E. *COLI* TOTAL MAXIMUM DAILY LOAD FOR THE CHEYENNE RIVER, PENNINGTON COUNTY SOUTH DAKOTA

Topical Report RSI-2143

prepared for

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

June 2010

RESPEC
CONSULTING & SERVICES

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by

Cindie M. McCutcheon

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

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Total Maximum Daily Load Summary

Waterbody Name/Description	Cheyenne River (Fall River to Cedar Creek)
Assessment Unit I.D.	SD-CH-R-CHEYENNE_03
Size of Impaired Waterbody	57.1 miles (91.9 kilometers)
Size of Watershed (Incremental)	1,000 square miles (2,589 square kilometers)
Size of Watershed (Cumulative)	8,920 square miles (23,102 square kilometers)
Location	10-digit Hydrologic Unit Codes (HUC): 1012010903, 1012010905, and 1012010907
Impaired Designated Use(s)	Immersion Recreation
Cause(s) of Impairment	E. *coli* bacteria
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points End Points	Indicator Name: E. *coli* bacteria Threshold Values: Maximum daily concentration of 235 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 126 cfu/100 mL. These criteria apply from May through September.
Analytical Approach	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

Total Maximum Daily Load Summary	
Waterbody Name/Description	Cheyenne River (Cedar Creek to Belle Fourche River)
Assessment Unit I.D.	SD-CH-R-CHEYENNE_04
Size of Impaired Waterbody	87.3 miles (140.5 kilometers)
Size of Watershed (Incremental)	3,423 square miles (8,866 square kilometers)
Size of Watershed (Cumulative)	12,343 square miles (31,968 square kilometers)
Location	10-Digit Hydrologic Unit Codes (HUC): 1012010911, 1012011105, 1012011109, 1012011102, and 1012010907
Impaired Designated Use(s)	Immersion Recreation
Cause(s) of Impairment	E. *coli* bacteria
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points End Points	Indicator Name: E. *coli* bacteria Threshold Values: Maximum daily concentration of 235 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 126 cfu/100 mL. These criteria apply from May through September.
Analytical Approach	Load duration curves, Bacterial Indicator Tool, and Hydrological Simulation Program - FORTRAN (HSPF) modeling

Total Maximum Daily Load Summary

Waterbody Name/Description	Cheyenne River (Belle Fourche River to Bull Creek)
Assessment Unit I.D.	SD-CH-R-CHEYENNE_05
Size of Impaired Waterbody	44.6 miles (71.8 kilometers)
Size of Watershed (Incremental)	843 square miles (2,184 square kilometers)
Size of Watershed (Cumulative)	13,186 square miles (34,151 square kilometers)
Location	10-digit Hydrologic Unit Codes (HUC): 1012011202 and 1012011206
Impaired Designated Use(s)	Immersion Recreation
Cause(s) of Impairment	E. *coli* bacteria
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points End Points	Indicator Name: E. *coli* bacteria Threshold Values: Maximum daily concentration of 235 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 126 cfu/100 mL. These criteria apply from May through September.
Analytical Approach	Load duration curves, **Bacterial Indicator Tool**, and **Hydrological Simulation Program - FORTRAN** (**HSPF**) modeling

Total Maximum Daily Load Summary

Waterbody Name/Description	Cheyenne River (Bull Creek to mouth)
Assessment Unit I.D.	SD-CH-R-CHEYENNE_06
Size of Impaired Waterbody	37.9 miles (70.0 kilometers)
Size of Watershed (Incremental)	2,563 square miles (3,369 square kilometers)
Size of Watershed (Cumulative)	15,749 square miles (40,790 square kilometers)
Location	10-digit Hydrologic Unit Code (HUC): 1012011207 and 1012011211
Impaired Designated Use(s)	Limited Contact Recreation and Immersion Recreation
Cause(s) of Impairment	E. *coli* bacteria
Cycle Most Recently Listed	2010
Total Maximum Daily Load End Points End Points	Indicator Name: E. *coli* bacteria Threshold Values: Maximum daily concentration of 235 colony-forming units per 100 milliliters (cfu/100 mL) and a geometric mean of at least five samples over a 30-day period 126 cfu/100 mL. These criteria apply from May through September.
Analytical Approach	Load duration curves, **Bacterial Indicator Tool**, and **Hydrological Simulation Program - FORTRAN** (**HSPF**) modeling

TABLE OF CONTENTS

LIST OF TABLES

TABLE **PAGE**

LIST OF TABLES
(Continued)

LIST OF FIGURES

1.0 INTRODUCTION

The intent of this document is to clearly identify the components of the Total Maximum Daily Loads (TMDLs), 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. South Dakota recently adopted E. *coli* criteria for the protection of the limited contact and immersion recreation uses. This TMDL document addresses the current E. *coli* bacteria impairment (SD-CH-R-CHEYENNE_05) and the likely E. *coli* bacteria impairments (SD-CH-R-CHEYENNE_03, SD-CH-R-CHEYENNE_04, and SD-CH-R-CHEYENNE_06) of the Cheyenne River within the Lower Cheyenne River Watershed. Listed reaches were assigned to priority category 1 (high priority) in the 2010 impaired waterbodies list [South Dakota Department of Environment and Natural Resources, 2010]. No segments were listed as impaired for E. *coli* in the most recently approved impaired waterbodies list (2008), as the E. *coli* had not yet been adopted at that time [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.

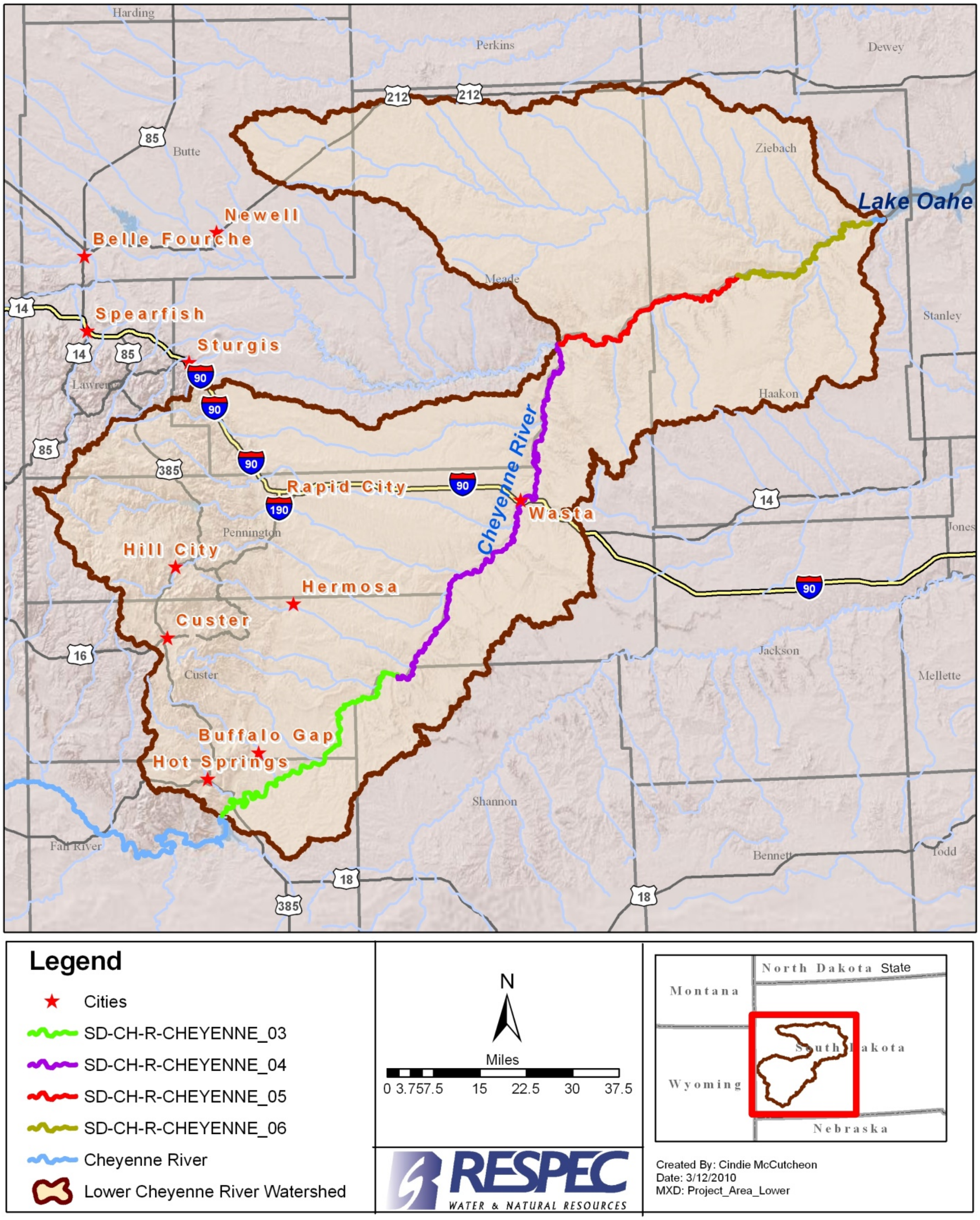

Figure 1-1. Lower Cheyenne River Watershed E. *coli* Impaired and Likely Impaired Reaches.

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

One Lower Cheyenne River Segment (SD-CH-R-CHEYENNE_05) within the Lower Cheyenne River Watershed was 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 E. *coli* bacteria that exceeded the daily maximum criterion for the protection of the immersion recreation use and the limited contact recreation use. Immersion recreation use criteria are more stringent than the limited contact recreation use criteria. Three other Lower Cheyenne River Segments (SD-CH-R-CHEYENNE_03, SD-CH-R-CHEYENNE_04, and SD-CH-R-CHEYENNE_06) were not listed as impaired in South Dakota's 2010 303(d) list for E. *coli*; however, these segments were listed for fecal coliform bacteria concentrations which have been shown to significantly correlate with E. *coli* concentrations. The three segments which are not yet listed for E. *coli* had criteria exceedances greater than 10 percent; however, the number of samples during the recreational season required for listing had not yet been reached at the time the South Dakota 2010 303(d) list was written. Cheyenne River Segments SD-CH-R-CHEYENNE_04, SD-CH-R-CHEYENNE_05, and SD-CH-R-CHEYENNE_06 were first listed as impaired with fecal coliform bacteria in South Dakota's 2004 303(d) list, while SD-CH-R-CHEYENNE_03 was first listed as impaired with fecal coliform bacteria in South Dakota's 2010 303(d) list [South Dakota Department of Environment and Natural Resources, 2010]. Because South Dakota did not adopt the E. *coli* criteria for the protection of the limited contact and immersion recreation uses until 2010, Segment SD-CH-R-CHEYENNE_05 was not listed as impaired for E. *coli* until 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 E. *coli* data from multiple sites within the Lower Cheyenne River Watershed since 2000. For the purposes of this TMDL summary, data were used from stations located along the Cheyenne River near Buffalo Gap (CHR04), Redshirt (CHR05), Scenic (CHR08), Wasta (CHR10), Smithville (CHR16), Plainview (CHR14), and Eagle Butte (CHR13). Table 1-2 lists the water-quality stations used for the E. *coli* TMDL development, and Figure 1-4 shows their locations.

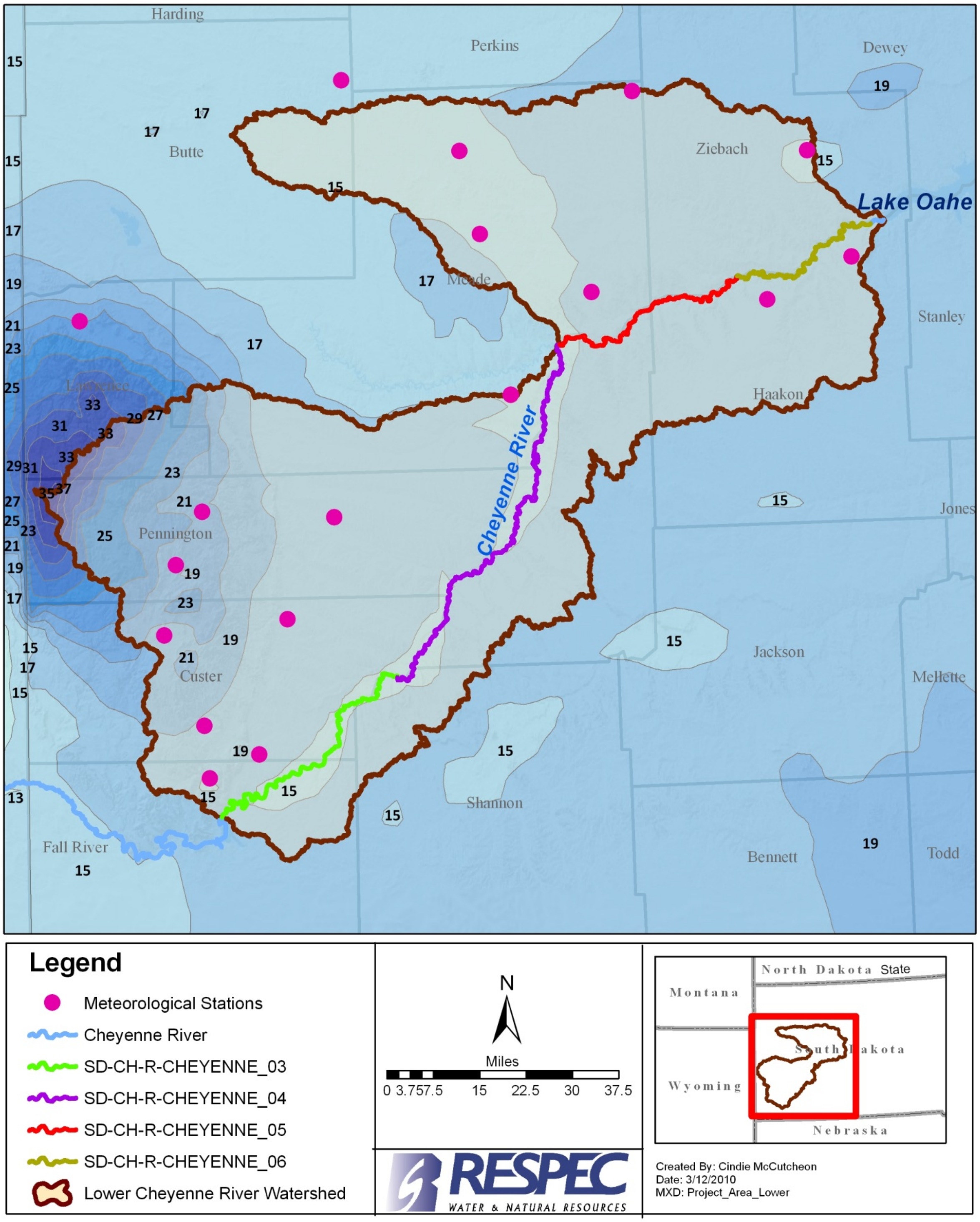

Figure 1-2. Lower Cheyenne River Watershed Precipitation (in Inches).

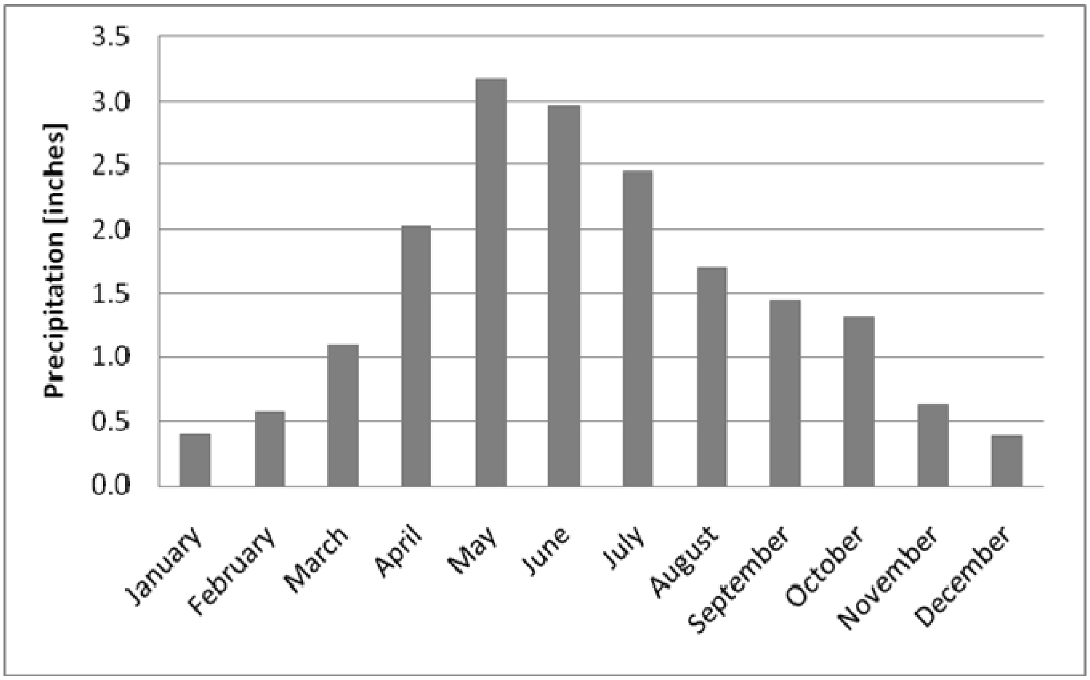

Figure 1-3. Historical Average Monthly Precipitation From 1984 Through 2008 for the Lower Cheyenne Watershed.

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

Model Land Use	Total Area (%)
Urban/Effective Impervious Area (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 E. *coli* Total Maximum Daily Load Development (Recreational Season)

Fecal Coliform Monitoring Stations	Project	Segment	Data Available	Calculated E. *coli* Data Points	Observed E. *coli* Data Points
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007–2009	0	2
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999–2009	126	4
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007–2009	0	2
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967–2009	196	5
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008–2009	0	2
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968–2009	250	44
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999–2009	63	3

Cheyenne River Segment SD-CH-R-CHEYENNE_05 is currently the only segment which 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 colony-forming units per 100 milliliters (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 waterbodies 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 reaches 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. However, because these reaches are impaired according to the fecal coliform bacteria standard, they will likely be impaired according to the E. *coli* bacteria standard once enough data are available.

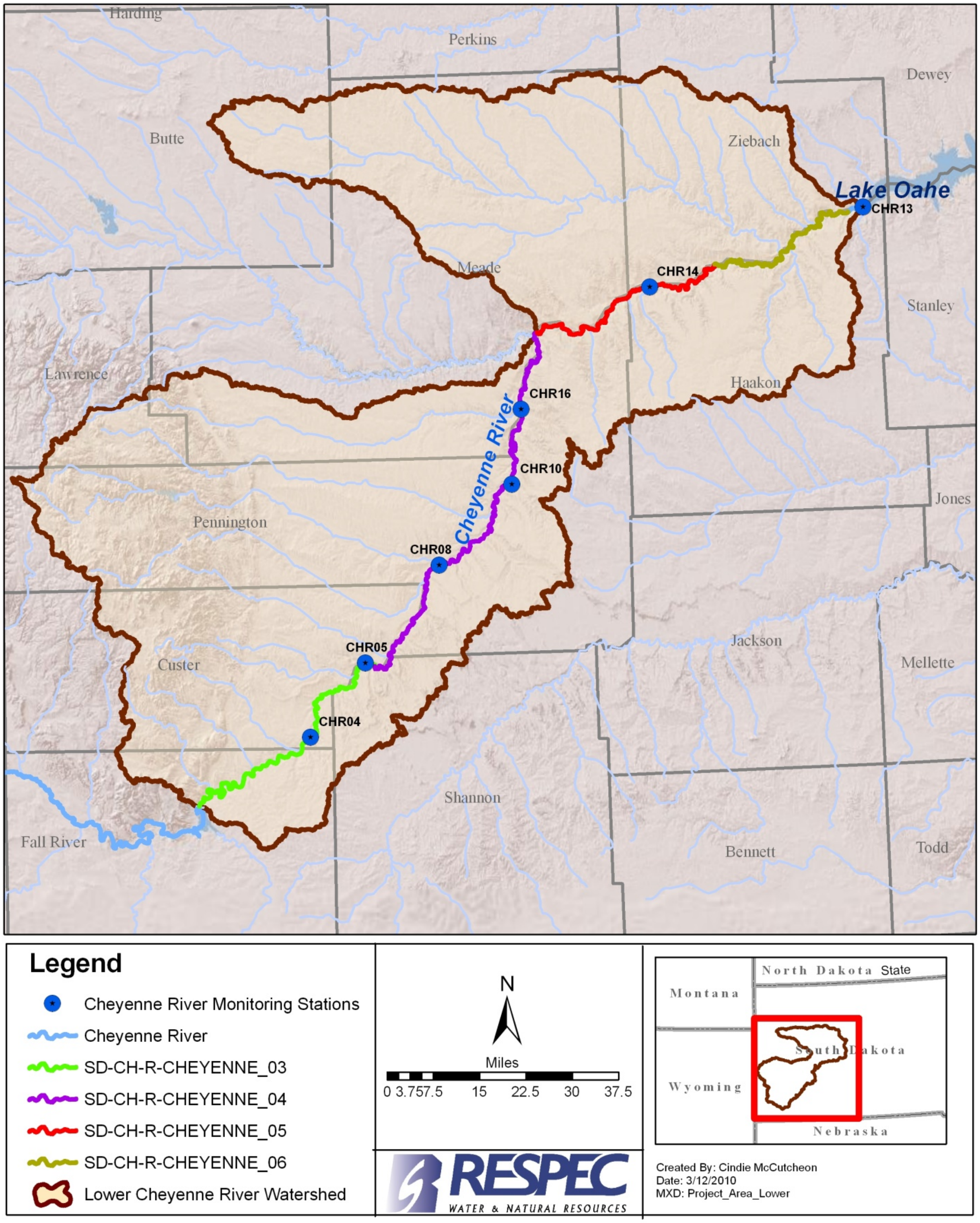

Figure 1-4. Monitoring Stations Within the Lower Cheyenne River Watershed.

A total of 114 paired fecal coliform and E. *coli* samples existed along the Cheyenne River throughout the study area. 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. Because the two indicators are closely related, the paired fecal coliform and E. *coli* were used to develop site-specific translator functions to convert fecal coliform loading estimates to E. *coli* loading estimates to address impairments to the immersion recreation and limited contact recreation use of the Cheyenne River. Figure 1-5 shows a plot of E. *coli* versus fecal coliform for the entire project area. The first step for translation requires the regression analysis equation (Equation 1-1) to convert fecal coliform concentration to E. *coli* concentrations. Once concentrations are available, they can be combined with flow data to compute loading estimates. For the entire project area, the mean ratio of E. *coli* to fecal coliform was calculated to be 1.051 cfu E. *coli*/cfu fecal coliform. Site-specific translator functions, as well as statistics showing function significance, are shown in Table 1-3.

$$(E) = 0.2901(F) = 93.076 \qquad (1\text{-}1)$$

where:

F = fecal coliform concentration

E = E. *coli* concentration.

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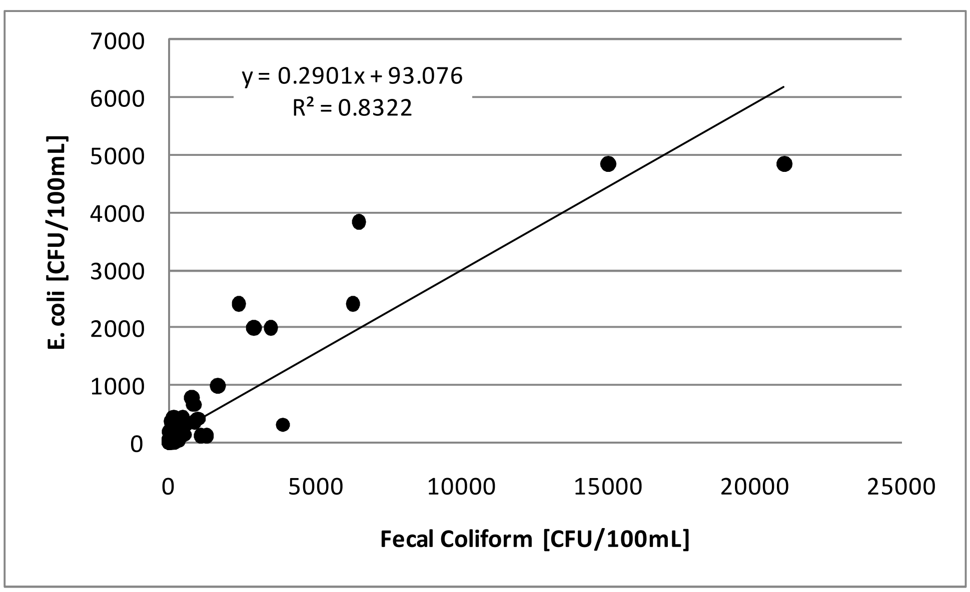

Figure 1-5. Plot of Fecal Coliform Versus E. *coli* for the Entire Project Area.

Table 1-3. Translator Functions to Calculate E. *coli* Concentrations From Fecal Coliform Concentrations

Fecal Coliform Monitoring Stations	Site	*n*	Equation	Pearson r^2	Spearman r_s
Cheyenne River at Redshirt, SD	CHR05	14	$E = (F^{0.7525})(e^{0.9353})$	0.84	0.87
Cheyenne River near Wasta, SD	CHR10	13	$E = 0.5867(F) + 22.9071$	0.99	0.77
Cheyenne River near Plainview, SD	CHR14	55	$E = 0.2722(F) + 98.2754$	0.86	0.82
Cheyenne River near Eagle Butte, SD	CHR13	6	$E = 0.5654(F) + 39.1412$	0.97	1.00

E. *coli* 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 E. *coli* bacteria criterion of 235 cfu/100 mL and to find E. *coli* concentration ranges (Table 1-4). Fecal coliform data from the effective criterion period were translated to E. *coli* data using site-specific regression equations (Table 1-3) for the furthest downstream sites (CHR05, CHR14, and CHR13) within each reach with the exception of reach SD-CH-R-CHEYENNE_04, which had far more samples available at the second site from the end (CHR10). Percent of exceedance at these sites was calculated using observed E. *coli* data when available combined with calculated E. *coli* data (Table 1-5).

Table 1-4. Recreational Season Percent Exceedance of Observed E. *coli* Concentration Criteria and E. *coli* Concentration Ranges for Project Sites Within the Lower Cheyenne River Watershed

Fecal Coliform Monitoring Stations	Project	Number of Samples Exceeding Criterion	Total Number of Samples	Percent Exceedance	Concentration Range (cfu/100 mL)
Cheyenne River at Redshirt, SD	CHR05	1	4	25%	52–313
Cheyenne River near Wasta, SD	CHR10	1	5	20%	6–3,840
Cheyenne River near Plainview, SD	CHR14	11	44	25%	2–4,840
Cheyenne River near Eagle Butte, SD	CHR13	1	3	33%	16–980

Table 1-5. Recreational Season Percent Exceedance of Observed and Calculated E. *coli* Concentration Criteria and E. *coli* Concentration Ranges for Project Sites Within the Lower Cheyenne River Watershed

Fecal Coliform Monitoring Stations	Project	Number of Samples Exceeding Criterion	Total Number of Samples	Percent Exceedance	Concentration Range (cfu/100 mL)
Cheyenne River at Redshirt, SD	CHR05	23	126	17%	4–8,221
Cheyenne River near Wasta, SD	CHR10	77	196	39%	6–123,230
Cheyenne River near Plainview, SD	CHR14	87	250	35%	2–25,141
Cheyenne River near Eagle Butte, SD	CHR13	22	63	35%	16–13,609

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 standards 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.

South Dakota recently adopted E. *coli* criteria for the protection of the limited contact and immersion recreation uses. Current E. *coli* criteria for the immersion recreation and limited contact recreation use require that (1) no sample exceeds 235 cfu/100 mL and 1,178 cfu/100 mL, respectively, and (2) the geometric mean of a minimum of five samples collected during separate 24-hour periods for any 30-day period must not exceed 126 cfu/100 mL and 630 cfu/100 mL, respectively. Since only one or two water samples were collected during any 30-day period, compliance with the geometric mean criterion was evaluated using the **Hydrological Simulation Program – FORTRAN** (**HSPF**) model-predicted, daily concentrations. The geometric mean, as defined in ARSD Article 74:51:01:01, is the *nth* root of a product of *n* factors. The E. *coli* criteria are applicable from May 1 through September 30. Reaches must meet the more stringent standards of immersion recreation since they are 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 based on either the daily maximum (235 cfu/100 mL) or 30-day average (126 cfu/100 mL) E. *coli* bacteria criterion, depending on which criterion required the greatest load reduction.

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

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate[a]	≤ 750	mg/L	30-day average
	≤ 1,313	mg/L	Daily maximum
Total dissolved solids[a]	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	Daily maximum
Total petroleum hydrocarbon[a]	≤ 10	mg/L	Daily maximum
Oil and grease[a]	≤ 10	mg/L	Daily maximum
Nitrates as N[a]	≤ 50	mg/L	30-day average
	≤ 88	mg/L	Daily maximum
Dissolved oxygen[b,c]	≥ 5.0	mg/L	Daily minimum
Total suspended solids[b,c]	≤ 90	mg/L	30-day average
	≤ 158	mg/L	Daily maximum
Temperature[b]	≤ 90	°F	Daily maximum
Temperature[c]	≤ 80	°F	Daily maximum
pH[b,c]	6.5 and ≤ 9.0	Standard units	
Undisassociated hydrogen sulfide[b,c]	≤ 0.002	mg/L	Daily maximum
Total ammonia nitrogen as N[b,c]	Equation-based limit	mg/L	30-day average (Mar 1–Oct 31)
	Equation-based limit	mg/L	30-day average (Nov 1–Feb 29)
	Equation-based limit	mg/L	Daily maximum
Fecal coliform[d,e]	< 200	cfu /100 mL	Geometric mean (May 1–Sep 30)
	< 400	cfu /100 mL	Daily maximum (May 1–Sep 30)
E. *coli*[d,e]	≤ 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[f]	≤ 2,500	micromhos/cm	30-day average
	≤ 4,375	micromhos/cm	Daily maximum
Sodium adsorption ratio[f]	≤ 10		Daily maximum

(a) Criteria for fish and wildlife propagation, recreation, and stock watering use.
(b) Criteria for 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.

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 were 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 E. *coli* 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, 2000].

3.2.1 Agriculture

Manure from livestock is a potential source of E. *coli* 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, which is summarized by county and 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

County, State	Beef Cattle	Dairy Cattle	Cattle/ Calves	Hogs/ Pigs	Sheep	Bison	Horses	Chickens
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 E. *coli* 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. Bacteriodetes (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 that tested 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 fecal coliform **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. Fecal coliform loading results were converted to E. *coli* loadings as discussed in Section 1.3. 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

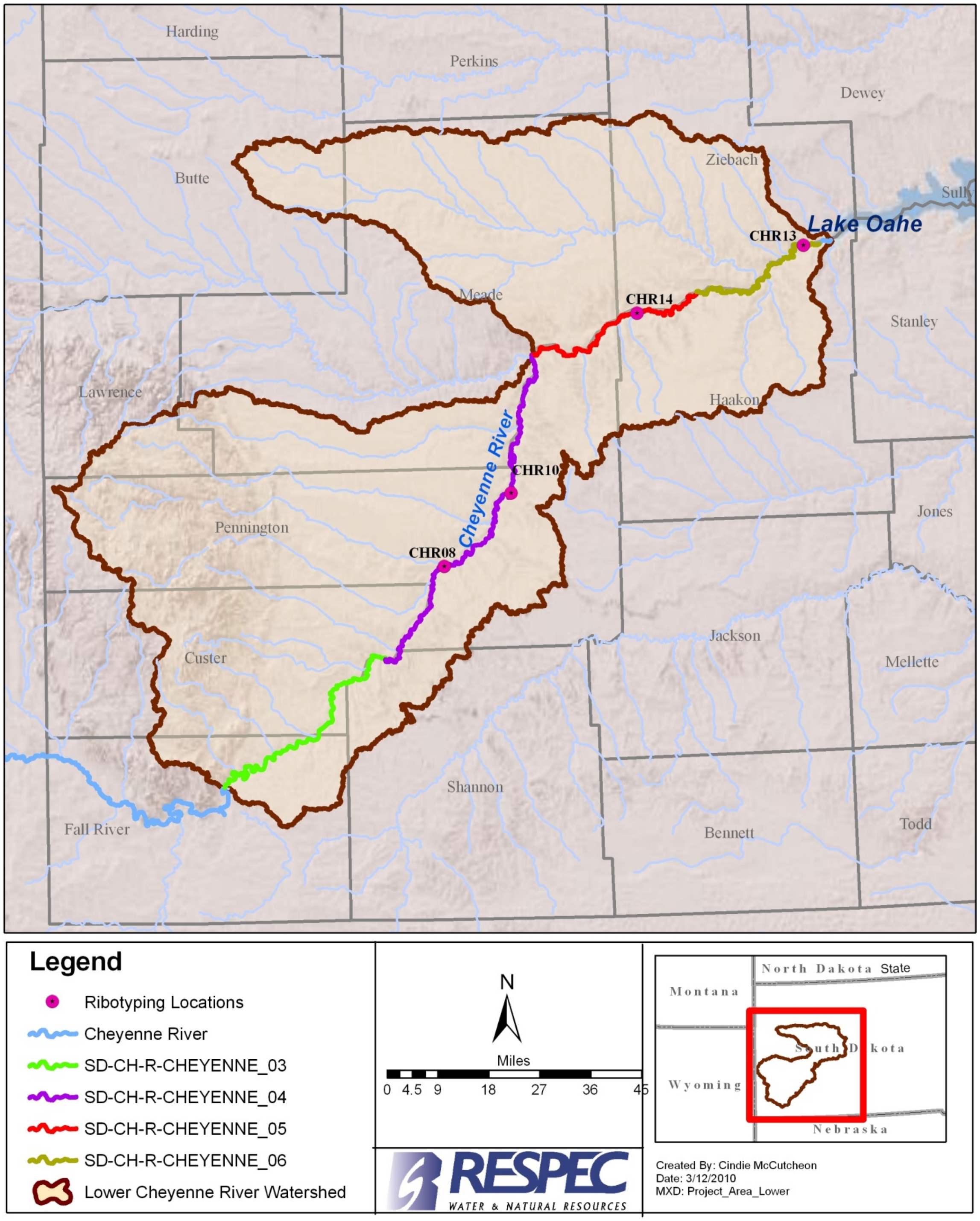

Figure 3-1. BST Locations Used Within the Lower Cheyenne River Watershed.

storage rates for each source. The buildup and washoff of fecal coliform are simulated based on these rates and precipitation. The accumulation and storage rates were calculated using BIT. Failing on-site wastewater treatment systems, livestock, and wildlife 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 and 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. The results are listed in Table 3-4.

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

Indicator Flow Type Site	Bacteriodetes (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%**

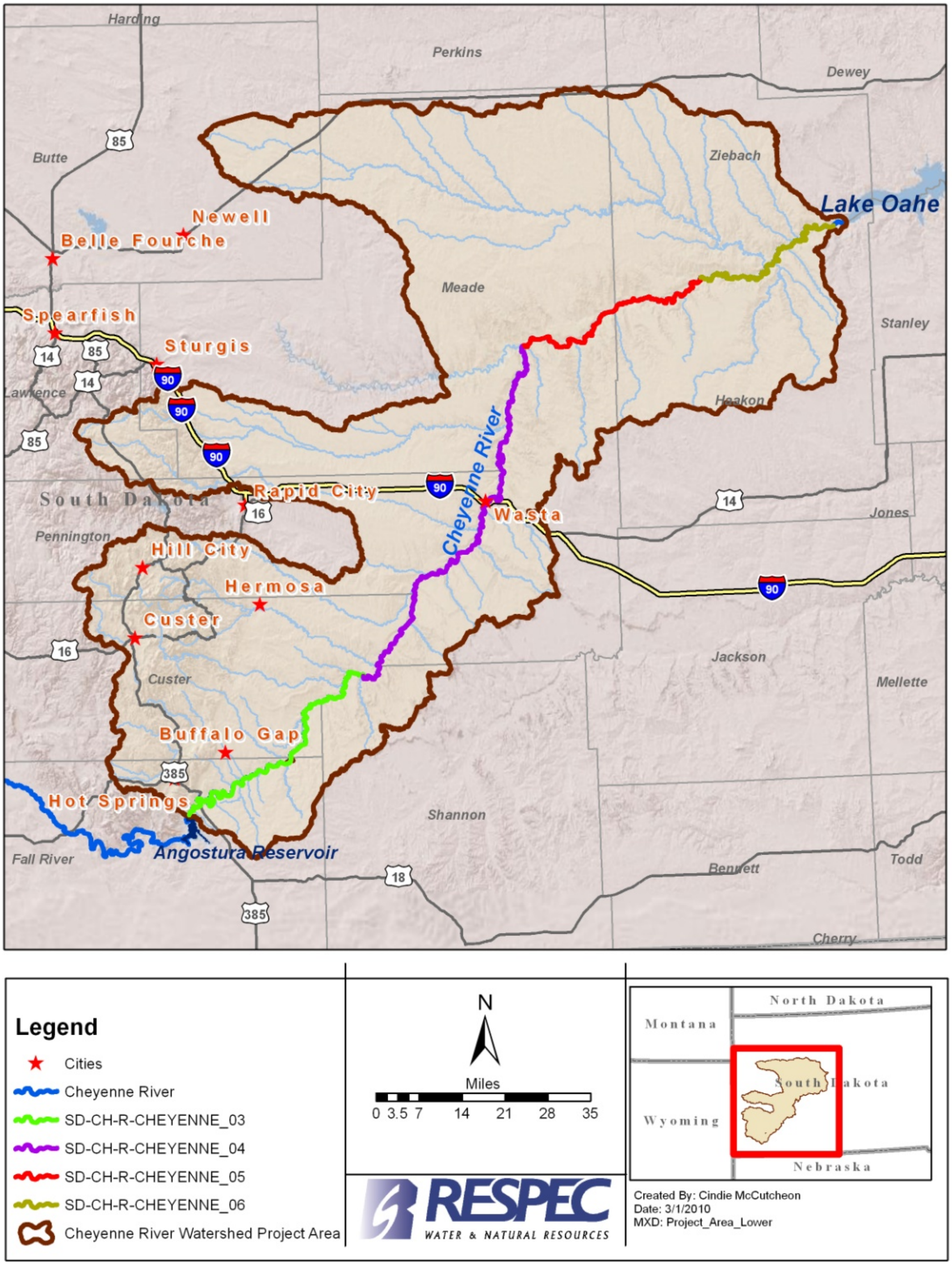

Figure 3-2. HSPF-Modeled Lower Cheyenne River Watershed E. *coli* Impaired Reaches.

Table 3-4. E. *coli* 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
Nonpoint Sources				
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
Direct Sources[(a)]				
Direct Defecation	0.31	0.03	0.02	0.01
On-site Wastewater Treatment System 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. 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 loading capacity 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, E. *coli* 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 E. *coli* 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 E. *coli* 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 E. *coli* 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 high, moist, midrange, dry, and low flow 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 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].

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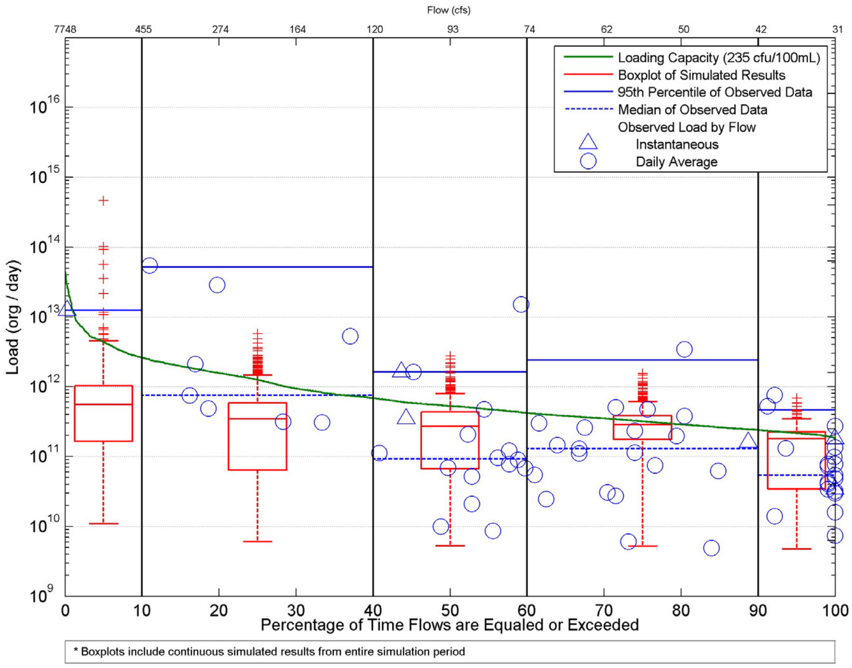

Figure 4-1. Reach SD-CH-R-CHEYENNE_03 Load Duration Curve Representing Allowable Daily E. *coli* Loads Based on Daily Maximum E. *coli* Criteria.

RSI-1737-10-064

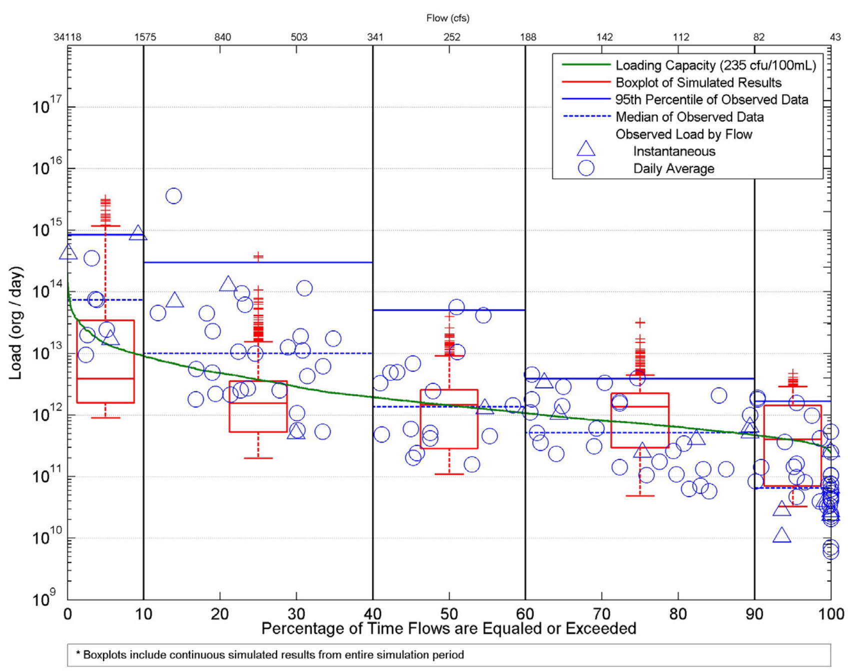

Figure 4-2. Reach SD-CH-R-CHEYENNE_04 Load Duration Curve Representing Allowable Daily E. *coli* Loads Based on Daily Maximum E. *coli* Criteria.

RSI-1737-10-065

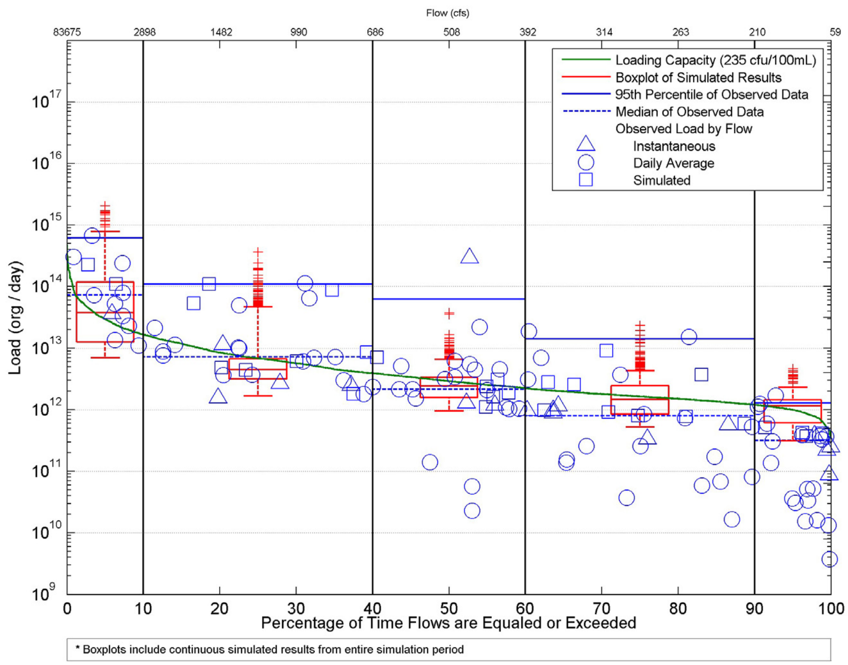

Figure 4-3. Reach SD-CH-R-CHEYENNE_05 Load Duration Curve Representing Allowable Daily E. *coli* Loads Based on Daily Maximum E. *coli* Criteria.

RSI-1737-10-066

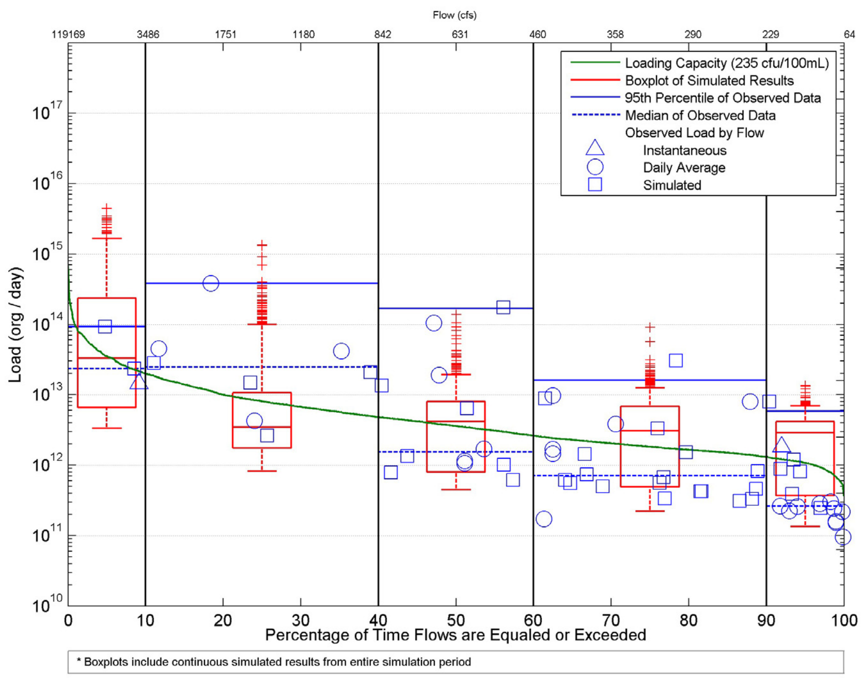

Figure 4-4. Reach SD-CH-R-CHEYENNE_06 Load Duration Curve Representing Allowable Daily E. *coli* Loads Based on Daily Maximum E. *coli* Criteria.

RSI-1737-10-067

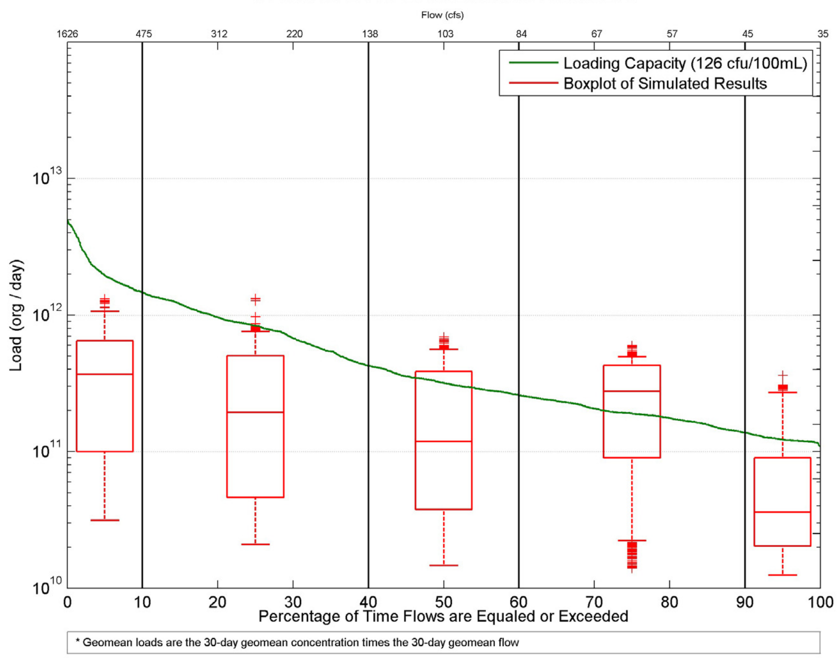

Figure 4-5. Reach SD-CH-R-CHEYENNE_03 Load Duration Curve Representing Allowable E. *coli* Loads Based on Geometric Mean E. *coli* Criteria.

RSI-1737-10-068

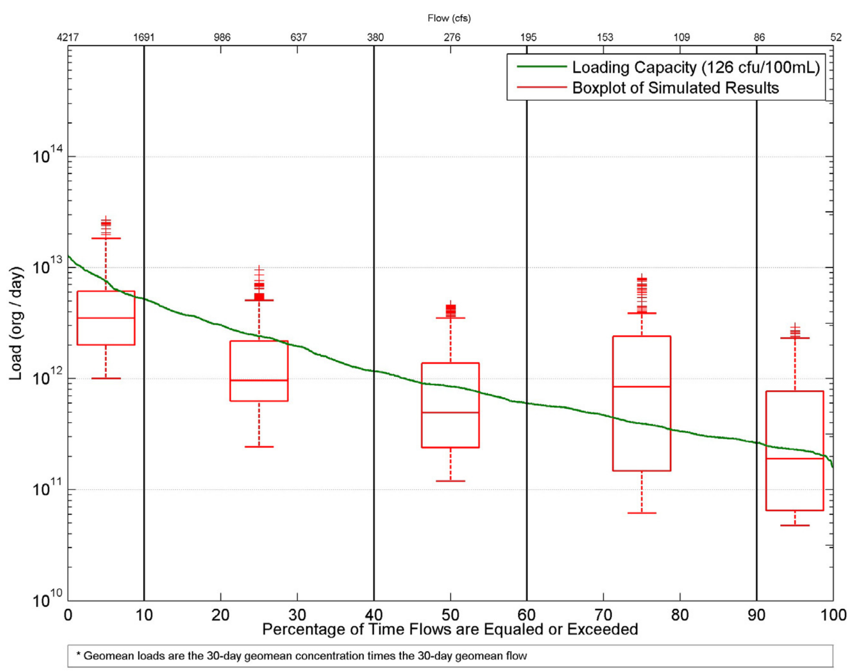

Figure 4-6. Reach SD-CH-R-CHEYENNE_04 Load Duration Curve Representing Allowable E. *coli* Loads Based on Geometric Mean E. *coli* Criteria.

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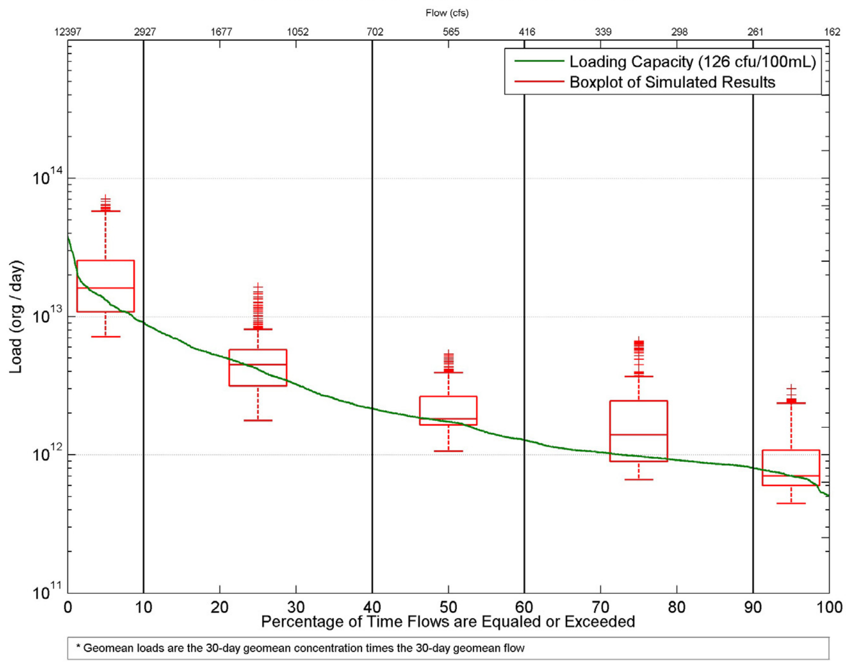

Figure 4-7. Reach SD-CH-R-CHEYENNE_05 Load Duration Curve Representing Allowable E. *coli* Loads Based on Geometric Mean E. *coli* Criteria.

RSI-1737-10-070

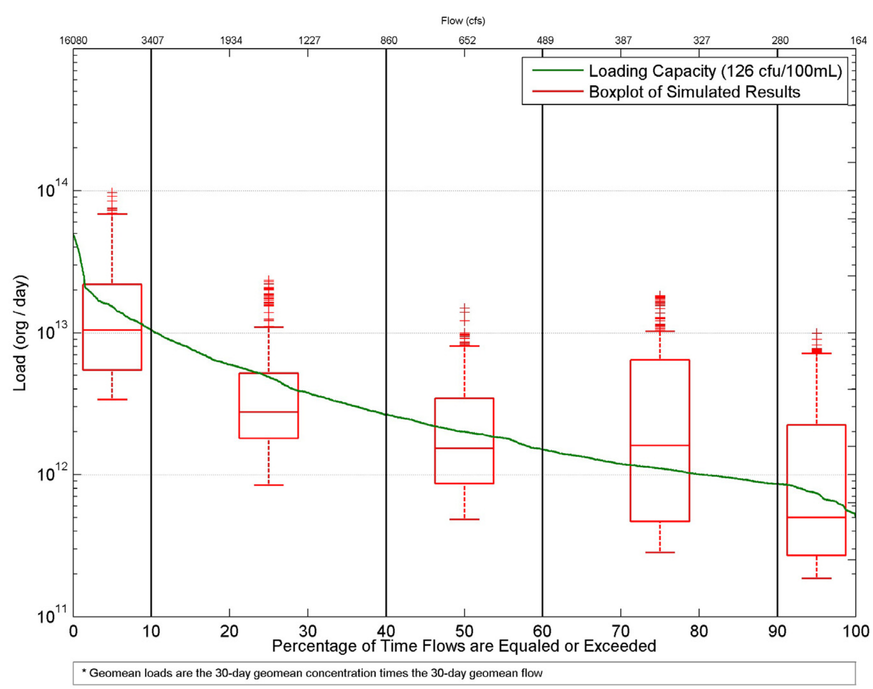

Figure 4-8. Reach SD-CH-R-CHEYENNE_06 Load Duration Curve Representing Allowable E. *coli* Loads Based on Geometric Mean E. *coli* Criteria.

The LDCs shown in Figures 4-1 through Figure 4-8 represent dynamic expressions of the E. *coli* bacteria TMDLs for Cheyenne River segments that are based on the daily maximum and 30-day average E. *coli* 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 E. *coli* 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 below.

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

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 E. *coli* bacteria load allocation (LA) for each table, the loading capacity was first determined using the data sources specified. The daily maximum criterion (235 cfu/ 100 mL) was used in the calculation of the daily maximum loading capacities, and the geometric mean criterion (126 cfu/100 mL) was used for the calculation of the geometric mean loading capacities. The loading capacities for Cheyenne River were calculated by multiplying the specified E. *coli* bacteria criterion by the specified flow data, as listed above.

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 load allocation (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 E. *coli* 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 (cfu × 10^9/day) by calculating the product of E. *coli* sample concentrations (cfu/100 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^{th} percentile of the range of these estimates within each flow zone was defined as the baseline daily load.

To estimate current 30-day geometric mean loads (cfu × 10^9/month), the product of the geometric mean concentrations (cfu/100 mL) and monthly average stream flows (cfs) for reach endpoints, calculated from modeled data, was multiplied by a conversion factor (0.0245). The 95^{th} 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 and calculated E. *coli* 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 E. *coli* 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 150 cfs). Table 5-3 was created using simulated geometric mean data for both flow and E. *coli* concentration. The allocations based on the observed and calculated E. *coli* daily maximum data require slightly greater reductions in all flow zones except the low flow zones than the allocations based on simulated data. The allocations requiring the greatest reductions in the low flow zone are the allocations based on geometric mean simulated data. Thus the allocations listed for the moist, midrange, and dry flow zones from the observed and calculated E. *coli* data and allocations listed for the low flow zone from the simulated geometric mean data represent the TMDL goals to attain compliance with all applicable water-quality standards, with the critical conditions occurring during moist flows as listed in Table 5-4.

Table 5-1. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_03 (Observed Flow Data and Observed and Calculated E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	484–133 cfs	132–81 cfs	80–43 cfs	41–33 cfs
LA	25,051	2,075	597	322	73
WLA	0	0	0	0	0
MOS	1,466	276	69	92	163
TMDL	26,517	2,351	666	414	236
Current Load	12,381	51,715	1,639	2,405	466
Load Reduction	0	49,364	973	1,991	230
Load Reduction	0%	95%	59%	83%	49%

Table 5-2. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_03 (Simulated Flow and E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	484–133 cfs	132–81 cfs	80–43 cfs	41–33 cfs
LA	17,585	1,839	633	350	212
WLA	0	0	0	0	0
MOS	1,698	674	117	101	32
TMDL	19,283	2,513	751	452	244
Current Load	4,618	1,585	882	606	364
Load Reduction	0	0	131	154	120
Load Reduction	0%	0%	15%	25%	33%

Table 5-3. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 487 cfs	486–150 cfs	148–83 cfs	82–44 cfs	43–35 cfs
LA	4,029	995	369	198	120
WLA	0	0	0	0	0
MOS	504	404	70	52	13
TMDL	4,533	1,399	439	249	134
Current Load	1,090	766	574	495	274
Load Reduction	0	0	135	246	140
Load Reduction	0%	0%	24%	50%	51%

Table 5-4. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 486 cfs	484–133 cfs	132–81 cfs	80–43 cfs	43–35 cfs
LA	25,051	2,075	597	322	120
WLA	0	0	0	0	0
MOS	1,466	276	69	92	13
TMDL	26,517	2,351	666	414	134
Current Load	12,381	51,715	1,639	2,405	274
Load Reduction	0	49,364	973	1,991	140
Load Reduction	0%	95%	59%	83%	51%

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 and calculated E. *coli* data and observed flow data, while Table 5-6 was created using simulated E. *coli* data and simulated flow data. Table 5-7, created using simulated geometric mean data for both flow and E. *coli* 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 except the moist flow zone. 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 and calculated daily maximum and simulated 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 and midrange flows, as listed in Table 5-8.

Table 5-5. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_04 (Observed Flow Data and Observed E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 1,681 cfs	1,680–386 cfs	385–200 cfs	199–79 cfs	78–43 cfs
LA	50,760	6,451	1,524	820	194
WLA	0	0	0	0	0
MOS	5,865	1,598	397	207	260
TMDL	56,624	8,049	1,920	1,027	454
Current Load	281,121	89,723	20,226	2,520	1,150
Load Reduction	224,497	81,674	18,305	1,493	696
Load Reduction	80%	91%	91%	59%	60%

Table 5-6. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_04 (Simulated Flow and E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 1,681 cfs	1,680–386 cfs	385–200 cfs	199–79 cfs	78–43 cfs
LA	51,394	6,517	1,676	844	311
WLA	0	0	0	0	0
MOS	5,806	2,185	473	249	138
TMDL	57,200	8,701	2,149	1,092	449
Current Load	459,892	9,094	4,132	2,703	1,716
Load Reduction	402,692	393	1,983	1,611	1,266
Load Reduction	88%	4%	48%	60%	74%

Table 5-7. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Mid-range	Dry	Low
	> 1,727 cfs	1,726–392 cfs	390–195 cfs	194–84 cfs	83–52 cfs
LA	9,389	3,641	904	453	182
WLA	0	0	0	0	0
MOS	2,406	1,320	277	124	71
TMDL	11,794	4,961	1,181	577	253
Current Load	15,249	4,285	2,772	2,264	1,336
Load Reduction	3,455	0	1,591	1,687	1,083
Load Reduction	23%	0%	57%	75%	81%

Table 5-8. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	> 1,681 cfs	**1,680–386 cfs**	**385–200 cfs**	**194–84 cfs**	**83–52 cfs**
LA	51,394	6,451	1,524	453	182
WLA	0	0	0	0	0
MOS	5,806	1,598	397	124	71
TMDL	57,200	8,049	1,920	577	253
Current Load	459,892	89,723	20,226	2,264	1,336
Load Reduction	402,692	81,674	18,305	1,687	1,083
Load Reduction	88%	91%	91%	75%	81%

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 and calculated E. *coli* data and observed flow data, while Table 5-10 was created using simulated E. *coli* 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 E. *coli* 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 5-9. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_05 (Observed Flow Data and Observed and Calculated E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	224–59 cfs
LA	98,892	12,560	3,099	1,768	535
WLA	0	0	0	0	0
MOS	11,786	2,438	724	385	638
TMDL	110,678	14,998	3,823	2,153	1,173
Current Load	545,181	102,532	42,820	14,378	1,484
Load Reduction	434,503	87,534	38,997	12,224	311
Load Reduction	80%	85%	91%	85%	21%

Table 5-10. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_05 (Simulated) Flow and E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	224–59 cfs
LA	125,602	12,675	3,271	1,856	505
WLA	0	0	0	0	0
MOS	13,255	3,010	818	453	775
TMDL	138,857	15,685	4,089	2,308	1,280
Current Load	782,985	25,659	6,943	4,644	2,657
Load Reduction	644,128	9,974	2,854	2,336	1,377
Load Reduction	82%	39%	41%	50%	52%

Table 5-11. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 3,020 cfs	3,018–743 cfs	742–431 cfs	429–257 cfs	256–162 cfs
LA	26,850	6,301	1,750	1,110	584
WLA	0	0	0	0	0
MOS	4,308	2,124	473	182	201
TMDL	31,158	8,425	2,223	1,292	785
Current Load	47,671	6,536	4,664	3,939	2,926
Load Reduction	16,513	0	2,441	2,647	2,141
Load Reduction	35%	0%	52%	67%	73%

Table 5-12. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 2,981 cfs	2,980–728 cfs	727–419 cfs	418–226 cfs	256–162 cfs
LA	125,602	12,560	3,099	1,768	584
WLA	0	0	0	0	0
MOS	13,255	2,438	724	385	201
TMDL	138,857	14,998	3,823	2,153	785
Current Load	782,985	102,532	42,820	14,378	2,926
Load Reduction	644,128	87,534	38,997	12,224	2,141
Load Reduction	82%	85%	91%	85%	73%

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 and calculated E. *coli* 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 E. *coli* 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 E. *coli* concentration. In the high flow zone, 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 and calculated daily maximum bacteria and observed flow data require the greatest reduction. In the 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, as listed in Table 5-16. Critical conditions for reach SD-CH-R-CHEYENNE_06 occur during dry flow conditions.

Table 5-13. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_06 (Observed Flow Data and Observed and Calculated E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 3,632 cfs	3,630–889 cfs	888–479 cfs	477–246 cfs	245– 64 cfs
LA	118,009	14,276	3,812	2,116	589
WLA	0	0	0	0	0
MOS	11,930	3,547	788	454	681
TMDL	129,939	17,823	4,600	2,570	1,271
Current Load	74,551	34,287	45,145	32,328	4,304
Load Reduction	0	16,463	40,545	29,758	3,033
Load Reduction	0%	48%	90%	92%	70%

Table 5-14. Cheyenne River E. *coli* Bacteria Total Maximum Daily Load Based on the Daily Maximum Criterion for Reach SD-CH-R-CHEYENNE_06 (Simulated Flow and E. *coli* Data)

TMDL Component	Flow Zone (expressed as cfu × 10^9/day)				
	High	**Moist**	**Midrange**	**Dry**	**Low**
	> 3,632 cfs	**3,630–889 cfs**	**888–479 cfs**	**477–246 cfs**	**245–64 cfs**
LA	147,180	15,348	3,913	2,108	584
WLA	0	0	0	0	0
MOS	15,082	3,632	1,052	513	813
TMDL	162,262	18,980	4,965	2,621	1,398
Current Load	836,346	29,768	10,834	7,541	4,203
Load Reduction	674,084	10,788	5,868	4,920	2,805
Load Reduction	81%	36%	54%	65%	67%

Table 5-15. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	**Moist**	**Mid-range**	**Dry**	**Low**
	> 3,513 cfs	**3,512–918 cfs**	**916–513 cfs**	**512–278 cfs**	**277–164 cfs**
LA	36,778	7,432	2,247	1,258	629
WLA	0	0	0	0	0
MOS	4,691	2,387	516	261	223
TMDL	41,469	9,819	2,763	1,519	852
Current Load	45,340	11,292	6,455	5,938	4,767
Load Reduction	3,870	1,473	3,692	4,420	3,915
Load Reduction	9%	13%	57%	74%	82%

Table 5-16. Cheyenne River E. *coli* 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 × 10^9/day)				
	High	Moist	Midrange	Dry	Low
	> 3,632 cfs	3,630–889 cfs	888–479 cfs	477–246 cfs	277–164 cfs
LA	147,180	14,276	3,812	2,116	629
WLA	0	0	0	0	0
MOS	15,082	3,547	788	454	223
TMDL	162,262	17,823	4,600	2,570	852
Current Load	836,346	34,287	45,145	32,328	4,767
Load Reduction	674,084	16,463	40,545	29,758	3,915
Load Reduction	81%	48%	90%	92%	82%

According to the U.S. Environmental Protection Agency [2007], the high flow 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 (133–484 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 and midrange flow conditions (200–1,680 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 (246–477 cfs).

5.3 WASTE LOAD ALLOCATION

No point sources of E. *coli* 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-CHEYENNNE-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 E. *coli* concentrations in the Cheyenne River displayed seasonal variation. Available recreational season daily flow, E. *coli*, and transformed fecal coliform data were used to calculate the maximum and minimum average monthly flows and bacteria concentrations (Table 6-1) for four Cheyenne River project sites (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 site CHR13 (2,728). A large range of E. *coli* and transformed fecal coliform concentrations occurred, with the lowest monthly average fecal coliform concentration occurring at project site CHR05 (63 cfu/100 mL) and the highest monthly average fecal coliform concentration occurring at site CHR10 (3,683 cfu/100 mL).

Table 6-1. Cheyenne River Maximum and Minimum Monthly Average Recreational Season Flows and E. *coli* (Observed and Calculated) Concentrations

Project Site	Maximum Monthly Average Flow (cfs)	Minimum Monthly Average Flow (cfs)	Maximum Monthly Average Fecal Coliform Concentration (cfu/100 mL)	Minimum Monthly Average Fecal Coliform Concentration (cfu/100 mL)
CHR05	193 (June)	71 (August)	685 (July)	63 (May)
CHR10	1,080 (June)	159 (September)	3,683 (June)	420 (September)
CHR14	1,992 (June)	377 (September)	1,345 (June)	357 (May)
CHR13	2,728 (June)	351 (September)	2,446 (August)	128 (September)

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 E. *coli* loads is taken into account, as stream flow and bacteria delivery to the stream is related to seasonal changes in precipitation.

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

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 E. *coli* 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 E. *coli* 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 waste load allocation 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 E. *coli* 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, and (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 38 percent of the time (3 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, an 18 percent reduction for Reach SD-CH-CHEYENNE_05, and a 13 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. With implementation of Scenario 2, the model predicts that the daily maximum criterion would be exceeded 41 percent of the time (3 percent less than base conditions) in the Cheyenne River at the Belle Fourche River confluence with the Cheyenne. 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 reductions 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, 0 percent reduction for Reach SD-CH-CHEYENNE_05, and 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 57 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 28 percent of the average recreation season bacteria load in Reach SD-CH-R-CHEYENNE_04, approximately 27 percent in Reach SD-CH-R-CHEYENNE_05, and approximately 30 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 33 percent to Reach SD-CH-R-CHEYENNE_03, 54 percent to REACH SD-CH-R-CHEYENNE_04, 38 percent to Reach SD-CH-R-CHEYENNE_05, and 42 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 58 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 livestock exclusion and grazing management practices (Scenarios 4 and 5), the model predicted a reduction in average recreation season bacteria loads of approximately 90 percent, which is greater than the required load reduction of 58 percent. Thus implementation of Scenario 5 is expected to achieve the TMDL goal.

An average estimated 85 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 82 percent—3 percent less than the required load reduction of 85 percent. A difference of 3 percent is within the model error and the explicit margin of safety of the TMDL. Thus implementation of Scenarios 4 and 5 are expected to achieve the TMDL goal.

An average estimated 83 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 84 percent—1 percent higher than the required load reduction of 83 percent. Thus implementation of Scenarios 2, 4, and 5 are expected to achieve the TMDL goal.

On average, an estimated 79 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 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 85 percent which is greater than the required load reduction of 79 percent. Thus implementation of Scenarios 2, 4, and 5 are 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

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APPENDIX A

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

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	***E. Coli*** **Total Maximum Daily Load for the Cheyenne River, Pennington County, South Dakota**
Submitted by:	**Cheryl Saunders, SD DENR**
Date Received:	**July 22, 2010**
Review Date:	**August 16, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Public Notice Draft**
Notes:	

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

☐ Approve
☐ Partial Approval
☐ Disapprove
☐ Insufficient Information

Approval Notes to Administrator:

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

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

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

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

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

1. Problem Description

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

1.1 TMDL Document Submittal Letter

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

Minimum Submission Requirements.

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

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

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

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

SUMMARY: The Cheyenne River *E. coli* 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. One segment of the lower Cheyenne River is identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated *E.*

coli concentrations (SD-CH-R-CHEYENNE_05). Three additional segments are likely to be impaired for *E. coli* now or in the future, however there is currently insufficient data to make a definitive determination. The four segments covered by this TMDL document 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 fecal coliform. The TSS and fecal coliform impairments will be addressed in separate TMDL documents.

The designated uses for the four segments of the Cheyenne River 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, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)).

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

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

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

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

SUMMARY: The Cheyenne River segments addressed by these TMDLs are now, or likely to be impaired when additional data is collected, based on *E. coli* concentrations that are impacting the immersion recreation beneficial uses. South Dakota has applicable numeric standards for *E. coli* that may be applied to these river segments. The numeric standards being implemented in these TMDLs are: a daily maximum value of *E. coli* of 235 cfu/100mL in any one sample, and a maximum geometric mean of 126 cfu/100mL during a 30-day period. The standards for *E. coli* are applicable from May 1 to September 30. Discussion of additional applicable water quality standards for the Cheyenne River can be found on pages 11 - 13 of the TMDL document.

COMMENTS: Footnote "d" on page 11 of the TMDL says that the *E. coli* 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.

SD DENR RESPONSE: "limited contact recreation" in footnote "d" on page 13 was changed to "immersion recreation."

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 *E. coli* established to protect the immersion recreation beneficial uses for the four Cheyenne River segments. The *E. coli* targets are: daily maximum of $\leq$ 235 cfu/100mL in any one sample, and maximum geometric mean of $\leq$ 126 cfu/100mL during a 30-day period. The *E. coli* standards are applicable from May 1 to September 30.

COMMENTS: None.

3. Pollutant Source Analysis

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

Minimum Submission Requirements:

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

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

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

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

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

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

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

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

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Cheyenne River TMDL describes how the *E. coli* 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 *E. coli* data from multiple sites within the lower Cheyenne River watershed since 2000. For the purposes of this TMDL document, data were used from stations which are listed in the Data Set Description section below. Historical data collected from May 1 to September 30 (applicable dates for the *E. coli* water quality standard) from each monitoring station were used in the TMDL technical analysis.

Bacteria sample data for the Cheyenne River impaired reaches show a statistically significant correlation (*Spearman rs*, = 0.84) between fecal coliform bacteria and E. *coli* concentrations. Because the two indicators are closely related, the paired fecal coliform and E. *coli* were used to develop site-specific translator functions to convert fecal coliform loading estimates to E. *coli* loading estimates to address impairments to the immersion recreation and limited contact recreation use of the Cheyenne River. The translation requires a regression analysis equation to convert fecal coliform concentration to E. *coli* concentrations. Once concentrations are available, they can be combined with flow data to compute loading estimates. For the entire project area, the mean ratio of E. *coli* to fecal coliform was calculated to be 1.051 cfu E. *coli*/cfu fecal coliform. Site-specific translator functions, as well as statistics showing function significance, are shown in Table 1-3 of the TMDL document.

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. Fecal coliform results were converted to *E. coli* loading as discussed in Section 1.3 of the TMDL document.

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 *E. coli* 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 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 *E. coli* in the four segments of the Cheyenne River.

COMMENTS: The TMDL table of contents (p. v) lists Section 4.0. as "Technical Analysis." However, on page 21, Section 4.0 is titled "Load Duration Curve Analyses." We prefer the "Technical Analysis" title.

SD DENR RESPONSE: Chapter 4.0 title was changes from "Loade 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 in 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 *E. coli* data from multiple sites within the lower Cheyenne River watershed since 2000. 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 E. *coli* Total Maximum Daily Load Development (Recreational Season)

Fecal Coliform Monitoring Stations	Project	Segment	Data Available	Calculated E. *coli* Data Points	Observed E. *coli* Data Points
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007–2009	0	2
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999–2009	126	4
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007–2009	0	2
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967–2009	196	5
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008–2009	0	2
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968–2009	250	44
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999–2009	63	3

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 *E. coli* 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 *E. coli* bacteria load allocation (LA), the loading capacity was first determined using the data sources specified. The daily maximum criterion (235 cfu/100 mL) was used in the calculation of the daily maximum loading capacities, and the geometric mean criterion (126 cfu/100 mL) was used for the calculation of the geometric mean loading capacities. The loading capacities for the Cheyenne River were calculated by multiplying the specified *E. coli* 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 *E. coli* 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 *E. coli* loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months.

COMMENTS: None.

5. Public Participation

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

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

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

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

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

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

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

6. Monitoring Strategy

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

Minimum Submission Requirements:

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

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

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

SUMMARY: The 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 *E. coli* 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 *E. coli* 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 *E. coli* 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
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SEP 2 9 2010

RECEIVED

OCT 5 2010

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

Ref: 8EPR-EP

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

Re: TMDL Approvals
Cheyenne River; E. coli; 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

ENCLOSURE 1: APPROVED TMDLs

E. Coli 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.
1	Causes addressed from the 2010 303(d) list.
0	Determinations that no pollutant TMDL needed.

Segment: Cheyenne River from Belle Fourche River to Bull Creek

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

Parameter/Pollutant (303(d) list cause): E. COLI - 227

Water Quality Targets: < = 126 cfu/100 mL 30-day geometric mean; < = 235 cfu/100mL single sample maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	0.2E+13	CFU/DAY	
LA	1.3E+13	CFU/DAY	
TMDL	1.5E+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 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.

Date Submitted: 9/24/2010

Segment: Cheyenne River from Bull Creek to mouth

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

Parameter/Pollutant (303(d) list cause): E. COLI - 227

Water Quality Targets: <= 126 cfu/100 mL 30-day geometric mean; <= 235 cfu/100mL single sample maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	0.8E+12	CFU/DAY	
LA	3.8E+12	CFU/DAY	
TMDL	4.6E+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.

Segment: Cheyenne River from Cedar Creek to Belle Fourche River

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

Parameter/Pollutant (303(d) list cause): E. COLI - 227

Water Quality Targets: <= 126 cfu/100 mL 30-day geometric mean; <= 235 cfu/100mL single sample maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	1.6E+12	CFU/DAY	
LA	6.5E+12	CFU/DAY	
TMDL	8.1E+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 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): E. COLI - 227

Water Quality Targets: < = 126 cfu/100 mL 30-day geometric mean; < = 235 cfu/100mL single sample maximum

Allocation*	Value	Units	Permits
WLA	0	CFU/DAY	
MOS	0.3E+12	CFU/DAY	
LA	2.1E+12	CFU/DAY	
TMDL	2.4E+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.

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

ENCLOSURE 2

EPA REGION VIII TMDL REVIEW

TMDL Document Info:

Document Name:	***E. Coli*** **Total Maximum Daily Load for the Cheyenne River, Pennington County, South Dakota**
Submitted by:	**Rich Hanson, SD DENR**
Date Received:	**September 24, 2010**
Review Date:	**September 28, 2010**
Reviewer:	**Vern Berry, EPA**
Rough Draft / Public Notice / Final?	**Final**
Notes:	

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

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

Approval Notes to Administrator:

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

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

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

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

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

1. Problem Description

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

1.1 TMDL Document Submittal Letter

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

Minimum Submission Requirements.

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

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

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

Recommendation:

☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

SUMMARY: The final Cheyenne River *E. coli* 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. One segment of the lower

Cheyenne River is identified on the 2010 South Dakota 303(d) waterbody list as impaired due to elevated *E. coli* concentrations (SD-CH-R-CHEYENNE_05). Three additional segments are likely to be impaired for *E. coli* now or in the future, however there is currently insufficient data to make a definitive determination. The four segments covered by this TMDL document 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 fecal coliform. The TSS and fecal coliform impairments will be addressed in separate TMDL documents.

The designated uses for the four segments of the Cheyenne River 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, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)).

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

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

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

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

SUMMARY: The Cheyenne River segments addressed by these TMDLs are now, or likely to be impaired when additional data is collected, based on *E. coli* concentrations that are impacting the immersion recreation beneficial uses. South Dakota has applicable numeric standards for *E. coli* that may be applied to these river segments. The numeric standards being implemented in these TMDLs are: a daily maximum value of *E. coli* of 235 cfu/100mL in any one sample, and a maximum geometric mean of 126 cfu/100mL during a 30-day period. The standards for *E. coli* are applicable from May 1 to September 30. Discussion of additional applicable water quality standards for the Cheyenne River can be found on pages 11 - 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 *E. coli* established to protect the immersion recreation beneficial uses for the four Cheyenne River segments. The *E. coli* targets are: daily maximum of ≤ 235 cfu/100mL in any one sample, and maximum geometric mean of ≤ 126 cfu/100mL during a 30-day period. The *E. coli* standards are applicable from May 1 to September 30.

COMMENTS: None.

3. Pollutant Source Analysis

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

Minimum Submission Requirements:

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

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

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

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

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

SUMMARY: The TMDL document identifies the land 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 *E. coli* 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 *E. coli* 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 <u>all</u> of the components of a TMDL document. It is vitally important that the technical basis for <u>all</u> conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

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

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

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

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

Where:

TMDL = Total Pollutant Loading Capacity of the waterbody

LAs = Pollutant Load Allocations

WLAs = Pollutant Wasteload Allocations

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

Minimum Submission Requirements:

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

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

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

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

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

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

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

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

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

SUMMARY: The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Cheyenne River TMDLs describe how the *E. coli* 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 *E. coli* data from multiple sites within the lower Cheyenne River watershed since 2000. For the purposes of this TMDL document, data were used from stations which are listed in the Data Set Description section below. Historical data collected from May 1 to September 30 (applicable dates for the *E. coli* water quality standard) from each monitoring station were used in the TMDL technical analysis.

Bacteria sample data for the Cheyenne River impaired reaches show a statistically significant correlation (*Spearman rs*, = 0.84) between fecal coliform bacteria and E. *coli* concentrations. Because the two indicators are closely related, the paired fecal coliform and E. *coli* were used to develop site-specific translator functions to convert fecal coliform loading estimates to E. *coli* loading estimates to address impairments to the immersion recreation and limited contact recreation use of the Cheyenne River. The translation requires a regression analysis equation to convert fecal coliform concentration to E. *coli* concentrations. Once concentrations are available, they can be combined with flow data to compute loading estimates. For the entire project area, the mean ratio of E. *coli* to fecal coliform was calculated to be 1.051 cfu E. *coli*/cfu fecal coliform. Site-specific translator functions, as well as statistics showing function significance, are shown in Table 1-3 of the TMDL document.

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. Fecal coliform results were converted to *E. coli* loading as discussed in Section 1.3 of the TMDL document.

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*.

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 *E. coli* 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 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 *E. coli* in the four 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 in 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 *E. coli* data from multiple sites within the lower Cheyenne River watershed since 2000. 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 E. *coli* Total Maximum Daily Load Development (Recreational Season)

Fecal Coliform Monitoring Stations	Project	Segment	Data Available	Calculated E. *coli* Data Points	Observed E. *coli* Data Points
Cheyenne River near Buffalo Gap, SD	CHR04	SD-CH-R-CHEYENNE_03	2007–2009	0	2
Cheyenne River at Redshirt, SD	CHR05	SD-CH-R-CHEYENNE_03	1999–2009	126	4
Cheyenne River at Scenic, SD	CHR08	SD-CH-R-CHEYENNE_04	2007–2009	0	2
Cheyenne River near Wasta, SD	CHR10	SD-CH-R-CHEYENNE_04	1967–2009	196	5
Cheyenne River near Smithville, SD	CHR16	SD-CH-R-CHEYENNE_04	2008–2009	0	2
Cheyenne River near Plainview, SD	CHR14	SD-CH-R-CHEYENNE_05	1968–2009	250	44
Cheyenne River near Eagle Butte, SD	CHR13	SD-CH-R-CHEYENNE_06	1999–2009	63	3

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 *E. coli* 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 *E. coli* bacteria load allocation (LA), the loading capacity was first determined using the data sources specified. The daily maximum criterion (235 cfu/100 mL) was used in the calculation of the daily maximum loading capacities, and the geometric mean criterion (126 cfu/100 mL) was used for the calculation of the geometric mean loading capacities. The loading capacities for the Cheyenne River were calculated by multiplying the specified *E. coli* 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 *E. coli* loads are taken into account. Highest steam flows typically occur during late spring, and the lowest stream flows occur during the winter months.

COMMENTS: None.

5. Public Participation

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

Minimum Submission Requirements:

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

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

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

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

COMMENTS: 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

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 <u>is not</u> 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 *E. coli* 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 *E. coli* 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 *E. coli* 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.