2,411	1,353
Current Load	80,306	19,189	13,566	14,872	12,204
Load Reduction	14,481	3,604	9,181	12,461	10,852
Load Reduction	18%	19%	68%	84%	89%

**Table 5-16. Cheyenne River Fecal Coliform Bacteria Total Maximum Daily Load for Reach SD-CH-R-CHEYENNE\_06 Based on the Greatest Allocations Required for Each Flow Zone From the Previous Three Tables**

TMDL Component	Flow Zone (expressed as cfu × 10 <sup>9</sup> /day)				
	High	Moist	Midrange	Dry	Low
	> 3,632 cfs	3,631–889 cfs	888–479 cfs	478–246 cfs	277–164 cfs
LA	250,519	24,300	6,488	3,601	998
WLA	0	0	0	0	0
MOS	25,671	6,038	1,341	773	354
TMDL	276,190	30,338	7,829	4,375	1,353
Current Load	2,955,114	74,376	187,723	145,372	12,204
Load Reduction	2,678,924	44,038	179,894	140,997	10,852
Load Reduction	91%	59%	96%	97%	89%

reductions. Allocation criteria requiring the greatest reduction for each flow zone will represent the TMDL goals to attain compliance with all applicable water-quality standards, as listed in Table 5-16. Critical conditions for reach SD-CH-R-CHEYENNE\_06 occur during dry flow conditions.

According to U.S. Environmental Protection Agency [2007], the high- and low-flow hydrologic conditions should not be selected as critical conditions because these extreme flows are not representative of typical conditions. Thus for Reach SD-CH-R-CHEYENNE\_03, critical conditions occur during the moist flow conditions (133–485 cfs) as the greatest load reductions are required during this flow regime. For Reach SD-CH-R-CHEYENNE\_04, critical conditions occur during the moist flow conditions (386–1,680 cfs). For Reach SD-CH-R-CHEYENNE\_05, critical conditions occur during midrange flow conditions (419–727 cfs), and for Reach SD-CH-R-CHEYENNE\_06, critical conditions occur during dry flow conditions (246–478 cfs).

### **5.3 WASTE LOAD ALLOCATION**

No point sources of fecal coliform bacteria discharge directly to the impaired segment or tributary of the impaired segments of the Cheyenne River within the Lower Cheyenne River Watershed, so the WLA is assigned a zero value. Point source discharges do exist upstream of the impaired segments. However, these discharges are not accounted for within the Lower Cheyenne River Watershed TMDLs. This is because they are accounted for in other TMDLs and the bacteria loads from these facilities likely do not have a large impact on the impaired segments of the Cheyenne River because of travel time and decay rates of the bacteria. Two permitted concentrated animal feeding operations are located within the Lower Cheyenne River Watershed. One is in Fall River County and would potentially drain to SD-CH-R-CHEYENNE-03, and one is in Meade County which would potentially drain to SD-CH-R-CHEYENNE-06. However, these permitted concentrated animal feeding operations are not currently allowed to discharge within the Lower Cheyenne River Watershed.



## **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 the Cheyenne River displayed seasonal variation. Available recreational season daily flow and fecal coliform data were used to calculate the maximum and minimum average monthly flows and bacteria concentrations (Table 6-1) for five Cheyenne River project sites (CHR04, CHR05, CHR10, CHR14, and CHR13). Monthly average stream flows ranged considerably, with the lowest monthly average stream flow occurring at Project Site CHR05 (71 cfs) and the highest monthly average stream flow at Project Site CHR13 (2,728). A large range of fecal coliform concentrations occurred, with the lowest monthly average fecal coliform concentration occurring at project site CHR04 (37 cfu/100 mL) and the highest monthly average fecal coliform concentration occurring at site CHR10 (6,393 cfu/100 mL).

The highest bacteria concentrations generally occur during the recreational season. 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 bacteria TMDL is seasonal, as it is effective only during the period of May 1 through September 30. Since the criteria for fecal coliform bacteria concentrations are in effect from May 1 through September 30, the TMDL is also applicable only during this time period.

**Table 6-1. Cheyenne River Maximum and Minimum Monthly Average Recreational Season Flows and Fecal Coliform Concentrations**

<b>Project Site</b>	<b>Maximum Monthly Average Flow</b>	<b>Minimum Monthly Average Flow</b>	<b>Maximum Monthly Average Fecal Coliform Concentration</b>	<b>Minimum Monthly Average Fecal Coliform Concentration</b>
CHR04	284 cfs (May)	92 cfs (August)	454 cfu/100 mL (August)	37 cfu/100 mL (June)
CHR05	193 cfs (June)	71 cfs (August)	2,952 cfu/100 mL (July)	90 cfu/100 mL (May)
CHR10	1,080 cfs (June)	159 cfs (September)	6,393 cfu/100 mL (June)	679 cfu/100 mL (September)
CHR14	1,992 cfs (June)	377 cfs (September)	4,522 cfu/100 mL (June)	887 cfu/100 mL (May)
CHR13	2,728 cfs (June)	351 cfs (September)	4,257 cfu/100 mL (August)	164 cfu/100 mL (September)

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. 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 wash-off from the watershed.

## 7.0 PUBLIC PARTICIPATION

Efforts taken to gain public education, review, and comment during development of the Cheyenne River fecal coliform bacteria TMDLs 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 the development of the TMDLs. The public notice was published in the *Rapid City Journal* and the *Hot Springs Star*. The document was also made available through the SD DENR's website.

Specifically at the start of this project, several individual meetings were held and presentations were given to stakeholders groups. These meetings included individual meetings with the South Dakota Game, Fish and Parks, the National Forest Service, Badlands National Park, Black Hills RC&D, Pennington Conservation District, Elk Creek Conservation District, East Pennington Conservation District, Fall River Conservation District, the Belle Fourche River Watershed Partnership, and the Cheyenne River Watershed Partnership—formed at the start of this project. Regular updates were given to the Cheyenne River Watershed Partnership, including presentations at four partnership meetings. Two public meetings were held as part of this project; one in Rapid City, South Dakota, and one in Hot Springs, South Dakota. Additionally, several presentations were given about the project each year at the annual Western South Dakota Hydrology conference, for each of the 4 years of the project duration. Scientists and engineers from the Midwest area working in the area of water quality and stream health regularly attend this conference as well as many local stakeholders. This conference allowed the project team to give project updates to the professional and stakeholder communities annually while receiving feedback on the technical aspects of the project.

## 8.0 MONITORING STRATEGY

During and after the implementation of management practices, monitoring will be necessary to ensure attainment of the TMDLs. Stream water-quality monitoring will be accomplished through SD DENR's ambient water-quality monitoring stations on Cheyenne River (STORET I.D.s: 460123, 460865, 468860, and 460133), which are sampled on a monthly basis during the recreational season.

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 the 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 load 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 South Dakota portion of the Lower Cheyenne River 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 in South Dakota. Based on water-quality monitoring, bacterial source tracking, and HSPF model results, the recommended control measures to be implemented in South Dakota are expected to achieve the required load reductions and attain the TMDL goal.

Five management scenarios were simulated for each bacteria impaired reach using the HSPF model:

1. Rapid Creek compliance with the South Dakota water-quality standard.
2. Belle Fourche River compliance with the South Dakota water-quality standard.
3. Removal of on-site wastewater treatment system bacteria loads.
4. Elimination of direct defecation by cattle.
5. General rangeland management.

Model results show that reducing Rapid Creek loads to meet South Dakota water-quality criteria (Scenario 1) would result in a 0 percent reduction for all impaired reaches. Percent reductions were calculated for the average recreation season (May 1 through September 30) load in the Cheyenne River. Similarly, with implementation of Scenario 1, the model predicts that the daily maximum criterion would be exceeded 25 percent of the time (2 percent less than base conditions) in the Cheyenne River at the Rapid Creek confluence with the Cheyenne River. For these reasons, bacteria loads from the Rapid Creek do not appear to significantly contribute to the recreation use impairment of the Cheyenne River.

Model results show that reducing Belle Fourche River loads to meet South Dakota water-quality criteria (Scenario 2) would result in a 0 percent reduction for Reaches SD-CH-R-CHEYENNE\_03 and SD-CH-R-CHEYENNE\_04, a 28 percent reduction for Reach SD-CH-CHEYENNE\_05, and a 20 percent reduction for Reach SD-CH-R-CHEYENNE\_06 for the average recreation season load in the Cheyenne River. With implementation of Scenario 2, the model predicts that the daily maximum criterion would be exceeded 29 percent of the time (4 percent less than base conditions) in the Cheyenne River at the Belle Fourche River confluence with the Cheyenne River. For these reasons, bacteria loads from the Belle Fourche River do appear to contribute to the recreation use impairment of the Cheyenne River. Because the Belle Fourche River confluence with the Cheyenne River is located at the endpoint of Reach SD-CH-R-CHEYENNE\_04, the Belle Fourche River has no effect on Reaches SD-CH-R-

CHEYENNE\_03 and SD-CH-R-CHEYENNE\_04. Thus 0 percent reduction from Scenario 2 in these two reaches were expected.

The model also shows that the removal of the on-site wastewater treatment system bacteria load (Scenario 3) would result in a 0 percent reduction for Reach SD-CH-R-CHEYENNE\_03, a 0 percent reduction for Reach SD-CH-R-CHEYENNE\_04, a 0 percent reduction for Reach SD-CH-R-CHEYENNE\_05, and a 0 percent reduction for Reach SD-CH-R-CHEYENNE\_06. Percent reductions were calculated for the average recreation season (May 1 through September 30) load in the Cheyenne River. Because of the Scenario 3 results, on-site wastewater treatment system BMPs are recommended for those systems in the South Dakota portion of the watershed that are in close proximity to the Cheyenne River.

Exclusion of cattle from streams (Scenario 4) appears to be a possible management practice for the Lower Cheyenne River Watershed. Based on the simulation, approximately 19 percent of the average recreation season bacteria load in Reach SD-CH-R-CHEYENNE\_03 of the Cheyenne River could be reduced by implementing livestock exclusion practices, such as installing fence to exclude livestock from streams and off-stream water supplies. Approximately 5 percent of the average recreation season bacteria load in Reach SD-CH-R-CHEYENNE\_04, approximately 4 percent in Reach SD-CH-R-CHEYENNE\_05, and approximately 7 percent in Reach SD-CH-R-CHEYENNE\_06 could be reduced by implementing livestock exclusion practices.

Lastly, grazing management practices (Scenario 5) were simulated using a uniform reduction factor of 87 percent based on observed bacteria concentration reductions from a previous study [Sheffield et al., 1997]. In the model, the reduction factor was applied to all pastureland. With this implementation scenario, the predicted average recreation season loads delivered were reduced by approximately 70 percent to Reach SD-CH-R-CHEYENNE\_03, 82 percent to REACH SD-CH-R-CHEYENNE\_04, 57 percent to Reach SD-CH-R-CHEYENNE\_05, and 62 percent to Reach SD-CH-R-CHEYENNE\_06. Grazing practices, such as seasonal access or rotational grazing, reduce the intensity and duration of grazing. These practices result in improved rangeland health, thereby increasing water infiltration and reducing runoff. Scenario 5 considers the improvement of small unpermitted animal feeding operations throughout the watershed. No permitted concentrated animal feeding operations are currently allowed to discharge within the Lower Cheyenne River Watershed.

An average estimated 65 percent load reduction is required within Segment SD-CH-R-CHEYENNE\_03 to meet water-quality standards based on the overall percent difference between the current loads and TMDL targets across all flow conditions. With the implementation grazing management practices (Scenario 5), the model predicted a reduction in average recreation season bacteria loads of approximately 70 percent, which is greater than the required load reduction of 65 percent. Thus implementation of Scenario 5 is expected to achieve the TMDL goal.

An average estimated 92 percent load reduction is required within Segment SD-CH-R-CHEYENNE\_04 to meet water-quality standards based on the overall percent difference between the current loads and TMDL targets across all flow conditions. With the implementation of livestock exclusion and grazing management practices (Scenarios 4 and 5, respectively), the model predicted a reduction in average recreation season bacteria loads of approximately 87 percent—slightly less than the required load reduction of 92 percent. A difference of 6 percent is within the model error and the explicit MOS of the TMDL. Thus implementation of Scenarios 4 and 5 is expected to achieve the TMDL goal.

An average estimated 91 percent load reduction is required within Segment SD-CH-R-CHEYENNE\_05 to meet water-quality standards based on the overall percent difference between the current loads and TMDL targets across all flow conditions. With the implementation of Belle Fourche River and Rapid Creek bacteria compliance, livestock exclusion, and grazing management practices (Scenarios 2, 4, and 5, respectively), the model predicted a reduction in average recreation season bacteria loads of approximately 89 percent—slightly less than the required load reduction of 91 percent. A difference of 2 percent is within the model error and the explicit margin of safety of the TMDL. Thus implementation of Scenarios 2, 4, and 5 is expected to achieve the TMDL goal.

On average, an estimated 86 percent load reduction is required within Segment SD-CH-R-CHEYENNE\_06 to meet water-quality standards based on the overall percent difference between the current loads and TMDL targets across all flow conditions. With the implementation of Rapid Creek and Belle Fourche River compliance, livestock exclusion, and grazing management practices (Scenarios 1, 2, 4, and 5 respectively), the model predicted a reduction in average recreation season bacteria loads of approximately 89 percent, which is greater than the required load reduction of 86 percent. Thus implementation of Scenarios 2, 4, and 5 is expected to achieve the TMDL goal.

Funds to implement watershed water-quality improvements can be obtained through 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. These programs include Consolidated Water Facilities Construction Program, Clean Water State Revolving Fund (SRF) Program, and the Section 319 Nonpoint Source Program.

## 10.0 REFERENCES

**Administrative Rules of South Dakota, 2010.** *ASRD: 74:51:01:30*, South Dakota Administrative Rules, retrieved February 23, 2010, from the World Wide Web at <http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=74:51:01:30>

**High Plains Regional Climate Center, 2009.** *Climate Data Services*, retrieved February 23, 2010, from the World Wide Web at <http://www.hprcc.unl.edu/services/index.php?p=online>

**Mynam, S., 2009.** *Distribution Characteristics of Wildlife and Livestock for the Development of Fecal Coliform Loading in the Lower Cheyenne River Watershed*, master of science thesis, South Dakota School of Mines and Technology, Rapid City, SD.

**Sheffield, R. E.; S. Mostaghimi; D. H. Vaughan; E. R. Collins, Jr.; and V. G. Allen, 1997.** "Off-Stream Water Sources From Grazing Cattle as a Stream Bank Stabilization and Water Quality BMP," *American Society of Agricultural Engineers*, Vol. 40, pp. 595–604.

**South Dakota Department of Environmental and Natural Resources, 2010.** *The 2010 South Dakota Integrated Report for Surface Water Quality Assessment*, prepared by South Dakota Department of Environment and Natural Resources, Pierre, SD.

**South Dakota Department of Environmental and Natural Resources, 2008.** *The 2008 South Dakota Integrated Report for Surface Water Quality Assessment*, prepared by South Dakota Department of Environment and Natural Resources, Pierre, SD.

**U.S. Environmental Protection Agency, 2001.** *Bacterial Indicator Tool Users Guide*, EPA-823-B-01-003, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

**U.S. Environmental Protection Agency, 2007.** *An Approach for Using Load Duration Curves in the Development of TMDLs*, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.



**APPENDIX A**

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

## EPA REGION VIII TMDL REVIEW

### TMDL Document Info:

<b>Document Name:</b>	<b>Fecal Coliform Total Maximum Daily Load for Cheyenne River, Pennington County, South Dakota</b>
<b>Submitted by:</b>	<b>Cheryl Saunders, SD DENR</b>
<b>Date Received:</b>	<b>July 22, 2010</b>
<b>Review Date:</b>	<b>August 9, 2010</b>
<b>Reviewer:</b>	<b>Vern Berry, EPA</b>
<b>Rough Draft / Public Notice / Final?</b>	<b>Public Notice Draft</b>
<b>Notes:</b>	

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 Cheyenne River fecal coliform TMDL was submitted to EPA for review during the public notice period via an email from Cheryl Saunders, SD DENR on July 22, 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 Cheyenne River is a stream located in southwestern South Dakota. The Cheyenne River is the largest western tributary to the Missouri River in South Dakota with a contributing drainage area of approximately 24,240 square miles. The River drains northeasterly to Lake Oahe. The Cheyenne River watershed consists of three large parts: 1) the Upper Cheyenne River watershed above Angostura Reservoir (7,920 square miles); 2) the Belle Fourche River watershed, the largest contributing tributary drainage area (7,220 square miles); and 3) the Lower Cheyenne River watershed below Angostura Reservoir (7,930 square miles).

The Cheyenne River flows to the Missouri River from the Middle Cheyenne-Spring sub-basin (HUC 10120109), and the Lower Cheyenne sub-basin (HUC 10120112). The focus of the TMDL document is on the lower portion of the Cheyenne River watershed below Angostura Reservoir. Four segments of the lower Cheyenne River are identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated

fecal coliform concentrations. The four listed segments are: 1) Cheyenne River from Fall River to Cedar Creek (57.1 miles; SD-CH-R-CHEYENNE\_03); 2) Cheyenne River from Cedar Creek to Belle Fourche River (87.3 miles; SD-CH-R-CHEYENNE\_04); 3) Cheyenne River from Belle Fourche River to Bull Creek (44.6 miles; SD-CH-R-CHEYENNE\_05); and 4) Cheyenne River from Bull Creek to mouth (37.9 miles; SD-CH-R-CHEYENNE\_06). All four segments are also listed as impaired for total suspended solids (TSS), and segment SD-CH-R-CHEYENNE\_05 is also listed as impaired for *Escherichia coli*. All four segments are identified as high priority for TMDL development. The TSS and *E. coli* impairments will be addressed in separate TMDL documents.

The designated uses for the listed segments of the Cheyenne River segments include: warmwater semipermanent fish life propagation waters, warmwater permanent fish life propagation waters, immersion recreation waters, limited-contact recreation waters, irrigation waters, fish and wildlife propagation, recreation, and stock watering.

**COMMENTS:** None.

### 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, all TMDL documents must be written to meet the existing water quality standards 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 Cheyenne River segments addressed by these TMDLs are 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 these river segments. The numeric standards being implemented in these TMDLs 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 the Cheyenne River can be found on pages 9 - 13 of the TMDL document.

**COMMENTS:** Footnote “d” on page 11 of the TMDL says that the fecal coliform criteria are based on the limited contact recreation use. This appears to be an error and should be corrected to say that the criteria are based on the immersion recreation use.

Page 11 also 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 possible future *E. coli* impairments to the immersion recreation and limited contact recreation use of the Cheyenne River.” It seems that this statement is not needed in the fecal coliform TMDL because a separate TMDL document was written to address the existing and potential future *E. coli* impairments in the lower Cheyenne River watershed. We recommend removing the statement in quotes above from the TMDL document.

SD DENR Response: “limited contact recreation” on footnote “d” on page 11 was changed to “immersion recreation.” The future *E. coli* TMDL statement was removed from page 11.

## 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, embeddness, 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 these TMDLs are based on the numeric water quality standards for fecal coliform established to protect the immersion recreation beneficial uses for the four Cheyenne River segments. 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 use in the lower watershed as predominately agricultural consisting of mainly of rangeland. 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 Lower Cheyenne River Watershed**

<b>Model Land Use</b>	<b>Total Area (%)</b>
Urban/EIA	1.2
Forest	10.3
Cropland	6.4
Rangeland	75.5
Barren	2.3
Groundwater Recharge	3.6
Open Water	0.6

No permitted point source dischargers are located in the lower Cheyenne River watershed. There are permitted point sources located in upstream tributaries which are addressed by the state of South Dakota as separate stream segments. Bacteria loads from upstream tributaries have been accounted for in boundary conditions.

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of fecal coliform within the Cheyenne River watershed include agricultural runoff, as well as wildlife and human sources. Using the best available information, loadings were estimated from each of these sources using the EPA's Bacterial Indicator Tool (BIT). This tool estimates loading sources 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, 2001].

Manure from livestock is a potential source of fecal coliform to the stream. Livestock in the basin are predominantly beef cattle, sheep, and horses. Livestock population densities in the watershed were estimated using Census of Agriculture data and summarized by county. Livestock contribute bacteria loads to the Cheyenne River directly by defecating while wading in the stream 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 14 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 for the lower Cheyenne River watershed.



SD DENR Response: A table of livestock densities by county was inserted into Section 3.2.1.

## 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., stream 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 Cheyenne River TMDL describes how the fecal coliform loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segments.

The South Dakota Department of Environment and Natural Resources (SD DENR) and the United States Geological Service (USGS) have been collecting fecal coliform data from multiple sites within the lower Cheyenne River watershed dating back to 1967. For the purposes of this TMDL document, data were used from stations which are listed in the Data Set Description section below. Figure 1-4 of the TMDL document shows the monitoring stations used in collecting data. Historical data collected from May 1 to September 30 (applicable dates for the fecal coliform water quality standard) from each monitoring station were used in the TMDL technical analysis.

Recreational beneficial use standards are applicable only from May through September (recreation season). Only discharge data collected during the recreation season from each stream segment were used to develop the flow duration curves. Recreational season discharge dates ranged from 1950 through 2008 for segment SD-CH-R-CHEYENNE\_03, 1981 through 2009 for segment SD-CH-R-CHEYENNE\_04, and 1960 through 2009 for segment SD-CH-R-CHEYENNE\_05.

The Hydrological Simulation Program – FORTRAN (HSPF) model was used to determine the contribution of fecal coliform bacteria from identified sources in the Cheyenne River Watershed and to evaluate the implementation of best management practices (BMPs) to control these sources. The nonpoint sources in the study area were modeled in HSPF by estimating per acre fecal coliform accumulation rates and maximum fecal coliform storage rates for each source. The buildup and washoff of fecal coliform was simulated based on these rates and precipitation. The accumulation and storage rates were calculated using BIT.

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 *An Approach for Using Load Duration Curves in the Development of TMDLs* (US EPA, 2006).

The LDCs shown in Figures 4-1 through 4-8 in the TMDL document, represent dynamic expressions of parameter-specific TMDLs for the impaired segments of the Cheyenne River that are based on the daily maximum and 30-day geometric mean fecal coliform criteria, resulting in a unique loads that correspond to measured and simulated average daily flows.

Two bacteria LDCs were constructed for each bacteria-impaired reach of the Cheyenne River within the lower Cheyenne River watershed. The curve, which represents loading capacity, within the first LDC for each reach, was constructed using the product of simulated flow data, the daily maximum bacteria criteria, and a unit conversion factor. Points plotted within the first LDC for each reach include observed loads which were calculated using observed bacteria and flow data from monitoring stations. The first LDCs also include box plots of simulated average daily loads for each flow zone calculated using simulated bacteria and flow data from reach endpoints. Box plots in the second LDC for each reach 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 for each of the four listed segments of Cheyenne River. The TMDL loading capacities in all four segments are included in Tables 5-4, 5-8, 5-12 and 5-16 of the TMDL document. These loads, when met, will attain compliance with all applicable water quality standards for fecal coliform in the listed segments of the Cheyenne River.

**COMMENTS:** The TMDL table of contents (p. v) lists Section 4.0. as “Technical Analysis.” However, on page 20, Section 4.0 is titled “Load Duration Curve Analyses.” We prefer the “Technical Analysis” title.

SD DENR Response: Chapter 4.0 title was changed from “Load Duration Curve Analysis” to “Technical Analysis.”

## **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 Cheyenne River TMDL data description and summary are included mostly in the Significant Sources section of the document. The full data set is not included in the TMDL. The South Dakota Department of Environment and Natural Resources (SD DENR) and the United States Geological Service (USGS) have been collecting fecal coliform data from multiple sites within the lower Cheyenne River watershed dating back to 1967. Also, a total of 114 paired fecal coliform and *E. coli* samples existed along the Cheyenne River throughout the study area. The data set also includes the flow record on the Cheyenne River that was used to create the load duration curves for the four segments included in this TMDL document. Table 1-2, excerpted from the TMDL document, lists the monitoring locations and number of samples collected for the segments included in the TMDL.

**Table 1-2. Water-Quality Stations in the Lower Cheyenne River Watershed Used for Fecal Coliform Total Maximum Daily Load Development**

Fecal Coliform Monitoring Stations	Project	Segment	Data Available	Number of Data Points
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007–2009	18
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999–2009	123
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007–2009	21
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967–2009	196
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008–2009	8
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968–2009	250
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999–2009	63

COMMENTS: None.

**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:** No point sources of fecal coliform bacteria discharge directly to the impaired segment or tributary of the impaired segments of the lower Cheyenne River watershed. Therefore, the WLA is zero for all four segments covered by the TMDL document. Point source discharges do exist upstream of the impaired segments. However, these discharges are not accounted for within the lower Cheyenne River watershed TMDLs because they are accounted for in other TMDLs. Also, the bacteria loads from these facilities likely do not have a large impact on the impaired segments of the Cheyenne River due to the travel time and decay rates of the bacteria.

Two permitted concentrated animal feeding operations are located within the lower Cheyenne River watershed. One is in Fall River County and would potentially drain to SD-CH-R-CHEYENNE-03, and one is in Meade County which would potentially drain to SD-CH-R-CHEYENNNE-06. However, these permitted concentrated animal feeding operations are not currently allowed to discharge within the lower Cheyenne River watershed.

**COMMENTS:** None.

### 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 the Cheyenne River were calculated by multiplying the specified fecal coliform bacteria criterion by the specified flow data. 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 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 WLA is assigned a zero value, as no point sources of fecal coliform bacteria discharge into the bacteria impaired segments of the Cheyenne River. 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. Rangeland for cattle grazing is the dominate landuse 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).

- If the MOS is implicit, 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.
- If the MOS is explicit, 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.
- If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach 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 Cheyenne River TMDLs include explicit MOSs for each segment derived by calculating the difference between the loading capacity at the mid-point of each of the five flow zones and the loading capacity at the minimum flow in each zone. The explicit MOS values are included in Tables 5-4, 5-8, 5-12 and 5-16 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 stream 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 Response: information regarding the number of presentations, types of stakeholder groups and attendance, and publishing of the 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](http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf)

Recommendation:

Approve  Partial Approval  Disapprove  Insufficient Information

**SUMMARY:** The Cheyenne River will continue to be monitored through SD DENR's ambient water quality monitoring stations on the Cheyenne River. Stream water-quality monitoring will be accomplished through SD DENR's ambient water-quality monitoring stations on the Cheyenne River 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. Monitoring locations should be based on the location and type of BMPs installed. 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 South Dakota portion of the lower Cheyenne River watershed. Several types of control measures are available for reducing fecal coliform bacteria loads, and recommendations to address the identified sources in South Dakota 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 in South Dakota are expected to achieve the required load reductions and attain the TMDL goals. Implementations of grazing management practices on rangelands in the watershed appear to have the greatest fecal coliform load reduction potential. Funds to implement watershed water quality improvements can be obtained through the SD DENR. There are no permitted point sources in the impaired segments included in the TMDL document; therefore a demonstration of reasonable assurance is not required.

**COMMENTS:** None.

## 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 Cheyenne River fecal coliform TMDLs include daily loads expressed as colonies forming units (cfu) per day. The daily TMDL loads are included in TMDL Section of the document.

**COMMENTS:** None.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION 8

1595 Wynkoop Street  
DENVER, CO 80202-1129  
Phone 800-227-8917  
<http://www.epa.gov/region08>

RECEIVED

Ref: 8EPR-EP

SEP 30 2010

OCT 5 2010

Steven M. Pirner  
Secretary  
South Dakota Department of Environment & Natural Resources  
Joe Foss Building  
523 East Capitol  
Pierre, SD 57501-3181

DEPT. OF ENVIRONMENT AND  
NATURAL RESOURCES,  
SECRETARY'S OFFICE

Re: TMDL Approvals  
*Cheyenne River; Fecal Coliform; SD-CH-R-  
CHEYENNE\_03; SD-CH-R-CHEYENNE\_04; SD-CH-R-  
CHEYENNE\_05; SD-CH-R-CHEYENNE\_06*

Dear Mr. Pirner:

We have completed our review of the total maximum daily loads (TMDLs) as submitted by your office for the waterbodies listed in the enclosure to this letter. In accordance with the Clean Water Act (33 U.S.C. 1251 *et. seq.*), we approve all aspects of the TMDLs as developed for the water quality limited waterbodies as described in Section 303(d)(1). Based on our review, we feel the separate elements of the TMDLs listed in the enclosed table adequately address the pollutants of concern as given in the table, taking into consideration seasonal variation and a margin of safety.

Thank you for submitting these TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Vern Berry and he may be reached at 303-312-6234.

Sincerely,

Carol L. Campbell  
Assistant Regional Administrator  
Office of Ecosystems Protection  
and Remediation

Enclosures



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ENCLOSURE 1: APPROVED TMDLs

Fecal Coliform Total Maximum Daily Load for the Cheyenne River, Pennington County, South Dakota (RESPEC for SD DENR, June 2010)

Submitted: 9/24/2010

- 4 Pollutant TMDLs completed.
- 4 Causes addressed from the 2010 303(d) list.
- 0 Determinations that no pollutant TMDL needed.

Segment: Cheyenne River from Bull Creek to mouth

303(d) ID: SD-CH-R-CHEYENNE 06

Parameter/Pollutant (303(d) list cause):	FECAL COLIFORM - 259	Water Quality	Targets: maximum	Permits
Allocation*	Value	Units		
WLA	0	CFU/DAY		
MOS	1.3E+12	CFU/DAY		
LA	6.5E+12	CFU/DAY		
TMDL	7.8E+12	CFU/DAY		

**Notes:** The loads shown represent the loads during the midrange flow regime as defined by the load duration curve for the lower Cheyenne River, segment 06 (see Figure 4-4 of the TMDL). The midrange range flows are when significant differences occur between the existing loads and the target loads, and represent the flow regime that is most likely to be targeted for BMP implementation.

ENCLOSURE 1: APPROVED TMDLs

Date Submitted: 9/24/2010

Segment: Cheyenne River from Cedar Creek to Belle Fourche River

303(d) ID: SD-CH-R-CHEYENNE 04

Parameter/Pollutant (303(d) list cause): FECAL COLIFORM - 259 Water Quality <= 200 cfu/100 mL 30-day geometric mean; <= 400 cfu/100mL single sample  
Targets: maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	0.3E+13	CFU/DAY	
LA	1.1E+13	CFU/DAY	
TMDL	1.4E+13	CFU/DAY	

Notes: The loads shown represent the loads during the moist flow regime as defined by the load duration curve for the lower Cheyenne River, segment 04 (see Figure 4-2 of the TMDL). The moist range flows are when significant differences occur between the existing loads and the target loads, and represent the flow regime that is most likely to be targeted for BMP implementation.

Segment: Cheyenne River from Fall River to Cedar Creek

303(d) ID: SD-CH-R-CHEYENNE 03

Parameter/Pollutant (303(d) list cause): FECAL COLIFORM - 259 Water Quality <= 200 cfu/100 mL 30-day geometric mean; <= 400 cfu/100mL single sample  
Targets: maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	0.5E+12	CFU/DAY	
LA	3.5E+12	CFU/DAY	
TMDL	4.0E+12	CFU/DAY	

Notes: The loads shown represent the loads during the moist flow regime as defined by the load duration curve for the lower Cheyenne River, segment 03 (see Figure 4-1 of the TMDL). The moist range flows are when significant differences occur between the existing loads and the target loads, and represent the flow regime that is most likely to be targeted for BMP implementation.

ENCLOSURE 1: APPROVED TMDLs

Date Submitted: 9/24/2010

Segment: Cheyenne River from the Belle Fourche River to Bull Creek

303(d) ID: SD-CH-R-CHEYENNE 05

Parameter/Pollutant (303(d) list cause): FECAL COLIFORM - 259 Water Quality <= 200 cfu/100 mL 30-day geometric mean; <= 400 cfu/100mL single sample  
Targets: maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
LA	21.4E+12	CFU/DAY	
TMDL	25.5E+12	CFU/DAY	
MOS	4.1E+12	CFU/DAY	

Notes: The loads shown represent the loads during the moist flow regime as defined by the load duration curve for the lower Cheyenne River, segment 05 (see Figure 4-3 of the TMDL). The moist range flows are when significant differences occur between the existing loads and the target loads, and represent the flow regime that is most likely to be targeted for BMP implementation.

\* LA = Load Allocation, WLA = Wasteload Allocation, MOS = Margin of Safety, TMDL = sum(WLAs) + sum(LAs) + MOS

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

<b>Document Name:</b>	<b>Fecal Coliform Total Maximum Daily Load for Cheyenne River, Pennington County, South Dakota</b>
<b>Submitted by:</b>	<b>Rich Hanson, SD DENR</b>
<b>Date Received:</b>	<b>September 24, 2010</b>
<b>Review Date:</b>	<b>August 28, 2010</b>
<b>Reviewer:</b>	<b>Vern Berry, EPA</b>
<b>Rough Draft / Public Notice / Final?</b>	<b>Final</b>
<b>Notes:</b>	

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 final Cheyenne River fecal coliform TMDL was submitted to EPA for review and approval via an email from Rich Hanson, SD DENR on September 24, 2010. The email included the final TMDL document and a letter requesting approval of the TMDL.

**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 Cheyenne River is a stream located in southwestern South Dakota. The Cheyenne River is the largest western tributary to the Missouri River in South Dakota with a contributing drainage area of approximately 24,240 square miles. The River drains northeasterly to Lake Oahe. The Cheyenne River watershed consists of three large parts: 1) the Upper Cheyenne River watershed above Angostura Reservoir (7,920 square miles); 2) the Belle Fourche River watershed, the largest contributing tributary drainage area (7,220 square miles); and 3) the Lower Cheyenne River watershed below Angostura Reservoir (7,930 square miles).

The Cheyenne River flows to the Missouri River from the Middle Cheyenne-Spring sub-basin (HUC 10120109), and the Lower Cheyenne sub-basin (HUC 10120112). The focus of the TMDL document is on the lower portion of the Cheyenne River watershed below Angostura Reservoir. Four segments of the lower

Cheyenne River are identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated fecal coliform concentrations. The four listed segments are: 1) Cheyenne River from Fall River to Cedar Creek (57.1 miles; SD-CH-R-CHEYENNE\_03); 2) Cheyenne River from Cedar Creek to Belle Fourche River (87.3 miles; SD-CH-R-CHEYENNE\_04); 3) Cheyenne River from Belle Fourche River to Bull Creek (44.6 miles; SD-CH-R-CHEYENNE\_05); and 4) Cheyenne River from Bull Creek to mouth (37.9 miles; SD-CH-R-CHEYENNE\_06). All four segments are also listed as impaired for total suspended solids (TSS), and segment SD-CH-R-CHEYENNE\_05 is also listed as impaired for *Escherichia coli*. All four segments are identified as high priority for TMDL development. The TSS and *E. coli* impairments will be addressed in separate TMDL documents.

The designated uses for the listed segments of the Cheyenne River segments include: warmwater semipermanent fish life propagation waters, warmwater permanent fish life propagation waters, immersion recreation waters, limited-contact recreation waters, irrigation waters, fish and wildlife propagation, recreation, and stock watering.

**COMMENTS:** None.

### 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, all TMDL documents must be written to meet the existing water quality standards 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 Cheyenne River segments addressed by these TMDLs are 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 these river segments. The numeric standards being implemented in these TMDLs 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 the Cheyenne River can be found on pages 9 - 13 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 these TMDLs are based on the numeric water quality standards for fecal coliform established to protect the immersion recreation beneficial uses for the four Cheyenne River segments. 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 use in the lower watershed as predominately agricultural consisting of mainly of rangeland. 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 Lower  
Cheyenne River Watershed**

Model Land Use	Total Area (%)
Urban/EIA	1.2
Forest	10.3
Cropland	6.4
Rangeland	75.5
Barren	2.3
Groundwater Recharge	3.6
Open Water	0.6

No permitted point source dischargers are located in the lower Cheyenne River watershed. There are permitted point sources located in upstream tributaries which are addressed by the state of South Dakota as separate stream segments. Bacteria loads from upstream tributaries have been accounted for in boundary conditions.

Based on review of available information and communication with state and local authorities, the primary nonpoint sources of fecal coliform within the Cheyenne River watershed include agricultural runoff, as well as wildlife and human sources. Using the best available information, loadings were estimated from each of these sources using the EPA's Bacterial Indicator Tool (BIT). This tool estimates loading sources based on the density and distribution of animals (livestock and wildlife) and failing on-site wastewater treatment systems in the watershed.

Manure from livestock is a potential source of fecal coliform to the stream. Livestock in the basin are predominantly beef cattle, sheep, and horses. Livestock population densities in the watershed were estimated using Census of Agriculture data and summarized by county. Livestock contribute bacteria loads to the Cheyenne River directly by defecating while wading in the stream 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:** None.

#### **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., stream 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 Cheyenne River TMDLs describes how the fecal coliform loads were derived in order to meet the applicable water quality standards for the 303(d) impaired stream segments.

The South Dakota Department of Environment and Natural Resources (SD DENR) and the United States Geological Service (USGS) have been collecting fecal coliform data from multiple sites within the lower Cheyenne River watershed dating back to 1967. For the purposes of this TMDL document, data were used from stations which are listed in the Data Set Description section below. Figure 1-4 of the TMDL document shows the monitoring stations used in collecting data. Historical data collected from May 1 to September 30 (applicable dates for the fecal coliform water quality standard) from each monitoring station were used in the TMDL technical analysis.

Recreational beneficial use standards are applicable only from May through September (recreation season). Only discharge data collected during the recreation season from each stream segment were used to develop the flow duration curves. Recreational season discharge dates ranged from 1950 through 2008 for segment SD-CH-R-CHEYENNE\_03, 1981 through 2009 for segment SD-CH-R-CHEYENNE\_04, and 1960 through 2009 for segment SD-CH-R-CHEYENNE\_05.

The Hydrological Simulation Program – FORTRAN (HSPF) model was used to determine the contribution of fecal coliform bacteria from identified sources in the Cheyenne River Watershed and to evaluate the implementation of best management practices (BMPs) to control these sources. The nonpoint sources in the study area were modeled in HSPF by estimating per acre fecal coliform accumulation rates and maximum fecal coliform storage rates for each source. The buildup and washoff of fecal coliform was simulated based on these rates and precipitation. The accumulation and storage rates were calculated using BIT.

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 *An Approach for Using Load Duration Curves in the Development of TMDL*.

The LDCs shown in Figures 4-1 through 4-8 in the TMDL document, represent dynamic expressions of parameter-specific TMDLs for the impaired segments of the Cheyenne River that are based on the daily maximum and 30-day geometric mean fecal coliform criteria, resulting in a unique loads that correspond to measured and simulated average daily flows.

Two bacteria LDCs were constructed for each bacteria-impaired reach of the Cheyenne River within the lower Cheyenne River watershed. The curve, which represents loading capacity, within the first LDC for each reach, was constructed using the product of simulated flow data, the daily maximum bacteria criteria, and a unit conversion factor. Points plotted within the first LDC for each reach include observed loads which were calculated using observed bacteria and flow data from monitoring stations. The first LDCs also include box plots of simulated average daily loads for each flow zone calculated using simulated bacteria and flow data from reach endpoints. Box plots in the second LDC for each reach 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 for each of the four listed segments of Cheyenne River. The TMDL loading capacities in all four segments are included in Tables 5-4, 5-8, 5-12 and 5-16 of the TMDL document. These loads, when met, will attain compliance with all applicable water quality standards for fecal coliform in the listed segments of the Cheyenne River.

**COMMENTS:** None.

#### 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 Cheyenne River TMDL data description and summary are included mostly in the Significant Sources section of the document. The full data set is not included in the TMDL. The South Dakota Department of Environment and Natural Resources (SD DENR) and the United States Geological Service (USGS) have been collecting fecal coliform data from multiple sites within the lower Cheyenne River watershed dating back to 1967. Also, a total of 114 paired fecal coliform and *E. coli* samples existed along the Cheyenne River throughout the study area. The data set also includes the flow record on the



Cheyenne River that was used to create the load duration curves for the four segments included in this TMDL document. Table 1-2, excerpted from the TMDL document, lists the monitoring locations and number of samples collected for the segments included in the TMDL.

**Table 1-2. Water-Quality Stations in the Lower Cheyenne River Watershed Used for Fecal Coliform Total Maximum Daily Load Development**

Fecal Coliform Monitoring Stations	Project	Segment	Data Available	Number of Data Points
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007-2009	18
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999-2009	123
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007-2009	21
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967-2009	196
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008-2009	8
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968-2009	250
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999-2009	63

COMMENTS: None.

#### 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:** No point sources of fecal coliform bacteria discharge directly to the impaired segment or tributary of the impaired segments of the lower Cheyenne River watershed. Therefore, the WLA is zero for

all four segments covered by the TMDL document. Point source discharges do exist upstream of the impaired segments. However, these discharges are not accounted for within the lower Cheyenne River watershed TMDLs because they are accounted for in other TMDLs. Also, the bacteria loads from these facilities likely do not have a large impact on the impaired segments of the Cheyenne River due to the travel time and decay rates of the bacteria.

Two permitted concentrated animal feeding operations are located within the lower Cheyenne River watershed. One is in Fall River County and would potentially drain to SD-CH-R-CHEYENNE-03, and one is in Meade County which would potentially drain to SD-CH-R-CHEYENNNE-06. However, these permitted concentrated animal feeding operations are not currently allowed to discharge within the lower Cheyenne River watershed.

**COMMENTS:** None.

#### 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 the Cheyenne River were calculated by multiplying the specified fecal coliform bacteria criterion by the specified flow data. 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 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 MOS from the loading capacity. The resulting LA was allocated to the various nonpoint sources identified in the watershed. Rangeland for cattle grazing is the dominate landuse 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).
- If the MOS is implicit, 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.
- If the MOS is explicit, 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.
- If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach 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 Cheyenne River TMDLs include explicit MOSs for each segment derived by calculating the difference between the loading capacity at the mid-point of each of the five flow zones and the loading capacity at the minimum flow in each zone. The explicit MOS values are included in Tables 5-4, 5-8, 5-12 and 5-16 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: None.

## 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](http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf)

Recommendation:

- Approve    Partial Approval    Disapprove    Insufficient Information

**SUMMARY:** The Cheyenne River will continue to be monitored through SD DENR's ambient water quality monitoring stations on the Cheyenne River. Stream water-quality monitoring will be accomplished through SD DENR's ambient water-quality monitoring stations on the Cheyenne River 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. Monitoring locations should be based on the location and type of BMPs installed. 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 South Dakota portion of the lower Cheyenne River watershed. Several types of control measures are available for reducing fecal coliform bacteria loads, and recommendations to address the identified sources in South Dakota 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 in South Dakota are expected to achieve the required load reductions and attain the TMDL goals. Implementations of grazing management practices on rangelands in the watershed appear to have the greatest fecal coliform load reduction potential. Funds to implement watershed water quality improvements can be obtained through the SD DENR. There are no permitted point sources in the impaired segments included in the TMDL document; therefore a demonstration of reasonable assurance is not required.

**COMMENTS:** None.

## 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 Cheyenne River fecal coliform TMDLs include daily loads expressed as colonies forming units (cfu) per day. The daily TMDL loads are included in TMDL Section of the document.

**COMMENTS:** None.