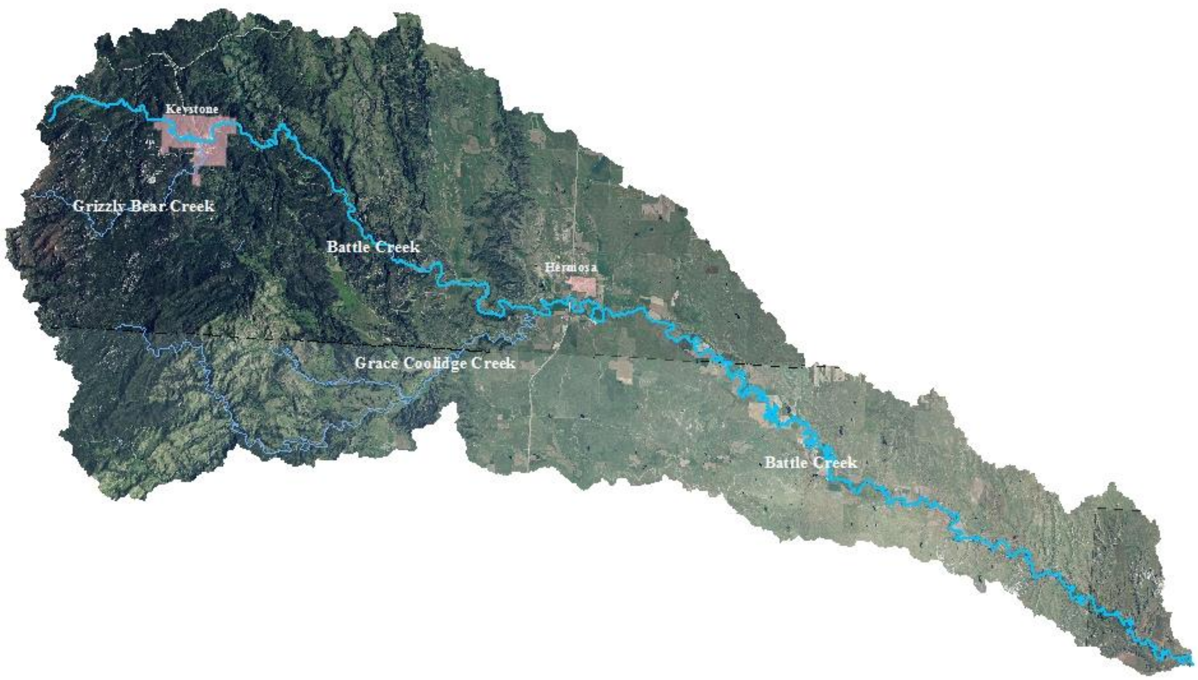
Fecal Coliform and *Escherichia coli* Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota



Prepared by:

Robert L. Smith
South Dakota Department of
Environment and Natural Resources
Watershed Protection Program

September, 2013

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

List of Tables

List of Tables (continued)

List of Figures

List of Figures (continued)

List of Acronyms

ADB	Assessment Database
AFO	Animal Feeding Operation
ARSD	Administrative Rules of South Dakota
AUID	Assessment Unit Identification
BIT	Bacteria Indicator Tool
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CFU	Colony Forming Units
DMR	Discharge Monitoring Report
ICIS	Integrated Compliance Information System
LA	Load Allocation
LDC	Load Duration Curve
MGD	Million Gallons per Day
MPN	Most Probable Number
MOS	Margin Of Safety
NASS	National Agricultural Statistics Service
NPDES	National Pollutant Discharge Elimination System
SDCL	South Dakota Codified Law
SD DENR	South Dakota Department of Environment and Natural Resources
SD DENR SWQP	South Dakota Department of Environment and Natural Resources Surface Water Quality Program
SD GF&P	South Dakota Game Fish and Parks
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
US EPA	United States Environmental Protection Agency
WLA	Wasteload Allocation
WQM	Water Quality Monitoring
WWTF	Wastewater Treatment Facility

Total Maximum Daily Load Summary Table

Water Body Name/Description:	Battle Creek (from Teepee Gulch to its confluence with the Cheyenne River)
Assessment Unit IDs:	SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS
Size of Impaired Waterbody:	111.8 stream kilometers (69.5 stream miles)
Size of Watershed:	78,145 hectares, (193,102 acres)
Location:	Hydrologic Unit Codes (12-digit HUC): 101201090801, 101201090802, 01201090803, 101201090804, 101201090805, 101201090806, 101201090807, 101201090808, 101201090809
Impaired Designated Use(s):	Limited contact recreation waters
Cause(s) of Impairment:	Fecal coliform and *E. coli* bacteria
Cycle First and Most Recently Listed:	
SD-CH-R-BATTLE_02	
Fecal coliform bacteria	2012/2012
Escherichia coli	2012/2012
SD-CH-R-BATTLE_01_USGS	
Fecal coliform bacteria	2010/2012
Escherichia coli	2012/2012
Waterbody Type:	Stream
303(d) Listing Parameters:	
SD-CH-R-BATTLE_02	Fecal coliform bacteria *E. coli* bacteria
SD-CH-R-BATTLE_01_USGS	Fecal coliform bacteria *E. coli* bacteria
Designated Uses:	
SD-CH-R-BATTLE_02	Coldwater permanent fish life propagation waters, limited contact recreation waters, fish and wildlife propagation, recreation, and stock watering and irrigation waters
SD-CH-R-BATTLE_01_USGS	Warmwater marginal fish life propagation waters, limited contact recreation waters, fish and wildlife propagation, recreation, and stock watering and irrigation waters
TMDL End Points:	
Indicator Names:	Fecal coliform and *E. coli* bacteria
Threshold Values:	
Fecal coliform	Maximum daily concentration of ≤ 2,000 CFU/100 mL in any one sample or a geometric mean of ≤ 1,000 CFU/100 mL based on a minimum of 5 samples obtained during separate 24-hour periods for any 30 day period. These criteria apply from May 1st through September 30th.
Escherichia coli	Maximum daily concentration of ≤ 1,178 MPN/100 mL in any one sample or a geometric mean of ≤ 630 MPN100 mL based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period. These criteria apply from May 1st through September 30th.
Analytical Approach:	Load Duration Curves, Bacterial Indicator Tool and statistical analysis.

TMDL Submittal Table for segments of Battle Creek, Pennington and Custer Counties, South Dakota.

				TMDL End Points		Wasteload Allocations		Load Allocations		
Waterbody Name / Description	Waterbody ID	Cycle First/Most Recently Listed	Cause(s) of Impairment	Indicator Name	Threshold Values	WLA (CFU*10^9/day)	WLA Permitted Facilities (Permit Number)	LA (CFU*10^9/day)	MOS (CFU*10^9/day)	TMDL (CFU*10^9/day)
Battle Creek (Teepee Gulch Creek to SD Highway 79)	SD-CH-R-BATTLE_02	2012/2012	Fecal Coliform	Fecal Coliform	≤ 2,000 CFU/100mL any one sample; ≤ 1,000 CFU/100mL geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period	29	SD0024007	10,346	1,153	11,528 High Flow Zone (acute)
Battle Creek (Teepee Gulch Creek to SD Highway 79)	SD-CH-R-BATTLE_02	2012/2012	*Escherichia coli*	*Escherichia coli*	≤ 1,178 MPN/100mL any one sample; ≤ 630 MPN/100mL geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period	17	SD0024007	657	75	749 Moist Flow Zone (acute)
Battle Creek (SD Highway 79 to Cheyenne River)	SD-CH-R-BATTLE_01_USGS	2010/2012	Fecal Coliform	Fecal Coliform	≤ 2,000 CFU/100mL any one sample; ≤ 1,000 CFU/100mL geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period	17	SD0022349	16,328	1,816	18,161 High Flow Zone (acute)
Battle Creek (SD Highway 79 to Cheyenne River)	SD-CH-R-BATTLE_01_USGS	2012/2012	*Escherichia coli*	*Escherichia coli*	≤ 1,178 MPN/100mL any one sample; ≤ 630 MPN/100mL geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period	10	SD0022349	9,617	1,070	10,697 High Flow Zone (acute)

1.0 Introduction and Watershed Description

This TMDL document addresses fecal coliform and *Escherichia coli* bacteria impairments of Battle Creek segments SD-CH-R-BATTLE_02 from Teepee Gulch Creek to South Dakota Highway 79 and segment SD-CH-R-BATTLE_01_USGS from South Dakota Highway 79 to the Cheyenne River. These impairments were assigned a priority 1-category (high-priority) in the 2012 Integrated Report (SD DENR, 2012). These TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by US EPA.

Additionally, segment SD-CH-R_BATTLE_01_USGS is designated as threatened for warmwater marginal fish life use in the 2012 Integrated Report due to elevated Total Suspended Solids (TSS) and is included in the 2012 303(d) list. This impairment was first listed in 2010.

Segment SD-CH-R-BATTLE_02 is listed on the 2012 303(d) list as impaired for coldwater permanent fish life use due to elevated temperature. The temperature impairment was first listed in 2004. TSS and temperature impairments of these two segments will be addressed in separate TMDL summary documents.

1.1 CWA Section 303(d) Listing Information

Table 1 303(d) impaired segments in Battle Creek based on the 2012 Integrated Report*

Waterbody AUID	From	To	Parameter
SD-CH-R-BATTLE_01_USGS	SD Highway 79	Cheyenne River	Fecal Coliform *E. coli*
SD-CH-R-BATTLE_02	Teepee Gulch Creek	SD Highway 79	Fecal Coliform *E. coli*

*** See Figure 2 map for segment locations**

1.1.1 Fecal Coliform

Battle Creek segment SD-CH-R-BATTLE_01_USGS was first listed in 2010 as impaired for limited contact recreation use due to exceedence of the fecal coliform bacteria criteria and has been listed in the current 303(d) listing cycle 2012.

In 2011, a watershed assessment of Battle Creek was completed to evaluate existing and potential pollution problems. Assessment data showed that 84 to 86 percent of all fecal coliform bacteria samples collected at the downstream end of segment SD-CH-R-BATTLE_02 near highway 79 (BATTLE02A and BATTLE02) violated surface water quality standards (Figure 2 and Appendix A Table A1). Based on that data, Battle Creek segment SD-CH-R-BATTLE_02 was listed as impaired for limited contact recreation use due to increased fecal coliform and listed in the 2012 Integrated Report for Surface Water Quality. The study found the primary pollution sources in the Battle Creek basin to be agricultural runoff (90.2 percent in Table 6 and 90.9 percent in Table 7).

1.1.2 *E. coli*

E. coli bacteria have been collected in the Battle Creek since September of 2001. In the 2012 Integrated Report, the lower two segments of Battle Creek (SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS) were listed as impaired for limited contact recreation use due to increased *E. coli* bacteria and placed on the 303(d) list (SD DENR, 2012).

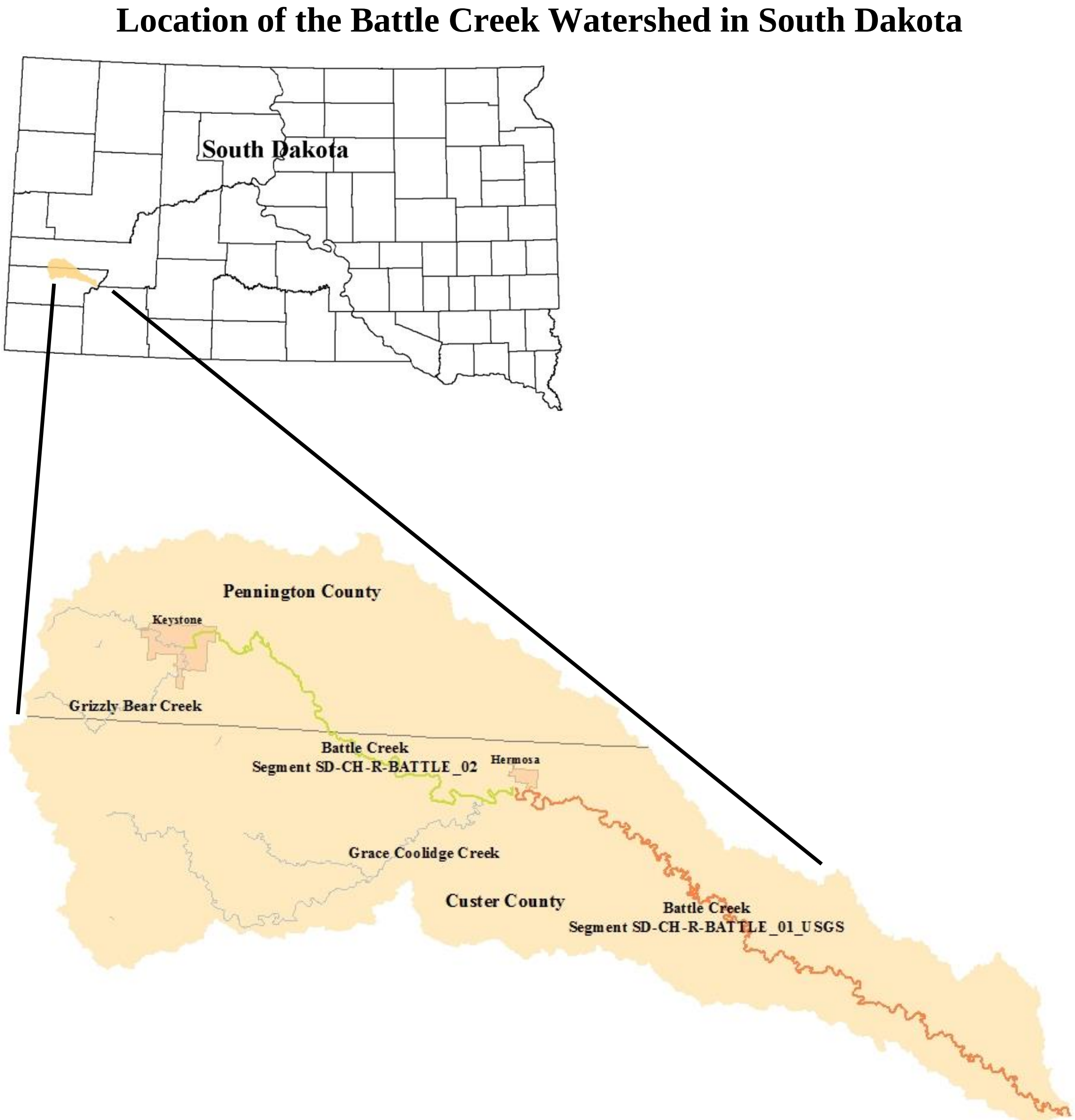


Figure 1 Location of the Battle Creek watershed within South Dakota.

1.2 Topography

Battle Creek is a perennial mountain stream located in Custer and Pennington Counties of South Dakota. Battle Creek is a tributary of the Cheyenne River, which flows into the Missouri River. The drainage area of Battle Creek is approximately 302 square miles (782 square kilometers) at the confluence with the Cheyenne River.

The impaired (303(d) listed) segments of Battle Creek have a combined length of 69.5 stream miles (111.8 stream kilometers) beginning at Teepee Gulch at Keystone, SD and ends where Battle Creek empties into the Cheyenne River (Figure 1, Figure 2 and Table 1). The drainage area of the 303(d) listed segments is approximately 193 square miles (500 square kilometers).

Battle Creek Watershed including AUID identifiers, Monitoring Sites, ADB Segment Lengths, and Permitted Waste Water Treatment Facilities (WWTF) in 2013

Figure 2 Battle Creek watershed with monitoring sites, AUID identifiers, and current ADB segment lengths.

1.3 Geology and Soils

1.3.1 Geology

The underlying geology for the Battle Creek watershed is shown in Figure 3. The main geology of the upper impaired segment of Battle Creek (SD-CH-R-BATTLE_02) flows through (X_h) Harney Peak Granite with Pink to tan, fine-grained to pegmatitic, peraluminous, muscovite granite and pegmatite containing accessory biotite, garnet, apatite, and tourmaline. Main body is a composite dome-shaped mass consisting of hundreds of separate intrusions; more than 20,000 sills and dikes occur adjacent to the main body. Metagraywacke (X_{gw}) composed of Light- to dark-gray, siliceous mica schist and impure quartzite. Metagraywacke can be further differentiated where possible into three primary tongues or lenses (Xgw1, Xgw2, and Xgw3). Metaquartzite (X_q) made up of Light-tan quartzite, siliceous schist, and minor chert. The other major geologic group in the upper Battle Creek watershed is the Inyan Kara Group which includes the Fall River and Lakota Formations. The Fall River Formation (K_{fl}) has variegated brown, red, and gray to purple, calcareous, well-sorted, fine-grained sandstone, siltstone, and shale containing mica; while the Lakota Formation has yellow, brown, red-brown, and gray to black claystone, silty pebble conglomerate, and massive to thin-bedded, cross-bedded sandstone and locally interbedded with freshwater limestone and bituminous coal beds (Martin et al., 2004).

Geology of the lower segment of Battle Creek (SD-CH_R-BATTLE_01_USGS) is different than the upper portions of the Battle Creek watershed. Pierre Shale (K_p) is composed of blue-gray to dark-gray, fissile to blocky shale with persistent beds of bentonite, black organic shale, and light-brown chalky shale. Pierre Shale contains minor sandstone, conglomerate, abundant carbonate and ferruginous concretions. The White River Group (T_w) includes the Brule, Chadron, Chamberlain Pass, and Slim Buttes Formations. The Brule Formation has white, pink, light-green, and light-brown, massive to thin-bedded, bentonitic claystone, tuffaceous siltstone, and well-bedded, calcareous, tuffaceous quartz sandstone. The Chadron Formation upper beds are gray to light-brown to maroon bentonite, claystone, siltstone, and tuffaceous fine-grained sandstone, with local silicified carbonate lenses. The basal portion consists of poorly cemented, white, coarse-grained arkose and conglomerate. Chamberlain Pass Formation has pale-olive to pale-red, mottled mudstone containing white, cross-bedded channel sandstone with basal conglomerate. The last formation that makes up the White River Group is the Slim Buttes Formation has white, grayish- to yellowish-orange, and pale-red to pink siltstone, clayey siltstone, bentonitic claystone, medium to fine-grained sandstone, and conglomerate. Terrace deposits (Q_t) composed of clay- to boulder-sized clasts deposited as pediments, paleochannels, and terrace fills of former flood plains. The other major geologic group in the lower Battle Creek watershed is Alluvium (Q_{al}) made up of clay- to boulder-sized clasts with locally abundant organic material (Martin et al., 2004).

1.3.2 Soils

Soil Associations in the upper portion of the watershed are composed of Buska-Mocmont-Rock Outcrop Association comprised of rock outcrop and deep, well drained, gently sloping to very steep, loamy soils formed in material weathered from micaceous schist and granite; on mountains. Pactola-Rock Outcrop-Virkula Association soils with rock outcrop and deep, well drained, gently sloping to very steep, loamy soils formed in material weathered from steeply tilted metamorphic rock; on mountains. Moving down in elevation Battle Creek flows through the Vanocker-Sawdust-Paunsaugunt Association soils with deep and shallow, well drained, gently sloping to very steep, loamy soils formed in material weathered from limestone and calcareous sandstone; on mountains. Nevee-Gypnevee-Rekop Association soils composed of deep and shallow, well drained and somewhat excessively drained, gently sloping to very steep, silty and loamy soils form in material weathered from siltstone, sandstone, silty shale and gypsum; on uplands. Canyon-Rockoa-Rock Outcrop Association has rock outcrop and shallow and deep, well drained, gently sloping to very steep, loamy soils formed in material weathered interbedded limestone, sandstone, and shale; on uplands and mountains (USDA, 1990).

Soil Associations in the lower portion of the watershed from approximately South Dakota Highway 79 to the Cheyenne River has five associations and are composed the Owanka-Haverson-Colombo Association with deep, well drained, nearly level, loamy and silty soils on terraces, fans and flood plains. Orella-Fairburn-Badland Association having shallow, well drained, moderately sloping to steep, clayey and loamy soils and Badland on dissected plains. The Norrest-Fairburn-Emigrant Association have moderately deep and shallow, well drained, nearly level to steep, silty and loamy soils on dissected plains and other plains. Pierre-Kyle Association has moderately deep and deep, well drained, nearly level to strongly sloping, clayey soils on dissected plains, other plains, and fans. Samsil-Pierre Association with shallow and moderately deep well drained, moderately sloping to very steep, clayey soils on dissected plains (USDA, 1996).

1.4 Land Use/Land Cover

Much of the upper portion of the watershed (segment SD-CH-R-BATTLE_02) is located within the Black Hills National Forest and is predominantly forested with ponderosa pine (73 percent) followed by herbaceous rangeland (13 percent) and cropland and pasture (4 percent). The lower portion of the watershed (segment SD-CH-R-BATTLE_01_USGS) is dominated by herbaceous rangeland (87 percent), cropland and pastureland (9 percent), nonforested wetlands (2 percent), and two percent were forested (Figure 4).

1.5 Climate and Precipitation

The area around Battle Creek is usually warm in summer. Hot days frequently occur during the summer. In winter cold periods occur when artic air moves in from the north and northwest. Cold periods alternate with milder periods, which often occur when westerly winds are warmed as they move downslope. Most precipitation falls as rain during the warmer part of the year. The precipitation is normally heaviest in late spring and early summer. Snow falls frequently in winter, but the snow cover usually disappears during milder periods.

Average annual precipitation in the upper portion of the Battle Creek watershed in the Black Hills was approximately 18 inches (0.46 m) while the average annual precipitation in the lower portion of the watershed below South Dakota Highway 79 was 15.52 inches (0.39 m) based on Pennington and Custer Counties Soil Survey data (USDA, 1990 and USDA, 1996). Snowfall in the Black Hills portion of the watershed averaged approximately 45 inches (1.14 m) while the lower portions of the watershed averaged 32 inches (0.81 m). Over 75 percent of the annual precipitation occurs during the months of April through September.

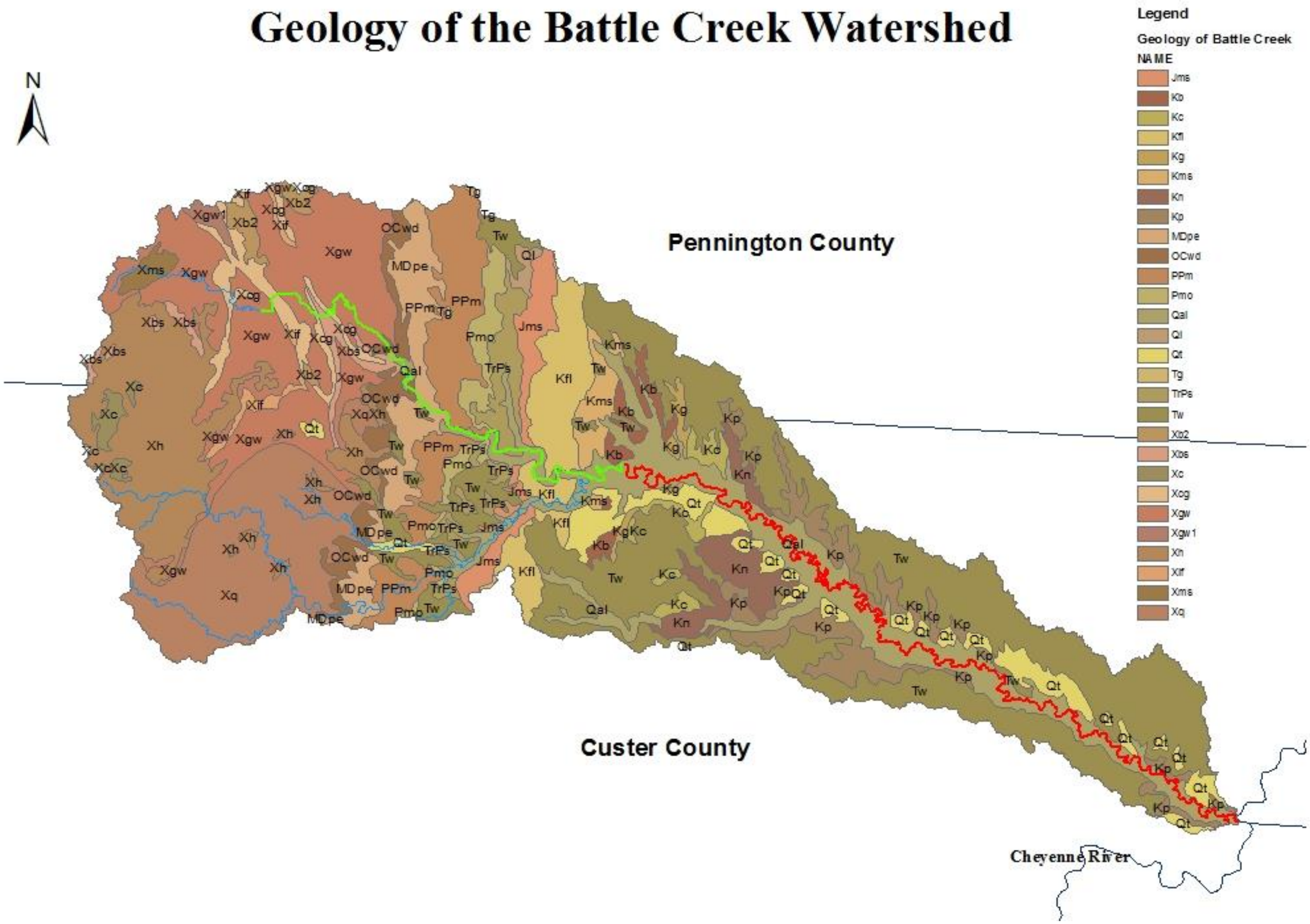


Figure 3 Underlying geology of the Battle Creek watershed, Pennington and Custer Counties, South Dakota.

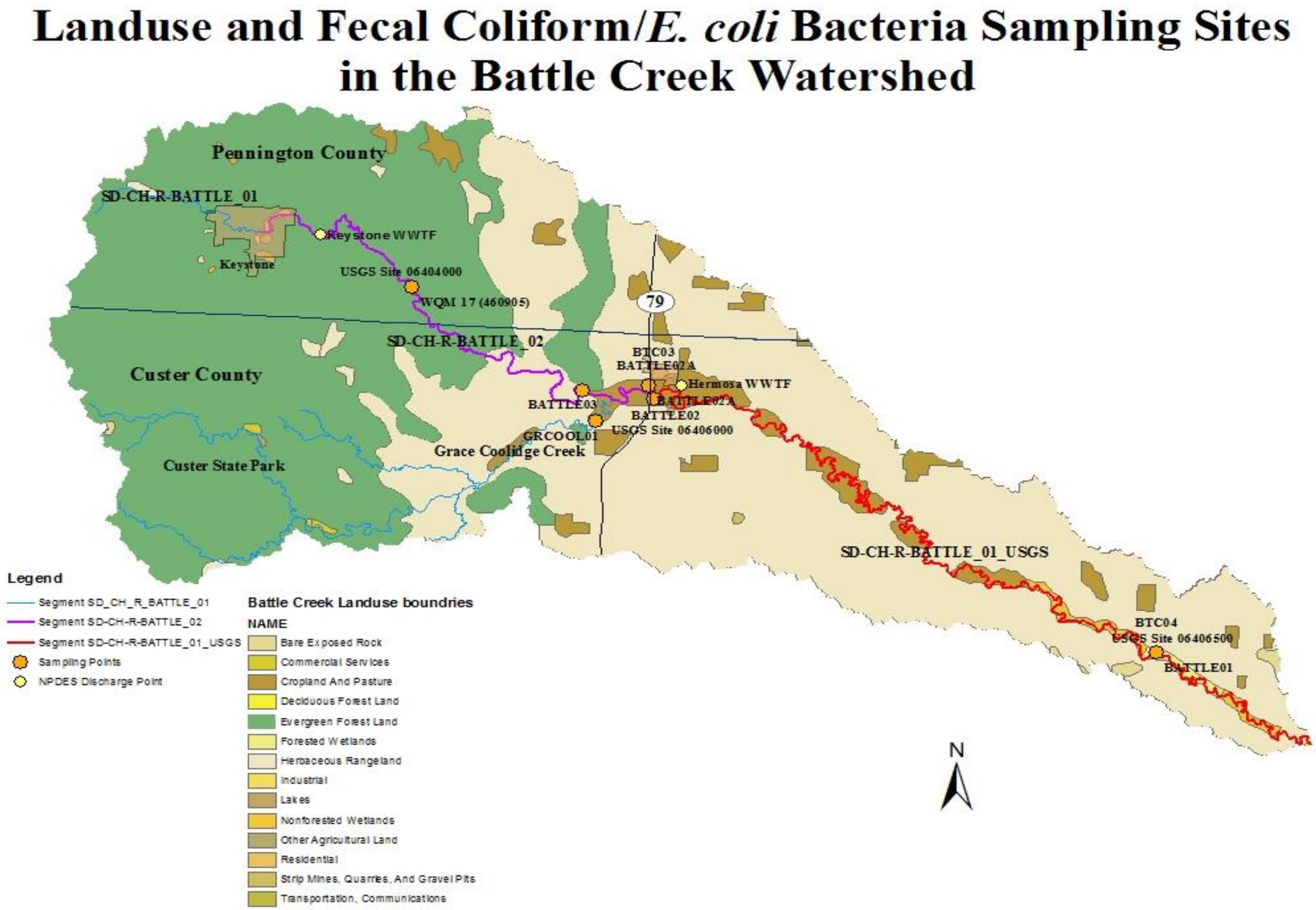


Figure 4 2006 Landuses in Battle Creek, Pennington and Custer Counties, South Dakota

1.6 Available Water Quality Data

As early as May of 1968, the South Dakota Department of Environment and Natural Resources (SD DENR) have collected fecal coliform bacteria samples from Battle Creek at WQM 17 (DENR 460905) near Hayward, SD (segment SD-CH-R-BATTLE_02) as part of the State-wide Ambient Surface Water Quality Monitoring Program (Figure 2 and Appendix A, Table A2). *E. coli* bacteria sampling was not initiated at WQM 17 (DENR 460905) until the summer of 2001. Fecal coliform and *E. coli* sampling at this site are collected monthly during the recreation season (May 1st through September 30th). WQM 17 is also USGS stream monitoring gage 06404000, Battle Creek near Keystone, South Dakota. WQM data and USGS flows from this site were used to analyze conditions in the upper part of segment SD-CH-R-BATTLE_02.

Another monitoring site in segment SD-CH-R-BATTLE_02 site BATTLE03 consisting of multiple random grab samples collected monthly during the recreation season of 2011 (Appendix A, Table A1). This site was located on Battle Creek at the last bridge crossing on Highway 40 before the Highway 79 junction (Figure 2). The confluence of Grace Coolidge Creek with Battle Creek is downstream of BATTLE03 and upstream Battle Creek assessment monitoring site BATTLE02A (Figure 2). Battle Creek assessment monitoring site GRCOOL01 was set up and monitored upstream of the confluence at the first bridge crossing on Highway 36 West of Highway 79 in 2011 (Figure 2 and Appendix A, Table A1). Available data consisted of multiple random grab samples collected monthly during the recreation season in 2011. The furthest downstream Battle Creek monitoring site in segment SD-CH-R-BATTLE_02 was BATTLE02A that was sampled randomly every month throughout the recreation season during 2011. This site was located where Highway 79 crosses Battle Creek South of Hermosa, South Dakota (Figure 2). This site was also sampled as part of the Lower Cheyenne River assessment monitoring site BTC03 on Battle Creek with samples collected during the recreation season from 2007 through 2009 (Figure 2 and Appendix A, Table A3).

Battle Creek assessment monitoring site BATTLE02 in the upper reach of segment SD-CH-R-BATTLE_01_USGS and was sampled for fecal coliform and *E. coli* multiple times every month throughout the recreation season in 2011 (Figure 2 and Appendix A, Table A1). This site was also a USGS stream monitoring site 06406000, Battle Creek at Hermosa (Figure 2). BATTLE02 water quality data and USGS flows from 06406000 were used to analyze loading in the upper part of segment SD-CH-R-BATTLE_01_USGS.

During this study, the lower portion of segment SD-CH-R-BATTLE_01_USGS water quality samples were collected at BATTLE01 (Figure 2). This site was a USGS stream monitoring site 06406500, Battle Creek below Hermosa and was part of the Lower Cheyenne River assessment monitoring site BTC04 on Battle Creek with samples collected during the recreation season from 2007 through 2009 and 2011, respectively (Figure 2 and Appendix A, Table A3). BTC04 and BATTLE01 Battle Creek sample data were combined with USGS flow data to calculate loads and compliance.

All sample data collected during this project followed SD DENR Water Resources Assistance Programs Standard Operating Procedure and Quality Assurance Project Plan protocols for proper field, data collection, and Quality Assurance/Quality Control techniques (SD DENR, 2005 and

SD DENR, 2011). QA/QC results for water quality sampling during this project are located in Appendix A, Tables A5 through A7. Data show most samples were within precision criteria based on relative percent difference and log range criterion except for one *E. coli* sample set collected on September 28, 2011 at GRCOOL01. Typically *E. coli* bacteria do not display a normal distribution and randomly show log range precision values outside the overall precision criterion value. Since this *E. coli* sample pair was the only sample pair that exceeded the overall *E. coli* precision criterion value and all fecal coliform bacteria sample pairs were below their overall fecal coliform precision criterion value, this sample was considered an anomaly and was not removed from the limited data collected at GRCOOL01.

1.6.1 Fecal Coliform Data

Combining all available fecal coliform sample data from 2001 through 2011 (93 samples from WQM 17, Cheyenne River BTC03, and Battle Creek assessments) collected from May through September in segment SD-CH-R-BATTLE_02 indicated that 19.4 percent of the samples exceeded the daily maximum surface water quality standard for fecal coliform bacteria protective of limited contact recreation use (Table 2). A total of 76 samples collected within segment SD-CH-R-BATTLE_01_USGS from Cheyenne River BTC04 and Battle Creek assessment monitoring sites show 34.2 percent of all samples collected within segment SD-CH-R-BATTLE_01_USGS exceeded the daily maximum surface water quality standard protective of limited contact recreation use (Table 2). Overall, 26.0 percent of all samples collected in Battle Creek (Teepee Gulch Creek in Keystone to the Cheyenne River) exceeded water quality standards for fecal coliform bacteria.

Table 2 Data availability for Fecal Coliform analysis by segment in Battle Creek

Parameter	**Assessment Unit ID Segment [1]**	**Beneficial Use**	**Number of Samples**	**Overall Violation Percentage**
Fecal Coliform Bacteria	SD-CH-R-BATTLE_02	Limited contact recreation	93	19.4
	SD-CH-R-BATTLE_01_USGS	Limited contact recreation	76	34.2
Total			169	26.0

Shaded = Exceeded listing criteria

[1] = SD-CH-R-BATTLE_02 = Teepee Gulch Creek to South Dakota Highway 79, and SD-CH-R-BATTLE_01_USGS = South Dakota Highway 79 to the Cheyenne River.

1.6.2 *E. coli* Data

In May 2009, SD DENR adopted *E. coli* bacteria standards for immersion recreation and limited contact recreation waters beneficial use categories. This bacterium is known to be a better indicator of fecal contamination than fecal coliform because the presence of *E. coli* bacteria is strongly correlated with the presence of pathogens. There are six species of fecal coliform bacteria found in animal and human waste. *E. coli* is one type of the six species of fecal coliform bacteria. A rare strain of *E. coli*, *E. coli* 0157:H7 can cause potentially dangerous outbreaks and illness.

Currently, South Dakota is transitioning from fecal coliform bacteria as the main indicator of fecal contamination in recreation waters to *E. coli* bacteria. One hundred sixty-two *E. coli* samples have been collected since June of 2001 and were used to determine beneficial use impairment by segment in Battle Creek (Table 3). Data indicate that 25.9 percent of all the *E. coli* samples collected from Battle Creek segment SD-CH-R-BATTLE_02 exceeded water quality standards for limited contact recreation waters, while 45.5 percent of *E. coli* samples collected from Battle Creek segment SD-CH-R-BATTLE_01_USGS exceeded water quality standards for limited contact recreation use. Overall, 35.2 percent of all *E. coli* samples collected from both segments exceeded water quality standards for limited contact recreation use.

Table 3 Data availability for *E. coli* bacteria analysis by segment in Battle Creek

Parameter	Assessment Unit ID Segment [1]	Beneficial Use	Number of Samples	Violation Percentage
E. coli Bacteria	SD-CH-R-BATTLE_02	Limited contact recreation	85	25.9
	SD-CH-R-BATTLE_01_USGS	Limited contact recreation	77	45.5
Total			162	35.2

Shaded = Exceeded listing criteria

[1] = SD-CH-R-BATTLE_02 = Teepee Gulch Creek to South Dakota Highway 79, and SD-CH-R-BATTLE_01_USGS = South Dakota Highway 79 to the Cheyenne River.

1.6.3 Stream Flows

United States Geological Survey has and is monitoring three stream gages in the Battle Creek watershed (Table 4 and Figure 2).

Table 4 USGS monitoring sites in Battle Creek used for long-term flow analysis

USGS Station Number	USGS Site Name	Available Data Dates	AUID Segment
06404000	Battle Creek near Keystone, South Dakota	1945 - 2011	SD-CH-R-BATTLE_02
06406000	Battle Creek at Hermosa, South Dakota	1949 - 2011	SD-CH-R-BATTLE_01_USGS
06406500	Battle Creek below Hermosa, South Dakota	1950 - 2011	SD-CH-R-BATTLE_01_USGS

Long-term USGS discharge data from two of the three monitoring sites listed in Table 4 were used to develop fecal coliform and *E. coli* load duration curves for segments SD-CH-R-BATTLE_02 (06406000, Battle Creek at Hermosa) and SD-CH-R-BATTLE_01_USGS (06406500, Battle Creek below Hermosa) on Battle Creek.

2.0 Water Quality Standards

2.1 Numeric Standards

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 are assigned by the state based on a beneficial use analysis of each waterbody. Water quality standards have been defined in South Dakota state statutes (Administrative Rules of South Dakota, ARSD §74:51:01 – 74:51:03) 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.

Individual parameters determine the support of these beneficial uses. Each beneficial use classification has a set of unique, numeric criteria. Water quality values that exceed those criteria impair the beneficial use and violate water quality standards.

Battle Creek has been assigned the following beneficial uses: coldwater permanent fish life propagation (Teepee Gulch Creek to South Dakota Highway 79), warmwater marginal fish life propagation (South Dakota Highway 79 to Cheyenne River), limited contact recreation, fish and wildlife propagation, recreation and stock watering, and irrigation. Table 5 lists the most stringent criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion was used.

Table 5 Numeric surface water quality standards by segment for Battle Creek, Pennington and Custer Counties, South Dakota 2012

	Segment			
	SD_CH_R_BATTLE_01_USGS		SD_CH_R_BATTLE_02	
Parameter	**Criterion**	**Special Conditions**	**Criterion**	**Special Conditions**
Total Dissolved Solids	≤2,500 mg/l	30-day average	≤ 2,500mg/l	30-day average
	≤4,375 mg/l	Daily maximum	≤ 4,375mg/l	daily maximum
Total Suspended Solids	≤ 150mg/l	30-day average	≤ 30 mg/l	30-day average
	≤ 263mg/l	daily maximum	≤ 53 mg/l	daily maximum
Total Ammonia Nitrogen as N	Equal to or less than the result from Equation 3 in Appendix A (SDCL§74:51:01)	30-day average May 1 – October 31	Equal to or less than the result from Equation 3 in Appendix A (SDCL§74:51:01)	30-day average
	Equal to or less than the result from Equation 4 in Appendix A (SDCL§74:51:01)	30-day average November 1 – April 30		
	Equal to or less than the result from Equation 2 in Appendix A (SDCL§74:51:01)	daily maximum		
			Equal to or less than the result from Equation 1 in Appendix A (SDCL§74:51:01)	daily maximum
Dissolved Oxygen	≥ 4 mg/l	Daily minimum, October 1 – April 30	≥ 6.0 mg/l	daily minimum
	≥5mg/l	Daily minimum, May 1 – September 30	≥ 7.0 mg/l	in spawning areas during spawning
Un-disassociated Hydrogen Sulfide	≤ 0.002 mg/l	Daily maximum	≤ 0.002 mg/l	daily maximum
pH	≥ 6.0 - ≤ 9.0	See SDCL §74:51:01:07	≥ 6.5 - ≤ 9.0	See SDCL §74:51:01:07

Table 5 (continued). Numeric surface water quality standards by segment for Battle Creek, Pennington and Custer Counties, South Dakota 2012

	Segment			
	SD_CH_R_BATTLE_01_USGS		SD_CH_R_BATTLE_02	
Parameter	**Criterion**	**Special Conditions**	**Criterion**	**Special Conditions**
Temperature	≤ 90° F	See SDCL §74:51:01:31	≤ 65° F	See SDCL §74:51:01:31
Fecal Coliform (May 1 to September 30)	≤ 1,000 CFU/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period	≤ 1,000 CFU/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period
	≤ 2,000 CFU/100ml	in any one sample	≤ 2,000 CFU/100ml	in any one sample
***Escherichia coli* (May 1 to September 30)**	≤ 630 MPN/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period	≤ 630 MPN/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period
	≤ 1,178 MPN/100ml	in any one sample	≤ 1,178 MPN/100ml	in any one sample
Total Coliform			≤ 5,000 CFU/100ml	Geometric mean of a minimum of 5 samples during separate 24-hour periods for a 30-day period and may not exceed this value in more than 20 percent of the samples examined in the same 30-day period
Conductivity at 25° C	≤ 2,500 micromhos/cm	30-day average	≥2,500 micromhos/cm	30-day average
	≤ 4,375micromhos/cm	daily maximum	≥4375 micromhos/cm	Daily maximum

Table 5 (continued). Numeric surface water quality standards by segment for Battle Creek, Pennington and Custer Counties, South Dakota 2012

Parameter	Segment			
	SD_CH_R_BATTLE_01_USGS		SD_CH_R_BATTLE_02	
	Criterion	**Special Conditions**	**Criterion**	**Special Conditions**
Nitrates as N	≤ 50 mg/L	30-day average	≤ 50 mg/l	30-day average
	≤ 88 mg/L	daily maximum	≤ 88 mg/L	daily maximum
Sodium adsorption ratio	≤ 10		≤ 10	
Oil and Grease	≤ 10 mg/L	See § 74:51:01:10	≤ 10 mg/L	See § 74:51:01:10
Total Petroleum Hydrocarbons	≤ 10 mg/L	See § 74:51:01:10	≤ 10 mg/l	See § 74:51:01:10

2.2 Narrative Standards

In addition to physical and chemical standards, South Dakota has developed narrative criteria for the protection of aquatic life uses. *All waters of the state must be free from substances, whether attributable to human-induced point source discharge or non-point source activities, in concentration or combinations which will adversely impact the structure and function of indigenous or intentionally introduced aquatic communities* (ASRD § 74:51:01:12).

South Dakota has narrative standards that may also be applied to the undesired eutrophication of lakes and streams. ARSD § 74:51:01:05; 06; 08; and 09 contains language that prohibits the presence of materials causing pollutants to form, visible pollutants, taste and odor producing materials, and nuisance aquatic life. Specific ARSD narrative languages for the above conditions are provided below.

§ **74:51:01:05. Materials causing pollutants to form in waters.** *Wastes discharged into surface waters of the state may not contain a parameter which violates the criterion for the waters' existing or designated beneficial use or impairs the aquatic community as it naturally occurs. Where the interaction of materials in the wastes and the waters causes the existence of such a parameter, the material is considered a pollutant and the discharge of such pollutants may not cause the criterion for this parameter to be violated or cause impairment to the aquatic community.*

§ **74:51:01:06. Visible pollutants prohibited.** *Raw or treated sewage, garbage, rubble, un-permitted fill materials, municipal wastes, industrial wastes, or agricultural wastes which produce floating solids, scum, oil slicks, material discoloration, visible gassing, sludge deposits, sediments, slimes, algal blooms, fungus growths, or other offensive effects may not be discharged or caused to be discharged into surface waters of the state.*

§ **74:51:01:08. Taste-and odor-producing materials.** *Materials which will impart undesirable tastes or undesirable odors to the receiving water may not be discharged or caused to be discharged into surface waters of the state in concentrations that impair a beneficial use.*

§ **74:51:01:09. Nuisance aquatic life.** *Materials which produce nuisance aquatic life may not be discharged or caused to be discharged into surface waters of the state in concentrations that impair an existing or designated beneficial use or create a human health problem.*

3.0 TMDL Targets

3.1 Fecal Coliform

Current fecal coliform criteria for limited contact recreation use requires that 1) no sample exceeds 2,000 CFU/100 mL (acute target) and 2) the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period not exceed 1,000 CFU/100 mL (chronic target). The geometric mean, as defined in ARSD § 74:51:01:01 is the n^{th} root of a product of n factors. Fecal coliform criteria are applicable from May 1 through September 30, the recreation season. Greater than 10 percent of samples must exceed water quality criteria collected within a five year period for that parameter to be included as a cause of impairment on the 303(d) impaired waters list.

3.2 *E. coli*

South Dakota has adopted *E. coli* criteria for the protection of the limited contact and immersion recreation uses. Limited contact recreation standards for *E. coli* requires that 1) no sample exceeds 1,178 MPN/100 mL (acute target) and 2) the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period not exceed 630 MPN/100 mL (chronic target). Greater than 10 percent of samples must exceed water quality criteria collected within a five year period for that parameter to be included as a cause of impairment on the 303(d) impaired waters list.

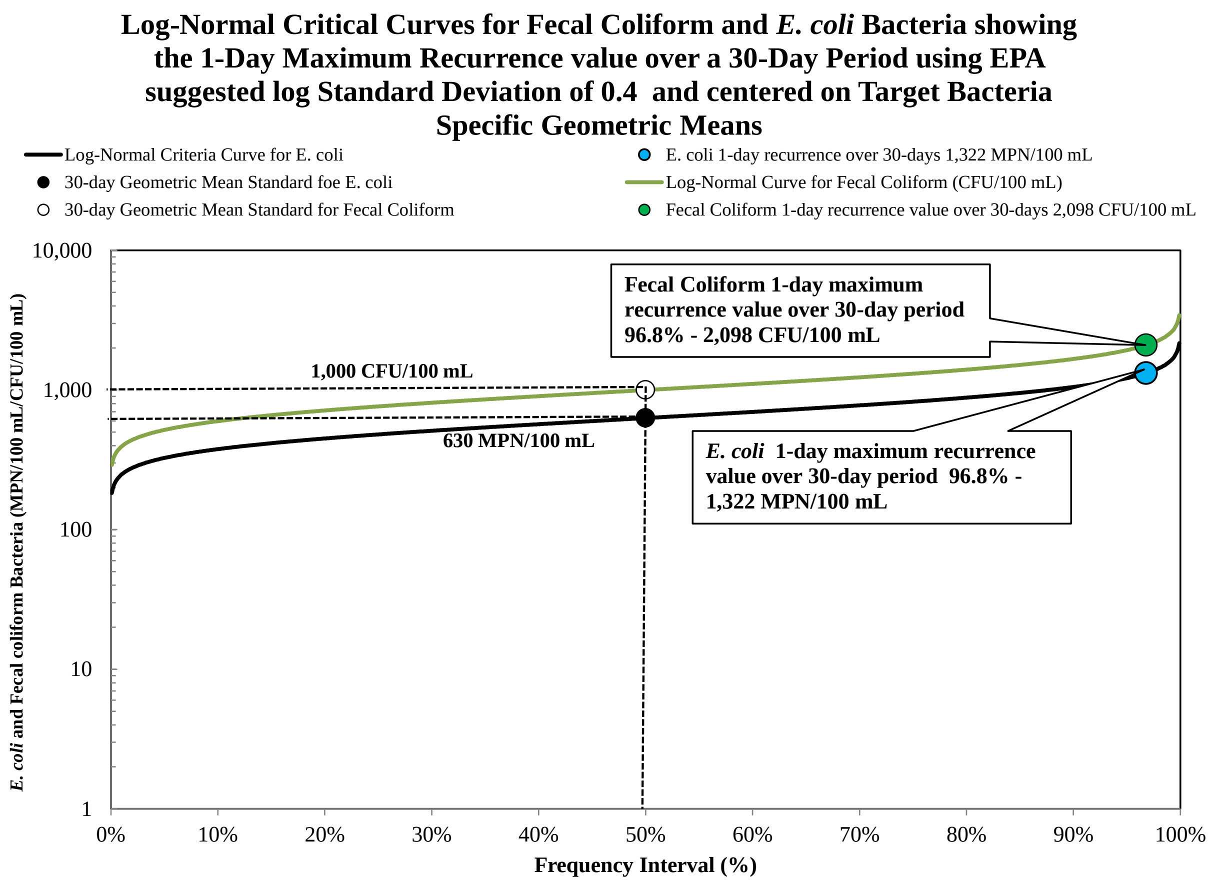


Figure 5 Log-normal criteria curves for *E. coli* and fecal coliform bacteria centered on bacteria specific geometric means to predict 1-day maximum recurrence values for limited – contact recreation waters.

TMDL fecal coliform and *E. coli* targets for segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS were based on acute standards. These acute standards are to be compared to individual water sample results and are "*not to exceed*" or single sample maximum (SSM) values. As discussed in the EPA guidance document, *"An Approach for Using Load Duration Curves in the Development of TMDLs*" (US EPA, 2007), the relationship between the 30-day geometric mean and the SSM (daily maximum) is based on the assumption that bacteria data can be described using a log-normal frequency distribution centered on bacteria specific geometric mean standards (chronic standards) for limited contact recreation waters and a log standard deviation of 0.4. This is shown in Figure 5. This approach provides linkage analysis between the not to exceed value used as the daily maximum TMDL target (acute standard) and the 30-day geometric mean (chronic standard) for bacteria (fecal coliform and *E. coli).* Log-normal standard deviations for fecal coliform and *E. coli* bacteria based on data collected in Battle Creek were slightly higher at 0.87 and 0.89, respectively. Whether using watershed specific (Appendix B, Figures B-1 and B-2) or EPA guidance document standard deviations, treating the watershed to bacteria specific daily maximum (acute) standard values reduce 30-day geometric means for fecal coliform and *E. coli* bacteria below their geometric mean (chronic) standards. Since the guidance documents log-normal standard deviation was more conservative than the watershed specific standard deviations; the log-normal standard deviation from the guidance document was used to provide linkage analysis between the not to exceed value used as the daily maximum TMDL target (acute standard) and the 30-day geometric mean (chronic standard).

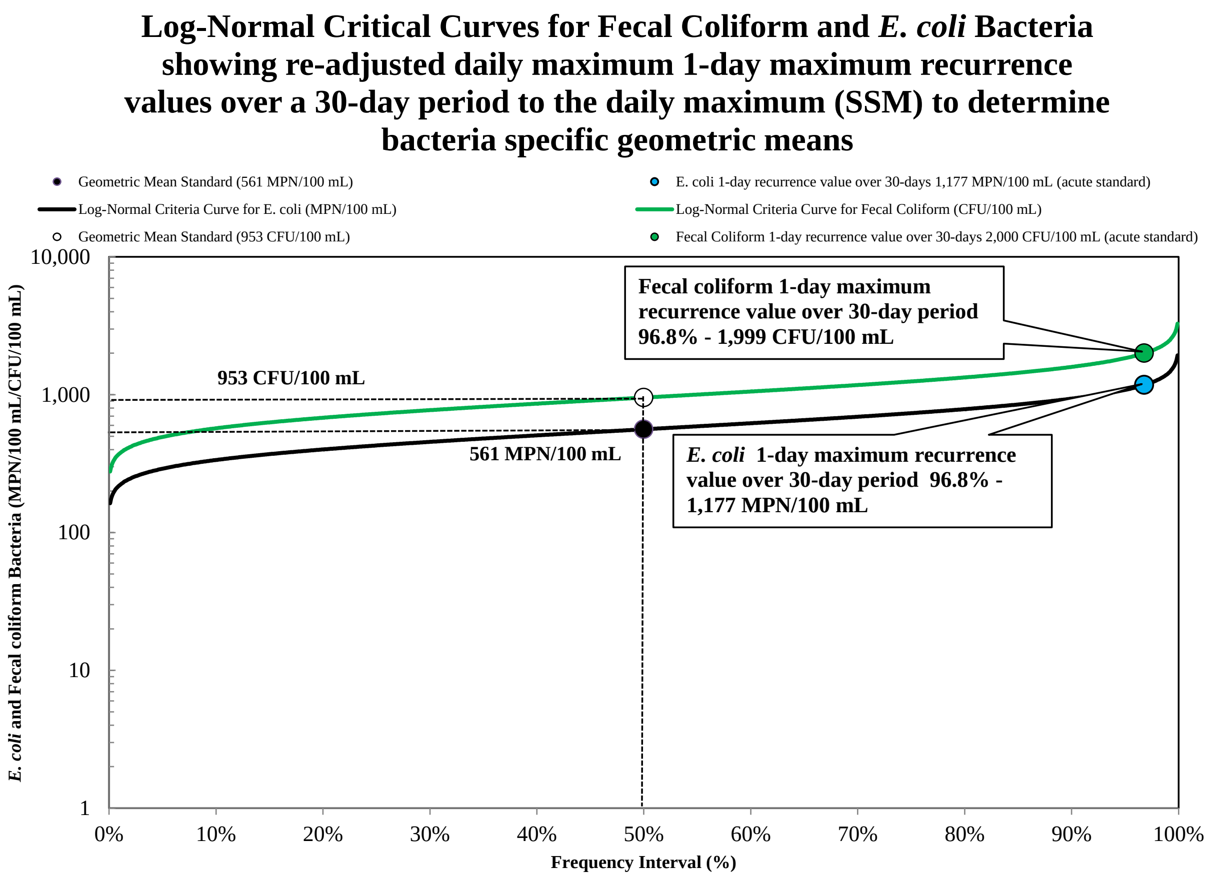


Figure 6 Log-Normal Critical Curves for Fecal Coliform and *E. coli* Bacteria showing re-adjusted daily maximum 1-day recurrence values over a 30-day period to the daily maximum acute standard (SSM) to determine changes in bacteria specific geometric means.

Figure 5 indicates that when the log-normal distributions with log standard deviations of 0.4 centered on geometric mean values (chronic standards) for fecal coliform and *E. coli* bacteria (1,000 CFU/100 mL and 630 MPN/100 mL, respectively) are plotted; 1-day recurrence values are above acute standards for fecal coliform and *E. coli* (2,098 CFU/100 mL and 1,322 MPN/100 mL, respectively). Figure 6 shows the same log-normal relationships with 1-day recurrence values for fecal coliform and *E. coli* bacteria adjusted to meet the acute standards (2,000 CFU/100 mL and 1,178 MPN/100 mL, respectively). The corresponding geometric mean values (chronic standards) associated with the log-normal distributions with log standard deviations of 0.4 will be below 30-day water quality standards (953 CFU/100 mL and 561 MPN/100 mL, respectively).

Based on these scenarios, setting fecal coliform and *E. coli* TMDL target loads based on acute criteria (2,000 CFU/100 mL and 1,178 MPN/100 mL, respectively) will ensure that the geometric mean (chronic) criteria (1,000 CFU/100 mL and 630 MPN/100 mL) will also be achieved. Thus the selection of the daily maximum (acute) water quality criteria as the TMDL target will ensure that the geometric mean (chronic) standards assigned to the limited contact recreation beneficial use will also be met.

4.0 Significant Sources

4.1 Point Sources

4.1.1 SD-CH-R-BATTLE_02, Teepee Gulch Creek to South Dakota Highway 79

The City of Keystone is located in the upper portion of segment SD-CH-R-BATTLE_02 (Figure 2). This segment flows through the eastern half of Keystone (population ~ 337). Keystone has a wastewater treatment facility (WWTF) that discharges into Battle Creek approximately 2.5 miles downstream of Highway 16A and Highway 40 East of Keystone (Figure 2). Keystone was issued a discharge permit (Permit # SD0024007) in 2003 by SD DENR. As part of their permit, fecal coliform bacteria are routinely sampled five times per month from May 1st through September 30th each year. Recent Discharge Monitoring Report (DMR) data (2008 through 2012) indicated no water quality standard (effluent limitations) violations for fecal coliform bacteria were reported during the recreation season (Appendix A, Table A-4). The new permit, currently under a 30-day public notice and review with the final scheduled to be issued in 2013, also updated the bacteria indicator from fecal coliform to *E. coli* bacteria effluent limitations to ensure that water quality standards will be met during the recreation season. The effluent limitations for fecal coliform (2,000 CFU/100 mL) and *E. coli* bacteria (1,178 MPN/100 mL) in these permits are the surface water quality standards for recreational waters. The Keystone WWTF continuously discharges effluent into Battle Creek across from the lift station.

4.1.2 SD-CH-R-BATTLE_01_USGS, South Dakota Highway 79 to Cheyenne River

The Town of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS (Figure 2). Hermosa has a three cell treatment facility with land application and a permission to discharge permit. Battle Creek flows to the south of the treatment facility and land application field. The latest discharge permit for Hermosa was issued in 2009 by South Dakota DENR (Permit # SD0022349). As of the date of this report the City of Hermosa has not reported a discharge from this facility, thus no DMR data exists to evaluate compliance with effluent limitations for fecal coliform (2,000 CFU/100 mL) and *E. coli* bacteria (1,178 MPN/100 mL) in their permit.

4.2 Non-point Sources

Based on review of available information and communication with state and local authorities, the primary non-point sources of fecal coliform and by default *E. coli* bacteria within segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS include agricultural runoff, wildlife, and human sources (failing septic systems). Using the best available information, potential loadings were estimated based on the total production potential for each source and landuse using the EPA's Bacterial Indicator Tool (BIT) based on the density and distribution of animals (livestock and wildlife) and failing septic systems in the watershed (US EPA, 2000). The BIT model does not have *E. coli* specific production values incorporated into its reference tables. However, in this watershed, *E. coli* concentrations were significantly related to fecal coliform bacteria concentrations (r = 0.9640) based on $\log_{10}$ transformation; therefore, fecal coliform bacteria reference values were used as a surrogate for *E. coli* production potential (Figure 8).

4.2.1 Agriculture

Manure from livestock is a potential source of fecal coliform/*E. coli* bacteria to streams. Livestock in the basin are predominantly beef and dairy cattle, horses and some sheep. Livestock population densities in the watershed were estimated using National Agricultural Statistics Service data, which is summarized by county (NASS, 2009). Livestock contribute bacterial loads to Battle Creek directly by defecating while wading in the stream and riparian areas and indirectly by defecating on rangelands and pastures that are washed off during precipitation events.

4.2.2 Human

The majority of Battle Creek is relatively rural except for the towns of Keystone and Hermosa. Other localized populations along Battle Creek within segment SD-CH-R-BATTLE_02 are Hayward area where Iron Creek enters Battle Creek downstream to WQM 17 and immediately west of Hermosa from Highway 79 to one mile west of the confluence of Grace Coolidge Creek and Battle Creek (Figure 2). Developments in these areas are within and along the watershed riparian areas. These developments are rural, with no centralized wastewater collection or treatment facilities. Thus, failing septic systems are assumed to be the primary human source of bacterial loads to Battle Creek. Densities of septic systems in the watershed were derived from the most current 2008 South Dakota DOT structures layer counting farms and rural residences. Only farms and rural residences located near all segments of Battle and Grace Coolidge Creeks were used for estimating septic failure based on proximity and immediate loading potential. A fifteen percent failure rate was used to estimate human fecal/*E. coli* contributions.

4.2.3 Natural background/wildlife

Wildlife within the watershed is a natural background source of fecal coliform/*E. coli* bacteria. For watershed modeling purposes, wildlife population density estimates were obtained from the South Dakota Department of Game, Fish and Parks (Huxoll, 2002). Wildlife contributions to overall bacterial loads in Battle Creek were minimal based on fecal coliform/*E. coli* modeling.

4.3 Source Assessment

Bacterial source assessment modeling was carried out using data from the National Agricultural Statistics Service (NASS, 2009), SD GF&P wildlife assessment (Huxoll, 2002), and the US EPA BIT model (US EPA, 2000). Table 6 and Table 7 lists most animal sources for fecal coliform/*E. coli* in the Battle Creek watershed by AUID segment based on a per acre basis. Wildlife and livestock data were gathered and densities calculated assuming an equal distribution throughout the watershed.

The point source WLA for segment SD-CH-R-BATTLE_02 is the permit required bacteria effluent limits for the City of Keystone WWTF multiplied by the design flow for the WWTP the 80th percentile flow from DMR data, 0.38 Million Gallons per Day (MGD) and a conversion factor. The WLA was used for the total bacterial production from the Keystone WWTF because the WLA is their effluent limit based on their permit. The City of Keystone WWTF permit allows the City of Keystone to continuously discharge effluent to Battle Creek and they have been and are currently operating in compliance with bacterial limits based on compliance monitoring data (DMR). There are no permitted animal feeding operations (AFO or CAFO) in the Battle Creek segment SD-CH-R-BATTLE_02 watershed based on information from SD DENR.

Table 6 Total bacterial source production percentages by species for segment SD-CH-R-BATTLE_02 of Battle Creek, Pennington and Custer Counties, SD.

Species	Custer	Pennington	Custer #/acre	Pennington #/acre	Custer watershed #/acre	Pennington watershed #/acre	Watershed #/acre	CFU/animal/day	CFU/acre/day	Percent Contribution
milk cows	118	177	1.18E-04	9.96E-05	6.57E-05	4.43E-05	1.10E-04	1.01E+11	1.11E+07	0.35%
Cattle on range	21,540	52,314	2.16E-02	2.94E-02	1.20E-02	1.31E-02	2.51E-02	1.04E+11	2.61E+09	83.31%
cattle on feed	397	298	3.98E-04	1.68E-04	2.21E-04	7.47E-05	2.96E-04	1.04E+11	3.07E+07	0.98%
sheep	381	686	3.82E-04	3.86E-04	2.12E-04	1.72E-04	3.84E-04	1.20E+10	4.61E+06	0.15%
bison[1]	2,754	312	2.76E-03	1.76E-04	1.53E-03	7.82E-05	1.61E-03	1.04E+11	1.68E+08	5.35%
horses	1,798	2,665	1.80E-03	1.50E-03	1.00E-03	6.68E-04	1.67E-03	4.20E+08	7.01E+05	0.02%
humans	8,216	100,948	8.24E-03	5.68E-02	4.57E-03	2.53E-02	2.99E-02	1.48E+09	4.42E+07	1.41%
all wildlife									2.64E+08	8.42%
Total									3.13E+09	100.00%
whitetail deer	3,100	11,780	3.11E-03	1.18E-02	1.73E-03	5.26E-03	6.99E-03	5.00E+08	3.49E+06	
mule deer	2,900	3,230	2.91E-03	3.24E-03	1.61E-03	1.44E-03	3.06E-03	5.00E+08	1.53E+06	
elk[1]	2,300	1,650	2.31E-03	1.66E-03	1.28E-03	7.37E-04	2.02E-03	1.04E+11	2.10E+08	
antelope[2]	850	800	8.53E-04	8.02E-04	4.73E-04	3.57E-04	8.30E-04	5.00E+08	4.15E+05	
mountain goat[2]	80	85	8.02E-05	8.53E-05	4.45E-05	3.80E-05	8.25E-05	5.00E+08	4.12E+04	
bighorn sheep[2]	0	225	0.00E+00	2.26E-04	0.00E+00	1.00E-04	1.00E-04	5.00E+08	5.02E+04	
turkey	16,875	5,500	1.69E-02	5.52E-03	9.39E-03	2.46E-03	1.18E-02	9.30E+07	1.10E+06	
mink[3]	600	0	6.02E-04	0.00E+00	3.34E-04	0.00E+00	3.34E-04	1.25E+08	4.17E+04	
beaver	400	1,000	4.01E-04	1.00E-03	2.23E-04	4.47E-04	6.69E-04	2.50E+08	1.67E+05	
muskrat[3]	500	4,500	5.02E-04	4.51E-03	2.78E-04	2.01E-03	2.29E-03	1.25E+08	2.86E+05	
skunk[3]	3,200	3,090	3.21E-03	3.10E-03	1.78E-03	1.38E-03	3.16E-03	1.25E+08	3.95E+05	
badger[3]	200	2,000	2.01E-04	2.01E-03	1.11E-04	8.93E-04	1.00E-03	1.25E+08	1.26E+05	
coyote[5]	700	2,900	7.02E-04	2.91E-03	3.90E-04	1.30E-03	1.68E-03	4.09E+09	6.89E+06	
fox[5]	50	300	5.02E-05	3.01E-04	2.78E-05	1.34E-04	1.62E-04	4.09E+09	6.62E+05	
raccoon	1,500	2,860	1.50E-03	2.87E-03	8.35E-04	1.28E-03	2.11E-03	1.25E+08	2.64E+05	
bobcat[5]	200	380	2.01E-04	3.81E-04	1.11E-04	1.70E-04	2.81E-04	4.09E+09	1.15E+06	
jackrabbit[3]	100	3,000	1.00E-04	3.01E-03	5.56E-05	1.34E-03	1.40E-03	1.25E+08	1.74E+05	
pine martin[3]	45	80	4.51E-05	8.02E-05	2.50E-05	3.57E-05	6.08E-05	1.25E+08	7.60E+03	
mountain lion[5]	25	30	2.51E-05	3.01E-05	1.39E-05	1.34E-05	2.73E-05	4.09E+09	1.12E+05	
cottontail rabbit[3]	4,500	9,060	4.51E-03	9.09E-03	2.50E-03	4.05E-03	6.55E-03	1.25E+08	8.19E+05	
squirrel[3]	5,000	8,043	5.02E-03	8.07E-03	2.78E-03	3.59E-03	6.37E-03	1.25E+08	7.97E+05	
ruffed grouse[4]	200	250	2.01E-04	2.51E-04	1.11E-04	1.12E-04	2.23E-04	1.36E+08	3.03E+04	
partridge[4]	100	1,200	1.00E-04	1.20E-03	5.56E-05	5.36E-04	5.92E-04	1.36E+08	8.04E+04	
sharptail grouse[4]	1,500	5,780	1.50E-03	5.80E-03	8.35E-04	2.58E-03	3.42E-03	1.36E+08	4.65E+05	
canada goose	0	1,600	0.00E+00	1.60E-03	0.00E+00	7.15E-04	7.15E-04	4.90E+10	3.50E+07	

Source	CFU/acre/day	Percent
Agricultural runoff	2.82E+09	90.2%
Humans	4.42E+07	1.4%
Wildlife	2.64E+08	8.4%
All	3.13E+09	100.0%

[1] based on BIT beef cattle
[2] based on BIT deer
[3] based on BIT raccoon
[4] based on BIT chicken
[5] based on BIT dog

Table 7 Total bacterial source production percentages by species for segment SD-CH-R-BATTLE_01_USGS of Battle Creek, Custer Counties, SD.

Species	Custer	Custer #/acre	Custer watershed #/acre	Watershed #/acre	CFU/animal/day	CFU/acre/day	Percent Contribution
milk cows	118	1.18E-04	8.06E-05	8.06E-05	1.01E+11	8.14E+06	0.42%
Cattle on range	21,540	2.16E-02	1.47E-02	1.47E-02	1.04E+11	1.53E+09	78.73%
cattle on feed	397	3.98E-04	2.71E-04	2.71E-04	1.04E+11	2.82E+07	1.45%
sheep	381	3.82E-04	2.60E-04	2.60E-04	1.20E+10	3.12E+06	0.16%
bison[1]	2,754	2.76E-03	1.88E-03	1.88E-03	1.04E+11	1.96E+08	10.07%
horses	1,798	1.80E-03	1.23E-03	1.23E-03	4.20E+08	5.16E+05	0.03%
humans	8,216	8.24E-03	5.61E-03	5.61E-03	1.19E+09	6.67E+06	0.34%
all wildlife						1.71E+08	8.80%
Total						**1.94E+09**	**100.00%**
whitetail deer	3,100	3.11E-03	2.12E-03	2.12E-03	5.00E+08	1.06E+06	
mule deer	2,900	2.91E-03	1.98E-03	1.98E-03	5.00E+08	9.90E+05	
elk[1]	2,300	2.31E-03	1.57E-03	1.57E-03	1.04E+11	1.63E+08	
antelope[2]	850	8.53E-04	5.80E-04	5.80E-04	5.00E+08	2.90E+05	
mountain goat[2]	80	8.02E-05	5.46E-05	5.46E-05	5.00E+08	2.73E+04	
turkey	16,875	1.69E-02	1.15E-02	1.15E-02	9.30E+07	1.07E+06	
mink[3]	600	6.02E-04	4.10E-04	4.10E-04	1.25E+08	5.12E+04	
beaver	400	4.01E-04	2.73E-04	2.73E-04	2.50E+08	6.83E+04	
muskrat[3]	500	5.02E-04	3.41E-04	3.41E-04	1.25E+08	4.27E+04	
skunk[3]	3,200	3.21E-03	2.18E-03	2.18E-03	1.25E+08	2.73E+05	
badger[3]	200	2.01E-04	1.37E-04	1.37E-04	1.25E+08	1.71E+04	
coyote[5]	700	7.02E-04	4.78E-04	4.78E-04	4.09E+09	1.95E+06	
fox[5]	50	5.02E-05	3.41E-05	3.41E-05	4.09E+09	1.40E+05	
raccoon	1,500	1.50E-03	1.02E-03	1.02E-03	1.25E+08	1.28E+05	
bobcat[5]	200	2.01E-04	1.37E-04	1.37E-04	4.09E+09	5.58E+05	
jackrabbit[3]	100	1.00E-04	6.83E-05	6.83E-05	1.25E+08	8.53E+03	
pine martin[3]	45	4.51E-05	3.07E-05	3.07E-05	1.25E+08	3.84E+03	
mountain lion[5]	25	2.51E-05	1.71E-05	1.71E-05	4.09E+09	6.98E+04	
cottontail rabbit[3]	4,500	4.51E-03	3.07E-03	3.07E-03	1.25E+08	3.84E+05	
squirrel[3]	5,000	5.02E-03	3.41E-03	3.41E-03	1.25E+08	4.27E+05	
ruffed grouse[4]	200	2.01E-04	1.37E-04	1.37E-04	1.36E+08	1.86E+04	
partridge[4]	100	1.00E-04	6.83E-05	6.83E-05	1.36E+08	9.28E+03	
sharptail grouse[4]	1,500	1.50E-03	1.02E-03	1.02E-03	1.36E+08	1.39E+05	

Source	CFU/acre/day	Percent
Agricultural runoff	1.76E+09	90.9%
Humans	6.67E+06	0.3%
Wildlife	1.71E+08	8.8%
All	1.94E+09	100.0%

[1] based on BIT beef cattle
[2] based on BIT deer
[3] based on BIT raccoon
[4] based on BIT chicken
[5] based on BIT dog

The point source WLA for segment SD-CH-R-BATTLE_01_USGS is the permit required bacteria effluent limits (fecal coliform: 2,000 CFU/100 mL and *E. coli*: 1,178 MPN/100 mL) for the Town of Hermosa WWTF multiplied by the permit specified flow (based on discharge of 0.5 feet of wastewater drawdown per day in cell three or 0.23 MGD) and a conversion factor. The WLA was used for the total bacterial production from the Hermosa WWTF because the WLA is their effluent limit based on their permit. The Hermosa facility has a permission to discharge permit in that if at some point they would need to discharge they would have to contact SD DENR for permission to discharge and after approval may discharge under certain conditions to include water quality monitoring and flow (discharge) measurements. As of the date of this report Hermosa has not discharged, thus they are currently operating in compliance with their permit. There are no permitted animal feeding operations (AFO or CAFO) in the Battle Creek segment SD-CH-R-BATTLE_01_USGS watershed based on information from SD DENR.

5.0 Technical Analysis

5.1 Flow Duration Curve Analysis

Recreational beneficial use standards are applicable only from May through September (recreation season). Only discharge data collected during the recreation season from each stream segment were used to develop the flow duration curves in Figure 5. Recreational season discharge dates ranged from 1950 through 2011 for upper segment SD-CH-R-BATTLE_02, 1949 through 2011 for upper segment SD-CH-R-BATTLE_01_USGS, and 1950 through 2011 for lower portion of segment SD-CH-R-BATTLE_01_USGS.

USGS monitoring site 06406000 (assessment site BATTLE02) is located 0.9 stream kilometers (0.56 stream miles) downstream of the end of segment SD-CH-R-BATTLE_02 (South Dakota Highway 79). With the close proximity of this site to the segment SD-CH-R-BATTLE_02, discharge from this site was used for calculating flow characteristics, load duration curves, and exceedence percentages for segment SD-CH-R-BATTLE_02. This site was also deemed to be most representative and protective of the entire reach.

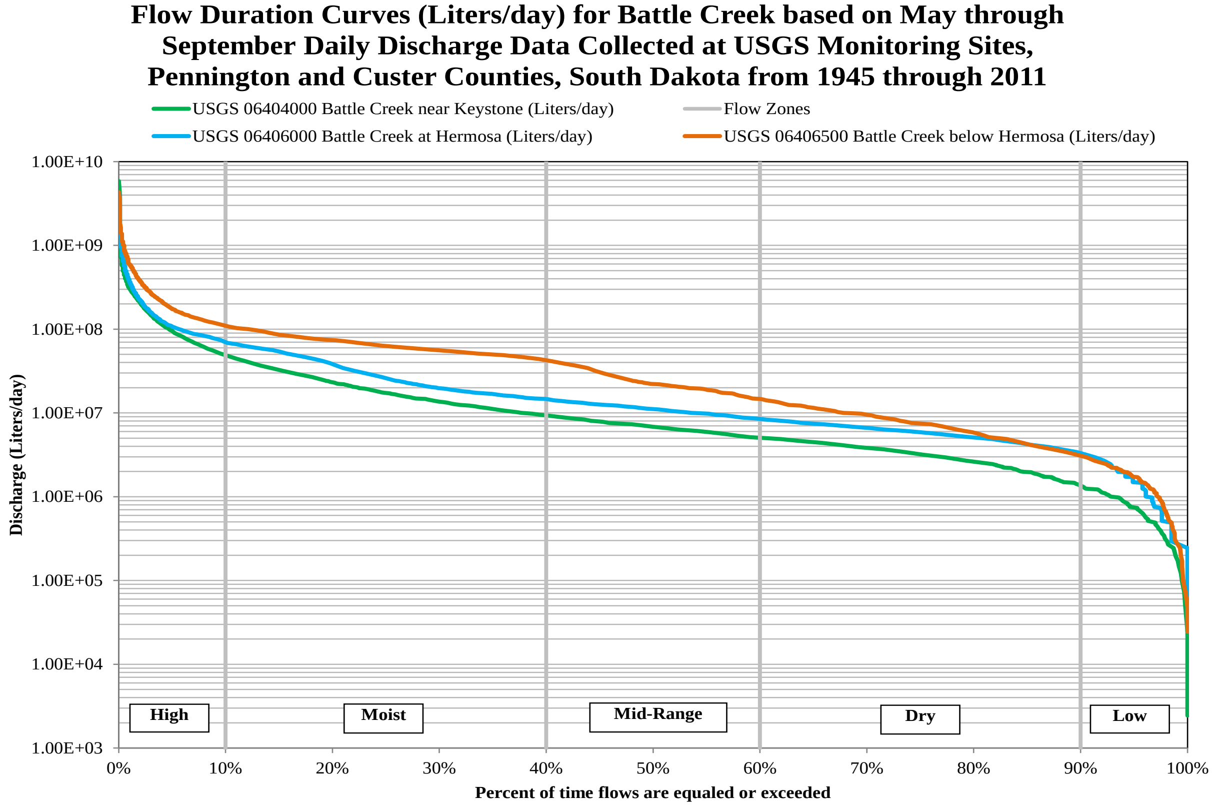


Figure 5 Flow duration curves (Liters/day) for Battle Creek based on USGS monitoring sites 06404000 Battle Creek near Keystone, 06406000 Battle Creek at Hermosa, and 06406500 Battle Creek below Hermosa in AUID Segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS, Pennington and Custer Counties, South Dakota from 1945 through 2011

Flow duration curves for Battle Creek are plotted together on Figure 5. The curve for the upper portion of segment SD-CH-R-Battle_02 (green line), located approximately 20.5 stream kilometers (12.7 miles) upstream of the end of segment SD-CH-R-Battle_02 was developed using flows from USGS monitoring site 06404000 Battle Creek near Keystone. The blue line represents flow duration from USGS monitoring site 06406000 Battle Creek at Hermosa and was used to evaluate segment SD-CH-R-Battle_02. The curve for segment SD-CH-R-Battle_01_USGS (red line) was developed using flows from USGS monitoring site 06406500 Battle Creek below Hermosa (Figure 2).

The flow duration curve from upper segment SD-CH-R-BATTLE_02 was lower throughout all flow zones compared to the upper portions of segment of SD-CH-R-Battle_01_USGS which represents segment SD-CH-R-BATTLE_02 and lower reaches of segment SD-CH-R-BATTLE_01_USGS. Duration curves from USGS monitoring sites 06406000 at Hermosa and 06406500 below Hermosa showed similar characteristics in the low flow zone and begin to diverge beginning in the dry through high flow zones indicating higher flows in lower Battle Creek below Hermosa.

5.2 Load Duration Curve Analysis

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, 2007).

Instantaneous or "observed" loads were calculated by multiplying the sample concentrations from each AUID segment (Sites WQM 17 (460905), BTC03, BATTLE03, and BATTLE02A for segment SD-CH-R-BATTLE_02; and Site BATTLE02, BTC04, and BATTLE01 for segment SD-CH-R-Battle_01_USGS), with measured flows at the time the water quality sample was collected, and a unit conversion factor. The locations of the SD DENR water quality monitoring sites on Battle Creek are shown in Figure 2.

When instantaneous loads are plotted on LDCs, characteristics of the water quality impairment are shown for each segment. Instantaneous loads that plot above the solid black curve (solid black curve = TMDL based on the daily maximum water quality criterion) are exceeding the daily maximum water quality (acute) criterion, while those below the curve are in compliance.

The LDCs shown in Figures 6, 7, 9, and 10 represents a dynamic expression of parameter-specific TMDLs for each impaired segment of Battle Creek that are based on the South Dakota daily maximum water quality criterion for fecal coliform bacteria and *E. coli* bacteria as the water quality target, resulting in a unique maximum daily load that corresponds to a measured average daily flow.

5.2.1 Fecal Coliform Bacteria

5.2.1.1 Segment: SD-CH-R-BATTLE_02

The LDC-based fecal coliform TMDL for segment SD-CH-R-BATTLE_02 was developed using 1950 through 2011 USGS 06406000 recreation season discharge (May 1st through September 30th) at Hermosa. Instantaneous fecal coliform data consisted of 2007 through 2009 Cheyenne River BTC03 data, 2011 assessment monitoring data from BATTLE03 and BATTLE02A, and ambient surface water quality data from WQM17 (Figure 2). The WLA for segment SD-CH-R-BATTLE_02 is the permit required bacteria effluent limits for the City of Keystone WWTF (fecal coliform: 2,000 CFU/100 mL) multiplied by the by the design flow (80th percentile flow from Discharge Monitoring Report (DMR) data, 0.38 Million Gallons per Day, MGD) and a conversion factor (Figure 6).

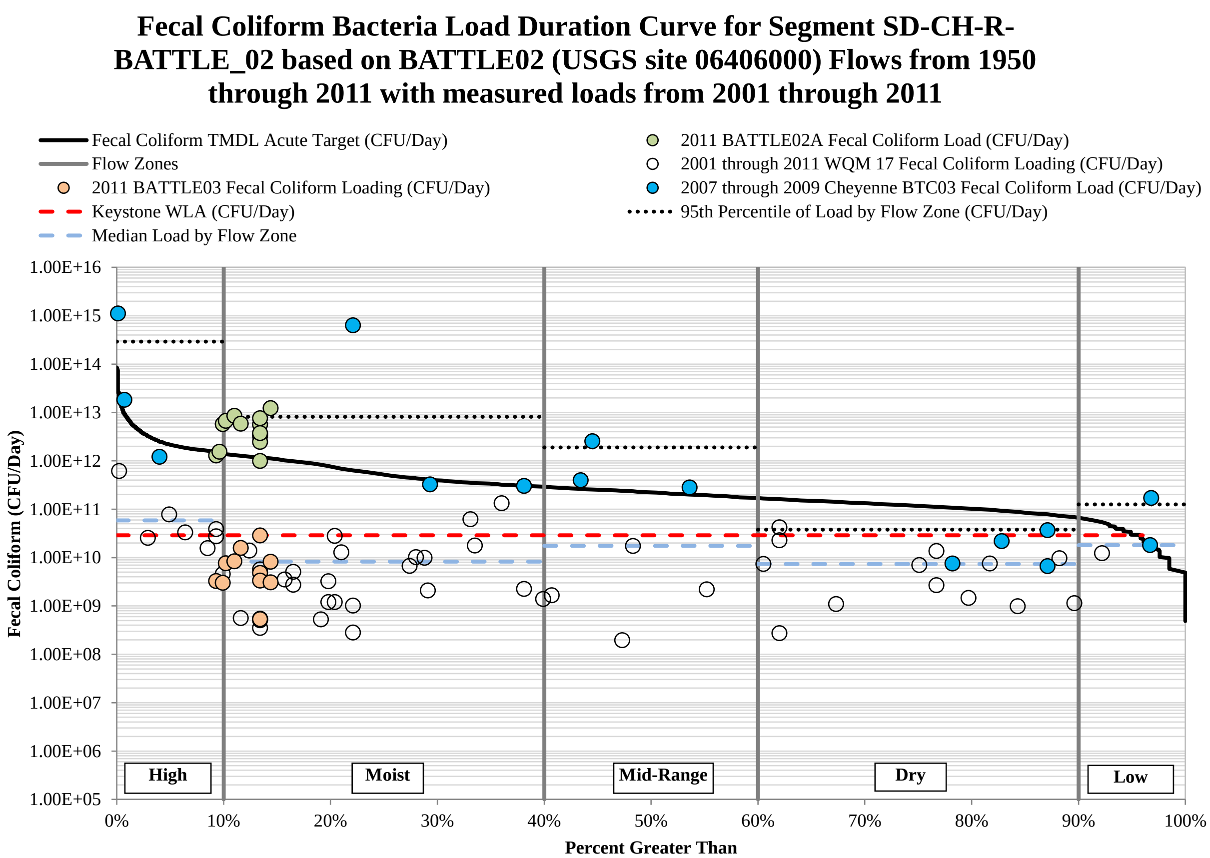


Figure 6 Fecal coliform load duration curve for segment: SD-CH-R-BATTLE_02 representing allowable daily fecal coliform loads based on acute fecal coliform criteria (≤ 2,000 CFU/100 mL) during the recreations seasons 2001 through 2011 loads in segment SD-CH-R-BATTLE_02 and 2007 through 2009 fecal coliform loads from the Cheyenne River project.

The acute fecal coliform load duration curve and instantaneous daily loads are displayed in Figure 6. Monitoring site WQM 17 (DENR 460905), instantaneous measured loads (clear circles) met allowable loads (TMDL) in all flow conditions (Appendix A, Table A2). Data collected in May through September 2011 from monitoring site BATTLE03 (orange circles) showed that all instantaneous measured loads were below allowable loads (TMDL) in all flow zones sampled. Combining upstream sampling sites WQM 17 (DENR 460905) and BATTLE03 data (64 samples since 2001) have been below allowable loads (TMDL) in all flow zones. Spatially, this area represents 28.7 stream kilometers (17.8 stream miles) or 84.7 percent of the entire segment (33.9 kilometers). These data show that fecal coliform impairment from Keystone to monitoring site BATTLE03 meets water quality standards for recreation waters.

A dramatic increase in fecal coliform violations and loading were observed from BATTLE03 to the end of the segment at Highway 79 (5.2 stream kilometers, 3.2 stream miles). Assessment data collected from August and September 2011 at BATTLE02A (green circles) upstream of Highway 79 indicated that 85.7 percent (12 out of 14 total samples) exceeded water quality standards for fecal coliform bacteria (Appendix A, Table A1). Originally the project only focused on downstream segment SD-CH-R-BATTLE_01_USGS (based on the 2010 IR, the only impaired reach based on the recreation standard). However, when sampling downstream monitoring site BATTLE02, 100 percent of the fecal coliform samples exceeded water quality standards on six consecutive sampling runs from July 25, 2011 through August 8, 2011. Sampling began upstream in segment SD-CH-R-BATTLE_02 to determine to what extent and how wide spread fecal coliform exceedences extend into segment SD-CH-R-BATTLE_02. In August 2011 three additional monitoring sites were setup to monitor the lower reaches of segment SD-CH-R-BATTLE_02. Additional sites on Battle Creek were BATTLE02A just upstream of Highway 79 and BATTLE03 just upstream of the first bridge crossing on Highway 40 West of Highway 79 (Figure 2). The BATTLE02A site location was also sampled during the 2007 through 2009 Cheyenne River Assessment as site BTC03 (Figure 2) and shown in Figure 6 as blue circles. Fecal coliform collected during this study indicated that 46.7 percent of the samples (7 out of 15 total samples) exceeded water quality standards (Appendix A, Table A3). Between monitoring sites BATTLE03 and BATTLE02A, Grace Coolidge Creek empties into Battle Creek contributing flow to the system. GRCOOL01 monitoring site was setup on the first bridge crossing on Highway 36 West of Highway 79 to monitor fecal coliform, *E. coli*, TSS, and discharge to determine what impact Grace Coolidge Creek loadings have on Battle Creek. Thirteen samples collected from GRCOOL01 in August and September 2011 showed no violations in water quality standards and did not contribute to the high fecal coliform loading observed in Battle Creek between BATTLE03 and BATTLE02A (Appendix A, Table A1). Note that sampling occurred at these additional locations (BATTLE02A, BATTLE03, and GRCOOL01) only during moist and high flow conditions and that exceedence percentages were only high at BATTLE02A (85.7 percent).

All monitoring site fecal coliform loading data collected from 2001 through 2011 were used to evaluate fecal coliform loading within segment: SD-CH-R-BATTLE_02. No fecal coliform exceedences were detected at BATTLE03 or GRCOOL01 during the 2011 sampling season. As mentioned above, in BATTLE02A all but two samples exceeded acute water quality standards. The impacted area described above is shown in Figure 2 as a cross-hatched area between monitoring sites BATTLE02A, BATTLE03, GRCOOL01 in segment SD-CH-R-BATTLE_02 and BATTLE02 in the upper end of segment SD-CH-R-BATTLE_01_USGS. Approximately

0.9 stream kilometers downstream of Highway 79 at BATTLE02 located in segment SD-CH-R-BATTLE_01_USGS, 84.2 percent of the samples collected during the recreation season (16 of 19 samples) exceeded water quality standards validating the exceedence data collected at BATTLE02A in segment SD-CH-R-BATTLE_02 (Appendix A, Table A1). Fecal coliform concentrations at BATTLE02 in segment SD-CH-R-BATTLE_01_USGS originated above BATTLE02A and below BATTLE03 and GRCOOL01 (Appendix A, Table A1). Overall loading throughout all flow zones exceeded acute standards by approximately 18.3 percent (Table 8).

Table 8 Fecal coliform concentration and loading exceedence percentages based on acute standards for Battle Creek segment SD-CH-R-BATTLE_02 from 2001 through 2011.

Flow Zone	Concentration Exceedence Percentage	Load Exceedence Percentage	Flows (cfs)
High	25.0	12.5	29 – 1,750
Moist	22.0	22.0	6 -28
Mid-Range	42.9	42.9	3.4 – 5.9
Dry	0.0	0.0	1.4 – 3.3
Low	33.3	33.3	0.01 -1.3
Overall	20.4	18.3	0.01 – 1,750

The critical condition for segment SD-CH-R-BATTLE_02 of Battle Creek watershed based on LDCs are higher to mid-range and low flow conditions during the recreation season. Water quality concentration and loading violations occurred in the high, moist, mid-range and low flow zones especially from the lower portion of Battle Creek between BATTLE03, GRCOOL01 and BATTLE02A (green circles). Applying conservative methodologies to TMDL development within segment SD-CH-R-BATTLE_02, the beneficial use based TMDL throughout all flow zones will be developed for fecal coliform based on the daily maximum acute criteria of 2,000 CFU/100 mL as the water quality target.

5.2.1.2 Segment: SD-CH-R-BATTLE_01_USGS

The LDC-based fecal coliform TMDL for segment SD-CH-R-Battle_01_USGS was developed using 1949 through 2011 USGS 06406500 recreation season discharge data below Hermosa. Instantaneous fecal coliform data consisted of 2007 through 2009 Cheyenne River BTC04 data, and 2011 Battle Creek assessment monitoring data from BATTLE02 and BATTLE01 (Figure 2). The WLA representing permitted fecal coliform bacteria effluent limits for the Town of Hermosa WWTF (2,000 CFU/100 mL) multiplied by the design flow (discharge of 0.5 feet of wastewater drawdown per day in cell three, 0.23 MGD) and a correction factor. The acute fecal coliform load duration curve, instantaneous measured daily loads, and the WLA are displayed in Figure 7. Cheyenne River BTC04 (orange circles), most of the BATTLE02 (rose circles) samples and a few BATTLE01 (grey circles) samples (instantaneous loads) in the high flow zone tended to exceed the acute maximum daily load criteria (TMDL) in a variety of flow zones. Overall loading throughout all flow zones exceeded acute standards by approximately 22.4 percent (Table 9).

Figure 7 shows that the majority of BATTLE02 samples exceed acute fecal coliform loading in the moist and high flow zones which appears to originate from the Battle Creek fecal coliform loading zone at or above BATTLE02A. Note that samples were collected at sites BATTLE02A and BATTLE02 only during high flow and moist flow conditions. By the time these loadings reach the lower portions of segment SD-CH-R-Battle_01_USGS at monitoring site BATTLE01 (grey circles) most waters meet flow based acute TMDL standards except during extremely high flows.

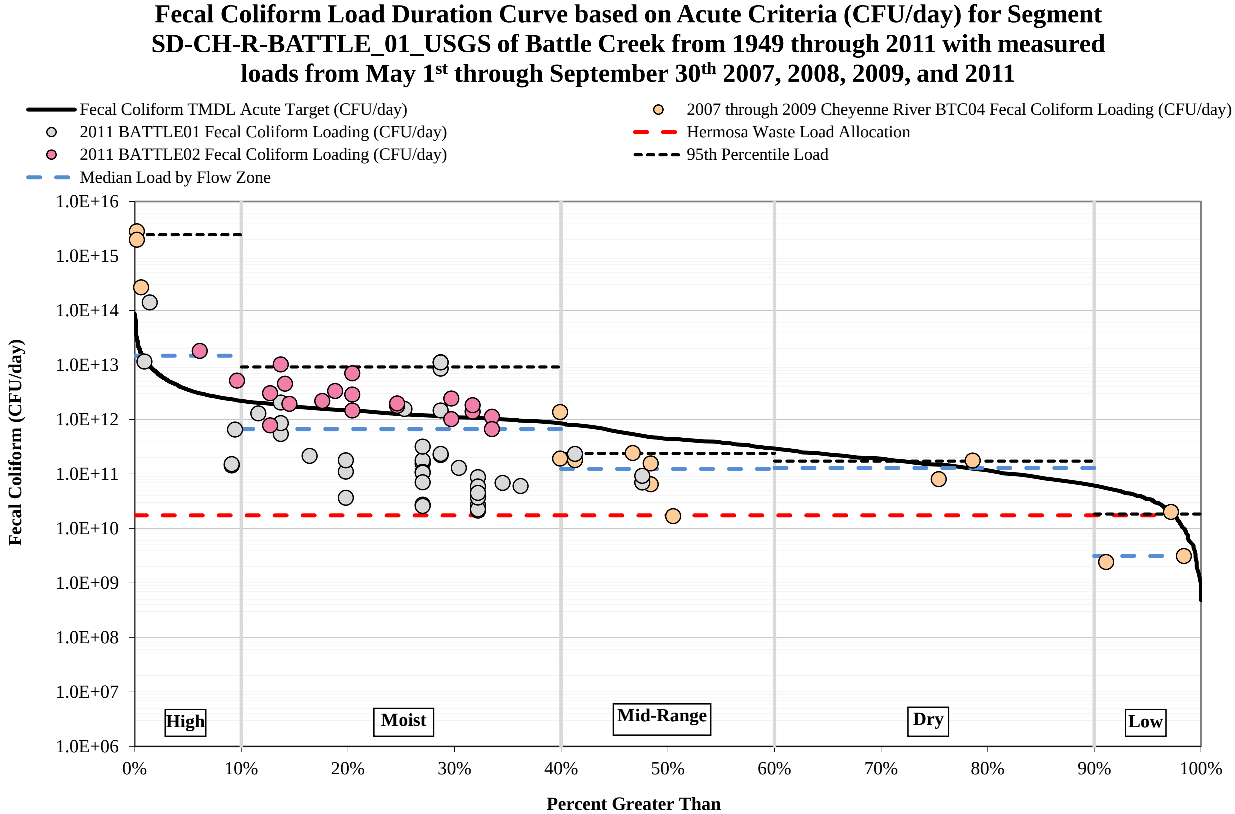


Figure 7 Fecal coliform load duration curve for segment: SD-CH-R-BATTLE_01_USGS represents the allowable daily fecal coliform loads based on the acute fecal coliform criterion (≤ 2,000 CFU/100 mL) during the recreation seasons 1949 through 2011. Instantaneous fecal coliform loads collected from assessment sites BATTLE01, BATTLE02, and 2007 through 2009 Lower Cheyenne River site BTC04 on Battle Creek during the recreation season.

Because of a wet cycle, all data collected during the 2011 Battle Creek watershed project were collected from flows in the high and moist flow zones. Fecal coliform sample data collected during the Cheyenne River project (2007 through 2009) had some samples collected throughout the entire flow regime. These data were used to assess loading in the mid-range, dry and low flow zones in Battle Creek. Based on Cheyenne River data, all samples collected in the mid-range and low flow zones were at or below acute loading standards; while one sample collected in the dry flow zone exceeded the daily acute TMDL standard (Figure 7). During the implementation phase, continued additional sampling should be conducted to further characterize and evaluate concentration and loading characteristics in segment SD-CH-R-Battle_01_USGS.

Table 9 Fecal coliform loading exceedence percentages based on acute standards for Battle Creek segment SD-CH-R-Battle_01_USGS, Custer County, South Dakota.

Flow Zone	Concentration Exceedence Percentage	Load Exceedence Percentage	Flows (cfs)
High	60.0	50.0	45 - 1,760
Moist	35.8	22.6	18 - 44
Mid-Range	0.0	0.0	6 - 17
Dry	50.0	0.0	1.4 - 5
Low	0.0	0.0	0.01 – 1.3
Overall	**34.2**	**22.4**	**0.01– 1,760**

The critical condition for segment SD-CH-R-BATTLE_01_USGS of Battle Creek watershed based on LDCs is higher flow conditions ($\geq$ 18 cfs) with the majority of concentration and loading violations occurring in the high and moist flow zones (Table 9). More samples need to be collected during the dry and low flow zones to further define/evaluate fecal coliform loading conditions and characteristics in segment SD-CH-R-BATTLE_01_USGS of Battle Creek.

Applying conservative methodologies to TMDL development within segment SD-CH-R-BATTLE_01_USGS, the beneficial use based TMDL throughout all flow zones will be developed for fecal coliform based on the daily maximum acute criteria of 2,000 CFU/100 mL as the water quality target.

5.2.2. *E. coli* Bacteria

E. coli bacteria in Battle Creek watershed have only been collected at one site, WQM 17 (DENR 460905) in segment SD-CH-R-BATTLE_02 since 2001 (50 samples). Four *E. coli* samples have been collected during the Cheyenne River Assessment from BTC03 and BTC04 in 2009. All remaining *E. coli* samples (102 samples) were collected in 2011 during the Battle Creek Assessment from BATTLE01, BATTLE02, BATTLE02A, BATTLE03, and GRCOOL01 (Appendix A, Tables A1 through A3). Thus the majority of *E. coli* samples were collected in 2011with flows in the moist and high flow zones.

All 2001 through 2011 paired fecal coliform and *E. coli* data (156 sample pairs) collected in the Battle Creek watershed during the recreation season were assembled to develop a regression equation to evaluate the overall relationship of fecal coliform and *E. coli* bacteria and to determine if fecal coliform bacteria are a good predictor of *E. coli* bacteria. Nineteen sample pairs were not used because one or both of the values were below detection limits and thirteen fecal coliform and *E. coli* sample data pairs from Grace Coolidge Creek (GRCOOL01) were not used because this data was from a watershed outside of Battle Creek. In total, 124 sample pairs were used to evaluate the fecal coliform and *E. coli* relationship in Battle Creek. All fecal coliform and *E. coli* data were transformed using Log_{10} to linearize the data and fitted with a linear regression line described by an equation (Figure 8). To apply this, fecal coliform count data are transformed, entered into the regression equation and the antilog of the results are the predicted *E. coli* bacteria counts.

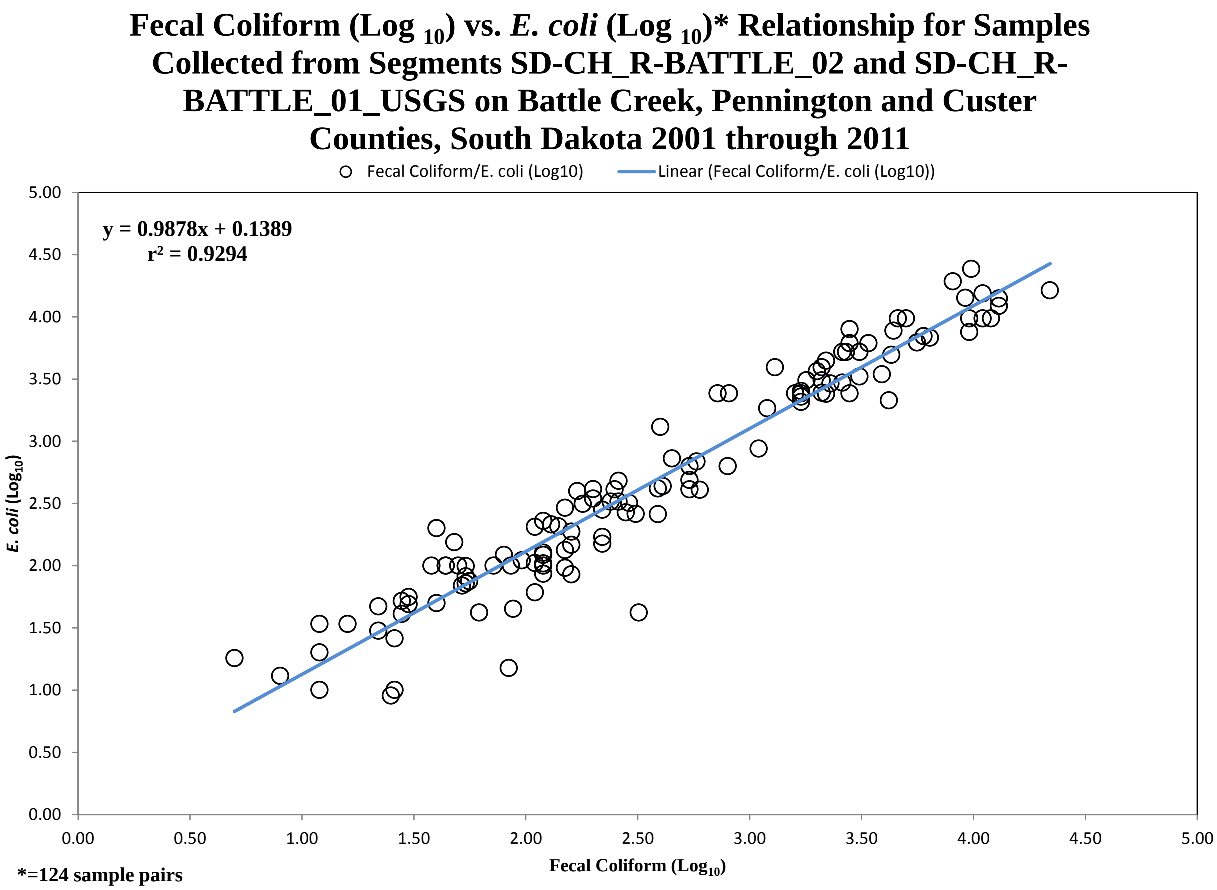


Figure 8 Fecal coliform and *E. coli* bacteria (Log $_{10}$) relationship for Battle Creek using all available paired data from 2001 through 2011 from segment SD-CH-R-BATTLE_02 and segment SD-CH-R-BATTLE_01_USGS.

Results show a significant relationship between fecal coliform and *E. coli* bacteria for Battle Creek from Keystone to the Cheyenne River with statistically significant (p=0.0000) relationship and high correlation coefficient (r = 0.9640) and coefficient of determination (r^2 = 0.9294). The correlation coefficient indicates the measure of intensity of the association between fecal coliform and *E. coli* and the coefficient of determination expresses the amount of common variation between the two variables. Using the regression equation developed for fecal coliform concentrations to predict *E. coli* bacteria concentrations and converting those concentrations to loads using USGS daily discharge to determine *E. coli* bacteria load were used to expand the *E. coli* data sets for segments SD-CH-R-BATTLE_02 and SD-CH_R_BATTLE_01_USGS in Battle Creek.

5.2.2.1. Segment SD-CH-R-BATTLE_02

The LDC-based TMDL for *E. coli* was developed for segment SD-CH-R-BATTLE_02 using long-term (1950 through 2011) seasonal (May through September) USGS discharge data collected from monitoring site 06406000, Battle Creek at Hermosa, SD. Instantaneous *E. coli* data collected from May through September consisted of samples collected at WQM 17

(460905) from 2001 through 2011, BTC03 as part of the lower Cheyenne River assessment project from September, 2007 through September 2009 (during the recreation season) and in 2011 as part of the Battle Creek watershed assessment project at sampling sites BATTLE02A and BATTLE03. The WLA for segment SD-CH-R-BATTLE_02 is the permit required bacteria effluent limits for the City of Keystone WWTF (1,178 MPN/100 mL) multiplied by the design flow for the WWTF (80th percentile flow from DMR data, 0.38 MGD) and a conversion factor (Figure 9).

E. coli Bacteria Load Duration Curve based on Acute Standard for Segment SD-CH-R-BATTLE_02 based on BATTLE02 (USGS site 06406000) Flows from 1946 through 2011 and measured loads from 1969, 1989 and 2001 through 2011

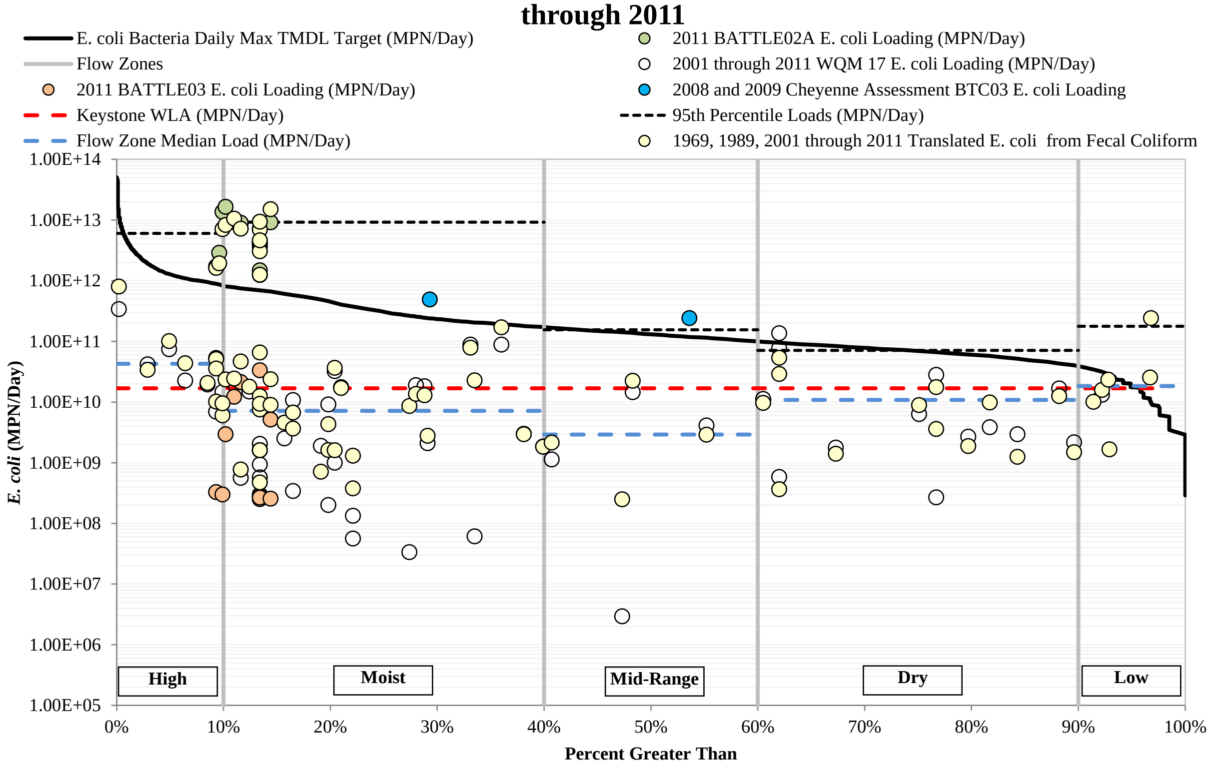


Figure 9 Load duration curve representing allowable daily _E. coli_ bacteria loads based on acute criteria (≤ 1,178 MPN/100 mL) during the recreation seasons 1946 to 2011. Instantaneous _E. coli_ loads from BATTLE02 and BATTLE03 in 2011, predicted _E. coli_ loads based on fecal coliform bacteria and the Cheyenne River watershed project (2008 and 2009).

The acute load duration curve for *E. coli* represents the daily maximum load based on flow and the State of South Dakota daily maximum criterion for *E. coli* bacteria, 1,178 MPN/day (Figure 9). All monitoring site *E. coli* and translated fecal coliform into *E. coli* loading data within segment: SD-CH-R-BATTLE_02 was used to evaluate *E. coli* loading in this segment. Data show random exceedences throughout all flow zones in Battle Creek. Cheyenne River Battle Creek monitoring site BTC03 (blue circles) shows two daily acute exceedences in the moist and mid-range flow zones. WQM 17 (DENR 460905, clear circles) data had one exceedence in the dry flow zone; while, BATTLE03 (gold circles) data collected from May through September

2011 showed no violations in *E. coli* loading (Figure 9). Site BATTLE02A (green circles) had the highest number of E. coli loading violations in segment SD-CH-R-BATTLE_02 (14 exceedences out of 14 total samples, 100 percent) with three exceedence in the high flow zone and eleven in the moist flow zone (Figure 9). Fifty-three fecal coliform samples were translated into *E. coli* bacteria concentrations and loads in segment SD-CH-R-BATTLE_02 (yellow circles) and represent all available fecal coliform concentrations collected from 2001 through 2011 with three additional WQM 17 samples (one collected in 1969 and two collected in 1989) to populate the low flow zone. Translated *E. coli* exceeded loading criteria three times in the high flow zone, eleven times in the moist flow zone, and twice in the low (Figure 9).

Monitoring site GRCOOL01 located on Grace Coolidge Creek near the confluence of Battle Creek was setup to determine what impact that watershed has on segment: SD-CH-R-BATTLE_02 of Battle Creek below BATTLE03 (Appendix A, Table A1). Data show that all *E. coli* bacteria concentrations (13 samples) collected at GRCOOL01 were below acute criteria for limited-contact recreation waters (1,178 MPN/100 mL). Thus, GRCOOL01 *E. coli* concentrations had minimal impact on Battle Creek below BATTLE03. Combining upstream sampling sites WQM 17 (DENR 460905) and BATTLE03 the overall exceedence percentage since 2001 has been 6.2 percent (four violations out of 64 samples). This represents 28.7 stream kilometers (17.8 stream miles) or 84.6 percent of the entire stream segment.

These data show that *E. coli* impairment from Keystone to monitoring site BATTLE03 tends to be limited, with one exceedence occurring in the dry flow zone and meets water quality standards for *E. coli* bacteria during the recreation season. However, downstream of BATTLE03 and GRCOOL01 and upstream of BATTLE02A and BATTLE02 located in downstream segment SD-CH-R-BATTLE_01_USGS; a significant increase in *E. coli* bacteria concentrations and loading occurs with 100 percent of the *E. coli* samples collected at monitoring sites BATTLE02A and BATTLE02 exceeding limited-contact recreation waters (1,178 MPN/100 mL). This area was called the zone of impairment and is shown as the cross-hatched area in Figure 2.

Table 10 *E. coli* loading exceedence percentages based on acute standard for Battle Creek segment SD-CH-R-BATTLE_02, Pennington and Custer Counties, South Dakota

Flow Zone	Concentration Exceedence Percentage	Load Exceedence Percentage	Flows (cfs)
High	23.1	7.7	29 – 1,750
Moist	26.3	23.2	6 -28
Mid-Range	11.1	11.1	3.4 – 5.9
Dry	11.5	3.8	1.4 – 3.3
Low	28.6	14.3	0.01 -1.3
Overall	22.7	16.6	0.01 – 1,750

The critical conditions for segment SD-CH-R-BATTLE_02 appears to be in the high, moist and low flow zones based on acute water quality violation percentages. However, TMDL percent reduction by flow zone indicates the moist and low flow zones require the greatest percent reductions (Table 10). Applying conservative methodologies to TMDL development within segment SD-CH-R-BATTLE_02, the beneficial use based TMDL throughout all flow zones will be developed for *E. coli* based on the daily maximum acute criteria of 1,178 MPN/100 mL as the water quality target.

5.2.2.2. Segment SD-CH-R-BATTLE_01_USGS

The LDC-based *E. coli* TMDL for segment SD-CH-R-Battle_01_USGS was developed using 1949 through 2011 USGS 06406500 discharge data below Hermosa and the daily maximum (acute) load based on flow (1,178 MPN/100 mL). Instantaneous *E. coli* data consisted of 2007 through 2009 Cheyenne River BTC04 data, and 2011 Battle Creek assessment monitoring data from monitoring sites BATTLE02 and BATTLE01 (Figure 2). The WLA representing permitted *E. coli* bacteria effluent limits for the Town of Hermosa WWTF (1,178 MPN/100 mL) multiplied by the design flow for the Town of Hermosa WWTF (discharge of 0.5 feet of wastewater drawdown per day in cell three, 0.23 MGD) and a conversion factor. The acute fecal coliform load duration curve, instantaneous measured daily loads, and the WLA are displayed in Figure 10.

E. coli Load Duration Curve based on Acute Criteria (MPN/day) for Segment SD-CH-R-BATTLE_01_USGS of Battle Creek from 1949 through 2011 with measured values from May 1st through September 30th 2007 through 2011

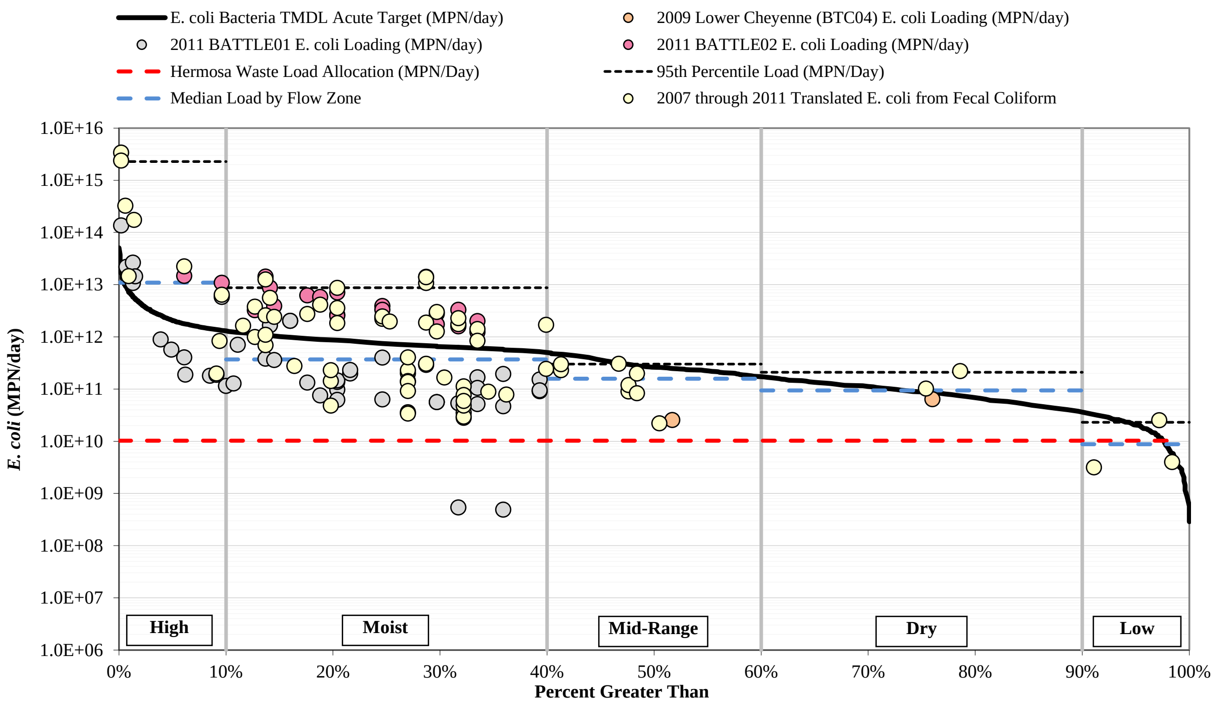


Figure 10 Load duration curve representing allowable daily *E. coli* bacteria loads based on daily maximum acute *E. coli* criteria (≤ 1,178 MPN/100 mL) during the recreation seasons 1949 to 2011. Instantaneous *E. coli* loads were collected from BATTLE02 and BATTLE01 during May through September 2011 translated fecal coliform samples from Cheyenne River watershed project BTC04 2007 through 2009 and *E. coli* samples collected during the Cheyenne River project 2008 and 2009.

All available monitoring site *E. coli* and translated fecal coliform loading data within segment SD-CH-R-Battle_01_USGS was used to evaluate *E. coli* loading in this segment. Data show random exceedences in most flow zones of Battle Creek (Figure 10). Cheyenne River Battle Creek monitoring site BTC04 *E. coli* (orange circles) showed no acute instantaneous daily load violations. Translated fecal coliform loading (yellow circles) from the Cheyenne River Battle Creek monitoring site BTC04 and Battle Creek assessment project collected in 2011 (BATTLE01 and BATTLE02) showed seven exceedences in the high flow zone, 24 in the moist, one in the mid-range, one in the dry, and one in the low flow zone. BATTLE02 (rose circles) monitoring site in the upper portion of segment SD-CH-R-BATTLE_01_USGS indicated two loading violation in the high flow zone and 17 loading violations in the moist flow zone; while, BATTLE01 (gray circles) monitoring site had six loading violations in the high flow zone and two in the moist flow zone (Figure 10). Overall loading throughout all flow zones exceeded acute standards by approximately 41.5 percent (Table 11).

Data suggests that *E. coli* loading in the upper portion of segment SD-CH-R-BATTLE_01_USGS was much higher and was attributed to increased loadings from the lower 5.2 stream kilometers (3.2 stream miles) of segment SD-CH-R-BATTLE_02. By the time Battle Creek loading reaches BATTLE01, *E. coli* loads are reduced possibly due to exponential decay and/or dilution reducing *E. coli* bacteria counts. These data show that during the recreation season *E. coli* bacteria loading impairment from Highway 79 to the Cheyenne River tends to be greater in the high, moist and dry flow zones.

Table 11 *E. coli* loading exceedence percentages based on acute standards for Battle Creek segment SD-CH-R-BATTLE_01_USGS, Custer County, South Dakota

Flow Zone	**Concentration Exceedence Percentage**	**Load Exceedence Percentage**	**Flows (cfs)**
High	68.0	60.0	45 - 1,760
Moist	44.1	44.1	18 - 44
Mid-Range	14.3	0.0	6 - 17
Dry	66.7	33.3	1.4 - 5
Low	33.3	0.0	0.01 – 1.3
Overall	45.6	41.5	0.01– 1,760

The critical condition for segment SD-CH-R-BATTLE_01_USGS appears to be in the higher flow regimes based on acute water quality violation percentages (Table 11). Applying conservative methodologies to TMDL development within segment SD-CH-R-BATTLE_01_USGS, the beneficial use based TMDL throughout all flow zones will be developed for *E. coli* based on the daily maximum acute criteria of 1,178 MPN/100 mL as the water quality target.

5.3 Loading Sources

In Section 4.0, significant sources of fecal coliform loading were defined as non-point source pollution originating from livestock. One of the more important concerns regarding non-point sources is variability in stream flows. Variable stream flows often cause different source areas and loading mechanisms to dominate (Cleland, 2003). Because there was long-term hydrologic data available within each impaired segment of Battle Creek, five flow regimes (i.e., high, moist, mid-range, dry and low) were selected to represent the hydrology of the TMDL watersheds. By relating runoff and loading characteristics based on LDCs for each flow regime, inference can be made as to which sources are likely to contribute to fecal coliform and *E. coli* bacteria loading within each impaired segment.

5.3.1 Fecal Coliform and *E. coli* Bacteria Sources

5.3.1.1. Point Sources

Two point sources were identified in the Battle Creek watershed. One source was identified in segment SD-CH-R-BATTLE_02 as the Keystone WWTF and has an authorized to discharge permit (Permit # SD0024007). This system is a continuous discharge mechanical plant with a design flow of 0.38 MGD and has low estimated potentials to pollute fecal coliform and *E. coli* bacteria based on reported DMR data (Appendix A, Table A4) throughout all event conditions, high through low flow zones (Table 12).

Table 12 Point and non-point sources of pollution and the potential to pollute[1] based on flow and load duration curves for Battle Creek, Pennington and Custer Counties, South Dakota 2011.

			Flow Regime				
Impaired Segment	**Parameter**	**Source**	**High**	**Moist**	**Mid-Range**	**Dry**	**Low**
SD-CH-R-BATTLE_02	Fecal Coliform *E. coli*	**Point Source**					
		Keystone WWTF	L	L	L	L	L
		Non-Point Source					
		Riparian area access, over – wintering and grazing	H	H	H	H	H
		Manure Application to cropland, pastureland and/or rangeland	H	H	M	L	L
		Intensive grazing	M	M	L	L	L
		Wildlife	L	L	L	L	L
SD-CH-R-BATTLE_01_USGS	Fecal Coliform *E. coli*	**Point Source**					
		Hermosa WWTF	L	L	L	L	L
		Non-Point Source					
		Riparian area access, over – wintering and grazing	H	H	H	H	H
		Manure Application to cropland, pastureland and/or rangeland	H	H	M	L	L
		Intensive grazing	M	L	L	L	L
		Wildlife	L	L	L	L	L

[1] = Potential to pollute (H – High, M – Moderate and L - Low)

The other point source was identified in segment SD-CH-R-BATTLE_01_USGS of Battle Creek as the Hermosa WWTF, a three pond system with a design flow of 0.23 MGD based on a 0.5 foot draw down of pond three per day and a permission to discharge permit (Permit # SD0022349). This facility has never discharged directly into segment SD-CH-R-BATTLE_01_USGS of Battle Creek. Potentials were estimated to be uniformly low throughout all flow zones due to the facility having never discharged directly to Battle Creek and as part of the permit the facility has land application that applies to outfall 002.

5.3.1.2. Non-point Sources

Animals grazing or temporarily confined in the riparian area contribute fecal coliform bacteria by depositing manure where it has an immediate impact on water quality. Due to the close proximity of manure to the stream or by direct deposition in the stream, riparian grazing and over-wintering impacts water quality in all flow zones throughout segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS in the Battle Creek watershed (Table 12). The potential fecal coliform/*E. coli* loading impact of riparian grazing and over-wintering were considered high in all flow zones and similar in both segments of Battle Creek. Restricting or limiting livestock from riparian areas will significantly reduce or eliminate the potential of direct manure deposition to the creek.

Manure application to cropland, pasture, and rangeland in the lower portion of segment SD-CH-R-BATTLE_02 and segments SD-CH-R-BATTLE_01_USGS is done to improve crop and pasture/rangeland grass production. During runoff events (high and moist flow zones), manure spread on pasture/rangeland has a high potential to mobilize, wash off (sheet and rill erosion), and contribute fecal coliform/*E. coli* bacteria load to Battle Creek (Table 12). Loading potentials in the mid-range flow zone were estimated to be moderate and low potentials in dry and low flow zones in Battle Creek.

Intensive grazing of livestock in upland areas build-up manure containing fecal coliform/*E. coli* bacteria and, similar to manure application, have the potential to mobilize and wash off upland areas of the watershed. These areas in the watershed are usually away from the impaired waterbody, which increases travel time and decreases the loading potential in the moist and mid-range flow zones compared to manure application. Flow and LDC-based estimates indicate a moderate potential to impact water quality in the high and moist flow zones in segment SD-CH-R-BATTLE_02 and low potential in the moist, dry, and low flow zone. Potential to pollute estimates in segment SD-CH_R-BATTLE_01_USGS were considered moderate potentials in the high flow zone and low potentials in the moist, mid-range, dry and low flow zones (Table 12).

Wildlife fecal coliform/*E. coli* loading potentials in segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS of the Battle Creek watershed were estimated to be low throughout all flow zones in both segments (Table 12). Estimates were based on SD GF&P Wildlife Game Assessment Reports (Huxoll, 2002) and Bacterial Indicator Tool (BIT) output with estimated wildlife loading potentials for each watershed. Wildlife loading potentials for segment SD-CH-R-BATTLE_02 were estimated at 6.76 percent and 8.78 percent for segment SD-CH-R-BATTLE_01_USGS (Table 6 and Table 7).

6.0 Margin of Safety and Seasonality

6.1 Margin of Safety (MOS)

In accordance with the regulations, a margin of safety was established to account for uncertainty in the data analyses. A margin of safety may be provided (1) by using conservative assumptions in the calculation of the loading capacity of the waterbody and (2) by establishing allocations that in total are lower than the defined loading capacity. In the case of Battle Creek downstream of Keystone, the latter approach was used to establish a safety margin for both the fecal coliform and *E. coli* TMDLs.

A 10% explicit MOS was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). This 10% explicit MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity. The remaining assimilative capacity was attributed nonpoint sources (LA) or point sources (WLA).

As new information becomes available and the TMDL is revisited, this unallocated capacity may be attributed to nonpoint sources and added to the load allocation, or the unallocated capacity may be attributed to point sources and become part of the waste load allocation.

6.2 Seasonality

Stream flows in Battle Creek displayed seasonal variation for the period of record (1949 through 2011). Highest stream flows typically occur during June throughout the watershed based on the May 1st through September 30th recreation season (Table 13). The lowest daily mean stream flows during the recreation season were similar throughout the Battle Creek watershed, with the lowest flows in segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS occurring in the summer and early fall (July and September, respectively) (Table 13). Fecal coliform bacteria concentrations were moderately correlated with stream flow in segments SD-CH-R-BATTLE_02 (r=0.53) and significantly correlated in segment SD-CH_R-BATTLE_01_USGS at (r=0.75). Similarly, *E. coli* bacteria concentrations were moderately correlated with stream flow in segment SD-CH-R-BATTLE_02 (r=0.65) and poorly correlated in segment SD-CH_R-BATTLE_01_USGS at (r=0.27).

Table 13 Highest and lowest mean daily flow for USGS monitoring sites in Battle Creek, Pennington and Custer Counties, South Dakota from 1949 through 2011.

		Highest Flows		Lowest Flows		
Segment	**Parameter**	**Month**	**Flow**	**Month**	**Flow**	**Season**
SD-CH-R-BATTLE_02	Fecal Coliform/ *E.coli*	June	1,750	July	0.01	May through September
SD-CH-R-BATTLE_01_USGS	Fecal Coliform/ *E.coli*	May	1,760	September	0.01	May through September

Since the criteria for fecal coliform and *E. coli* bacteria concentrations are in effect from May 1 through September 30, the TMDLs developed for these parameters and segments are also applicable only during this time period or season.

7.0 TMDL

The TMDL can be described by the following equation**:**

TMDL = WLA + LA + MOS, where:

TMDL = loading capacity (LC), or the greatest loading a waterbody can receive without violating water quality standards;

WLA = wasteload allocation, or the portion of the TMDL allocated to existing or future point sources;

LA = load allocation, or the portion of the TMDL allocated to existing or future non-point sources;

MOS = margin of safety, or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of the loading capacity.

To ensure that all applicable fecal coliform and *E. coli* criteria are met and aid in the implementation of these TMDLs, load allocations for fecal coliform and *E. coli* were calculated for each of the five flow zones using both the acute (daily maximum) criteria as the water quality target and using only data collected during the recreation season (May through September). Methods used to calculate the TMDL allocations are discussed in more detail below.

Flow duration curves were developed for each segment based on USGS stream gages, and defined flow duration intervals were used as a general indicator of hydrologic condition (i.e., wet vs. dry conditions, and to what degree). These intervals (or zones) provide additional insight about conditions and patterns associated with the impairments due to fecal coliform and *E. coli* bacteria concentrations (US EPA, 2007). As depicted in Figure 5, all flow duration curves for Battle Creek were plotted on one graph and uniformly divided into five zones. These zones represent high flow zones (0-10 percent), moist flow zones (10-40 percent), mid-range flow zones (40-60 percent), dry flow zones (60-90 percent), and low flow zones (90-100 percent). Flow intervals were defined by examining the range of flows for each of the sites based on flow duration curves plotted on Figure 5.

To develop fecal coliform and *E. coli* bacteria load allocations (LAs), the loading capacities (LCs) were first determined. The daily maximum (acute) criterion (2,000 CFU/100ml) was used for the fecal coliform calculations of the LCs for segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS. For *E. coli*, the daily maximum (acute) criterion (1,178 MPN/100ml) was used for the calculation of the LC for the previous segments outlined above. LCs for each applicable parameter (fecal coliform and *E. coli* bacteria) was produced for Battle Creek based on acute criteria. LCs were calculated by multiplying the acute fecal coliform and *E. coli* bacteria criteria by segment specific USGS daily average discharge measurements and a conversion factor. Thus, TMDLs were developed using the LDC approach, resulting in a flow-variable target that considers the entire flow regime within the recreational season (May 1st – September 30th) for fecal coliform and *E. coli*.

For each of the five flow zones, the 95th percentile of the range of LCs within each zone was set as the flow zone goal. Bacterial (fecal coliform and *E. coli*) 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 LCs will protect the limited contact recreation beneficial use and allow for the natural variability of the system.

The TMDL is the sum of WLA, LA, and MOS. Portions of the LC (TMDL) were allocated to non-point sources as a load allocation (LA), point sources as a wasteload allocation (WLA) and a margin of safety (MOS) to account for uncertainty in the calculations of load allocations. The method used to calculate the MOS is described in Section 6.1. The WLAs for fecal coliform and *E. coli* for segment SD-CH-R-BATTLE_02 is continuous discharge from the Keystone WWTF which is the permit required bacteria effluent limits for the City of Keystone WWTF (2,000 CFU/100 mL and 1,178 MPN/100 mL, respectively) multiplied by the design flow for the WWTF (80^{th} percentile flow from DMR data, 0.38 MGD) and a conversion factor. WLAs for fecal coliform in segment SD-CH-R-BATTLE_01_USGS is based on calculated discharge from the Hermosa WWTF which is a permission to discharge facility; but has never reported a discharge to Battle Creek. The WLAs for this facility represents permitted bacteria effluent limits for the Town of Hermosa WWTF (2,000 CFU/100 mL and 1,178 MPN/100 mL, respectively) multiplied by the design flow for the Town of Hermosa WWTF (discharge of 0.5 feet of wastewater drawdown per day in cell three, 0.23 MGD) and a conversion factor. These WLAs were calculated and assigned by SD DENR SWQP staff. The overall LAs by flow zone were determined by subtracting WLA and MOS from the TMDL.

7.1 Fecal Coliform

7.1.1 Segment SD-CH-R-BATTLE_02

The WLA for segment SD-CH-R-BATTLE_02 , Teepee Gulch Creek to Highway 79, is comprised of continuous discharge from the Keystone WWTF east of Keystone, SD. WLAs affect acute fecal coliform loading in segment SD-CH-R-BATTLE_02 throughout all flow zones from low through high flow zones (Table 14). WLA allocation for fecal coliform bacteria is the permit required bacteria effluent limits for the City of Keystone WWTF (2,000 CFU/100 mL) multiplied by the design flow for the WWTF (80^{th} percentile flow from DMR data, 0.38 MGD) and a conversion factor, resulting in $2.88 * 10^{10}$ CFU/Day or ($29 * 10^{9}$ CFU/Day).

Table 14 Acute fecal coliform TMDL for segment SD-CH-R-BATTLE_02 of Battle Creek, Pennington and Custer Counties, South Dakota 2011

Fecal Coliform TMDL for SD-CH-R-BATTLE_02 (Acute)

		Flow Zone				
		High	Moist	Mid-Range	Dry	Low
TMDL Component		29-1,750 cfs	6 - 28 cfs	3.4 - 5.9 cfs	1.4 - 3.3 cfs	0.01 -1.3 cfs
WLA (Keystone)	(CFU * 10^9/Day)	29	29	29	29	29
LA	(CFU * 10^9/Day)	10,346	1,116	218	116	29
MOS (10% Explicit)	(CFU * 10^9/Day)	1,153	127	27	16	6
TMDL (95th Percentile)	(CFU * 10^9/Day)	11,528	1,272	274	161	64
Current Load (95th Percentile)	(CFU * 10^9/Day)	292,636	8,158	1,900	38	156
Load Reduction	(CFU * 10^9/Day)	281,108	6,886	1,626	0	92
Load Reduction %		96%	84%	86%	0%	59%

Table 14 indicates that the current load based on the acute fecal coliform TMDL exceeded water quality standards in four flow zones (high, moist, mid-range and low) while the dry flow zone meets current water quality standards.

The critical condition for fecal coliform in segment SD-CH-R-BATTLE_02 of the Battle Creek watershed based on the LDC TMDL is event and low flow-based runoff conditions with all water quality violations occurring in the high, moist, mid-range, and low flow zones. Thus, allocations listed for the high, moist, mid-range, and low flow zones in Table 14 (using the acute criterion (2,000 CFU/100 mL)) represent the TMDL goals to attain compliance with all applicable water quality standards for fecal coliform bacteria in segment SD-CH-R-BATTLE_02.

7.1.2. Segment SD-CH-R-BATTLE_01_USGS

The WLA for Battle Creek segment SD-CH-R-BATTLE_01_USGS, Highway 79 to Cheyenne River is comprised of calculated discharge for the Hermosa WWTF. WLA for fecal coliform in segment SD-CH-R-BATTLE_01_USGS is based on possible discharge from the Hermosa WWTF which is a permission to discharge facility; but has never reported a discharge to Battle Creek. The WLAs for this facility represents permitted bacteria effluent limits for the Town of Hermosa WWTF (2,000 CFU/100 mL multiplied by the design flow for the Town of Hermosa WWTF (discharge of 0.5 feet of wastewater drawdown per day in cell three, 0.23 MGD) and a conversion factor, resulting in 1.69 $*10^{10}$ CFU/Day or (17 $*10^{9}$ CFU/Day). The Hermosa WLA represents the fecal coliform effluent limit and accounts for possible loading from the facility in case of a permit-allowed discharge into segment SD-CH-R-BATTLE_01_USGS that could occur in all flow zones (Table 15).

Table 15 Acute fecal coliform TMDL for segment SD-CH_R_BATTLE_01_USGS of Battle Creek, Custer County, South Dakota 2011

Fecal Coliform TMDL for SD-CH-R-BATTLE_01_USGS (Acute)

		Flow Zone				
		High	**Moist**	**Mid-Range**	**Dry**	**Low**
TMDL Component		**46-1,760 cfs**	**19 - 45 cfs**	**7 - 18 cfs**	**6 - 1.4 cfs**	**0.01 -1.3 cfs**
WLA (Hermosa)	(CFU * 10^9/Day)	17	17	17	17	17
LA	(CFU * 10^9/Day)	16,328	1,788	732	234	36
MOS	(CFU * 10^9/Day)	1,816	201	83	28	6
TMDL (95th Percentile)	(CFU * 10^9/Day)	18,161	2,006	832	279	59
Current Load (95th Percentile)	(CFU * 10^9/Day)	2,467,605	9,239	239	173	18
Load Reduction	(CFU * 10^9/Day)	2,449,444	7,233	0	0	0
Load Reduction %		99%	78%	0%	0%	0%

Current loading based on the acute fecal coliform TMDL exceeded water quality standards in the high and moist flow zones by 99 percent and 78 percent, respectively; while the mid-range, dry and low flow zones meet water quality and loading based on acute standards (Table 15).

The TMDL goals for fecal coliform in segment SD-CH-R-BATTLE_01_USGS are based on the acute criterion (2,000 CFU/100 mL) in the high and moist flow zones (Table 15). These goals, when met, will attain compliance with all applicable water quality standards for fecal coliform bacteria in segment SD-CH-R-BATTLE_01_USGS.

The critical condition for segment SD-CH-R-BATTLE_01_USGS of Battle Creek watershed based on the TMDL is event-based runoff conditions with all water quality violations occurring in the high and moist flow zones.

7.2 Escherichia coli (*E. coli*)

7.2.1 Segment SD-CH-R-BATTLE_02

The *E. coli* WLA for segment SD-CH-R-BATTLE_02 , Teepee Gulch Creek to Highway 79, is comprised of continuous discharge from the Keystone WWTF east of Keystone, SD. WLAs affect acute *E. coli* loading in segment SD-CH-R-BATTLE_02 throughout all flow zones from high through low flow zones (Table 16). WLA allocation for *E. coli* bacteria is the permit required bacteria effluent limits for the City of Keystone WWTF (1,178 MPN/100 mL) multiplied by the design flow for the WWTF (80^{th} percentile flow from DMR data, 0.38 MGD) and a conversion factor, resulting in $1.69 *10^{10}$ MPN/Day or ($17 *10^{9}$ MPN/Day).

Table 16 Acute *E. coli* TMDL for segment SD-CH-R-BATTLE_02 of Battle Creek, Pennington and Custer Counties, South Dakota 2011

***Escherichia coli* TMDL for SD-CH-R-BATTLE_02 (Acute)**

		Flow Zone				
		High	**Moist**	**Mid-Range**	**Dry**	**Low**
TMDL Component		**29-1,750 cfs**	**6 - 28 cfs**	**3.4 - 5.9 cfs**	**1.4 - 3.3 cfs**	**0.01 -1.3 cfs**
WLA (Keystone)	(MPN * 10^9/Day)	17	17	17	17	17
LA	(MPN * 10^9/Day)	6,094	657	128	69	16
MOS	(MPN * 10^9/Day)	679	75	16	10	4
TMDL (95th Percentile)	(MPN * 10^9/Day)	6,790	749	161	95	37
Current Load (95th Percentile)	(MPN * 10^9/Day)	7,180	9,123	197	101	188
Load Reduction	(MPN * 10^9/Day)	390	8,374	36	6	151
Load Reduction %		5%	92%	18%	6%	80%

Table 16 indicates that the current load based on the acute *E. coli* TMDL criteria by flow zone exceeded the standards throughout all flow zones (high through low); however, exceedence percentages in the high and dry flow zones were below the less than 10 percent listing criteria. The TMDL goal for *E. coli* in segment SD-CH-R-BATTLE_02 is acute criteria based on the moist, mid-range and low flow zones (Table 16).

The TMDL goals for *E. coli* in segment SD-CH-R-BATTLE_02 are based on the acute criterion (1,178 MPN/100 mL) in all flow zones, especially, the high, moist, and low flow zones (Table 16). These goals, when met, will attain compliance with all applicable water quality standards for *E. coli* bacteria in segment SD-CH-R-BATTLE_02.

The critical condition for *E. coli* bacteria segment SD-CH-R-BATTLE_02 of the Battle Creek watershed based on the LDC TMDL are moist, mid-range and low flow-based runoff conditions with all water quality violations occurring in the high, moist, mid-range, dry, and low flow zones. Thus, allocations listed for all flow zones in Table 16 (using the acute criterion (1,178 MPN/100 mL)) represent the TMDL goals to attain compliance with all applicable water quality standards for *E. coli* bacteria in segment SD-CH-R-BATTLE_02.

7.2.2. Segment SD-CH-R-BATTLE_01_USGS

The WLA for *E. coli* bacteria in Battle Creek segment SD-CH-R-BATTLE_01_USGS, Highway 79 to Cheyenne River is comprised of calculated discharge for the Hermosa WWTF. WLA for *E. coli* in segment SD-CH-R-BATTLE_01_USGS is based on possible discharge from the Hermosa WWTF which is a permission to discharge facility; but has never reported a discharge to Battle Creek. The WLAs for this facility represents permitted *E. coli* bacteria effluent limits for the Town of Hermosa WWTF (1,178 MPN/100 mL) multiplied by the design flow for the Town of Hermosa WWTF (discharge of 0.5 feet of wastewater drawdown per day in cell three, 0.23 MGD) and a conversion factor, resulting in 1.03 $*10^{10}$ MPN/day or 10 $*10^{9}$ MPN/day. The Hermosa WLA represents the *E. coli* effluent limit and accounts for possible loading from the facility in case of a permit-allowed discharge into segment SD-CH-R-BATTLE_01_USGS that could occur in all flow zones (Table 17).

Table 17 Acute *E. coli* TMDL for segment SD-CH_R_BATTLE_01_USGS of Battle Creek, Custer County, South Dakota 2011

Escherichia coli **TMDL for SD-CH-R-BATTLE_01_USGS (Acute)**

		Flow Zone				
		High	**Moist**	**Mid-Range**	**Dry**	**Low**
TMDL Component		**46-1,760 cfs**	**19 - 45 cfs**	**7 - 18 cfs**	**6 - 1.4 cfs**	**0.01 -1.3 cfs**
WLA (Hermosa)	(MPN * 10^9/Day)	10	10	10	10	10
LA	(MPN * 10^9/Day)	9,617	1,054	431	138	22
MOS	(MPN * 10^9/Day)	1,070	118	49	16	4
TMDL (95th Percentile)	(MPN * 10^9/Day)	10,697	1,182	490	164	35
Current Load (95th Percentile)	(MPN * 10^9/Day)	749,606	6,708	281	174	20
Load Reduction	(MPN * 10^9/Day)	738,909	5,526	0	10	0
Load Reduction %		99%	82%	0%	6%	0%

Current loading based on the acute *E. coli* TMDL exceeded water quality standards in the high, moist, and dry flow zones by 99 percent, 82 percent, and six percent, respectively; while the mid-range and low flow zones meet water quality standards (Table 17). The six percent exceedence percentage in the dry flow zones was below the less than 10 percent listing criteria. Based on this, current loading indicates that mid-range, dry, and low flow zones currently meet loading based on acute standards.

The TMDL goals for *E. coli* in segment SD-CH-R-BATTLE_01_USGS are based on the acute criterion (1,178 MPN/100 mL) in the high and moist flow zones (Table 17). These goals, when met, will attain compliance with all applicable water quality standards for *E. coli* bacteria in segment SD-CH-R-BATTLE_01_USGS.

The critical condition for segment SD-CH-R-BATTLE_01_USGS of Battle Creek watershed based on the *E. coli* TMDL is event-based runoff conditions with all water quality violations occurring in the high, moist flow zones.

8.0 Allocations and Recommendations

8.1 Wasteload Allocations (WLAs)

8.1.1. Fecal Coliform

Fecal coliform bacteria is one of the 303(d) listed parameters for segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS based on the 2012 Integrated Report with each segment having a permitted facility discharging or could discharge into Battle Creek. Wasteload allocations for fecal coliform are discussed below.

8.1.1.1. Segment SD-CH-R-BATTLE_02

The City of Keystone impacts Battle Creek via WWTF runoff that contributes fecal coliform bacteria loading. The wastewater treatment facility for the City of Keystone, located about 1.8 miles east of Keystone in the southeast ¼ of the northwest ¼ of Section 10, Township 2 South, Range 6 East, in Pennington County, South Dakota (Latitude 43° 53' 29.3", Longitude 103° 23' 23.9", Navigational Quality GPS). The City of Keystone's wastewater treatment facility, constructed in 1999 and serves a year-round population of 337 persons, with no known industrial users were contributing flow to the system. The summer months have an increased tourist population. The wastewater treatment facility has been designed to handle these extreme variations in flow. The average design flow of this facility is 150,000 gallons per day (gpd) in the winter and 300,000 gpd in the summer. After the wastewater leaves the clarification area and before being discharged, the wastewater is disinfected using ultraviolet (UV) disinfection before being discharged through a 6" Parshall flume for effluent flow measurement. This disinfection system includes two channels designed for a hydraulic detention time of seven seconds. Each channel is designed to treat the design peak flow of the plant. The UV system is the horizontal tube type with continuous monitoring of each bulb for UV transmittance. These systems are very effective in treating (killing) bacteria (fecal coliform and *E. coli*) in effluent discharge

Keystone was issued a discharge permit (Permit # SD0024007) in 2003 by SD DENR. As part of their permit, fecal coliform bacteria are routinely sampled five times per month from May 1st through September 30th each year. The new permit for the City of Keystone only is currently under a 30-day public notice and review with the final scheduled to be issued in 2013 also updated the bacteria indicator from fecal coliform to *E. coli* bacteria effluent limitations to ensure that water quality standards will be met during the recreation season. The effluent limitations for fecal coliform (2,000 CFU/100 mL) and *E. coli* bacteria (1,178 MPN/100 mL) in these permits are the surface water quality standards for recreational waters. The Keystone WWTF continuously discharges effluent into Battle Creek across from the lift station. The acute fecal coliform WLA for Keystone was calculated at $29 * 10^9$ CFU/day. The City of Keystone WWTF permit allows the City of Keystone to discharge effluent (to include fecal coliform) at or below standards listed above to Battle Creek and they have been and are currently operating in compliance with bacterial (fecal coliform) limits based on compliance monitoring (DMR) data.

8.1.1.2. Segment SD-CH-R-BATTLE_01_USGS

Hermosa has a wastewater treatment facility that could potentially discharge fecal coliform into segment SD-CH-R-BATTLE_01_USGS of Battle Creek. Hermosa was issued a discharge permit in 2009 by SD DENR (Permit # SD-0022349). As part of their permit, if and when they would need to discharge out of Outfall 001 they would need to obtain permission from the SD DENR. No discharge shall occur until permission has been granted by the Secretary. A system to land apply wastewater on 180 acres of farmland near the WWTF is available and is denoted as Outfall 002. The wastewater used for land application would originate from the second or third stabilization pond. The act of land application is not considered a discharge. The permittee shall not allow a discharge to occur from the land application site to waters of the state. If discharge were to occur, the permit outlines requirements, parameters (to include fecal coliform) and locations for sampling discharge. As of the date of this report, the Hermosa WWTF has not ever discharged to Battle Creek and has had minimal to no impact on fecal coliform concentrations in segment SD-CH-R-BATTLE_01_USGS of Battle Creek.

Point source fecal coliform production for segment SD-CH-R-BATTLE_01_USGS used the WLA for the Town of Hermosa WWTF calculated by SD DENR SWQP based on discharge of 0.5 feet of wastewater drawdown per day (0.23 MGD) in cell three and fecal coliform permit standards. The acute fecal coliform WLA for Keystone was calculated at $17 * 10^9$ CFU/day

8.1.2. *E. coli* Bacteria

Segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS of Battle Creek are listed as impaired for *E. coli* bacteria in the 2012 Impaired Waters List (SD DENR, 2012) with each segment having a permitted facility discharging or could discharge *E. coli* bacteria into Battle Creek. Wasteload allocations for *E. coli* bacteria are discussed below.

8.1.2.1. Segment SD-CH-R-BATTLE_02

Keystone was issued its latest discharge permit in 2003 (Permit # SD0024007) in 2003 by SD DENR. The current permit has been extended and is in the process of being revised and updated to include *E. coli* bacteria. Keystone was issued a discharge permit (Permit # SD0024007) in 2003 by SD DENR. As part of their permit, fecal coliform bacteria are routinely sampled five times per month from May 1st through September 30th each year. The new permit, currently under a 30-day public notice and review with the final scheduled to be issued in 2013, also updated the bacteria indicator from fecal coliform to *E. coli* bacteria effluent limitations to ensure that water quality standards will be met during the recreation season. The effluent limitations for *E. coli* bacteria (1,178 MPN/100 mL) in this permit are the surface water quality standards for recreational waters. The Keystone WWTF continuously discharges effluent into Battle Creek across from the lift station.

Point source *E. coli* production for segment SD-CH-R-BATTLE_02 used the WLA for the City of Keystone WWTF based on design flow and *E. coli* effluent limits. The *E. coli* standards are as follows: They shall not exceed 1,178 MPN per 100 milliliters in any one sample from May 1st to September 30th and shall not exceed a concentration of 630 MPN per 100 milliliters as a geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period, and they shall not exceed this value in more than 20 percent of the samples examined in this 30-day period.

The acute *E. coli* WLA for Keystone WWTF, calculated by SD DENR SWQP, was calculated at 17 * 10^9 MPN/day. The updated and revised City of Keystone WWTF permit will define the City of Keystone to discharge effluent (to include *E. coli*) to Battle Creek and will update sampling protocols to include *E. coli* to determine compliance with updated *E. coli* bacteria limits based on compliance monitoring data.

8.1.2.2. Segment SD-CH-R-BATTLE_01_USGS

Hermosa has a wastewater treatment facility that could potentially discharge *E. coli* bacteria into segment SD-CH-R-BATTLE_01_USGS of Battle Creek. Hermosa was issued a discharge permit in 2009 by SD DENR (Permit # SD0022349). As part of their permit, if and when they would need to discharge out of Outfall 001 they would need to obtain permission from the SD DENR. No discharge shall occur until permission has been granted by the Secretary. A system to land apply wastewater on 180 acres of farmland near the WWTF is available and is denoted as Outfall 002. The wastewater used for land application would originate from the second or third stabilization pond. The act of land application is not considered a discharge. The permittee shall not allow a discharge to occur from the land application site to waters of the state. If discharge were to occur, the permit outlines requirements, parameters (to include *E. coli*) and locations for sampling discharge. As of the date of this report, the Hermosa WWTF has not ever discharged to Battle Creek and has had minimal to no impact on bacteria concentrations in segment SD-CH-R-BATTLE_01_USGS of Battle Creek.

Point source *E. coli* production for segment SD-CH-R-BATTLE_01_USGS used the WLA for the Town of Hermosa WWTF calculated by SD DENR SWQP based on discharge of 0.5 feet of wastewater drawdown per day in cell three and *E. coli* permit limits. The acute *E. coli* WLA for Keystone was calculated at 10 * 10^9 MPN/day

8.2 Load Allocation (LA)

8.2.1. Fecal Coliform Bacteria

Fecal coliform load allocations for segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS of Battle Creek are discussed below.

8.2.1.1. Segment SD-CH-R-BATTLE_02

All excess fecal coliform loading in segment SD-CH-R-BATTLE_02 appears to originate within segment SD-CH-R-BATTLE_02 based on discharge data collected at USGS monitoring site 06404000 near Keystone, SD and 06406000 at Hermosa, SD, water quality monitoring data collected at SD WQM 17, DENR 460905, and assessment monitoring sites BATTLE03, BATTLE02A, and GRCOOL01. As discussed in Section 5.3.1.1, data from monitoring sites WQM 17 (DENR 460905), and BATTLE03 represent fecal coliform loading conditions in the upper 84.7 percent of the segment SD-CH-R-BATTLE_02 watershed (28.7 stream kilometers, 17.8 stream miles). Grace Coolidge Creek flows into segment SD-CH-R-BATTLE_02 downstream of monitoring site BATTLE03 and upstream of monitoring site BATTLE02A and was monitored three stream kilometers upstream of the confluence of Battle Creek at assessment monitoring site GRCOOL01 (Figure 2). During the study thirteen water quality and flow samples were collected during the recreation season to determine what impact the Grace Coolidge Creek watershed has on fecal coliform, *E. coli*, and TSS loading to Battle Creek. GRCOOL01 fecal coliform concentrations and loading values were well below water quality standards (zero exceedences) suggesting the Grace Coolidge watershed has little impact on fecal coliform concentrations and loading in Battle Creek segment SD_CH_R_BATTLE_02. Combining all data collected since 2001 above BATTLE03 and GRCOOL01 (77 samples) no water quality/loading samples exceeded acute water quality and TMDL daily loading standards in upper portion of the Battle Creek and Grace Coolidge watersheds based on load duration curve methodology

The remainder of segment SD_CH_R_BATTLE_02 from BATTLE03 and GRCOOL01 down to the end of the segment at Highway 79, monitoring sites BATTLE02A and monitoring site BTC03, saw a significant increase (85.7 percent and 46.7 percent, respectively) in fecal coliform concentration and loading exceedences.

This area is denoted in Figure 2 as the zone of impairment due to high exceedence percentages at BATTLE02A, Cheyenne River project BTC03, and downstream monitoring site BATTLE02. Within the zone of impairment of the segment SD-CH-R-BATTLE_02, landuse includes increased development all with septic systems, small family farms (hobby farms) with a variety of livestock (mostly horses and cattle), and individual residences. This area also has a few larger operations with cattle, limited row crops, pasture and rangeland. Possible sources of fecal coliform loading during base flow (low) conditions may include wildlife, domestic animals, livestock, and septic systems. Major BMPs recommended for this segment during base flows are to identify and repair failing septic systems in and around the alluvium, reduce livestock and domestic animals direct or sustained access to the stream or riparian zone, and improving livestock waste management storage and distribution.

Exceedence of the fecal coliform criteria also occurred during moderate to high flows and shows a different system response than during non-event sampling. Initial fecal coliform management issues are landuse practices along the stream during this time period. The majority of the load occurs during high and especially moist flow zone/event conditions.

The majority of loading from non-point sources based on production potentials is comprised of livestock and manure management on agricultural cropland, pastureland, and rangeland near Battle Creek. BMPs to address these sources should include riparian zone management, increasing the size and supplementing structure of the riparian zone, and significantly reducing prolonged livestock access to riparian zones through exclusion, limited short term, or flash grazing and off-stream watering. These practices are directed at livestock impacts on or adjacent to creeks and streams based on bacterial source production percentages in segment SD-CH-R-BATTLE_02 (Table 6) with the highest potential sources as cattle on range (84.3 percent) and wildlife (6.8 percent). Based on LDC TMDL analysis, current load based on the acute fecal coliform TMDL exceeded water quality standards by 96 percent in the high flow, 84 percent in the moist flow zone, 86 percent in the mid-range and 59 percent in the low flow; while the dry flow zone meets current water quality standards (Table 14).

8.2.1.2. Segment SD-CH-R-BATTLE_01_USGS

A significant load reduction in the high and moist flow zones will be required in segment SD-CH-R-BATTLE_01_USGS from Highway 79 to the confluence of the Cheyenne River. This segment of the watershed begins at Highway 79 just south of Hermosa and within one mile becomes very rural with widely scattered farms and ranches. The majority of the landuse in this segment is crop and pastureland with some fields irrigated by center pivot spray systems that are in and near the alluvial plain along sections of Battle Creek segment SD-CH-R-BATTLE_01_USGS. During the Battle Creek watershed assessment project 84 percent of the samples collected at BATTLE02 exceeded water quality and TMDL loading standards in the high and moist flow zones and were attributed to upstream segment SD-CH-R-BATTLE_02 loading. The remaining loading values in the segment were from downstream monitoring site BATTLE01 and Cheyenne River site BTC04.

Based on all available data, the TMDL specifies a 99 percent reduction in the fecal coliform loading in the high flow zone and 78 percent in the moist flow zone with the remaining flow zones meeting TMDL standards based on the acute criteria (Table 15). Initial fecal coliform management issues are landuse practices along the stream during this time period. The majority of the load occurs during high and especially the moist flow zone (event conditions). The majority of the landuse in this segment is herbaceous rangeland (87 percent) along with nine percent crop and pastureland. Possible sources of excess fecal coliform loading during high and moist flow conditions in this segment include riparian area grazing by livestock, manure application to cropland, pastureland, and rangeland, intensive grazing, and over-wintering livestock in the riparian zone. BMPs recommended for this segment consist of riparian zone management of livestock limiting access to the stream and flash grazing. This can be provided through grazing management, exclusionary fencing, alternative off-stream watering practices, and installation of livestock stream crossing structures.

The majority of loading from non-point sources based on production potentials is comprised of livestock and manure management on agricultural cropland, pastureland, and rangeland near Battle Creek. BMPs to address these sources should include riparian zone management, increasing the size and supplementing structure of the riparian zone, and significantly reducing the prolonged livestock access to riparian zones through exclusion, limited short term, or flash grazing and off-stream watering. These practices are directed at livestock impacts on or adjacent to creeks and streams based on bacterial source production percentages in segment SD-CH-R-BATTLE_01_USGS (Table 7) with the highest potential sources as cattle on range (78.5 percent) and wildlife (8.8 percent) and are similar to those from SD-CH-R-BATTLE_02. Based on LDC TMDL analysis, current loads will need to be reduced by approximately 99 percent in the high flow zone and 78 percent in the moist flow zone to meet the TMDL developed for this segment of Battle Creek.

8.2.2. *E. coli* Bacteria

8.2.2.1. Segment SD-CH-R-BATTLE_02

Flow zones requiring reductions to meet flow zone-specific *E. coli* bacteria TMDLs were similar to flow zones based on fecal coliform bacteria for this stream, segment SD-CH-R-BATTLE_02. Some of the *E. coli* loads in the low flow zone were estimated using regression analysis between fecal coliform and *E. coli* bacteria and applying the regression equation to fecal coliform concentrations in the low flow zone to predict *E. coli* concentrations and ultimately loading. Similar to segment SD-CH-R-BATTLE_02 for fecal coliform, combining all *E. coli* data collected above BATTLE03 and GRCOOL01 (78 samples) three water quality/loading samples collected at WQM 17 (DENR 460905 exceeded acute water quality standards and TMDL daily loading standards in upper portion of the Battle Creek and Grace Coolidge watersheds. In total, 95.3 percent of all the samples collected in segment SD_CH_R_BATTLE_02 above BATTLE03 and Grace Coolidge Creek watershed above GRCOOL01, met water quality and TMDL daily loading based on load duration curve methodology.

Based on all available data, the TMDL specifies a five percent reduction in the *E. coli* loading in the high flow zone, 92 percent in the moist flow zone, 18 percent in the mid-range flow zone 6 percent in the dry flow zone and 80 percent in the low flow zone based on the acute criteria (Table 16). Possible non point sources of excess *E. coli* loading during high, moist and dry flow zones in this segment include riparian area grazing by livestock, manure application to cropland, pastureland, and rangeland, intensive grazing, and over-wintering livestock in the riparian zone. Similar to fecal coliform, BMPs recommended for *E. coli* in this segment consist of riparian zone management of livestock limiting access to the stream and flash grazing. This can be provided through grazing management, exclusionary fencing, alternative off-stream watering practices, and installation of livestock stream crossing structures.

The majority of loading from non-point sources based on production potentials is comprised of livestock and manure management on agricultural cropland, pastureland, and rangeland near Battle Creek. BMPs to address these sources should include riparian zone management, increasing the size and supplementing structure of the riparian zone, and significantly reducing prolonged livestock access to riparian zones through exclusion, limited short term, or flash grazing and off-stream watering. These practices are directed at livestock impacts on or adjacent to creeks and streams based on bacterial source production percentages in segment SD-CH-R-BATTLE_02 (Table 6) with the highest potential sources as cattle on range (84.3 percent) and wildlife (6.8 percent). Based on LDC TMDL analysis, current loads will need to be reduced by approximately 78 percent to meet the TMDL developed for this segment of Battle Creek in the moist flow zone.

Non-point sources and flow zones requiring reductions for *E. coli* bacteria for segment SD-CH-R-BATTLE_02 were similar except for the dry flow zone to those identified for fecal coliform bacteria. Thus, all identified sources, reductions and BMPs outlined for fecal coliform in segment SD-CH-R-BATTLE_02 and realized reductions apply to the *E. coli* bacteria impairment of segment SD-CH-R- BATTLE_02.

8.2.2.2 Segment SD-CH-R-BATTLE_01_USGS

Non-point sources will require a significant load reduction in the high and moist and dry flow zones in segment SD-CH-R-BATTLE_01_USGS from Highway 79 to the confluence of the Cheyenne River. This segment of the watershed begins at Highway 79. During the Battle Creek watershed assessment project 100 percent of the samples collected at BATTLE02A in segment SD-CH-R-BATTLE_02 exceeded *E. coli* water quality standards and TMDL loading capacity in the high and moist flow zones; while 95 percent of the *E. coli* in segment SD-CH-R-BATTLE_01_USGS collected at BATTLE02 exceeded *E. coli* water quality standards and TMDL loading capacity in the high and moist flow zones. *E. coli* loading exceedences in upper segment SD-CH-R-BATTLE_01_USGS were attributed to upstream segment SD-CH-R-BATTLE_02 loading based on monitoring site BATTLE02A exceedence data and were similar to fecal coliform bacteria loadings except for the dry flow zone. The remaining *E. coli* loading values in this segment were from downstream monitoring site BATTLE01 and Cheyenne River site BTC04.

Based on all available data, the TMDL specifies a 99 percent reduction in the *E. coli* loading in the high flow zone, 82 percent in the moist flow zone and 6 percent in the dry flow zone. Only the mid-range and low flow zones meet TMDL standards based on the acute criteria (Table 17). Possible non-point sources of excess *E. coli* loading during high, moist and dry flow zones in this segment include riparian area grazing by livestock, manure application to cropland, pastureland, and rangeland, intensive grazing, and over-wintering livestock in the riparian zone. Similar to fecal coliform, BMPs recommended for *E. coli* in this segment consist of riparian zone management of livestock by limiting access to the stream and flash grazing. This can be provided through grazing management, exclusionary fencing, alternative off-stream watering practices, and installation of livestock stream crossing structures.

Exceedence of the *E. coli* criteria also occurred during lower flows and shows a different system response than during event sampling. Initial *E. coli* management issues are landuse practices along and within the stream during drier conditions (dry and low flow conditions). *E. coli* bacteria loading during these conditions are generally from livestock and wildlife defecating directly in or adjacent to the stream.

The majority of loading from non-point sources based on production potentials is comprised of livestock and manure management on agricultural cropland, pastureland, and rangeland near Battle Creek. BMPs to address these sources should include riparian zone management, increasing the size and supplementing structure of the riparian zone, and significantly reducing the prolonged livestock access to riparian zones through exclusion, limited short term, or flash grazing and off-stream watering. These practices are directed at livestock impacts on or adjacent to creeks and streams based on bacterial source production percentages in segment SD-CH-R-BATTLE_01_USGS (Table 7) with the highest potential sources as cattle on range (78.5 percent) and wildlife (8.8 percent) and are similar to those from SD-CH-R-BATTLE_02. Based on LDC TMDL analysis, current loads will need to be reduced by approximately 99 percent in the high flow zone and 82 percent in the moist flow zone, and 6 percent in the dry flow zone to meet the TMDL developed for this segment of Battle Creek.

9.0 Public Participation

Discussions were held with stakeholders, landowners and a private consultant about project issues and results along Battle Creek in 2011 and 2012. The project and WWTF were discussed with the Town of Hermosa engineer during an inspection in 2012. In April of 2013 a final presentation on project results and conclusions were presented at the VFW Hall in Hermosa, SD with approximately 20 people in attendance. All comments and public input from meetings, written, or personal communications and presentations regarding the Battle Creek fecal coliform and *E. coli* TMDL including US EPA comments were addressed and incorporated in the current document before and after the August public notice period. However, this document underwent a second public notice period in September of 2013 and was discussed at a second public presentation in Keystone, SD on September 26, 2013 (attended by approximately 25 people) for temperature, fecal coliform and *E. coli* TMDLs developed for Battle Creek. Attending this presentation was a representative of the US EPA Region 8 out of Denver, Colorado who fielded many questions about these projects from attendees. Specific responses to US EPA and public comments received during the September public notice period received by October 1, 2013 are attached and addressed in Appendix C.

10.0 Monitoring Strategy

During the development/design phase of the project, sample data from this study and some supplemental exploratory sampling may occur to better define and target areas of concern and determine appropriate or optimal BMPs to install to address and reduce excess bacterial loading and support a viable and efficient Project Implementation Plan (PIP) for Battle Creek. During and after the implementation of management practices, monitoring will be necessary to continue to track and assess BMP effectiveness and ultimately demonstrate TMDL attainment. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations on Battle Creek via existing and possibly future WQM monitoring sites sampled on a monthly basis during the recreation season (May through September). During the recreation season bacterial monitoring should be increased to collect at least 5 samples per month to monitor the geometric mean criterion. Additional monitoring and evaluation efforts should be targeted toward rural BMPs to document the effectiveness of implemented BMPs. Battle Creek monitoring locations should be based on the location and type of BMPs installed.

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

11.0 Reasonable Assurance

Battle Creek segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS are impaired by both point and non-point sources. When a TMDL is developed for waters impaired by both point and nonpoint sources and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. Reasonable assurance ensures that a TMDL's WLA and load allocations are properly calibrated to meet the applicable water quality standards.

Reasonable assurance of the TMDL established for SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS in Battle Creek will require a comprehensive approach that addresses:

- Wastewater discharges under NPDES permits.
- Non-point source pollution.
- Existing and potential future sources, and
- Regulatory and voluntary approaches.

There is reasonable assurance that the goals of these TMDLs established for Battle Creek can be met with proper planning between state and local regulatory agencies, organizations and stakeholders, BMP implementation, and access to adequate financial resources.

The TMDL wasteload allocation (WLA) for segment SD-CH-R-BATTLE_02 is from the City of Keystone WWTF that is regulated through the City of Keystone NPDES permit; while the WLA for segment SD-CH-R-BATTLE_01_USGS is from the Town of Hermosa WWTF which is regulated by the Town of Hermosa NPDES permit.

11.1 Point Sources

The City of Keystone WWTF located in upper portion of segment SD-CH-R-BATTLE_02 continues to operate in compliance with their NPDES permit and has been upgrading their treatment system with new technology to improve plant efficiencies and water quality in Battle Creek.

City of Keystone WWTF

- Continue scheduled sewer repair.
- Continue upgrading treatment system as new technologies become available.
- Extend ultra-violet effluent treatment from the recreation season (May through September) to year round to help reduce fecal coliform/*E. coli* concentrations in Battle Creek which may decrease or control possible sediment source bacterial re-suspension during higher event flows.

Town of Hermosa WWTF

- Continue scheduled WWTF and as needed sewer repair
- Continue upgrading treatment system as new technologies become available

Previous and continued commitment and support from local governments (City of Keystone and the Town of Hermosa) to permit compliance, facility improvement, and improving water quality provide a reasonable assurance that future efforts in point source reduction and control will continue towards achieving TMDL targets and improved water quality in the Battle Creek watershed.

11.2 Non-point Source

Pennington County has adopted On-Site Wastewater Treatment Ordinances regulating septic systems within Pennington County, Ordinance NO 34-08. This ordinance requires periodic inspections of on-site treatment systems throughout Pennington County which includes segment SD-CH-R-BATTLE_02 of Battle Creek beginning at Teepee Gulch Creek and ending at the Pennington County line. If deficiencies are found during an inspection timely mitigation is required. This ordinance is scheduled to be fully implemented by 2016 (Brittney Molitor, Pennington County - Water Protection Coordinator, personal communication, 2013) and should reduce fecal coliform and *E. coli* concentrations in segments SD-CH-R-BATTLE_01 and 15.5 stream kilometers (9.6 stream miles) of SD-CH-R-BATTLE_02 in Pennington County.

There are many active watershed groups that provide watershed stewardship and have vested interest in the Battle Creek watershed. These include the City of Keystone, the Town of Hermosa, Pennington County, Custer County, South Dakota GFP, Pennington County Conservation District, Natural Resource Conservation Service, Black Hills Fly Fishers, Cheyenne River Watershed Partnership, South Dakota School of Mines and Technology, and the United States Geological Survey. Some of these groups have supported the Battle Creek Assessment Project with comments, data, and/or technical support and are eager to plan and support an upcoming implementation project.

Pennington County is committed to reducing non-point source bacterial concentrations in Battle Creek by enacting on-site wastewater treatment ordinances requiring inspections and mitigation. The past and present support from local governments and the substantial number of active watershed groups that support an implementation project in Battle Creek provides reasonable assurance those future efforts in non-point source reductions achieving TMDL targets and improved water quality in the Battle Creek watershed.

Reasonable assurance for non-point sources by segment in Battle Creek will be accomplished through methods and projects outlined in Section 12.0 Restoration Strategy but are not exhaustive.

12.0 Restoration Strategy

Implementation of BMPs is required to achieve the recommended TMDLs for Battle Creek. The study area is represented by two segments 1) Teepee Gulch Creek to Highway 79 (SD-CH-R-BATTLE_02, and 2) Highway 79 to the Cheyenne River (SD-CH-R-BATTLE_01_USGS).

The recommended priority for implementation of BMPs is the lower end of segment SD-CH-R-BATTLE_02, and segment SD-CH-R-BATTLE_01_USGS, respectively. Lower portion of segment SD-CH-R-BATTLE_02 is clearly higher priority because of the current loading documented in this report than the lower portion of segment SD-CH-R-BATTLE_01_USGS near the Cheyenne River. However, the priority difference between segment SD-CH-R-BATTLE_02, and segment SD-CH-R-BATTLE_01_USGS is not significant. Priority ranking was based on the overall percent exceedence reductions required within each segment. The higher loading percentages seen in the upper portion of segment SD-CH-R-BATTLE_01_USGS were from loading originating in the lower portion segment SD-CH-R-BATTLE_02.

Within segment SD-CH-R-BATTLE_02, BMPs that reduce fecal coliform/*E. coli* loads should include but are not limited to:

- management practices to improve and protect the riparian buffer zone through grazing management practices, exclusionary BMPs with off-stream watering and residential zoning,
- implementation of the septic system inspection program within Battle Creek to document the condition of existing septic tank systems, identify failing systems and develop a mechanism/program to repair or replace failing systems

For segment SD-CH-R-BATTLE_01_USGS, a significant reduction in fecal coliform/*E. coli* will take place with implementation of BMPs upstream and should include but are not limited to:

- management practices to improve and protect the riparian buffer zone through grazing management practices, exclusionary BMPs with off-stream watering and vegetation development,
- riparian and stream bank erosion control measures, and
- development of cattle crossing areas for reduced stream access and erosion

The Lower Cheyenne River Watershed Assessment Project has recently been completed and broad support to begin an implementation project is evident. Battle Creek is part of the Cheyenne River watershed and could be included in a larger, basin-wide implementation project. Major entities that could be involved in planning, funding and supporting this project as it pertains to Battle Creek are: West Dakota Water Development District, Pennington and Custer Counties, Pennington and Custer County Conservation Districts, Cheyenne River Partnership and the Natural Resource Conservation Service.

Funds to implement watershed water quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Non-point Source Program. USDA programs may also provide cost share for certain BMPs and local organizations often contribute in-kind services and funding.

13.0 Literature Cited

ARSD 74:51:01 – 74:51:03. South Dakota Administrative Rules. Accessed May 23, 2008 at URL http://legis.state.sd.us/rules/DisplayRule.aspx?Rule=74:51:01

Cleland, B. 2003. TMDL Development from the "Bottom Up"-Part III: Duration Curves and Wet-Weather Assessments. America's Clean Water Foundation, Washington, DC.

Huxoll, Cory, 2002. South Dakota Game Fish and Parks; South Dakota Game Report No. 2003-11; 2002 Annual Report County Wildlife Assessments with a summary of the 1991- 2002 Assessments.

Martin, J.E., Sawyer, J.F., Fahrenbach, M.D., Tomhave, D.W., and Schulz, L.D., 2004, Geologic map of South Dakota: South Dakota Geological Survey General Map 10, scale 1:500,000

NASS, 2009. South Dakota Agriculture 2009. United States Department of Agriculture's National Agricultural Statistics Service, South Dakota Field Office. Sioux Falls, SD. 136 pp.

SD DENR. 2004. The 2004 South Dakota integrated report for surface water quality assessment. South Dakota Department of Environment and Natural Resources. Pierre, SD.

SD DENR. 2005. Standard operating procedures for field samplers volume I – tributary and in-lake sampling techniques: South Dakota Department of Environment and Natural Resources, Pierre, SD

SD DENR. 2006. The 2006 South Dakota integrated report for surface water quality assessment. South Dakota Department of Environment and Natural Resources, Pierre, SD.

SD DENR. 2008. The 2008 South Dakota integrated report for surface water quality assessment. South Dakota Department of Environment and Natural Resources, Pierre, SD.

SD DENR. 2010. The 2010 South Dakota integrated report for surface water quality assessment: South Dakota Department of Environment and Natural Resources, Pierre, SD.

SD DENR. 2011. Water Resources Assistance Program Quality Assurance Project Plan, Revision III: South Dakota Department of Environment and Natural Resources, Pierre, SD.

SD DENR. 2012. The 2012 South Dakota integrated report for surface water quality assessment: South Dakota Department of Environment and Natural Resources, Pierre, SD.

US EPA (U.S. Environmental Protection Agency). 2000. *Bacterial Indicator Tool User's Guide*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-823-B-01-003.

US EPA. 2007. *An Approach for Using Load Duration Curves in Developing TMDLs*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Washington, DC.

US EPA. 2007. *Options for Expressing Daily Loads in TMDLs* (EPA 841-R-07-006). U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, Washington, DC.

USGS. 2010. Unpublished data provided by the United States Geological Survey, South Dakota District Office.

USDA. 1990. Soil Survey of Custer and Pennington Counties, Black Hills Parts, South Dakota. United States Department of Agriculture, Soil Conservation Service and Forest Service, in cooperation with the South Dakota Agricultural Experiment Station, 295 pp.

USDA. 1996. Soil Survey of Custer and Pennington Counties, Prairie Parts, South Dakota. United States Department of Agriculture, Soil Conservation Service and Forest Service, in cooperation with the South Dakota Agricultural Experiment Station, 288 pp.

APPENDIX A:
Battle Creek Fecal Coliform and *E. coli* Bacteria Samples and QA/QC Tables

Table A1. Battle and Grace Coolidge Creeks routine and event fecal coliform and *E. coli* bacteria monitoring samples collected during the Battle Creek Assessment in 2011.

	Battle Creek Assessment Project (2011)														
	BATTLE01			BATTLE02A			BATTLE02			BATTLE03			GRCOOL01		
Sample Date	Discharge[1] CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml	Discharge[1] CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml	Discharge[1] CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml	Discharge[1] CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml	Discharge[1] CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml
05/03/2011	20*	150	96												
05/05/2011	18*	140	206												
05/09/2011	18*	200	345												
05/10/2011	21*	240	326												
05/17/2011	18*	130	214												
05/18/2011	20*	170	397												
05/19/2011	34*	2,000	2,450												
05/25/2011	192*	2,100	3,080												
05/26/2011	209*	2,700	5,200												
05/31/2011	577*	11,000	9,678												
06/01/2011	310*	2,300	2,910												
06/02/2011	212*	1,700	2,070												
06/07/2011	90*	600	406												
06/09/2011	73*	290	318												
06/15/2011	61*	120	127												
06/20/2011	50*	160	147												
06/27/2011	45*	120	104												
06/30/2011	43*	120	122												
07/11/2011	42*	580	687												
07/20/2011	29*	220	281												
07/21/2011	29*	260	326												
07/22/2011	30*	150	133												
07/25/2011	32*	220	170				44*	2,800	7,950						
07/26/2011	62*	280	268				34*	12,000	9,678						
07/27/2011	46*	2,600	5,200				34*	4,600	9,680						
07/28/2011	37*	1,200	1,840				33*	5,000	9,678						
08/01/2011	28.4	160	85				30*	9,600	9,678						
08/08/2011	40.6	540	410				31*	11,000	15,400						
08/09/2011	44.2	800	630	25.0	2,100	3,930	25.0	3,100	3,310						
08/10/2011	35.1	250	410	25.0	1,700	2,280	25.0	2,200	4,430	13.4	10	1	15.4	28	100
08/15/2011	30.2	50	100	24.1	8,100	19,200	24.1	4,400	7,710	12.3	10	1	14.4	40	100
08/18/2011	30*	160	187	23.2	9,800	24,200	23.2	2,000	3,650	12.0	26	10	15.2	100	86
08/22/2011	28.4	40	200	22.4	13,000	14,000	22.4	3,900	3,450	12.2	28	41	14.8	66	20
08/25/2011	23.6	44	100	20.2	5,600	6,200	20.2	2,800	6,130	12.3	16	1	13.2	60	100
08/29/2011	23.6	540	630	19.0	9,600	7,540	19.0	3,100	5,200	13.6	86	100	13.3	240	310
08/30/2011				21.1	9,200	14,200				11.6	56	75			
09/19/2011	23.6	120	100	19.3	6,000	6,970	19.3	4,300	4,950	11.1	2	1	11.4	56	1
09/20/2011	21.1	50	1	19.8	4,200	2,130	19.8	2,600	2,950	11.4	12	1	11.3	100	200
09/21/2011	22.7	38	100	20.4	13,000	12,200	20.4	3,400	6,130	10.3	2	1	11.5	20	100
09/22/2011	21.5	44	100	20.5	1,700	2,530	20.5	1,800	3,090	11.1	2	1	11.6	58	1
09/26/2011	22.4	110	205	17.8	6,400	6,770	17.8	2,200	2,400	10.9	2	1	10.6	54	150
09/27/2011	21*	72	100				19.8	1,300	3,920						
09/28/2011	20.6	88	1	19.0	22,000	16,300				11.1	32	1	11.0	130	260
09/29/2011										10.5	12	20	11.2	34	63
Total		42	42		14	14		19	19		14	14		13	13
Exceeds Daily Max		5	8		12	14		16	19		0	0		0	0
Percent Exceeds		11.9%	19.0%		85.7%	100.0%		84.2%	100.0%		0.0%	0.0%		0.0%	0.0%

[1]= Instantaneous discharge
***=Daily average discharge USGS**

Table A2. Battle Creek routine monthly monitoring of fecal coliform and *E. coli* bacteria samples collected during the recreation season (May 1 through September 30) in 2001 through 2011.

	Ambient Water Quality Monitoring Data (2001 through 2011)		
	WQM 17		
Sample Date	**Discharge***	**Fecal Coliform (CFU/100ml)**	***E. coli* (MPN/100ml)**
05/21/2001	9.3	25	9
06/13/2001	19.0	84	15
07/16/2001	22.0	62	42
08/27/2001	2.3	5	0
09/19/2001	4.3	5	18
05/15/2002	14.0	8	0
06/10/2002	4.1	12	10
07/23/2002	2.5	290	0
08/26/2002	0.02	400	6
09/17/2002	0.69	400	2
05/13/2003	23.0	0	0
06/09/2003	8.2	6	0
07/16/2003	0.13	320	42
08/19/2003	0.31	220	150
05/18/2004	1.5	1,700	2,420
06/09/2004	1.1	52	69
07/06/2004	1.7	54	72
09/15/2004	0.53	540	488
05/04/2005	1.3	720	2,420
06/22/2005	4.3	400	1,300
07/18/2005	2.3	310	260
08/16/2005	5.6	54	82
05/18/2006	2.8	200	411
06/21/2006	3.5	88	45
07/12/2006	0.39	120	228
08/15/2006	0.10	450	727
09/21/2006	0.05	810	2,420
05/16/2007	2.2	180	313
06/20/2007	1.3	390	416
09/11/2007	0.23	260	479
05/15/2008	11.0	10	0
06/10/2008	24.0	22	30
07/07/2008	14.0	390	259
08/18/2008	3.0	30	56
09/29/2008	0.70	16	34
05/21/2009	15.0	28	52
06/30/2009	12.0	96	110
07/23/2009	11.0	12	34
08/24/2009	3.3	26	26
09/14/2009	7.5	54	99
05/26/2010	229.0	110	61
06/09/2010	35.0	30	49
07/22/2010	16.0	40	50
08/25/2010	1.4	410	436
09/22/2010	1.2	120	86
05/18/2011	9.4	22	47
06/21/2011	29.0	110	105
07/19/2011	7.5	150	291
08/17/2011	3.9	48	154
09/21/2011	1.8	8	13
Total		50	50
Exceeds Daily Max		0	4
Percent Exceeds		0.0%	8.0%

*** = Daily average discharge USGS**

Table A3. Battle Creek fecal coliform and *E. coli* bacteria samples collected during the recreation season (May 1 through September 30) from the Lower Cheyenne River Watershed Project in 2007 through 2009.

	Lower Cheyenne River Assessment Data (2007 through 2009)					
	BTC03			BTC04		
Sample Date	Discharge* CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml	Discharge* CFS	Fecal Coliform CFU/100ml	*E. coli* MPN/100ml
05/30/2007	1.6	170		0.20	640	
06/12/2007	1.6	940				
07/10/2007	0.4	2,000				
08/13/2007	0.4	20,000				
08/17/2007	1,140.0	40,000				
08/18/2007	187.0	4,000		583.0	140,000	
08/23/2007	2.2			9.9	1,000	
09/16/2007	1.9	470		0.4	2,000	
05/14/2008	2.2	140		1.1	90	
06/02/2008	51.0	970		332.0	33,000	
06/17/2008	5.4	3,000		15.0	490	
07/10/2008	6.2	2,000		9.1	290	
07/18/2008	4.7			9.1	700	
08/06/2008	5.2	20,000		2.5	2,900	
08/10/2008	13.0	2,000,000		16.0	3,500	
09/16/2008	4.1	2,800	2,420	3.0	1,100	870
05/19/2009	8.3	1,600	2,420	8.6	80	122
Total		15	2		13	2
Exceeds Daily Max		7	2		4	0
Percent Exceeds		46.7%	100.0%		30.8%	0.0%

*** = Daily average discharge USGS**

Table A4. Keystone WWTF fecal coliform bacteria statistics from an EPA database[1]

	Fecal Coliform	
Date	**30-Day Maximum**	**30-Day Geometric Mean**
5/31/2008	10	5.07
6/30/2008	3	2.16
7/31/2008	12	2.94
8/31/2008	56	7.4
9/30/2008	6	3.56
5/31/2009	2	2
6/30/2009	64	9.12
7/31/2009	130	12.6
8/31/2009	89	35
9/30/2009	82	51.1
5/31/2010	54	6.22
6/30/2010	140	32.4
7/31/2010	1,000	331
8/31/2010	54	24
9/30/2010	46	16.6
5/31/2011	1,900	741.3
6/30/2011	74	15.34
7/31/2011	1,800	981.9
8/31/2011	95	9.12
9/30/2011	17	6.45
5/31/2012	4	2.38
6/30/2012	140	19.31
7/31/2012	120	68.13
8/31/2012	52	22.14
9/30/2012	110	26.56

[1] = *E coli* data was not available from the database because the *E. coli* bacteria standards did not apply to the facility until the new permit was issued in July 2013.

Table A5. Quality Assurance Quality Control blank sample analysis for samples collected on Battle and Grace Coolidge Creeks in 2011.

Project	Sample Date	Sample Time	Site	Fecal Coliform CFU/100mL	*E. coli* MPN/100mL
Battle Creek	05/03/2011	11:16	BATTLE01	2	1
Battle Creek	05/10/2011	9:40	BATTLE01	2	1
Battle Creek	06/07/2011	9:20	BATTLE01	2*	1
Battle Creek	07/20/2011	10:45	BATTLE01	2	1
Battle Creek	08/09/2011	13:55	BATTLE02	2	1
Battle Creek	08/15/2011	14:15	GRCOOL01	2	1
Battle Creek	08/25/2011	8:45	BATTLE03	2	1
Battle Creek	09/19/2011	9:35	BATTLE02A	2	1
Battle Creek	09/28/2011	9:30	GRCOOL01	2	1
Standard Deviation				0	0
Mean				2	1
QA/QC Criteria Met				TRUE	TRUE

*** = Original blank sample analyzed using high detection limit so laboratory blank was used.**

Table A6. Quality Assurance Quality Control for precision using relative percent difference analysis for fecal coliform and *E. coli* samples collected on Battle and Grace Coolidge Creeks in 2011.

Site	Date	Time	Type	Fecal Coliform Bacteria CFU/100mL	*E. coli* Bacteria MPN/100mL
BATTLE01	05/03/2011	11:16	Grab	150	96
BATTLE01	05/03/2011	11:16	Replicate Grab	120	96
			Relative Percent Difference	5.6%	0.0%
BATTLE01	05/10/2011	9:40	Grab	240	326
BATTLE01	05/10/2011	9:40	Replicate Grab	270	326
			Relative Percent Difference	2.9%	0.0%
BATTLE01	06/07/2011	9:20	Grab	600	406
BATTLE01	06/07/2011	9:20	Replicate Grab	400	534
			Relative Percent Difference	10.0%	6.8%
BATTLE01	07/20/2011	10:45	Grab	220	281
BATTLE01	07/20/2011	10:45	Replicate Grab	210	208
			Relative Percent Difference	1.2%	7.5%
BATTLE02	08/09/2011	13:55	Grab	3100	3310
BATTLE02	08/09/2011	13:55	Replicate Grab	2600	3310
			Relative Percent Difference	4.4%	0.0%
GRCOOL01	08/15/2011	14:15	Grab	40	100
GRCOOL01	08/15/2011	14:15	Replicate Grab	46	100
			Relative Percent Difference	3.5%	0.0%
BATTLE03	08/25/2011	8:45	Grab	16	0.5*
BATTLE03	08/25/2011	8:45	Replicate Grab	20	0.5*
			Relative Percent Difference	5.6%	0.0%
BATTLE02A	09/19/2011	9:35	Grab	6000	6970
BATTLE02A	09/19/2011	9:35	Replicate Grab	6200	6370
			Relative Percent Difference	0.8%	2.2%
GRCOOL01	09/28/2011	9:30	Grab	130	260
GRCOOL01	09/28/2011	9:30	Replicate Grab	150	100
			Relative Percent Difference	3.6%	22.2%

Shaded = Exceeds the QA/QC criteria RPD $\geq$ 20 percent
*** = Reported values were below detection limit, values shown are 1/2 the detection limit for specific parameter**

Table A7. Quality Assurance Quality Control for precision using log ranges analysis for fecal coliform and *E. coli* samples collected on Battle and Grace Coolidge Creeks in 2011.

Site	Date	Time	Type	Fecal Coliform Bacteria CFU/100mL	Range	Meets QA/QC Criteria	E-coli Bacteria MPN/100mL	Range	Meets QA/QC Criteria
BATTLE01	05/03/2011	11:16	Grab	150	2.18		96	1.98	
BATTLE01	05/03/2011	11:16	Replicate Grab	120	2.08		96	1.98	
					0.097	TRUE		0.000	TRUE
BATTLE01	05/10/2011	9:40	Grab	240	2.38		326	2.51	
BATTLE01	05/10/2011	9:40	Replicate Grab	270	2.43		326	2.51	
					0.051	TRUE		0.000	TRUE
BATTLE01	06/07/2011	9:20	Grab	600	2.78		406	2.61	
BATTLE01	06/07/2011	9:20	Replicate Grab	400	2.60		534	2.73	
					0.176	TRUE		0.119	TRUE
BATTLE01	07/20/2011	10:45	Grab	220	2.34		281	2.45	
BATTLE01	07/20/2011	10:45	Replicate Grab	210	2.32		208	2.32	
					0.020	TRUE		0.131	TRUE
BATTLE02	08/09/2011	13:55	Grab	3,100	3.49		3,310	3.52	
BATTLE02	08/09/2011	13:55	Replicate Grab	2,600	3.41		3,310	3.52	
					0.076	TRUE		0.000	TRUE
GRCOOL01	08/15/2011	14:15	Grab	40	1.60		100	2.00	
GRCOOL01	08/15/2011	14:15	Replicate Grab	46	1.66		100	2.00	
					0.061	TRUE		0.000	TRUE
BATTLE03	08/25/2011	8:45	Grab	16	1.20		1	0.00	
BATTLE03	08/25/2011	8:45	Replicate Grab	20	1.30		1	0.00	
					0.097	TRUE		0.000	TRUE
BATTLE02A	09/19/2011	9:35	Grab	6,000	3.78		6,970	3.84	
BATTLE02A	09/19/2011	9:35	Replicate Grab	6,200	3.79		6,370	3.80	
					0.014	TRUE		0.039	TRUE
GRCOOL01	09/28/2011	9:30	Grab	130	2.11		260	2.41	
GRCOOL01	09/28/2011	9:30	Replicate Grab	150	2.18		100	2.00	
					0.062	TRUE		0.415	FALSE
				Σ Ranges	**0.65**	**Precision Criterion**	**Σ Ranges**	**0.70**	**Precision Criterion**
				Avg. Range	**0.07**	**0.2**	**Avg. Range**	**0.08**	**0.3**

Shaded = log range value above the precision criterion for one sample set of *E. coli* and was deemed unacceptable.

APPENDIX B:

Fecal Coliform and *E. coli* Log-Normal Distribution Critical Curves using Battle Creek Standard Deviations

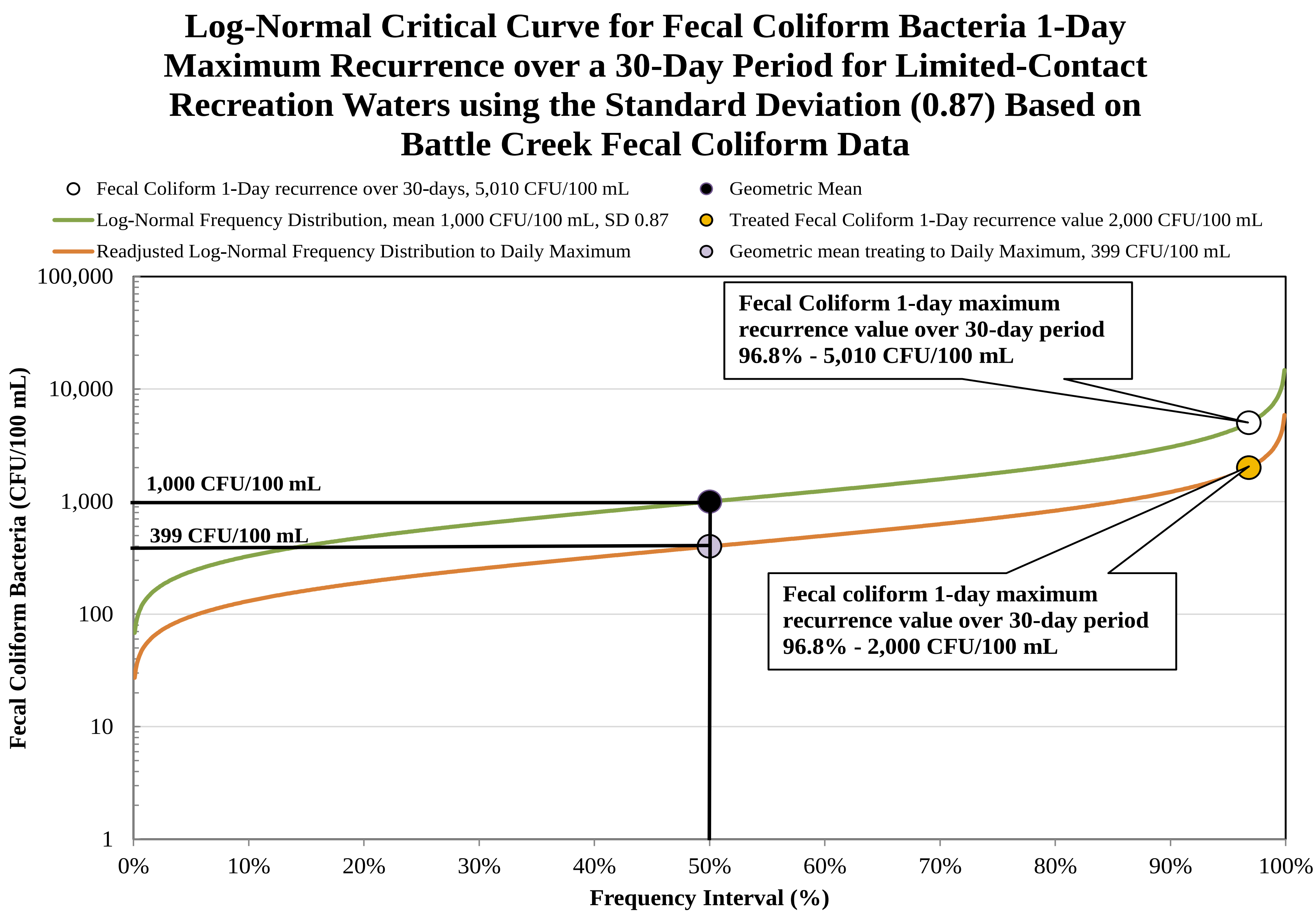


Figure B-1 Log-Normal distributions for fecal coliform using the watershed specific standard deviation of 0.87.

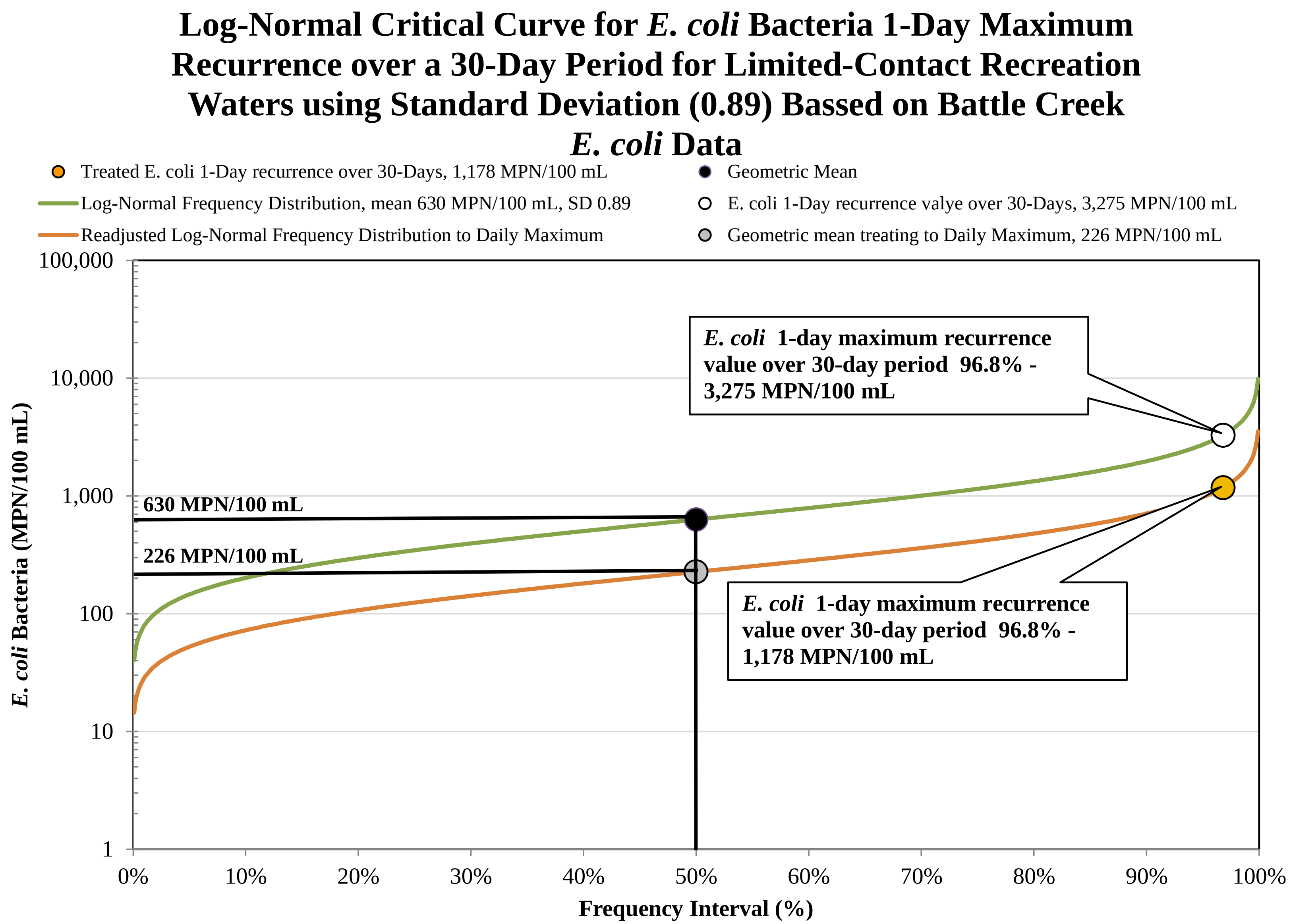


Figure B-2 Log-Normal distributions for *E. coli* using the watershed specific standard deviation of 0.89.

APPENDIX C:
Public Comments

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Fecal Coliform and Escherichia coli Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota**
Submitted by:	**South Dakota Department of Environment and Natural Resources**
Date Received:	**July 25, 2013**
Review Date:	**July 31, 2013**
Reviewer:	**Bonnie Lavelle**
Rough Draft / Public Notice / Final Draft?	**Public Notice Draft**
Notes:	

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

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

Approval Notes to the 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 TMDL review elements identified in the following 8 sections:

1. Problem Description
   a.… TMDL Document Submittal
   b. Identification of the Waterbody, Impairments, and Study Boundaries
   c. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   a. Data Set Description
   b. Waste Load Allocations (WLA)
   c. Load Allocations (LA)
   d. Margin of Safety (MOS)
   e. 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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ 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 ☐ N/A

Summary:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The South Dakota Department of Environment and Natural Resources (SD DENR) submitted this public notice draft version of the document "Fecal Coliform and Escherichia coli Bacteria Total Maximum Daly Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota" to EPA via email message on July 25, 2013 . The transmittal email clearly indicated that this document is a public notice draft. Comments from the public were requested by September 1, 2013.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 1.0, "Introduction and Watershed Description" (page 1) identifies the pollutant and waterbody segment that the TMDLs are established for.

Section 1.1, "CWA Section 303(d) Listing Information" (page 1) identifies the waterbody and associated impairment as they appear on the most current EPA-approved 303(d) list.

Figure 1, "Location of the Battle Creek watershed within South Dakota" (page 2) shows the Battle Creek watershed boundaries.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the general location of the waterbody along with locations of surface water sampling stations and tributaries.

Figure 3, "Underlying geology of the Battle Creek watershed, Pennington and Custer Counties, South Dakota" (page 8) shows the geology of the Battle Creek watershed.

Figure 4, "2006 Land uses in Battle Creek, Pennington and Custer Counties, South Dakota (page 9) show the land use patterns within the Battle Creek watershed.

This TMDL document addresses the fecal coliform and Escherichia coli bacteria impairments of Battle Creek segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS. These segments are listed on the 2012 EPA-approved 303(d) list as impaired for limited contact recreation use and were assigned a priority 1 (high-priority) in the 2012 South Dakota Integrated Report for Surface Water Quality Assessment (2012 IR).

Additionally, SD DENR designated segment SD-CH-R_BATTLE_01_USGS as threatened for warm water marginal fish life use in the 2012 IR due to elevated Total Suspended Solids (TSS). This impairment is also included in the 2012 EPA-approved 303(d) list. The TSS impairment was first listed on the 303(d) list in 2010.

Segment SD-CH-R-BATTLE_02 is listed on the 2012 EPA-approved 303(d) list as impaired for coldwater permanent fish life use due to elevated temperature. The temperature impairment was first listed in 2004.

The TSS and temperature impairments of these two segments will be addressed in separate TMDL summary documents.

The following table summarizes the waterbodies and bacteria impairments as they appear on the 2012 EPA-approved 303(d) list:

Waterbody AUID	**From**	**To**	**Impaired Use**	**Parameter**	**EPA Category**	**Priority**
SD-CH-R-BATTLE_01_USGS	SD Highway 79	Cheyenne River	Limited Contact Recreation	Fecal Coliform *Escherichia coli*	5	1
SD-CH-R-BATTLE_02	Teepee Gulch Creek	SD Highway 79	Limited Contact Recreation	Fecal Coliform *Escherichia coli*	5	1

Battle Creek is a perennial mountain stream located in Custer and Pennington Counties of South Dakota. Battle Creek is a tributary of the Cheyenne River, which flows into the Missouri River. The drainage area of Battle Creek is approximately 302 square miles (781 square kilometers) at the confluence with the Cheyenne River.

The bacteria impaired segments of Battle Creek have a combined length of 74 stream miles. The drainage area of the bacteria impaired segments is approximately 69.5 square miles.

Much of the upper portion of the watershed (segment SD-CH-R-BATTLE_02) is located within the Black Hills National Forest and is predominantly forested with ponderosa pine (73 percent) followed by herbaceous rangeland (13 percent) and cropland and pasture (4 percent).

The lower portion of the watershed (segment SD-CH-R-BATTLE_01_USGS) is dominated by herbaceous rangeland (87 percent), cropland and pastureland (9 percent), nonforested wetlands (2 percent), and forest (2 percent).

The area around Battle Creek is usually warm in summer with frequent hot days. In winter, cold periods occur when arctic air moves in from the north and northwest. Cold periods alternate with milder periods, which often occur when westerly winds are warmed as they move down slope.

Most precipitation falls as rain during the warmer part of the year. The precipitation is normally heaviest in late spring and early summer. Snow falls frequently in winter, but the snow cover usually disappears during the mild periods.

Average annual precipitation in the upper portion of the Battle Creek watershed in the Black Hills is approximately 18 inches (0.46 m) while the average annual precipitation in the lower portion of the watershed below South Dakota Highway 79 is 15.52 inches (0.39 m) based on Pennington and Custer Counties Soil Survey data. Snowfall in the Black Hills portion of the watershed averages approximately 45 inches while the lower portions of the watershed averages 32 inches. Over 75 percent of the annual precipitation occurs during the months of April through September.

Sources of Bacteria Loading to Battle Creek

The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. Keystone has a wastewater treatment facility (WWTF) that discharges into Battle Creek approximately 2.5 miles downstream of Highway 16A east of Keystone. Discharges from this facility are regulated by SD DENR through a NPDES discharge permit (Permit # SD0024007) issued in 2003.

The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. The City of Hermosa's WWTF is a three cell treatment facility with land application. Battle Creek flows to the south of the treatment facility and land application field. Discharges from the Hermosa WWTF are regulated by SD DENR through a NPDES permit issued in 2009 (Permit # SD0022349). The permit requires that Hermosa obtain permission from SD DENR before discharging to Battle Creek.

The major nonpoint sources of bacteria loading to the two impaired segments of Battle Creek are agricultural runoff, wildlife and human sources (leaking septic systems).

Water Quality Monitoring Stations in Segment SD-CH-R-BATTLE_02

WQM17

During the recreation season (May through September), SD DENR collects monthly fecal coliform and E. coli bacteria samples from Battle Creek at WQM 17 (also designated as DENR 460905) near Hayward, SD in segment SD-CH-R-BATTLE_02. This sampling is performed by SD DENR as part of the State-wide ambient surface water quality monitoring program. Since 1968, samples have been analyzed for fecal coliform. In 2001, E. coli analysis was added to the monitoring program at WQM17. USGS stream monitoring gage 06404000, "Battle Creek near Keystone, South Dakota" is also located at site WQM17.

BATTLE03

Monitoring station BATTLE03 is located within segment SD-CH-R-BATTLE_02, downstream of WQM17 and upstream of the confluence of Grace Coolidge Creek and Battle Creek. This monitoring site was established during the 2011 Battle Creek assessment project. A total of 14 samples were collected from this site in August and September in 2011 and were analyzed for both fecal coliform and E. coli bacteria.

GRCOOL01

Monitoring station GRCOOL01 is located within Grace Coolidge Creek, a tributary to Battle Creek. This monitoring site was also established during the 2011 Battle Creek assessment project and 13samples were collected in August and September in 2011 and were analyzed for both fecal coliform and E. coli bacteria.

BATTLE02A/BTC03
Monitoring station BATTLE02A on segment SD-CH-R-BATTLE_02 is the same station as BTC03. It was designated as BTC03 during the 2007-2009 Lower Cheyenne River watershed assessment project and was re-named BATTLE02A in 2011 during the follow-up Battle Creek assessment project. During the Lower Cheyenne River watershed assessment, 15 fecal coliform samples were collected monthly from 2007 through 2009 at station BATTLE02A/BTC03 in segment SD-CH-R-BATTLE_02. Only 2 of these samples were also analyzed for E. coli bacteria levels. In 2011, during the Battle Creek assessment project, samples were again collected in August and September from BATTLE02A/BTC03. A total of 14 samples were collected in 2011 and were analyzed for fecal coliform and E. coli bacteria.

Water Quality Monitoring Stations in Segment SD-CH-R-BATTLE_01_USGS

BATTLE02
Monitoring station BATTLE02 is co-located with USGS stream gage 0640600 "Battle Creek below Hermosa", in the upper reach of segment SD-CH-R-BATTLE_01_USGS. This monitoring site was also established during the 2011 Battle Creek assessment project and 19 samples were collected during July, August and September of 2011 and were analyzed for both fecal coliform and E. coli bacteria.

BATTLE01/BTC04
Monitoring station BATTLE01 on segment SD-CH-R-BATTLE_01_USGS is the same station as BTC04. It was designated as BTC04 during the 2007-2009 Lower Cheyenne River watershed assessment project and was re-named BATTLE01 in 2011 during the follow-up Battle Creek assessment project. During the Lower Cheyenne River watershed assessment, 13 fecal coliform samples were collected monthly from 2007 through 2009 at station BATTLE01/BTC04 in segment SD-CH-R-BATTLE_01_USGS. Only 2 of these samples were also analyzed for E. coli bacteria levels. In 2011, during the Battle Creek assessment project, samples were again collected from May through September from BATTLE01/BTC04. A total of 42 samples were collected in 2011 (multiple samples were collected each month) and were analyzed for fecal coliform and E. coli bacteria. BATTLE01/BTC04 is also the location of USGS stream gage 06406500

Comments: *No comments.*

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).

Review Elements:

☒ 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 identified 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

<u>Summary</u>:

<u>This TMDL document contains sufficient information to satisfactorily address the review elements for this section.</u>

Section 2.0, "Water Quality Standards" (page 13) and Table 5 "Numeric surface water quality standards by segment for Battle Creek, Pennington and Custer Counties, South Dakota 2012" (page 14 -16)describe the applicable State of South Dakota water quality standards for Battle Creek segments SD-CH-R_BATTLE_01-USGS and SD-CH-R-BATTLE_02.

Section 2.1, "Numeric Standards" (page 13) describes the beneficial uses assigned to Battle Creek segments SD-CH-R-BATTLE_USGS_01 and SD-CH-R-BATTLE_02.

Section 2.2, "Narrative Standards" (page 17) describes the applicable narrative standards for Battle Creek segments SD-CH-R_BATTLE_01-USGS and SD-CH-R-BATTLE_02.

The bacteria impaired segments of Battle Creek have been assigned the following beneficial uses:

- *fish and wildlife propagation, recreation, and stock watering;*
- *irrigation;*
- *coldwater permanent fish life propagation (SD-CH-R-BATTLE_02);*
- *warm water marginal fish life propagation (SD-CH-R-BATTLE_01_USGS);*
- *Limited contact recreation.*

The State of South Dakota water quality criteria for fecal coliform and E. coli are:

- *fecal coliform criteria protective of limited contact recreation use*
  - *no sample exceeds 2,000 CFU/100 mL and*
  - *the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period may not exceed 1,000 CFU/100 mL. The geometric mean, as defined in ARSD § 74:51:01:01 is the n^{th} root of a product of n factors. Also, this value may not be exceeded in more than 20% of the samples examined in this same 30-day period.*
  - *Fecal coliform water quality criteria are applicable from May 1 through September 30, the recreation season.*
- *E. coli criteria protective of limited contact recreation use*
  - *no sample exceeds 1,178 cfu/100 mL and*
  - *the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period may not exceed 630 cfu/100 mL.*
  - *E. coli water quality criteria are applicable from May 1 through September 30, the recreation season.*

The pollutants of concern for these TMDLs are fecal coliform and E. coli bacteria. The TMDLs have been developed to meet the State of South Dakota water quality standards for fecal coliform and E. coli bacteria that apply to segments SD-CH-R-BATTLE_USGS_01 and SD-CH-R-BATTLE_ 02.

Comments: *No comments.*

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, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 3.0, "TMDL Targets" (pages 17-20) identifies the numeric TMDL water quality targets for fecal coliform and E. coli for the impaired segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02.

The TMDL daily water quality targets selected for the 2 impaired segments of Battle Creek are:

- *Fecal coliform water quality target:* *no sample may exceed 2,000 cfu/100 mL (based on the acute WQC); applicable from May 1 through September 30, the recreation season.*
- *E. coli water quality target:* *no sample may exceed 1,178 cfu/100 mL (based on the acute WQC); applicable from May 1 through September 30, the recreation season.*

As discussed in the previous section, the State of South Dakota water quality standards for E. coli and fecal coliform have two parts, a daily maximum value intended to be compared to individual sample results and a 30-day value intended to be compared to geometric mean of 5 sample results collected *over a 30-day period. The geometric mean, as defined in ARSD §74:51:01:01 is the n^{th} root of the product of n factors.*

In order to demonstrate that the selection of the daily maximum water quality criteria as TMDL daily water quality targets will ensure that the TMDLs will also achieve the 30-day geometric mean water quality criteria for fecal coliform and E. coli, the following linkage analysis applies:

As stated in the EPA guidance document, "An Approach for Using Load Duration Curves in the Development of TMDLs" (EPA, 2007), EPA's development of ambient water quality criteria for bacteria, specifically E. Coli, defines the statistical relationship between the daily maximum criteria and the 30-day mean criteria. This relationship can be used to demonstrate that attaining the maximum daily water quality criteria as the TMDL target will also result in the attainment of the 30-day geometric mean criteria.

The concepts used to develop the "not to exceed" or "daily maximum" value are described in the EPA document "Ambient Water Quality Criteria for Bacteria -1986" (EPA, 1986). In particular, the relationship between the EPA recommended 30-day geometric mean criteria and the single sample maximum criteria for E. coli is based on the assumption that bacteria data can be described using a log normal frequency distribution. The method used to identify the upper target values in the 1986 EPA recommended water quality criteria for bacteria (EPA, 1986) provides the linkage analysis between the daily maximum value and the 30-day mean value.

The upper targets are based on the assumption of a log-normal distribution using a log standard deviation of 0.4 centered on the target geometric mean value. The upper target is defined in the WQS as a value not to be exceeded within a 30-day averaging period. The recurrence interval associated with a 30-day averaging period is (k/k+1) % or (30/31) % or 96.8%.

In the case of Battle Creek, for a lognormal distribution of E. coli with a geometric mean of 630 cfu/100mL and a log standard deviation of 0.4, the 96.8% recurrence interval value is 1322 cfu/100mL. Achieving the daily maximum WQC for E. coli of 1178 cfu/100ml (which is less than the 96.8% recurrence interval) will ensure that the geometric mean of 630 cfu/100mL E. coli will also be achieved. Thus, the TMDL daily water quality target for E. coli of 1178 cfu/100mL will be protective of the 30-day geometric mean WQC of 630 cfu/100mL.

Similarly, using the same assumptions, the TMDL daily water quality target for fecal coliform of 2000 cfu/100mL will be protective of the 30-day geometric mean WQC of 1000 cfu/100mL. This is because, for a lognormal distribution of fecal coliform with a geometric mean of 1000 cfu/100mL and a log standard deviation of 0.4, the 96.8% recurrence interval value is 2098 cfu/100mL.

Comments: *Since the linkage analysis includes the assumption that bacteria data are log normally distributed with a log standard deviation of 0.4, please include in Section 3.0 the log standard deviations of the bacteria levels measured during the recent monitoring of both segments of Battle Creek.*

SD DENR Response: Log-normal distribution standard deviations based on Battle Creek data were added to Section 3.0 of the TMDL summary report, graphed in Appendix B, and reads as follows.

Log-normal standard deviations for fecal coliform and E. coli bacteria based on data collected in Battle Creek were slightly higher at 0.87 and 0.89, respectively. Whether using watershed specific (Appendix B, Figures B-1 and B-2) or EPA guidance document standard deviations, treating the watershed to bacteria specific daily maximum (acute) standard values reduce 30-day geometric means for fecal coliform and E. coli bacteria below their geometric mean (chronic) standards. Since the guidance document log-normal standard deviation was more conservative than the watershed specific standard deviations; the log-normal standard deviation from the guidance document was used to provide linkage analysis between the not to exceed value used as the daily maximum TMDL target (acute standard) and the 30-day geometric mean (chronic standard).

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 identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. 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.

Review Elements:

☒ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the locations of the cities Keystone and Hermosa. Point sources are located in the general vicinity of these cities.

Section 4.0, "Significant Sources" (pages 20-23) describes the point sources and non point sources of bacteria loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD- CH-R-BATTLE _02.

Point Sources:

- *The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. The City of Keystone's wastewater treatment facility (WWTF) discharges into Battle Creek segment SD-CH-R-BATTLE_02 approximately 2.5 miles downstream of Highway 16A, east of Keystone. Discharges from the Keystone WWTF are regulated by SD DENR pursuant to NPDES Permit #SD0024007, issued in 2003. The permit requires routine sampling of discharges five times per month from May 1st through September 30th each year. Samples are analyzed for fecal coliform. The permit will also be updated in 2013 to include E. coli bacteria effluent limitations. The effluent limitations in the current permit are the fecal coliform daily maximum WQC of 2000 cfu/100mL. The effluent limitations in the new permit will include the daily maximum WQC for E. coli of 1178 cfu/100mL. The facility discharges to Battle Creek continuously. The most recent Discharge Monitoring Report data for the facility (2008 through 2012) indicate that discharges met the permit required effluent limitations during the recreation season.*

- *The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. Hermosa's WWTF, a three cell treatment facility with land application, discharges into Battle Creek segment SD-CH-R-BATTLE_01_USGS. SD DENR regulates these discharges pursuant to NPDES permit # SD0022349 issued in 2009. The permit requires the facility to obtain permission from SD DENR prior to discharging. Battle Creek flows to the south of the WWTF and land application field. As of the date of the TMDL document, the City of Hermosa has not discharged from the WWTF. The NPDES permit-required effluent limitations for the City of Hermosa WWTF are 2,000 cfu/100mL fecal coliform and 1178 cfu/100ml E. coli.*

The following table summarizes the point sources and their contribution to loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02:

FACILITY	***GEOGRAPHIC LOCATION***	***DESCRIPTION***	***NPDES PERMIT #***	***PERMIT LIMITS***	***POTENTIAL LOADING***
City of Keystone, SD Wastewater Treatment Facility	*northern portion of segment SD-CH-R-BATTLE_02*	*Continuous discharge mechanical plant with design flow of 0.38 MGD*	*SD0024007*	*Current:* *2,000 cfu/100 mL fecal coliform* *New:* *2,000 cfu/100mL fecal coliform, 1,178 cfu/100mL E. coli*	*29 x 10^9 cfu/day fecal coliform* *17 x 10^9 cfu/day E. Coli*
City of Hermosa, SD Wastewater Treatment Facility	*Northern portion of segment SD-CH-R-BATTLE_01_USGS*	*3 cell treatment facility with land application; design flow of 0.23 MGD*	*SD0022349*	*2,000 cfu/100mL fecal coliform,* *1,178 cfu/100mL E. coli*	*17 x 10^9 cfu/day fecal coliform* *10 x 10^9 cfu/day E. coli*

Non Point Sources:
Nonpoint sources of fecal coliform and E. coli bacteria loading to segments SD-CH-R-BATTLE_01 and SD-CH-R-BATTEL_01_USGS are:

1. ***Livestock:*** *Manure from livestock contributes bacteria loading to Battle Creek either directly (manure is deposited directly into the stream while livestock are wading) or indirectly (surface runoff from rangeland areas where manure has been deposited while livestock are grazing or are temporarily confined). Additionally, manure is applied to cropland, pasture, and rangeland in the lower portion of segment SD-CH-R-BATTLE_02 and segment SD-CH-R-BATTLE_01_USGS to improve crop and pasture/rangeland grass production. Livestock in the basin are predominantly beef and dairy cattle, horses and some sheep.*

   Livestock population densities in the watershed were estimated using National Agricultural Statistics Service data from the year 2009, which is summarized by county. For each category of livestock, per acre densities were calculated assuming an equal distribution of animals through the watershed. EPA's Bacterial Indicator Tool (BIT) was then used to estimate (model) the bacteria loading into Battle Creek based on the density of each type of livestock animal. The output of the BIT is fecal coliform loading in units of CFU per day. The BIT does not currently have the capability to provide estimated E. coli loading. However, since E. coli concentrations and fecal coliform concentrations are correlated in this watershed, the relative percent contributions of loading from the various types of livestock calculated from the BIT were assumed to apply to both fecal coliform and E. coli. The bacteria loading to Battle Creek *segment SD-CH-R-BATTLE _01_USGS from livestock sources was estimated to be 2.78 x 10^9 CFU/acre/day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from livestock sources was estimated to be 2.83 x 10^9 CFU/acre/day.*

2. ***Wildlife:*** *Wildlife contributes fecal coliform and E. coli loading to both segments of Battle Creek similar to livestock, i.e., both directly and indirectly. Wildlife is considered to be a background source of fecal coliform and E. coli loading. In order to estimate the fecal coliform and E. coli loading to Battle Creek from wildlife sources, wildlife population density estimates for the watershed were obtained from the South Dakota Department of Game, Fish and Parks (SD GF&P, 2002). The BIT was then used to estimate (model) the bacteria loading into Battle Creek in units of CFU per day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_01_USGS from wildlife sources was estimated to be 2.2 x 10^8 CFU/acre/day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from wildlife sources was estimated to be 2.1 x 10^8 CFU/acre/day.*

3. ***Human:*** *Failing residential septic systems within the Battle Creek watershed are nonpoint sources of fecal coliform and E. coli loading to Battle Creek. Outside of the cities Keystone and Hermosa, the majority of Battle Creek is relatively rural. Localized populations along Battle Creek within segment SD-CH-R-BATTLE_02 are Hayward area where Iron Creek enters Battle Creek downstream to WQM 17 and immediately west of Hermosa from Highway 79 to one mile west of the confluence of Grace Coolidge Creek and Battle Creek. Developments in these areas are within and along the watershed riparian areas. These developments are rural, with no centralized wastewater collection or treatment facilities. Thus, failing septic systems are assumed to be the primary human source of bacterial loads to Battle Creek. The number of occupied residences was estimated using SD Department of Transportation data from 2008. A fifteen percent failure rate was used to estimate human fecal/E. coli contributions from septic systems. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_01_USGS from leaking septic systems was estimated to be 4.8 x 10^7 CFU/acre/day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from leaking septic systems was estimated to be 6 x 10^7 CFU/acre/day.*

The total bacteria loading to Battle Creek segment SD-CH-R-BATTLE_01_USGS from nonpoint sources is estimated to be 2 x 10^9 CFU/day.

The total bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from nonpoint sources is estimated to be 3.1 x 10^9 CFU/day.

The following table summarizes the percent contribution of each nonpoint source of bacteria loading to the impaired segments of Battle Creek:

Non Point Source	***Estimated Percent of Total Non Point Source Bacteria Loading to Segment SD-CH-R-BATTLE_01_USGS***	***Estimated Percent of Total Non Point Source Bacteria Loading to Segment SD-CH-R-BATTLE_02***
Milk cows	*0.42%*	*0.36%*
Cattle on range	*78.53%*	*84.35%*
Cattle on feed	*1.45%*	*0.99%*
Sheep	*0.16%*	*0.15%*
Bison	*10.04%*	*5.41%*
Horses	*0.03%*	*0.02%*
Wildlife	*8.78%*	*6.76%*
Septic Tanks	*0.58%*	*1.93%*

Comments: *No comments.*

SD DENR Response: SD DENR believes that the partial approval recommendation of section 3 of this EPA Region 8 TMDL Review Form and Decision Document was an error and should have been recommended as approve. EPA was contacted and discussed the partial approval status of this section of the document. EPA stated that the partial approve category was made in error and should have been marked as approve.

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin of Safety

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Load duration curves were used to develop the fecal coliform and E. coli loading capacities for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02. Load duration curves provide flow-variable TMDLs that describe allowable loading that will ensure water quality targets are achieved for any flow along the entire long term flow regime for the recreation season (from May 1 through September 30) for each segment.

Segment SD-CH-R-BATTLE_01_USGS

The load duration curves for segment SD-CH-R-BATTLE_01_USGS were developed using the long term flow record from USGS monitoring site 06406500, "Battle Creek below Hermosa", where stream discharge has been measured since 1949. Daily average flows during the recreation season were multiplied by the TMDL water quality targets of 2000 cfu/100mL fecal coliform and 1178 cfu/100mL E. coli, resulting in loading capacities or TMDLs expressed as cfu/day.

Five flow zones were designated for the recreational season for segment SD-CH-R-BATTLE_01_USGS:

1. *High flow zone: Flows in this zone are exceeded 0-10% of the time and consist of flows between 45 cfs-1760 cfs.*
2. *Moist flow zone: Flows in this zone are exceeded 10-40% of the time and consist of flows between 18 cfs -44 cfs.*
3. *Mid-Range flow zone: Flows in this zone are exceeded 40-60% of the time and consist of flows between 6 cfs – 17 cfs*
4. *Dry flow zone: Flows in this zone are exceeded 60-90% of the time and consists of flows between 1.4 cfs – 5 cfs.*
5. *Low flow zone: Flows in this zone are exceeded 90-100% of the time and consist of flows between 0.01 cfs – 1.3 cfs.*

Figure 7 on page 29 of the TMDL document presents the fecal coliform load duration curve for this segment. Figure 10 on page 34 of the TMDL document presents the E. coli load duration curve for this segment.

For each of the five flow zones, the 95th percentile point on the loading capacity curve was selected as the TMDL for that flow zone. The following table summarizes the fecal coliform and E. coli TMDLs for segment SD-CH-R-BATTLE_01_USGS:

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{13} cfu/day*	*2.0×10^{12} cfu/day*	*8.3×10^{11} cfu/day*	*2.8×10^{11} cfu/day*	*5.9×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*1.1×10^{13} cfu/day*	*1.2×10^{12} cfu/day*	*4.9×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*3.5×10^{10} cfu/day*

An explicit margin of safety (MOS) was reserved to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit 10% MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity.

The fecal coliform and E. coli waste load allocations for the City of Hermosa WWTF (permit number SD0022349) were calculated based on the E. coli and fecal coliform TMDL water quality targets multiplied by the a discharge of 0.5 feet of wastewater drawn down per day from treatment cell three, 0.23 million gallons per day (MGD), and a conversion factor.

After accounting for the MOS and LA, the remaining loading capacity was allocated to nonpoint sources as the load allocations for both fecal coliform and E. coli. This results in balanced TMDL equations.

The balanced TMDL equations for segment SD-CH-R-BATTLE_01_USGS are presented in Table 15 (fecal coliform) and Table 17 (E. coli).

Segment SD-CH-R-BATTLE_02:

The load duration curves for segment SD-CH-R-BATTLE_02 were developed using the long term flow record from USGS monitoring site 06406000, "Battle Creek at Hermosa, SD", where stream discharge has been measured since 1950. Daily average flows during the recreation season were multiplied by the TMDL water quality targets of 2000 cfu/100mL fecal coliform and 1178 cfu/100mL E. coli, resulting in loading capacities or TMDLs expressed as cfu/day.

Five flow zones were designated for the recreational season for segment SD-CH-R-BATTLE_03:

1. *High flow zone: Flows in this zone are exceeded 0-10% of the time and consist of flows between 29 cfs-1750 cfs.*
2. *Moist flow zone: Flows in this zone are exceeded 10-40% of the time and consist of flows between 6 cfs -28 cfs.*
3. *Mid-Range flow zone: Flows in this zone are exceeded 40-60% of the time and consist of flows between 3.4 cfs – 5.9 cfs*
4. *Dry flow zone: Flows in this zone are exceeded 60-90% of the time and consists of flows between 1.4 cfs – 3.3 cfs.*
5. *Low flow zone: Flows in this zone are exceeded 90-100% of the time and consist of flows between 0.01 cfs – 1.3 cfs.*

Figure 6 on page 26 of the TMDL document presents the fecal coliform load duration curve for this segment. Figure 9 on page 32 of the TMDL document presents the E. coli load duration curve for this segment.

For each of the five flow zones, the 95th percentile point on the loading capacity curve was selected as the TMDL for that flow zone. The following table summarizes the fecal coliform and E. coli TMDLs for segment SD-CH-R-BATTLE_02:

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.2×10^{13} cfu/day*	*1.3×10^{12} cfu/day*	*2.7×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*6.4×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*6.8×10^{12} cfu/day*	*7.5×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*9.5×10^{10} cfu/day*	*3.7×10^{10} cfu/day*

An explicit margin of safety (MOS) was reserved to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit 10% MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity.

The fecal coliform and E. coli waste load allocations for the City of Keystone WWTF (permit number SD0024007) were calculated based on the E. coli and fecal coliform TMDL water quality targets multiplied by the 80th percentile flow from Discharge Monitoring Report data (0.38 million gallons per day (MGD)) and a conversion factor.

After accounting for the MOS and LA, the remaining loading capacity was allocated to nonpoint sources as the load allocations for both fecal coliform and E. coli. This results in balanced TMDL equations.

The balanced TMDL equations for segment SD-CH-R-BATTLE_02 are presented in Table 14 (fecal coliform) and Table 16 (E. coli).

Comments: ***No comments.***

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…).

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Since May 1968, SD DENR has collected surface water samples from monitoring location WQM17, "Battle Creek" (Storet number 460905). Samples collected during the recreation season have historically been analyzed for fecal coliform bacteria levels. Since the summer of 2001, samples collected during the recreation season have also been analyzed for E. coli bacteria levels. Samples are collected monthly at location WQM17.

In 2007-2009, surface water samples were collected from location BTC03 (same location as BATTLE02A) in segment SD-CH-R-BATTLE_02 and from location BTC04 (same location as

BATTLE01)in segment SD-CH-R-BATTLE_01_USGS. These samples were analyzed for both fecal coliform and E. coli bacteria levels.

In 2011, surface water samples were collected from locations BATTLE03 and BATTLE02A/BTC03 in segment SD-CH-R-BATTLE_02, and from location BATTLE 02 and BATTLE01/BTC04 in segment SD-CH-R-BATTLE_01_USGS. Surface water samples were also collected from location GRCOOL01 in Grace Coolidge creek, a tributary to Battle Creek. These samples were analyzed for both fecal coliform and E, coli bacteria levels.

These three sampling programs combined provide the following dataset:

Stream Segment	***# fecal coliform samples***	***# E. coli samples***
SD-CH-R-BATTLE_01_USGS	*76*	*77*
SD-CH-R-BATTLE_02	*93*	*85*
Total	*169*	*162*

The monitoring data for segment SD-CH-R-BATTLE_02 indicate that in the upper portion of the segment, fecal coliform and E. coli concentrations occur sporadically above the WQC protective of limited contact recreation use. These exceedances occur throughout all flow zones so they don't appear to be flow-related. However, in the downstream portions of this segment (from monitoring location BATTLE03 to the end of the segment) a dramatic increase in fecal coliform concentrations was detected in 2011. The frequency of exceeding the WQC increased from location BATTLE03 to the end of the segment.

These observations led SD DENR to collect samples more frequently (samples were collected every 1-3 days) within the lower portion of SD-CH-R-BATTLE_02 in the summer of 2011. The results of the intensive sampling in 2011 indicate that Grace Coolidge Creek does not contribute a significant loading of fecal coliform to Battle Creek and that the highest loading of fecal coliform to Battle Creek occurs in the limited area between monitoring sites BATTLE02A, BATTLE03, AND GRCOOL01. This area is illustrated in Figure 2.

The monitoring data for segment SD-CH-R-BATTLE _01_USGS indicate that in the upper portion of this segment, fecal coliform and E. coli concentrations exceed the WQC for limited contact recreation use during moist and high flow conditions. In the lower portions of this segment however, the WQC are achieved except during the highest flow conditions.

Limitations of the monitoring data include the following:

- *All data collected during the 2011 Battle Creek assessment project were collected during high and moist flow conditions.*
- *During the 2011 Battle Creek assessment project, samples were not collected at the same frequency at all locations. In 2011, no samples were collected at BATTLE03, GRCOOL01, BATTLE02A or BATTLE02 during May, June or July. Data from 2007-2009 and in 2011 at BATTLE01 indicate that the highest concentrations of bacteria tend to occur during the latter part of the recreation season, therefore it's likely that the available data capture the most critical time of the recreation season.*

- *There are only 2 E.coli samples available from 2007-2009 at locations BATTLE02A/BTC03 and BATTLE01/BTC04.*

Comments: *In the summary tables of data found in Appendix A (Tables A1 – A-3), for each sample result, please also provide the instantaneous flow measurements taken during the sample collection.*

SD DENR Response: Instantaneous flow measurements and when instantaneous measurements were not available, USGS daily average discharges were included into Appendix A, Tables A1 – A3 for reference. See Tables A1 – A3.

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The fecal coliform and E. coli TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 include WLAs for the individual NPDES permitted point source dischargers located within the watersheds of the segments.

The NPDES permitted point source dischargers are identified, including the specific NPDES permit numbers and geographical locations.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the locations of the cities Keystone and Hermosa. Point sources are located in the general vicinity of these cities.

Section 4.0, "Significant Sources" (pages 20-23) describes the point sources and nonpoint sources of bacteria loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD- CH-R-BATTLE _02.

Point Sources

- *The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. The City of Keystone's wastewater treatment facility (WWTF) discharges into Battle Creek segment SD-CH-R-BATTLE_02 approximately 2.5 miles downstream of Highway 16A, east of Keystone. Discharges from the Keystone WWTF are regulated by SD DENR pursuant to NPDES Permit #SD0024007, issued in 2003. The permit requires routine sampling of discharges five times per month from May 1st through September 30th each year. Samples are analyzed for fecal coliform. The permit will also be updated in 2013 to include E. coli bacteria effluent limitations. The effluent limitations in the current permit are the fecal coliform daily maximum WQC of 2000 cfu/100mL. The effluent limitations in the new permit will include the daily maximum WQC for E. coli of 1178 cfu/100mL. The facility discharges to Battle Creek continuously. The most recent Discharge Monitoring Report data for the facility (2008 through 2012) indicate that discharges met the permit required effluent limitations during the recreation season.*

- *The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. Hermosa's WWTF, a three cell treatment facility with land application, discharges into Battle Creek segment SD-CH-R-BATTLE_01_USGS. SD DENR regulates these discharges pursuant to NPDES permit # SD0022349 issued in 2009. The permit requires the facility to obtain permission from SD DENR prior to discharging. Battle Creek flows to the south of the WWTF and land application field. As of the date of the TMDL document, the City of Hermosa has not discharged from the WWTF. The NPDES permit-required effluent limitations for the City of Hermosa WWTF are 2,000 cfu/100mL fecal coliform and 1178 cfu/100ml E. coli.*

<u>*The following table summarizes the point sources and their WLAs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02:*</u>

FACILITY	***GEOGRAPHIC LOCATION***	***DESCRIPTION***	***NPDES PERMIT #***	***WLA***
City of Keystone, SD Wastewater Treatment Facility	*northern portion of segment SD-CH-R-BATTLE_02*	*Continuous discharge mechanical plant with design flow of 0.38 MGD*	*SD0024007*	*29 x 10^9 cfu/day fecal coliform* *17 x 10^9 cfu/day E. Coli*
City of Hermosa, SD Wastewater Treatment Facility	*Northern portion of segment SD-CH-R-BATTLE_01_USGS*	*3 cell treatment facility with land application; design flow of 0.23 MGD*	*SD0022349*	*17 x 10^9 cfu/day fecal coliform* *10 x 10^9 cfu/day E. coli*

***<u>Comments</u>**: No comments.*

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.

Review Elements:

☒ 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 the 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**:*

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Load allocations were calculated for fecal coliform and E. coli for all flow zones on Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 using the load duration curve approach as follows:

1. *The loading capacity (in cfu/day) was determined by multiplying the long term average daily flow during the recreation season for each segment (using flow data from existing USGS gaging stations on each segment)by the TMDL water quality targets for fecal coliform and E. coli and a conversion factor.*
2. *An explicit margin of safety of 10% was allocated from each flow zone.*
3. *For each segment, the WLAs were then allocated for each point source that discharges to the segment.*
4. *Finally, the remaining loading capacity was allocated to the nonpoint sources as load allocations.*

The following tables provide a summary of the load allocations for each segment and each pollutant.

Summary of Fecal Coliform and E. Coli Load Allocations for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***TMDL Water Quality Target***	***High Flow (46-1760 cfs)***	***Moist Conditions (19-45 cfs)***	***Mid-Range Flow (7-18 cfs))***	***Dry Conditions (1.4- 6 cfs)***	***Low Flow (0.01-1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.6×10^{13} cfu/day*	*1.8×10^{12} cfu/day*	*7.3×10^{11} cfu/day*	*2.3×10^{11} cfu/day*	*3.6×10^{10} cfu/day*
E. coli	*1178cfu/100mL*	*9.6×10^{12} cfu/day*	*1.1×10^{12} cfu/day*	*4.3×10^{11} cfu/day*	*1.4×10^{11} cfu/day*	*2.2×10^{10} cfu/day*

Summary of Fecal Coliform and E. Coli Load Allocations for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***TMDL Water Quality Target***	***High Flow (29-1750 cfs)***	***Moist Conditions (6-28 cfs)***	***Mid -Range Flow (3.4-5.9 cfs)***	***Dry Conditions (1.4 -3.3 cfs)***	***Low Flow (0.01 - 1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.03×10^{13} cfu/day*	*1.1×10^{12} cfu/day*	*2.2×10^{11} cfu/day*	*1.2×10^{11} cfu/day*	*2.9×10^{10} cfu/day*
E. coli	*1178cfu/100mL*	*6.1×10^{12} cfu/day*	*6.6×10^{11} cfu/day*	*1.3×10^{11} cfu/day*	*6.9×10^{10} cfu/day*	*1.6×10^{10} cfu/day*

Although specific LAs are not provided for each identified non point sources within the Battle Creek watershed, the TMDL document states that the major non point sources of fecal coliform during base flow include wildlife, domestic animals, livestock and septic systems. The majority of loading from non point sources during moderate to high flows is from livestock and manure management on agricultural cropland, pastureland and rangeland. Based on the available data, the area just upstream of Highway 79 appears to be contributing the largest amount of bacteria loading to Battle Creek from non point sources.

***Comments**: No comments.*

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).

Review Elements:

- [x] 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.
- [x] 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:
[x] Approve [ ] Partial Approval [ ] Disapprove [ ] Insufficient Information

Summary:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

For each segment and each pollutant, an explicit margin of safety (MOS) of 10% of the total loading capacity was reserved to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, limitations of monitoring data).

The following tables provide a summary of the MOS allocations for each segment and each pollutant.

Summary of Fecal Coliform and E. Coli MOS Allocations for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***TMDL Water Quality Target***	***High Flow (46-1760 cfs)***	***Moist Conditions (19-45 cfs)***	***Mid-Range Flow (7-18 cfs))***	***Dry Conditions (1.4- 6 cfs)***	***Low Flow (0.01-1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{12} cfu/day*	*2×10^{11} cfu/day*	*8.3×10^{10} cfu/day*	*2.8×10^{10} cfu/day*	*6×10^{9} cfu/day*
E. coli	*1178cfu/100mL*	*1×10^{12} cfu/day*	*1.2×10^{11} cfu/day*	*4.9×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*4×10^{9} cfu/day*

Summary of Fecal Coliform and E. Coli MOS Allocations for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***TMDL Water Quality Target***	***High Flow (29-1750 cfs)***	***Moist Conditions (6-28 cfs)***	***Mid -Range Flow (3.4-5.9 cfs)***	***Dry Conditions (1.4 -3.3 cfs)***	***Low Flow (0.01 - 1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.2×10^{12} cfu/day*	*1.3×10^{11} cfu/day*	*2.7×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*6×10^{9} cfu/day*
E. coli	*1178cfu/100mL*	*6.8×10^{12} cfu/day*	*7.5×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*1×10^{10} cfu/day*	*4×10^{9} cfu/day*

***Comments**: No comments*

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.

Review Elements:

☒ 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**:*

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

By using the load duration curve approach to develop the TMDLs for Battle Creek, seasonal variability is taken into account. The TMDL, WLA, LAs and MOS are provided for all flow regimes thus, all seasons.

Based on the available monitoring data, the critical flow periods for fecal coliform and E. coli loading in segment SD-CH-R-BATTLE_01_USGS are during high flow and moist conditions. For segment SD-CH-R-BATTLE_02, the critical flow periods are during mid-range flow, moist conditions, and low flow. The majority of bacteria loading in this segment occurs in the lower portion of the segment, just upstream of Highway 79.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

SD DENR provided several opportunities for stakeholders and members of the general public to participate in the development of the TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02. These activities indicate that SD DENR developed the TMDLs in a process that was open to the public.

The following specific public participation activities were undertaken:

- *In 2011 and 2012, SD DENR held discussions with stakeholders and landowners about the Battle Creek project and sampling results for Battle Creek.*
- *During an inspection of the Hermosa WWTF, the project was discussed with the Town of Hermosa engineer.*
- *In June 2012, SD DENR issued a public notice that the draft TMDL document was available for public review and comment. The public notice provided information about how to obtain a copy of the draft document as well as instructions on how to submit comments to SD DENR. The deadline for submittal of comments by the public was July 1, 2012.*
- *Due to significant changes to the draft TMDL document as a result of EPA informal comments and the request from one citizen for an additional public comment period, SD DENR provided another opportunity for public review and comment on the revised draft TMDL document in 2013.*
- *In April of 2013, SD DENR presented the results of the Battle Creek assessment project and TMDLs at a public meeting in Hermosa. Approximately 20 people attended.*

Comments received from EPA on the June 2012 public notice draft version of the TMDL document were addressed in the September 2013 revised public notice draft version.

SD DENR will take into consideration the input provided during the public meetings and comments from the public provided during the two 30-day public notice periods as well any additional comments from EPA on the July 2013 public notice draft in the development of the final fecal coliform and E. coli TMDLs for Battle Creek.

Comments*: No comments.*

SD DENR Response: This section was marked as partial approval because this document underwent a second 30-day notice period and all public comments were not available until October 1st. At the end of the comment period October 1st any comments received from the public will be addressed and added to Appendix C of this document. When all comments are addressed the document will be submitted for final review and this section will be marked as approved. The following language was added to the public participation section of this document:

Discussions were held with stakeholders, landowners and a private consultant about project issues and results along Battle Creek in 2011 and 2012. The project and WWTF were discussed with the Town of Hermosa engineer during an inspection in 2012. In April of 2013 a final presentation on project results and conclusions were presented at the VFW Hall in Hermosa, SD with approximately 20 people in attendance. All comments and public input from meetings, written, or personal communications and presentations regarding the Battle Creek fecal coliform and E. coli TMDL including US EPA comments were addressed and incorporated in the current document before and after the August public notice period. However, this document underwent a second public notice period in September of 2013 and was discussed at a second public presentation in Keystone, SD on September 26, 2013 (attended by approximately 25 people) for temperature, fecal coliform and E. coli TMDLs developed for Battle Creek. Attending this presentation was a representative of the US EPA Region 8 out of Denver, Colorado who fielded many questions about these and other projects from attendees. Specific responses to US EPA and public comments received during the September public notice period received by October 1, 2013 are attached and addressed in Appendix C.

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.

Review Elements:

☒ 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

<u>Summary:</u>

Section 10, "Monitoring Strategy" (page 51) presents a monitoring strategy that describes the additional data to be collected.

The TMDL document states that in order to demonstrate attainment of the TMDLs, monitoring of Battle Creek will be necessary during and after the implementation of management practices. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring at station WQM17 on Battle Creek. SD DENR anticipates that the frequency of this monitoring will be monthly. The TMDL document recommends that during the recreation season, bacterial monitoring should be increased to collect at least 5 samples per month in order to have sufficient data to evaluate whether fecal coliform and E. coli bacteria levels achieve the water quality standards based on the 30-day geometric mean geometric mean.

The TMDL document also recommends that the monitoring program should include supplemental exploratory sampling to better define and target areas of concern. Monitoring to support the selection of locations of BMPs and to aid in the design of BMPs should be based on the type of BMPs installed.

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

Comments: *The monitoring strategy appears to rely on the ambient water quality monitoring station WQM17, located in the upper reach of segment SD--CH-R-BATTLE_02. While this location will be important to monitor, particularly since the historical data available at this location will support an assessment of trends, we believe that BATTLE01 and BATTLE02 are important to include in a long term monitoring program. We believe that at a minimum, monitoring at all three locations should continue throughout implementation and demonstration of TMDL attainment.*

Additional monitoring locations will likely be needed to determine the optimal locations for BMPs, the specific type of BMP, and the effectiveness of BMPs in achieving the TMDLs. Please include a description of these additional monitoring components in Section 10 of the TMDL document.

SD DENR Response: USGS is currently and are planning to continue to sample 06404000, Battle Creek near Keystone (WQM17), 06406000, Battle Creek at Hermosa (BATTLE01), and 06406500, Battle Creek below Hermosa (BATTLE02) sampling sites. SD DENR has contacted USGS about their agency collecting bacteria samples at sites, 06406000 and 06406500, during the recreation season and SD DENR paying for fecal coliform and *E. coli* bacterial analytical costs. At this time this, the issue is at the discussion stage and has not been approved or disapproved. The following paragraph was added to the monitoring strategy section of this document:

During the development/design phase of the project, sample data from this study and some supplemental exploratory sampling may occur to better define and target areas of concern and determine appropriate or optimal BMPs to install to address and reduce excess bacterial loading and support a viable and efficient Project Implementation Plan (PIP) for Battle Creek. During and after the implementation of management practices, monitoring will be necessary to continue to track and assess BMP effectiveness and ultimately demonstrate TMDL attainment. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations on Battle Creek via existing and possibly future WQM monitoring sites sampled on a monthly basis during the recreation season (May through September). During the recreation season bacterial monitoring should be increased to collect at least 5 samples per month to monitor the geometric mean criterion. Additional monitoring and evaluation efforts should be targeted toward rural BMPs to document the effectiveness of implemented BMPs. Battle Creek monitoring locations should be based on the location and type of BMPs installed.

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 12.0, "Restoration Strategy" (page 53) describes the strategy for achieving the fecal coliform and E. coli, TMDLs for Battle Creek.

Implementation of BMPs will be required. The highest priority area for implementation projects is the lower end of segment SD-CH-R-BATTLE_02, followed by segment SD-CH-R-BATTLE_01_USGS.

Within segment SD-CH-R-BATTLE_02, BMPs that reduce fecal coliform/E. coli loads will likely include:

- *improve and protect the riparian buffer zone through grazing management practices with off-stream watering and residential zoning,*
- *implement septic system inspection program within Battle Creek to document the condition of existing septic tank systems, identify failing systems and develop a mechanism/program to repair or replace failing systems*

- *investigate the survival, longevity and decay rate of pathogens in the sediments of Battle Creek over extended periods of time.*

For segment SD-CH-R-BATTLE_01_USGS, BMPs will likely include:

- *improve and protect the riparian buffer zone through grazing management practices with off-stream watering and vegetation development,*
- *riparian and stream bank erosion control measures, and*
- *development of cattle crossing areas for reduced stream access and erosion.*

Implementation projects for Battle Creek should be supported by and done within the context of a comprehensive watershed model for bacteria and Total Suspended Solids covering the entire Battle Creek watershed.

The Town of Keystone WWTF NPDES permit allows discharge of high concentrations of fecal coliform from October through April. There is limited knowledge on the survival of fecal coliform bacteria and associated pathogens in the stream and bank sediments. With survival, these pathogens are subject to re-suspension with high flows or other channel disturbances in spring and summer. As part of an implementation plan, it would be beneficial to supply funds to investigate the survival, longevity and decay rate of pathogens in the sediments of Battle Creek over extended periods of time.

The Lower Cheyenne River Watershed Assessment Project has recently been completed and broad support to begin an implementation project is evident. Battle Creek is part of the Cheyenne River watershed and could be included in a larger, basin-wide implementation project. Major entities that should be involved in planning, funding and supporting this project as it pertains to Battle Creek are the West Dakota Water Development District, Pennington County, Pennington County Conservation District, Cheyenne River Partnership and the Natural Resource Conservation Service.

Funds to implement watershed water quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Non-point Source Program.

The broad support for implementation and the availability of funding provide reasonable assurance that the load allocations required by the fecal coliform and E. coli TMDLs for Battle Creek will be achieved.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The fecal coliform and E.coli TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 are expressed in terms of a daily load i.e., in cfu per day.

Since the TMDLs were developed using the load duration curve approach, for each flow zone, the TMDL was selected as the 95th percentile of the range of values along the continuous loading capacity curve. Using the load duration curve approach, a TMDL is provided for any given flow condition.

The following tables summarize the fecal coliform and E. coli TMDLs.

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{13} cfu/day*	*2.0×10^{12} cfu/day*	*8.3×10^{11} cfu/day*	*2.8×10^{11} cfu/day*	*5.9×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*1.1×10^{13} cfu/day*	*1.2×10^{12} cfu/day*	*4.9×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*3.5×10^{10} cfu/day*

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.2×10^{13} cfu/day*	*1.3×10^{12} cfu/day*	*2.7×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*6.4×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*6.8×10^{12} cfu/day*	*7.5×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*9.5×10^{10} cfu/day*	*3.7×10^{10} cfu/day*

Comments: *No comments.*

9. References

EPA, 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006, August 2007. Office of Wetlands, Oceans, and Watersheds. http://www.epa.gov/owow/tmdl/techsupp.html

EPA, 1986. Ambient Water Quality Criteria for Bacteria – 1986. EPA 440/5-84-002. January 1986. Office of Water Regulations and Standards, Criteria and Standards Division.

Commenter Info:
Nathan Gjovik
3813 Back Nine Drive
Rapid City SD, 57703

Comments :
General Comments:
1. This report should be written such that a lay person could read, understand, and interpret the information.

This report follows EPA guidelines for TMDL summary submittal requirements. EPA reviews each TMDL against eight specific review elements that generally require sufficient technical rationale and analysis to support the final TMDL. SD DENR attempts to produce TMDL documents that meet the EPA technical requirements (which often include complex data analysis, modeling and a discussion of uncertainties) and that also can be understood by the general public. To further assist the public in understanding and interpreting the information, SD DENR provides an opportunity for public review and comment, often including a public meeting, to allow for questions from the public to be answered. The TMDL was reviewed by EPA with comments that are attached in Appendix C.

2. The report should include an appendix of acronyms.

Good idea, a list of acronyms has been added to the document (page viii) after the list of figures.

3. It appears the restoration strategy focuses on non-point discharge. Why is this?

The restoration strategy focuses on non-point source discharge sources because point source dischargers are required and regulated by their NPDES permit to meet water quality standards.

4. Why is there no actual data on discharges from the Keystone WWTF?

During this study recreation season fecal and *E. coli* 30-day maximum and 30-day geometric mean data from the Keystone WWTF was reviewed from 2008 through 2012 for reference. These monthly data were added to Appendix A; Table A4. Based on Discharge Monitoring Report (DMR) data, no violations were reported throughout this time period (recent).

5. Have DENR staff pulled independent samples to verify the effectiveness of the Keystone WWTF?

No not at the Keystone facility. WWTFs are rarely sampled by DENR and are only sampled when there is a complaint filed with SD DENR. DENR verifies the effectiveness of WWTFs by requiring each facility to submit all sample data collected at their facility either electronically or by direct entry. The data are uploaded to a federal database (ICIS). Every two to three years DENR staff review data from the original water quality datasheets and compare these with what was entered into the database and reported on their DMR for accuracy. Then

DMR data are re-calculated to determine if the original calculations were done correctly. All facilities are required to inform DENR within 24-hours when there is a major problem or an emergency discharge.

6. What impacts could exfiltration from Keystone/Hermosa sewer collection, and/or disposal, systems, have on the stream.

Exfiltration from Keystone and Hermosa WWTFs are considered minimal because Keystone ponds (two ponds) were lined with synthetic liners approximately six or seven years ago and Hermosa ponds (three ponds) are lined with bentonite as a seal. Hermosa has also purchased additional property to construct a forth cell (pond) to increase storage capacity. If this was an issue seeps and return flows would be seen in and around the ponds and possibly along the creek. If exfiltration were occurring from the Keystone and Hermosa ponds, pond levels would be lower than expected based on evaporation alone and would have been reported, investigated, and repaired in a timely manner based on their permit.

7. What impact could stream grade (i.e., slope) have on the data analysis/interpretation and "impairment?"

Slope or stream gradient has an impact on discharge (flow) with steeper gradients having higher flows and lower gradients lower flows; however, the actual discharge would still be the same with the same volume of water. Steeper gradient areas of the stream have more energy that can cause increased erosion and scouring transporting material downstream; while lower gradient areas have less energy and tend to deposit material in these areas. Higher stream gradient could impact bacteria by increasing turbidity in the stream and blocking ultraviolet light penetration that can kill bacteria. Lower stream gradient areas tend to deposit material reducing turbidity and increasing ultraviolet penetration that could reduce bacterial concentrations. Depending on landuse, soils, and riparian condition, bacterial concentrations could vary based on livestock feeding and over wintering areas close to the stream, riparian width, vegetative condition and structure, and based on soils may affect riparian vegetative composition resulting in varying filtration efficiencies. Impairment is not dependent on slope but is dependent on fecal coliform and *E. coli* bacteria counts and concentrations in the stream. If there is enough bacteria in the stream to exceed the standards, no matter what the flow, discharge, or slope the stream would be considered impaired and in need of a TMDL.

Specific Comments (page numbers from report titled "Fecal Coliform and *Escherichia coli* Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota":

1. Page 17: What is the basis for the exceedence limits for fecal coliform?

Exceedence limits are set based on beneficial use designated by the State of South Dakota and the corresponding surface water quality criteria for fecal coliform (ARSD §74:51:01). These surface water quality criteria are based on EPA's recommended ambient water quality criteria for bacteria and are intended to protect the public against unacceptable risk of gastroenteritis from contact with bacteria in water during recreational use.

In order to compare water quality data to fecal coliform bacteria water quality criteria for the purpose of determining whether a water body meets its designated beneficial use, SD DENR requires at least 20 samples within a water body reach. A minimum of two 30-day average results is used to compare to 30-day average criteria. In the case of fecal coliform water quality criteria, a water body is considered impaired (does not support its designated beneficial use) if the number of exceedences of the limit for fecal coliform bacteria is greater than 10 percent (or 3 or more exceedences between 10 and 19 samples) for the daily maximum criteria or greater than 10 percent (or 2 or more exceedences between 2 and 19 samples) for the 30-day average criteria.

2. Page 17: Why is the geometric mean used?

The geometric mean is used because bacteria data are typically non-normally distributed. Bacteria can grow at an exponential rate very quickly under the right conditions and this often produces data distributions where there are large numbers of samples with low concentration data along with a few samples with large concentrations of bacteria. The resultant data distribution is skewed and “non-normal”. Using a traditional arithmetic mean as a measure of “central tendency” is not appropriate because the arithmetic mean will be overly influenced by a few large data points. Use of the geometric mean procedure helps produce a more normal distribution and lessens the influence of these few large numbers.

3. Page 18: What is the basis for the exceedence limits for *E. coli*?

Exceedence limits are set based on beneficial use designated by the State of South Dakota and the corresponding surface water quality criteria for *E. coli* (ARSD §74:51:01). Similar to fecal coliform bacteria, the *E. coli* criteria are also based on EPA’s recommended ambient water quality criteria for bacteria and are intended to protect the public against unacceptable risk of gastroenteritis from contact with bacteria in water during recreational use.

In order to compare water quality data to *E. coli* bacteria water quality criteria for the purpose of determining whether a water body meets it’s designated beneficial use, SD DENR requires at least 20 samples within a water body reach. A minimum of two 30-day average results is used to compare to 30-day average criteria. In the case of E. coli water quality criteria, a water body is considered impaired (does not support its designated beneficial use) if the number of exceedences of the limit for *E. coli* bacteria is greater than 10 percent (or 3 or more exceedences between 10 and 19 samples) for the daily maximum criteria or greater than 10 percent (or 2 or more exceedences between 2 and 19 samples) for the 30-day average criteria.

4. Page 18: Why is the geometric mean used?

The geometric mean is used because bacteria data are typically non-normally distributed. Bacteria can grow at an exponential rate very quickly under the right conditions and this often produces data distributions where there are large numbers of samples with low concentration data along with a few samples with large concentrations of bacteria. This produces a data distribution that is skewed and “non-normal”. Using a traditional arithmetic mean as a measure of “central tendency” is not appropriate because the mean will be overly influenced by a few large data points. Use of the geometric mean procedure helps produce a more normal distribution and lessens the influence of these few large numbers.

5. Page 20: Why is the discharge limit for the Keystone WWTF set at the surface water quality standards?

All discharge facilities in the state including the Keystone WWTF have NPDES permits that require them to meet surface water quality standards for the receiving waterbody which are based on beneficial uses. Beneficial uses are assigned by the state based on a beneficial use analysis of each waterbody. Water quality standards have been defined in South Dakota state statutes (Administrative Rules of South Dakota, ARSD §74:51:01 – 74:51:03) in support of these uses.

It is my understanding that Battle Creek sometimes has low or no flow. Doesn't the Keystone WWTF NPDES standards setup the creek to be impaired?

Based on their NPDES permit and WWTF sampling data, the Keystone WWTF discharge at the end of pipe meets water quality standards. Even if there is little or no flow in Battle Creek and the treated discharge is 100 percent of the flow in Battle Creek, fecal coliform and *E. coli* bacteria discharged into the creek at or below their effluent limits (water quality standards) would not impair Battle Creek. Bacteria cannot be assigned a mixing zone and must meet water quality standards upon entering receiving waters (Battle Creek).

6. Page 25: It is unclear as to what the percentages pertain to in regard to the LDC flow intervals.

Percentages are flow duration intervals. For instance, in the low flow zone range from 90 percent to 100 percent thus out of all loads generated at this site 90 to 100 percent of all the loads were greater than the loads in the low flow zone. All other flow zone percentages are interpreted the same way.

7. Page 40: Why are the actual values not used for WLA (Keystone) within the table?

The actual values were used in the Keystone WLA which were $2.88 *10^{10}$ CFU/Day and adjusted to 10^9 for the table $28.8*10^9$ CFU/Day when rounded, $29 *10^9$ CFU/Day.

8. Page 42: Why are the actual values not used for WLA (Keystone) within the table?

The actual values were used in the Keystone WLA which were $1.69 *10^{10}$ CFU/Day and adjusted to 10^9 for the table $16.9*10^9$ CFU/Day when rounded, $17 *10^9$ CFU/Day.

9. Page 52: What are the repairs currently underway to the Keystone sewer system?

Within the last year, the City of Keystone WWTF has done upgrades to the clarifier, purchased and added a new backup pump for the lift station, a new computer, and alarm system for the facility.

George Ferebee's comments 9/23/13

11495 Gillette Prairie Rd
Hill City, SD 57745
September 23, 2013

SD DENR Secretary Pirner
523 East Capitol
Pierre, SD 57701

RE: Comments/questions regarding Battle Creek Bacteria TMDL

Dear Mr. Secretary:

I have read and studied a document dated July, 2013, with the title: "Fecal Coliform and *Escherichia coli* Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota." The front page of the document states: "Prepared by: Robert L. Smith South Dakota Department of Environment and Natural Resources Water Resources Assistance Program." Mr. Secretary, I was unable to find a signature anywhere in the document. Hence, I can only assume that Mr. Smith was in fact the document preparer.

Several months ago, before I was aware of the document's existence, I heard an individual who identified himself as Robert Smith present a briefing on the "bacteria" impairments of Battle Creek. Smith's briefing preceded a "temperature" impairment briefing by an individual who identified himself as an employee of RESPEC Consulting. As I recall, Smith's message to those of us in the audience that evening in Hermosa, SD was that DENR's work was basically done, that two of the three segments of Battle Creek needed "bacteria" reduction, and that all that remained was EPA approval (blessing) of the "document." As Smith was briefing, the word "premature" came to mind, over and over.

Mr. Secretary, I firmly believe that "bacteria" TMDLs for Battle Creek need more work before EPA opens another spigot of taxpayer dollars to allegedly implement BMPs. As you no doubt know, taxpayers have already lined the pockets of RESPEC Consulting to the tune of $678,609.14. Sadly, nothing to show for that wad of money.

Anyway, I suggest that Smith's "document" not be advanced to Denver until further work is done. Both in the field and in "document" preparation. For starters, I suggest that a "use attainability analysis" be done. (Hopefully, I have the jargon correct) Such analysis should not be done in stealth, but rather in the open with full public participation.

Sincerely,

George W. Ferebee

George W. Ferebee

cc: EPA

RECEIVED
SEP 23 2013
DEPT OF ENVIRONMENT & NATURAL RESOURCES - RAPID CITY

SD DENR Responses: Response to comments in 1st paragraph: TMDL documents prepared by SD DENR are not usually signed by the author. This document was indeed prepared by Robert L. Smith.

Response to comments in 2nd paragraph: SD DENR follows a standard protocol for the review of TMDL documents. A draft version of each TMDL document is made available to the general public for a period of 30 days to allow for review and comment. This is referred to as the "30-day public notice period", which allows for the submittal of comments from the public. Concurrently, the TMDL document is sent to the USEPA for their review and comment. SD DENR addresses all public comments received and all comments from the USEPA by making any necessary modifications and providing written responses. SD DENR then submits the revised version of the TMDL document and all responses to comments to USEPA with a formal request for approval.

SD DENR provided two opportunities for public review of this particular TMDL document. The first public comment period was from June 1, 2012 until July 1, 2012. SD DENR received no public comments during this period. However, USEPA submitted informal comments on March 26, 2013 with suggested modifications. Additionally, in April 2013, SD DENR discussed the TMDL document at a public meeting in Hermosa, SD.

USEPA's informal comments indicated that significant modifications would be necessary and that the TMDL values would likely change. Therefore, SD DENR decided to offer another public comment period to seek public input on the revised version. That public comment period was from August 1, 2013 – September 1, 2013. An additional 30-day comment period from September 1, 2013 until September 30, 2013 was added at the request of Mr. Ferebee.

SD DENR feels that by giving the public 90 days for review (three times the normal review period) we have provided sufficient opportunity for the public to comment. SD DENR did receive comments from the public, which we feel are adequately addressed in this document. Formal comments from the USEPA have also been addressed

The final version of the document that will be submitted to USEPA for approval has been modified significantly from the version that was discussed at the April 2013 meeting in Hermosa, SD, at which time Mr. Ferebee felt that formal submittal for approval would be premature. . SD DENR does not believe submittal of this version of the document, revised to address public and USEPA comments, to the USEPA for final approval is "premature".

Response to comments in 3rd paragraph: Comment noted. Also see the previous response. SD DENR believes that the revised version of the TMDL, modified to address public and USEPA comments, is ready for submittal to the USEPA for final approval and that more work is not needed.

Response to comments in 4th paragraph: See previous responses. Also, SD DENR believes a use attainability analysis is not warranted for Battle Creek. The Clean Water Act goal is protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. EPA's regulations state that these uses should be designated for all waters unless it is demonstrated that it is impractical to meet them. In the case of Battle Creek, a Use Attainability Analysis has been done and provided the basis for the designation of limited contact recreation beneficial use as opposed to the immersion recreation beneficial use. The State of South Dakota numeric water quality criteria for bacteria that are protective of limited contact recreation are as follows:

Fecal coliform: Daily Maximum (any one sample) – ≤2,000 colonies/100 mL

30-day Geometric Mean (minimum of 5 samples obtained during separate 24-hour periods for any 30-day period, and they may not exceed this value in more than 20 percent of the samples examined in this same 30-day period) – ≤1,000 colonies/100 mL

and

Escherichia coli: Daily Maximum (any one sample) – ≤1,178 colonies/100 mL

30-day Geometric Mean (minimum of 5 samples obtained during separate 24-hour periods for any 30-day period – ≤630 colonies/100 mL

The more stringent standard for bacteria is immersion recreation waters with fecal coliform ≤400 colonies/100 mL for any one sample and ≤200 colonies/100 mL for the 5 sample geometric mean. *Escherichia coli* bacteria standards based on immersion recreation waters are ≤235 colonies/100 mL for any one sample and ≤126 colonies/100 mL for the 5 sample geometric mean.

George Ferebee's comments 9/27/13

RECEIVED

SEP 27 2013

DEPT OF ENVIRONMENT & NATURAL RESOURCES - RAPID CITY

11495 Gillette Prairie Rd
Hill City, SD 57745
September 26, 2013

SD DENR Secretary Pirner
523 East Capitol
Pierre, SD 57701

RE: Comments/questions regarding Battle Creek Bacteria TMDL

Dear Mr. Secretary:

Reference my letter to you dated September 23, 2013, and delivered to Robert Smith at your Rapid City location on September 23, 2013. In that letter, I suggested that a "use attainability analysis" be done, and I, also, suggested more work before the TMDLs find their way to Denver.

Mr. Secretary, I suggest that the TMDLs be scrubbed for assertions, conclusions, statements, etc., that use *adjectives* as opposed to *quantification*, to include a probability number where actual numbers are not readily obtainable. For example, at paragraph 1.1.1., the document contains the following statement: "The study found the primary pollution sources in the Battle Creek basin to be agricultural runoff." In keeping with scientific methodology, at least as I learned it, the word "primary" should be replaced with a "number." Additionally, a **scientific** document would source its statements. How can you, DENR, expect a **scientific** review by EPA and/or the public of your submittals if they are loaded with adjectives such as illustrated above?

As I have previously mentioned, the bacteria TMDLs document needs considerable work. Every time I take a few minutes to review and analyze the document, I discover unfinished or shoddy work. For example, to illustrate my concerns, I have selected two statements and added my comments (See attachment to this letter).

Thank you. Looking forward to reviewing a document which meets scientific methodology as I learned it. By the way the 2008 Spring Creek TMDL bearing the name of Scott Kenner, PhD, would have undoubtedly earned an inferior grade by my professors. When I saw the word "pig" and read Kenner's assertion that they and dogs were the major polluters of Spring Creek, I was in disbelief. Still am. Scott Kenner has zero credibility with me.

Sincerely,

George W. Ferebee

George W. Ferebee

Atch: TMDL comments/questions

Comments/Questions

Battle Creek Bacteria TMDLs

Statement: "The intent of this document is to clearly identify the components of these TMDLs, support adequate public participation, and facilitate the US Environmental Protection Agency (US EPA) review." [Paragraph 1.0] **Comments/questions**: If the "components of these TMDLs" are *clearly* identified, I must plead guilty to an inferior grasp of the English language and no doubt a substandard education in math and science. The "components" are not clear to me. Concerning "support adequate public participation," seems to me that this "intent" needs considerable work. Before EPA review, I suggest that DENR aggressively pursue public participation, not only for public input but, also, public understanding; particularly, inclusions such as "Log-Normal Critical Curves," "Flow Duration Curves," and "Load Duration Curves."

Statement: "This ordinance is scheduled to be fully implemented by 2016 (Brittney Molitor, Pennington County – Water Protection Coordinator, personal communication, 2013) and should reduce fecal coliform and *E-coli* concentrations in segments SD-CH-R-BATTLE_01 and most of SD-CH-R-BATTLE_02 in Battle Creek." [Paragraph 11.2] **Comments/questions:** First, I question whether **most** of Segment BATTLE_02 is in Pennington County versus Custer County. Second, implicit in the prediction of possibly **reducing** fecal coliform and *e-coli* is actual "loading" contributions by on-site treatment systems (Septic systems). If Septic systems are, in fact, contributing to Battle Creek's *alleged* loading of fecal coliform and/or *e-coli,* such deposits (loadings) must be stealthy. No doubt the Septic systems are making deposits (loadings) in Battle Creek in a manner similar to what the **pigs** have been doing to Spring Creek. Third, if evidence exists that any Pennington County septic systems are actually contaminating any Pennington County water bodies, such evidence must be classified. To the best of my knowledge the Pennington County government has not revealed any evidence of any septic system causing contamination. A Scientist is obligated to provide evidentiary support for his/her statements (conclusions). Environmental Scientist Robert L. Smith who allegedly prepared the Battle Creek Bacteria TMDLs document should either retract any and all statements, such as "should reduce fecal coliform and *E-coli* concentrations," or come forth with credible evidence in support of his statements. As an aside, I have been asking and asking Pennington County officials for evidence of contamination by septic systems. Several years ago, I even wrote a letter to the, then, chairman of the Pennington Board of Commissioners. Still waiting for an answer. As a Scientist, Smith is obligated to pursue and present evidence in support of his statements. This TMDLs document is far from ready to travel to Denver!

George W. Ferebee

George W. Ferebee

RECEIVED

SEP 27 2013

DEPT OF ENVIRONMENT & NATURAL RESOURCES - RAPID CITY

SD DENR Responses:

Response to 1st paragraph of comment letter: As mentioned in our response to your first letter, the use attainability analysis is not warranted for Battle Creek because as far as recreational waters beneficial uses go (bacteria standards); all segments of Battle Creek are listed as limited contact recreation waters which have the most lenient bacterial standards (see comments and standards in responses to your 9/23/2013 letter).

Response to 2nd paragraph of comment letter: Adjectives throughout the documents were replaced with quantitative estimates or deleted where deemed appropriate. The probability number (MPN/100 mL) referred to in your letter are the reported values (counts) for *E coli* bacteria colonies based on standardized laboratory analysis techniques and reporting and is the accepted methodology under *Standard Methods for the Examination of Water and Wastewater* (Method 9223 B). Basically, an enzyme is added to the 100 mL *E. coli* water sample and placed into a machine that fills and seals a sterile counting tray with separate cells. Then the tray is incubated for 18 to 24-hours and cells change color and fluoresce if *E. coli* bacteria are present. The numbers of cells of different size are counted and a chart or computer program tells the technician the number of *E .coli* colonies in the sample. These results are reported as the number of *E. coli* colonies (MPN/100 mL) based on Standard Methods methodologies. These methods are used universally for counting and analysis of *E. coli* bacteria.

In reference to the word "primary" used in paragraph 1.1.1, language has been added to this section to further explain and justify the use of this term. Section 4.3 of the revised TMDL document is an assessment of the relative contribution of potential sources of bacteria to Battle Creek. Based on knowledge of land use patterns, the three potential sources of fecal coliform and E. Coli to surface water are: (1) manure from livestock (direct contribution by defecating while wading in the stream and riparian areas and indirect contribution by defecating on rangelands and pastures that are washed off during precipitation events); (2) human (indirect contribution by failing septic systems casing bacteria in groundwater that discharges to Battle Creek); and (3) wildlife (similar to livestock). Using livestock, human and wildlife population estimates, and assuming a 15% rate of failure of septic systems, SD DENR used EPA's Bacteria Indicator Tool (BIT), to estimate the relative contribution of bacteria produced in the watershed by each of the 3 potential sources. The relative contribution estimates are expressed in CFU of bacteria per acre per day. Using this methodology, livestock were estimated to contribute 90.9% of the total bacteria loading to segment SD-CH-R-BATTLE_01_USGS and 90.2% of the total bacteria loading to segment SD-CH-R-BATTLE_02. These estimates (90.2% and 90.9%) provide the basis for the statement that the "primary" pollution sources in the Battle Creek basin are agricultural. Agricultural runoff values and percent contributions from human and wildlife sources based on EPA's BIT tool were added to Tables six and seven in the report. These percentages and tables were cited and referenced at the end of the sentence in Section 1.1.1.

Response to 3rd paragraph of comment letter: Comment noted. SD DENR has edited the document to add clarity and supporting information where appropriate.

Response to 4th paragraph of comment letter: Comment noted.

Response to 1st Statement of “Comment/Questions page: The first sentence of the first paragraph in Section 1.0 is confusing and it was eliminated. This report follows EPA guidelines for TMDL summary submittal requirements and was reviewed by EPA with comments that are attached in Appendix C. Please note that the components of a TMDL include individual waste load allocations for point sources and load allocations for nonpoint sources and natural background. A TMDL is established at a level necessary to implement the applicable water quality standards for the water body considering seasonal variations and the TMDL includes a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

2) Further descriptions of terms outlined in the 1 nd Statement in your letter dated 9/27/2013 are as follows:

Log-normal critical curves

In this document log-normal critical curves were used to show the linkage between the daily maximum standard and the 30-day geometric mean standard. Essentially the relationship between the 30-day geometric mean and the Single Sample Maximum (daily maximum) is based on the assumption that bacteria data can be described using a log-normal frequency distribution centered on bacteria specific geometric mean standards (chronic standards) for limited contact recreation waters and a log standard deviation of 0.4.

Flow duration curves

Flow duration curve analysis looks at the cumulative frequency of historic flow data over a specified period. A flow duration curve relates flow values to the percent of time those values have been met or exceeded. The use of “percent of time” provides a uniform scale ranging between 0 and 100. Thus, the full range of stream flows is considered. Low flows are exceeded a majority of the time, while floods are exceeded infrequently (USEPA, 2007).

Load duration curves

The use of duration curves provides a technical framework for identifying “daily loads” in TMDL development, which accounts for the variable nature of water quality associated with different stream flow rates. Specifically, a maximum daily concentration limit can be used with basic hydrology and a flow duration curve to identify a TMDL that covers the full range of flow conditions. With this approach, ambient water quality data taken with some measure or estimate of flow at the time of sampling can be used to compute an instantaneous load. Using the relative percent exceedence from the flow duration curve that corresponds to the stream discharge at the time the water quality sample was taken, the computed load can be plotted in a duration curve format with points above the TMDL duration line exceeding the total daily maximum load and points below the TMDL duration line meeting the total daily maximum load based on stream discharge.

2nd Statement in Comments/Questions page:

Response to 1st comment: Based on stream kilometers, you are correct in that 47.1 percent of segment SD-CH-R-BATTLE_02 is in Pennington County and 52.9 percent of segment SD-CH-R-BATTLE_02 is in Custer County. However, based on drainage area and excluding other AUID basins (segment SD-CH-R-BATTLE_01, segment SD-CH-R-GRIZZLY_BEAR_01_USGS and segment SD-CH-R-GRACE_COOLIDGE_01) in the watershed; the drainage area of segment SD-CH-R-BATTLE_02 in Pennington County is approximately 33,000 acres and 17,500 acres in Custer County. Given this the paragraph was rewritten to include the number of stream kilometers in Pennington County (see below).

Response to 2nd comment: SD DENR uses a very conservative approach in identifying pollutant sources in a watershed and further investigation during the implementation phase may refine the identification and quantification of those sources. To ignore the impact of on-site wastewater systems in a watershed already impaired by bacteria would be irresponsible. All sources of fecal coliform and *E. coli* bacteria for on-site wastewater systems were estimated using the EPA BIT tool with a 15 percent failure rate.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
DENVER, CO 80202-1129
Phone 800-227-8917
http://www.epa.gov/region08
FEB 18 2014

RECEIVED
FEB 24 2014
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: Total Maximum Daily Load (TMDL) Approval *Fecal Coliform and Escherichia coli Battle Creek Segments SD-CH-R-BATTLE_02 SD-CH-R-BATTLE_01_USGS*
Dear Mr. Pirner:

We have completed our review of the TMDLs as submitted by your office for the water bodies listed above and 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 referenced above as developed for the water quality limited waterbodies as described in Section 303(d)(1). Based on our review, we believe the separate elements of the TMDLs as listed in the enclosed table (enclosure 1) adequately address the pollutants of concern identified in the table, taking into consideration seasonal variation and a margin of safety. Our complete decision document is included as enclosure 2.

Thank you for submitting the TMDLs for our review and approval. If you have any questions, the most knowledgeable person on my staff is Bonnie Lavelle and she may be reached at 303-312-6579.

Sincerely,

Martin Hestmark
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

Enclosures

ENCLOSURE 1: APPROVED TMDLs

Fecal Coliform and Escherichia coli Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota

Submitted: 11/25/2013

4	Pollutant TMDLs completed.
4	Causes addressed from the 2012 303(d) list.
0	Determinations that no pollutant TMDL needed.

Segment: Battle Creek - SD Highway 79 to Cheyenne River

303(d) ID: SD-CH-R-BATTLE 01 USGS

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

Water Quality Targets: Maximum concentration less than or equal to 1,178 MPN/100 mL in any one sample and geometric mean of minimum of 5 samples obtained during separate 24 hour periods for any 30 day period must be less than or equal to 630 MPN/100mL.

Allocation*	Value	Units	State Permits	Permits
WLA	10	BCFU/DAY		SD0022349
MOS	1070	BCFU/DAY		
LA	9617	BCFU/DAY		
TMDL	10697	BCFU/DAY		

Notes: Allocations are based on high flow conditions.Refer to TMDL document for allocations for moist, mid-range, dry and low flow conditions.

Parameter/Pollutant (303(d) list cause): FECAL COLIFORM - 259

Water Quality Targets: Maximum concentration less than or equal to 2000 cfu/100ml in any one sample and a geometric mean of less than or equal to 1000 cfu/100ml based on a minimum of 5 samples obtained during separate 24-hour periods for any 30 day period.

Allocation*	Value	Units	State Permits	Permits
WLA	17	BCFU/DAY		SD0022349
MOS	1816	BCFU/DAY		
LA	16328	BCFU/DAY		
TMDL	18161	BCFU/DAY		

Notes: Allocations are based on high flow conditions.Refer to TMDL document for allocations for moist, mid-range, dry and low flow conditions.

Segment: Battle Creek - Teepee Gulch Creek to SD Hoghway 79

303(d) ID: SD-CH-R-BATTLE 02

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

Water Quality Targets: Maximum concentration less than or equal to 1,178 MPN/100 mL in any one sample and geometric mean of minimum of 5 samples obtained during separate 24 hour periods for any 30 day period must be less than or equal to 630 MPN/100mL.

Allocation*	Value	Units	State Permits	Permits
WLA	17	BCFU/DAY		SD0024007
MOS	75	BCFU/DAY		
LA	657	BCFU/DAY		
TMDL	749	BCFU/DAY		

Notes: Allocations are based on moist flow conditions. Refer to TMDL document for allocations for high, mid-range, dry, and low flow conditions.

Parameter/Pollutant (303(d) list cause): FECAL COLIFORM - 259

Water Quality Targets: Maximum concentration less than or equal to 2000 cfu/100mL in any one sample and geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30 day period must be less than or equal to 1000 CFU/100mL.

Allocation*	Value	Units	State Permits	Permits
WLA	29	BCFU/DAY		SD0024007
MOS	1153	BCFU/DAY		
LA	10346	BCFU/DAY		
TMDL	11528	BCFU/DAY		

Notes: Allocations are based on high flow conditions.Refer to TMDL document for allocations for moist, mid-range, dry and low flow conditions.

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

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Fecal Coliform and Escherichia coli Bacteria Total Maximum Daily Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota**
Submitted by:	**South Dakota Department of Environment and Natural Resources**
Date Received:	**July 25, 2013**
Review Date:	**July 31, 2013**
Reviewer:	**Bonnie Lavelle**
Rough Draft / Public Notice / Final Draft?	**Public Notice Draft**
Notes:	

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

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

Approval Notes to the 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 TMDL review elements identified in the following 8 sections:

1. Problem Description
   1.1. TMDL Document Submittal
   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

ENCLOSURE 2

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 review elements 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 this review form 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 form 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

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

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ 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 ☐ N/A

Summary:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The South Dakota Department of Environment and Natural Resources (SD DENR) submitted this public notice draft version of the document "Fecal Coliform and Escherichia coli Bacteria Total Maximum Daly Loads (TMDLs) for Battle Creek, Pennington and Custer Counties, South Dakota" to EPA via *email message on July 25, 2013 . The transmittal email clearly indicated that this document is a public notice draft. Comments from the public were requested by September 1, 2013.*

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 1.0, "Introduction and Watershed Description" (page 1) identifies the pollutant and waterbody segment that the TMDLs are established for.

Section 1.1, "CWA Section 303(d) Listing Information" (page 1) identifies the waterbody and associated impairment as they appear on the most current EPA-approved 303(d) list.

Figure 1, "Location of the Battle Creek watershed within South Dakota" (page 2) shows the Battle Creek watershed boundaries.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the general location of the waterbody along with locations of surface water sampling stations and tributaries.

Figure 3, "Underlying geology of the Battle Creek watershed, Pennington and Custer Counties, South Dakota" (page 8) shows the geology of the Battle Creek watershed.

Figure 4, "2006 Land uses in Battle Creek, Pennington and Custer Counties, South Dakota (page 9) show the land use patterns within the Battle Creek watershed.

This TMDL document addresses the fecal coliform and Escherichia coli bacteria impairments of Battle Creek segments SD-CH-R-BATTLE_02 and SD-CH-R-BATTLE_01_USGS. These segments are listed on the 2012 EPA-approved 303(d) list as impaired for limited contact recreation use and were assigned a priority 1 (high-priority) in the 2012 South Dakota Integrated Report for Surface Water Quality Assessment (2012 IR).

Additionally, SD DENR designated segment SD-CH-R_BATTLE_01_USGS as threatened for warm water marginal fish life use in the 2012 IR due to elevated Total Suspended Solids (TSS). This impairment is also included in the 2012 EPA-approved 303(d) list. The TSS impairment was first listed on the 303(d) list in 2010.

Segment SD-CH-R-BATTLE_02 is listed on the 2012 EPA-approved 303(d) list as impaired for coldwater permanent fish life use due to elevated temperature. The temperature impairment was first listed in 2004.

The TSS and temperature impairments of these two segments will be addressed in separate TMDL summary documents.

The following table summarizes the waterbodies and bacteria impairments as they appear on the 2012 EPA-approved 303(d) list:

Waterbody AUID	From	To	Impaired Use	Parameter	EPA Category	Priority
SD-CH-R-BATTLE_01_USGS	SD Highway 79	Cheyenne River	Limited Contact Recreation	Fecal Coliform *Escherichia coli*	5	1
SD-CH-R-BATTLE_02	Teepee Gulch Creek	SD Highway 79	Limited Contact Recreation	Fecal Coliform *Escherichia coli*	5	1

Battle Creek is a perennial mountain stream located in Custer and Pennington Counties of South Dakota. Battle Creek is a tributary of the Cheyenne River, which flows into the Missouri River. The drainage area of Battle Creek is approximately 302 square miles (781 square kilometers) at the confluence with the Cheyenne River.

The bacteria impaired segments of Battle Creek have a combined length of 74 stream miles. The drainage area of the bacteria impaired segments is approximately 69.5 square miles.

Much of the upper portion of the watershed (segment SD-CH-R-BATTLE_02) is located within the Black Hills National Forest and is predominantly forested with ponderosa pine (73 percent) followed by herbaceous rangeland (13 percent) and cropland and pasture (4 percent).

The lower portion of the watershed (segment SD-CH-R-BATTLE_01_USGS) is dominated by herbaceous rangeland (87 percent), cropland and pastureland (9 percent), nonforested wetlands (2 percent), and forest (2 percent).

The area around Battle Creek is usually warm in summer with frequent hot days. In winter, cold periods occur when arctic air moves in from the north and northwest. Cold periods alternate with milder periods, which often occur when westerly winds are warmed as they move down slope.

Most precipitation falls as rain during the warmer part of the year. The precipitation is normally heaviest in late spring and early summer. Snow falls frequently in winter, but the snow cover usually disappears during the mild periods.

Average annual precipitation in the upper portion of the Battle Creek watershed in the Black Hills is approximately 18 inches (0.46 m) while the average annual precipitation in the lower portion of the watershed below South Dakota Highway 79 is 15.52 inches (0.39 m) based on Pennington and Custer Counties Soil Survey data. Snowfall in the Black Hills portion of the watershed averages approximately

45 inches while the lower portions of the watershed averages 32 inches. Over 75 percent of the annual precipitation occurs during the months of April through September.

Sources of Bacteria Loading to Battle Creek

The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. Keystone has a wastewater treatment facility (WWTF) that discharges into Battle Creek approximately 2.5 miles downstream of Highway 16A east of Keystone. Discharges from this facility are regulated by SD DENR through a NPDES discharge permit (Permit # SD0024007) issued in 2013.

The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. The City of Hermosa's WWTF is a three- cell treatment facility with one outfall that can discharge to Battle Creek and an additional system to land apply wastewater on 180 acres of farmland near the WWTF. The wastewater that is land applied would originate from the second or third stabilization pond. Land application is not considered a discharge. Battle Creek flows to the south of the WWTF and land application field. Discharges from the Hermosa WWTF are regulated by SD DENR through a NPDES permit issued in 2009 (Permit # SD0022349). The permit requires that Hermosa obtain permission from SD DENR before discharging to Battle Creek.

The major nonpoint sources of bacteria loading to the two impaired segments of Battle Creek are agricultural runoff, wildlife and human sources (leaking septic systems).

Water Quality Monitoring Stations in Segment SD-CH-R-BATTLE_02

WQM17

During the recreation season (May through September), SD DENR collects monthly fecal coliform and E. coli bacteria samples from Battle Creek at WQM 17 (also designated as DENR 460905) near Hayward, SD in segment SD-CH-R-BATTLE_02. This sampling is performed by SD DENR as part of the State-wide ambient surface water quality monitoring program. Since 1968, samples have been analyzed for fecal coliform. In 2001, E. coli analysis was added to the monitoring program at WQM17. USGS stream monitoring gage 06404000, "Battle Creek near Keystone, South Dakota" is also located at site WQM17.

BATTLE03

Monitoring station BATTLE03 is located within segment SD-CH-R-BATTLE_02, downstream of WQM17 and upstream of the confluence of Grace Coolidge Creek and Battle Creek. This monitoring site was established during the 2011 Battle Creek assessment project. A total of 14 samples were collected from this site in August and September in 2011 and were analyzed for both fecal coliform and E. coli bacteria.

GRCOOL01

Monitoring station GRCOOL01 is located within Grace Coolidge Creek, a tributary to Battle Creek. This monitoring site was also established during the 2011 Battle Creek assessment project and 13samples were collected in August and September in 2011 and were analyzed for both fecal coliform and E. coli bacteria.

BATTLE02A/BTC03
Monitoring station BATTLE02A on segment SD-CH-R-BATTLE_02 is the same station as BTC03. It was designated as BTC03 during the 2007-2009 Lower Cheyenne River watershed assessment project and was re-named BATTLE02A in 2011 during the follow-up Battle Creek assessment project. During the Lower Cheyenne River watershed assessment, 15 fecal coliform samples were collected monthly from 2007 through 2009 at station BATTLE02A/BTC03 in segment SD-CH-R-BATTLE_02. Only 2 of these samples were also analyzed for E. coli bacteria levels. In 2011, during the Battle Creek assessment project, samples were again collected in August and September from BATTLE02A/BTC03. A total of 14 samples were collected in 2011 and were analyzed for fecal coliform and E. coli bacteria.

Water Quality Monitoring Stations in Segment SD-CH-R-BATTLE_01_USGS

BATTLE02
Monitoring station BATTLE02 is co-located with USGS stream gage 0640600 "Battle Creek below Hermosa", in the upper reach of segment SD-CH-R-BATTLE_01_USGS. This monitoring site was also established during the 2011 Battle Creek assessment project and 19 samples were collected during July, August and September of 2011 and were analyzed for both fecal coliform and E. coli bacteria.

BATTLE01/BTC04
Monitoring station BATTLE01 on segment SD-CH-R-BATTLE_01_USGS is the same station as BTC04. It was designated as BTC04 during the 2007-2009 Lower Cheyenne River watershed assessment project and was re-named BATTLE01 in 2011 during the follow-up Battle Creek assessment project. During the Lower Cheyenne River watershed assessment, 13 fecal coliform samples were collected monthly from 2007 through 2009 at station BATTLE01/BTC04 in segment SD-CH-R-BATTLE_01_USGS. Only 2 of these samples were also analyzed for E. coli bacteria levels. In 2011, during the Battle Creek assessment project, samples were again collected from May through September from BATTLE01/BTC04. A total of 42 samples were collected in 2011 (multiple samples were collected each month) and were analyzed for fecal coliform and E. coli bacteria. BATTLE01/BTC04 is also the location of USGS stream gage 06406500.

Comments: No comments.

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).

Review Elements:

☒ 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 identified 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 2.0, "Water Quality Standards" (page 13) and Table 5 "Numeric surface water quality standards by segment for Battle Creek, Pennington and Custer Counties, South Dakota 2012" (page 14 -16)describe the applicable State of South Dakota water quality standards for Battle Creek segments SD-CH-R_BATTLE_01-USGS and SD-CH-R-BATTLE_02.

Section 2.1, "Numeric Standards" (page 13) describes the beneficial uses assigned to Battle Creek segments SD-CH-R-BATTLE_USGS_01 and SD-CH-R-BATTLE_02.

Section 2.2, "Narrative Standards" (page 17) describes the applicable narrative standards for Battle Creek segments SD-CH-R_BATTLE_01-USGS and SD-CH-R-BATTLE_02.

The bacteria impaired segments of Battle Creek have been assigned the following beneficial uses:

- *fish and wildlife propagation, recreation, and stock watering;*
- *irrigation;*
- *coldwater permanent fish life propagation (SD-CH-R-BATTLE_02);*
- *warm water marginal fish life propagation (SD-CH-R-BATTLE_01_USGS);*
- *Limited contact recreation.*

The State of South Dakota water quality criteria for fecal coliform and E. coli are:

- *fecal coliform criteria protective of limited contact recreation use*
    - *no sample exceeds 2,000 CFU/100 mL and*
    - *the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period may not exceed 1,000 CFU/100 mL. The geometric mean, as defined in ARSD § 74:51:01:01 is the n^{th} root of a product of n factors. Also, this value may not be exceeded in more than 20% of the samples examined in this same 30-day period.*
    - *Fecal coliform water quality criteria are applicable from May 1 through September 30, the recreation season.*
- *E. coli criteria protective of limited contact recreation use*
    - *no sample exceeds 1,178 cfu/100 mL and*
    - *the geometric mean of a minimum of 5 samples collected during separate 24-hour periods for any 30-day period may not exceed 630 cfu/100 mL.*
    - *E. coli water quality criteria are applicable from May 1 through September 30, the recreation season.*

The pollutants of concern for these TMDLs are fecal coliform and E. coli bacteria. The TMDLs have been developed to meet the State of South Dakota water quality standards for fecal coliform and E. coli bacteria that apply to segments SD-CH-R-BATTLE_USGS_01 and SD-CH-R-BATTLE_02.

Comments: *No comments.*

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, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 3.0, "TMDL Targets" (pages 17-20) identifies the numeric TMDL water quality targets for fecal coliform and E. coli for the impaired segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02.

The TMDL daily water quality targets selected for the 2 impaired segments of Battle Creek are:

- *Fecal coliform water quality target:* *no sample may exceed 2,000 cfu/100 mL (based on the acute WQC); applicable from May 1 through September 30, the recreation season.*
- *E. coli water quality target:* *no sample may exceed 1,178 cfu/100 mL (based on the acute WQC); applicable from May 1 through September 30, the recreation season.*

As discussed in the previous section, the State of South Dakota water quality standards for E. coli and fecal coliform have two parts, a daily maximum value intended to be compared to individual sample results and a 30-day value intended to be compared to geometric mean of 5 sample results collected over a 30-day period. The geometric mean, as defined in ARSD §74:51:01:01 is the n^{th} root of the product of n factors.

In order to demonstrate that the selection of the daily maximum water quality criteria as TMDL daily water quality targets will ensure that the TMDLs will also achieve the 30-day geometric mean water quality criteria for fecal coliform and E. coli, the following linkage analysis applies:

As stated in the EPA guidance document, "An Approach for Using Load Duration Curves in the Development of TMDLs" (EPA, 2007), EPA's development of ambient water quality criteria for bacteria, specifically E. Coli, defines the statistical relationship between the daily maximum criteria and the 30-day mean criteria. This relationship can be used to demonstrate that attaining the maximum daily water quality criteria as the TMDL target will also result in the attainment of the 30-day geometric mean criteria.

The concepts used to develop the "not to exceed" or "daily maximum" value are described in the EPA document "Ambient Water Quality Criteria for Bacteria -1986" (EPA, 1986). In particular, the relationship between the EPA recommended 30-day geometric mean criteria and the single sample maximum criteria for E. coli is based on the assumption that bacteria data can be described using a log normal frequency distribution. The method used to identify the upper target values in the 1986 EPA recommended water quality criteria for bacteria (EPA, 1986) provides the linkage analysis between the daily maximum value and the 30-day mean value.

The upper targets are based on the assumption of a log-normal distribution using a log standard deviation of 0.4 centered on the target geometric mean value. The upper target is defined in the WQS as a value not to be exceeded within a 30-day averaging period. The recurrence interval associated with a 30-day averaging period is (k/k+1) % or (30/31) % or 96.8%.

In the case of Battle Creek, for a lognormal distribution of E. coli with a geometric mean of 630 cfu/100mL and a log standard deviation of 0.4, the 96.8% recurrence interval value is 1322 cfu/100mL. Achieving the daily maximum WQC for E. coli of 1178 cfu/100ml (which is less than the 96.8% recurrence interval) will ensure that the geometric mean of 630 cfu/100mL E. coli will also be achieved.

Thus, the TMDL daily water quality target for E. coli of 1178 cfu/100mL will be protective of the 30-day geometric mean WQC of 630 cfu/100mL.

Similarly, using the same assumptions, the TMDL daily water quality target for fecal coliform of 2000 cfu/100mL will be protective of the 30-day geometric mean WQC of 1000 cfu/100mL. This is because, for a lognormal distribution of fecal coliform with a geometric mean of 1000 cfu/100mL and a log standard deviation of 0.4, the 96.8% recurrence interval value is 2098 cfu/100mL.

Comments: *No comments.*

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 identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. 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.

Review Elements:

☒ The TMDL should include an identification of the 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 the anthropogenic sources of the pollutant of concern have been identified, characterized, and 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the locations of the cities Keystone and Hermosa. Point sources are located in the general vicinity of these cities.

Section 4.0, "Significant Sources" (pages 20-23) describes the point sources and non point sources of bacteria loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD- CH-R-BATTLE _02.

Point Sources:

- *The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. The City of Keystone's wastewater treatment facility (WWTF) discharges into Battle Creek segment SD-CH-R-BATTLE_02 approximately 2.5 miles downstream of Highway 16A, east of Keystone. Discharges from the Keystone WWTF are regulated by SD DENR pursuant to NPDES Permit #SD0024007, issued in 2013. The permit requires routine sampling of discharges five times per month from May 1st through September 30th each year. Samples are analyzed for fecal coliform and E. coli. The permit includes fecal coliform and E. coli bacteria effluent limitations. The effluent limitations in the current permit are the fecal coliform daily maximum WQC of 2000 cfu/100mL and the daily maximum WQC for E. coli of 1178 cfu/100mL. The facility discharges to Battle Creek continuously. The most recent Discharge Monitoring Report data for the facility reviewed for this TMDL document (2008 through 2012) indicate that discharges met the permit required effluent limitations during the recreation season.*

- *The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. Hermosa's WWTF, a three cell treatment facility with land application, discharges into Battle Creek segment SD-CH-R-BATTLE_01_USGS. SD DENR regulates these discharges pursuant to NPDES permit # SD0022349 issued in 2009. The permit requires the facility to obtain permission from SD DENR prior to discharging. Battle Creek flows to the south of the WWTF and land application field. As of the date of the TMDL document, the City of Hermosa has not discharged from the WWTF. The NPDES permit-required effluent limitations for the City of Hermosa WWTF are 2,000 cfu/100mL fecal coliform and 1178 cfu/100ml E. coli.*

The following table summarizes the point sources and their contribution to loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02:

FACILITY	*GEOGRAPHIC LOCATION*	*DESCRIPTION*	*NPDES PERMIT #*	*PERMIT LIMITS*	*POTENTIAL LOADING*
City of Keystone, SD Wastewater Treatment Facility	*northern portion of segment SD-CH-R-BATTLE_02*	*Continuous discharge mechanical plant with design flow of 0.38 MGD*	*SD0024007*	*2,000 cfu/100mL fecal coliform, 1,178 cfu/100mL E. coli*	*29 x 10^9 cfu/day fecal coliform* *17 x 10^9 cfu/day E. Coli*
City of Hermosa, SD Wastewater Treatment Facility	*Northern portion of segment SD-CH-R-BATTLE_01_USGS*	*3 cell treatment facility with land application; design flow of 0.23 MGD*	*SD0022349*	*2,000 cfu/100mL fecal coliform,* *1,178 cfu/100mL E. coli*	*17 x 10^9 cfu/day fecal coliform* *10 x 10^9 cfu/day E. coli*

Non Point Sources:

Nonpoint sources of fecal coliform and E. coli bacteria loading to segments SD-CH-R-BATTLE_01 and SD-CH-R-BATTEL_01_USGS are:

1. ***Livestock:*** *Manure from livestock contributes bacteria loading to Battle Creek either directly (manure is deposited directly into the stream while livestock are wading) or indirectly (surface runoff from rangeland areas where manure has been deposited while livestock are grazing or are temporarily confined). Additionally, manure is applied to cropland, pasture, and rangeland in the lower portion of segment SD-CH-R-BATTLE_02 and segment SD-CH-R-BATTLE_01_USGS to improve crop and pasture/rangeland grass production. Livestock in the basin are predominantly beef and dairy cattle, horses and some sheep. Other livestock in the basin include bison, chickens and swine.*

   Livestock population densities in the watershed were estimated using National Agricultural Statistics Service data from the year 2009, which is summarized by county. For each category of livestock, per acre densities were calculated assuming an equal distribution of animals through the watershed. EPA's Bacterial Indicator Tool (BIT) was then used to estimate (model) the bacteria produced for potential loading into Battle Creek based on the density of each type of livestock animal. The output of the BIT is fecal coliform loading in units of CFU per acre per day. The BIT does not currently have the capability to provide estimated E. coli loading. However, since E. coli concentrations and fecal coliform concentrations are correlated in this watershed, the relative percent contributions of loading from the various types of livestock calculated from the BIT were assumed to apply to both fecal coliform and E. coli. The bacteria produced that could potentially result in loading to Battle Creek segment SD-CH-R-BATTLE _01_USGS from livestock sources was estimated to be 2.78 x 10^9 CFU/acre/day. The bacteria *produced that could potentially result in loading to Battle Creek segment SD-CH-R-BATTLE_02 from livestock sources was estimated to be 2.83 x 10^9 CFU/acre/day.*

2. ***Wildlife:*** *Wildlife contributes fecal coliform and E. coli loading to both segments of Battle Creek similar to livestock, i.e., both directly and indirectly. Wildlife is considered to be a background source of fecal coliform and E. coli loading. In order to estimate the fecal coliform and E. coli loading to Battle Creek from wildlife sources, wildlife population density estimates for the watershed were obtained from the South Dakota Department of Game, Fish and Parks (SD GF&P, 2002). The BIT was then used to estimate (model) the bacteria loading into Battle Creek in units of CFU per day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_01_USGS from wildlife sources was estimated to be 2.2 x 10^8 CFU/acre/day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from wildlife sources was estimated to be 2.1 x 10^8 CFU/acre/day.*

3. ***Human:*** *Failing residential septic systems within the Battle Creek watershed are nonpoint sources of fecal coliform and E. coli loading to Battle Creek. Outside of the cities Keystone and Hermosa, the majority of Battle Creek is relatively rural. Localized populations along Battle Creek within segment SD-CH-R-BATTLE_02 are Hayward area where Iron Creek enters Battle Creek downstream to WQM 17 and immediately west of Hermosa from Highway 79 to one mile west of the confluence of Grace Coolidge Creek and Battle Creek. Developments in these areas are within and along the watershed riparian areas. These developments are rural, with no centralized wastewater collection or treatment facilities. Thus, septic systems are assumed to be the primary human source of bacterial loads to Battle Creek. The number of occupied residences was estimated using SD Department of Transportation data from 2008. A fifteen percent failure rate was used to estimate human fecal/E. coli contributions from septic systems. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_01_USGS from leaking septic systems was estimated to be 4.8 x 10^7 CFU/acre/day. The bacteria loading to Battle Creek segment SD-CH-R-BATTLE_02 from leaking septic systems was estimated to be 6 x 10^7 CFU/acre/day.*

The total bacteria potentially produced within Battle Creek segment SD-CH-R-BATTLE_01_USGS from nonpoint sources is estimated to be 2 x 10^9 CFU/day.

The total bacteria potentially produced within Battle Creek segment SD-CH-R-BATTLE_02 from nonpoint sources is estimated to be 3.1 x 10^9 CFU/day.

The following table summarizes the percent contribution of each nonpoint source of bacteria loading to the impaired segments of Battle Creek:

Non Point Source	***Estimated Percent of Total Non Point Source Bacteria Loading to Segment SD-CH-R-BATTLE_01_USGS***	***Estimated Percent of Total Non Point Source Bacteria Loading to Segment SD-CH-R-BATTLE_02***
Pigs	*0.02%*	*0.02%*
Milk cows	*0.42%*	*0.36%*
Cattle on range	*78.53%*	*84.35%*
Cattle on feed	*1.45%*	*0.99%*
Sheep	*0.16%*	*0.15%*
Bison	*10.04%*	*5.41%*
Horses	*0.03%*	*0.02%*
Wildlife	*8.78%*	*6.76%*
Septic Tanks	*0.58%*	*1.93%*

Comments: *No comments.*

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the 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:

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

Where:		
TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin of Safety

Review Elements:

☒ 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:

- the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
- the distribution of land use in the watershed (e.g., urban, forested, agriculture);
- 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…;
- 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);
- 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Load duration curves were used to develop the fecal coliform and E. coli loading capacities for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02. Load duration curves provide flow-variable TMDLs that describe allowable loading that will ensure water quality targets are achieved for any flow along the entire long term flow regime for the recreation season (from May 1 through September 30) for each segment.

Segment SD-CH-R-BATTLE_01_USGS

The load duration curves for segment SD-CH-R-BATTLE_01_USGS were developed using the long term flow record from USGS monitoring site 06406500, "Battle Creek below Hermosa", where stream discharge has been measured since 1949. Daily average flows during the recreation season were multiplied by the TMDL water quality targets of 2000 cfu/100mL fecal coliform and 1178 cfu/100mL E. coli, resulting in loading capacities or TMDLs expressed as cfu/day.

Five flow zones were designated for the recreational season for segment SD-CH-R-BATTLE_01_USGS:

1. *High flow zone: Flows in this zone are exceeded 0-10% of the time and consist of flows between 45 cfs-1760 cfs.*
2. *Moist flow zone: Flows in this zone are exceeded 10-40% of the time and consist of flows between 18 cfs -44 cfs.*
3. *Mid-Range flow zone: Flows in this zone are exceeded 40-60% of the time and consist of flows between 6 cfs – 17 cfs*

4. *Dry flow zone: Flows in this zone are exceeded 60-90% of the time and consists of flows between 1.4 cfs – 5 cfs.*
5. *Low flow zone: Flows in this zone are exceeded 90-100% of the time and consist of flows between 0.01 cfs – 1.3 cfs.*

Figure 7 on page 29 of the TMDL document presents the fecal coliform load duration curve for this segment. Figure 10 on page 34 of the TMDL document presents the E. coli load duration curve for this segment.

For each of the five flow zones, the 95th percentile point on the loading capacity curve was selected as the TMDL for that flow zone. The following table summarizes the fecal coliform and E. coli TMDLs for segment SD-CH-R-BATTLE_01_USGS:

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{13} cfu/day*	*2.0×10^{12} cfu/day*	*8.3×10^{11} cfu/day*	*2.8×10^{11} cfu/day*	*5.9×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*1.1×10^{13} cfu/day*	*1.2×10^{12} cfu/day*	*4.9×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*3.5×10^{10} cfu/day*

An explicit margin of safety (MOS) was reserved to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit 10% MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity.

The fecal coliform and E. coli waste load allocations for the City of Hermosa WWTF (permit number SD0022349) were calculated based on the E. coli and fecal coliform TMDL water quality targets multiplied by the a discharge of 0.5 feet of wastewater drawn down per day from treatment cell three, 0.23 million gallons per day (MGD), and a conversion factor.

After accounting for the MOS and LA, the remaining loading capacity was allocated to nonpoint sources as the load allocations for both fecal coliform and E. coli. This results in balanced TMDL equations.

The balanced TMDL equations for segment SD-CH-R-BATTLE_01_USGS are presented in Table 15 (fecal coliform) and Table 17 (E. coli).

Segment SD-CH-R-BATTLE_02:

The load duration curves for segment SD-CH-R-BATTLE_02 were developed using the long term flow record from USGS monitoring site 06406000, "Battle Creek at Hermosa, SD", where stream discharge has been measured since 1950. Daily average flows during the recreation season were multiplied by the

TMDL water quality targets of 2000 cfu/100mL fecal coliform and 1178 cfu/100mL E. coli, resulting in loading capacities or TMDLs expressed as cfu/day.

Five flow zones were designated for the recreational season for segment SD-CH-R-BATTLE_03:

1. *High flow zone: Flows in this zone are exceeded 0-10% of the time and consist of flows between 29 cfs-1750 cfs.*
2. *Moist flow zone: Flows in this zone are exceeded 10-40% of the time and consist of flows between 6 cfs -28 cfs.*
3. *Mid-Range flow zone: Flows in this zone are exceeded 40-60% of the time and consist of flows between 3.4 cfs – 5.9 cfs*
4. *Dry flow zone: Flows in this zone are exceeded 60-90% of the time and consists of flows between 1.4 cfs – 3.3 cfs.*
5. *Low flow zone: Flows in this zone are exceeded 90-100% of the time and consist of flows between 0.01 cfs – 1.3 cfs.*

Figure 6 on page 26 of the TMDL document presents the fecal coliform load duration curve for this segment. Figure 9 on page 32 of the TMDL document presents the E. coli load duration curve for this segment.

For each of the five flow zones, the 95th percentile point on the loading capacity curve was selected as the TMDL for that flow zone. The following table summarizes the fecal coliform and E. coli TMDLs for segment SD-CH-R-BATTLE_02:

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_02

Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	1.2×10^{13} *cfu/day*	1.3×10^{12} *cfu/day*	2.7×10^{11} *cfu/day*	1.6×10^{11} *cfu/day*	6.4×10^{10} *cfu/day*
E. coli	*1178 cfu/100mL*	6.8×10^{12} *cfu/day*	7.5×10^{11} *cfu/day*	1.6×10^{11} *cfu/day*	9.5×10^{10} *cfu/day*	3.7×10^{10} *cfu/day*

An explicit margin of safety (MOS) was reserved to account for uncertainty (e.g., loads from tributary streams and effectiveness of controls). An explicit 10% MOS was calculated from the TMDL within each flow zone and reserved as unallocated assimilative capacity.

The fecal coliform and E. coli waste load allocations for the City of Keystone WWTF (permit number SD0024007) were calculated based on the E. coli and fecal coliform TMDL water quality targets multiplied by the 80th percentile flow from Discharge Monitoring Report data (0.38 million gallons per day (MGD)) and a conversion factor.

After accounting for the MOS and LA, the remaining loading capacity was allocated to nonpoint sources as the load allocations for both fecal coliform and E. coli. This results in balanced TMDL equations.

The balanced TMDL equations for segment SD-CH-R-BATTLE_02 are presented in Table 14 (fecal coliform) and Table 16 (E. coli).

Comments: *No comments.*

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…).
Review Elements:
☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Since May 1968, SD DENR has collected surface water samples from monitoring location WQM17, "Battle Creek" (Storet number 460905). Samples collected during the recreation season have historically been analyzed for fecal coliform bacteria levels. Since the summer of 2001, samples collected during the recreation season have also been analyzed for E. coli bacteria levels. Samples are collected monthly at location WQM17.

In 2007-2009, surface water samples were collected from location BTC03 (same location as BATTLE02A) in segment SD-CH-R-BATTLE_02 and from location BTC04 (same location as

BATTLE01)in segment SD-CH-R-BATTLE_01_USGS. These samples were analyzed for both fecal coliform and E. coli bacteria levels.

In 2011, surface water samples were collected from locations BATTLE03 and BATTLE02A/BTC03 in segment SD-CH-R-BATTLE_02, and from location BATTLE 02 and BATTLE01/BTC04 in segment SD-CH-R-BATTLE_01_USGS. Surface water samples were also collected from location GRCOOL01 in Grace Coolidge creek, a tributary to Battle Creek. These samples were analyzed for both fecal coliform and E, coli bacteria levels.

These three sampling programs combined provide the following dataset:

Stream Segment	***# fecal coliform samples***	***# E. coli samples***
SD-CH-R-BATTLE_01_USGS	*76*	*77*
SD-CH-R-BATTLE_02	*93*	*85*
Total	*169*	*162*

The monitoring data for segment SD-CH-R-BATTLE_02 indicate that in the upper portion of the segment, fecal coliform and E. coli concentrations occur sporadically above the WQC protective of limited contact recreation use. These exceedances occur throughout all flow zones so they don't appear to be flow-related. However, in the downstream portions of this segment (from monitoring location BATTLE03 to the end of the segment) a dramatic increase in fecal coliform concentrations was detected in 2011. The frequency of exceeding the WQC increased from location BATTLE03 to the end of the segment.

These observations led SD DENR to collect samples more frequently (samples were collected every 1-3 days) within the lower portion of SD-CH-R-BATTLE_02 in the summer of 2011. The results of the intensive sampling in 2011 indicate that Grace Coolidge Creek does not contribute a significant loading of fecal coliform to Battle Creek and that the highest loading of fecal coliform to Battle Creek occurs in the limited area between monitoring sites BATTLE02A, BATTLE03, AND GRCOOL01. This area is illustrated in Figure 2.

The monitoring data for segment SD-CH-R-BATTLE _01_USGS indicate that in the upper portion of this segment, fecal coliform and E. coli concentrations exceed the WQC for limited contact recreation use during moist and high flow conditions. In the lower portions of this segment however, the WQC are achieved except during the highest flow conditions.

Limitations of the monitoring data include the following:

- *All data collected during the 2011 Battle Creek assessment project were collected during high and moist flow conditions.*
- *During the 2011 Battle Creek assessment project, samples were not collected at the same frequency at all locations. In 2011, no samples were collected at BATTLE03, GRCOOL01, BATTLE02A or BATTLE02 during May, June or July. Data from 2007-2009 and in 2011 at BATTLE01 indicate that the highest concentrations of bacteria tend to occur during the latter*

- *part of the recreation season, therefore it's likely that the available data capture the most critical time of the recreation season.*
- *There are only 2 E.coli samples available from 2007-2009 at locations BATTLE02A/BTC03 and BATTLE01/BTC04.*

Comments: *No Comments.*

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.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The fecal coliform and E. coli TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 include WLAs for the individual NPDES permitted point source dischargers located within the watersheds of the segments.

The NPDES permitted point source dischargers are identified, including the specific NPDES permit numbers and geographical locations.

Figure 2, "Battle Creek watershed with monitoring sites, AUID identifiers and current ADB segment lengths" (page 4) shows the locations of the cities Keystone and Hermosa. Point sources are located in the general vicinity of these cities.

Section 4.0, "Significant Sources" (pages 20-23) describes the point sources and non point sources of bacteria loading to Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD- CH-R-BATTLE _02.

Point Sources

- *The City of Keystone (population 337) is located in the upper portion of segment SD-CH-R-BATTLE_02. The City of Keystone's wastewater treatment facility (WWTF) discharges into Battle Creek segment SD-CH-R-BATTLE_02 approximately 2.5 miles downstream of Highway 16A, east of Keystone. Discharges from the Keystone WWTF are regulated by SD DENR pursuant to NPDES Permit #SD0024007, issued in 2013. The permit requires routine sampling of discharges five times per month from May 1st through September 30th each year. Samples are analyzed for fecal coliform. The permit was updated in 2013 to include E. coli bacteria effluent limitations. The effluent limitations in the current permit are the fecal coliform daily maximum WQC of 2000 cfu/100mL and the daily maximum WQC for E. coli of 1178 cfu/100mL. The facility discharges to Battle Creek continuously. The most recent Discharge Monitoring Report data for the facilitythat were reviewed for this TMDL document (2008 through 2012) indicate that discharges met the permit required effluent limitations during the recreation season.*

- *The City of Hermosa (population, 398) is located in the upper portion of segment SD-CH-R-BATTLE_01_USGS. Hermosa's WWTF, a three cell treatment facility with land application, discharges into Battle Creek segment SD-CH-R-BATTLE_01_USGS. SD DENR regulates these discharges pursuant to NPDES permit # SD0022349 issued in 2009. The permit requires the facility to obtain permission from SD DENR prior to discharging. Battle Creek flows to the south of the WWTF and land application field. As of the date of the TMDL document, the City of Hermosa has not discharged from the WWTF. The NPDES permit-required effluent limitations for the City of Hermosa WWTF are 2,000 cfu/100mL fecal coliform and 1178 cfu/100ml E. coli.*

The following table summarizes the point sources and their WLAs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02:

FACILITY	***GEOGRAPHIC LOCATION***	***DESCRIPTION***	***NPDES PERMIT #***	***WLA***
City of Keystone, SD Wastewater Treatment Facility	*northern portion of segment SD-CH-R-BATTLE_02*	*Continuous discharge mechanical plant with design flow of 0.38 MGD*	*SD0024007*	*29 x 10^9 cfu/day fecal coliform* *17 x 10^9 cfu/day E. Coli*
City of Hermosa, SD Wastewater Treatment Facility	*Northern portion of segment SD-CH-R-BATTLE_01_USGS*	*3 cell treatment facility with land application; design flow of 0.23 MGD*	*SD0022349*	*17 x 10^9 cfu/day fecal coliform* *10 x 10^9 cfu/day E. coli*

***Comments**: No comments.*

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.

Review Elements:

☒ 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 the 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Load allocations were calculated for fecal coliform and E. coli for all flow zones on Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 using the load duration curve approach as follows:

1. *The loading capacity (in cfu/day) was determined by multiplying the long term average daily flow during the recreation season for each segment (using flow data from existing USGS gaging stations on each segment)by the TMDL water quality targets for fecal coliform and E. coli and a conversion factor.*
2. *An explicit margin of safety of 10% was allocated from each flow zone.*
3. *For each segment, the WLAs were then allocated for each point source that discharges to the segment.*
4. *Finally, the remaining loading capacity was allocated to the nonpoint sources as load allocations.*

The following tables provide a summary of the load allocations for each segment and each pollutant.

Summary of Fecal Coliform and E. Coli Load Allocations for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***TMDL Water Quality Target***	***High Flow (46-1760 cfs)***	***Moist Conditions (19-45 cfs)***	***Mid-Range Flow (7-18 cfs))***	***Dry Conditions (1.4- 6 cfs)***	***Low Flow (0.01-1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.6×10^{13} cfu/day*	*1.8×10^{12} cfu/day*	*7.3×10^{11} cfu/day*	*2.3×10^{11} cfu/day*	*3.6×10^{10} cfu/day*
E. coli	*1178cfu/100mL*	*9.6×10^{12} cfu/day*	*1.1×10^{12} cfu/day*	*4.3×10^{11} cfu/day*	*1.4×10^{11} cfu/day*	*2.2×10^{10} cfu/day*

Summary of Fecal Coliform and E. Coli Load Allocations for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***TMDL Water Quality Target***	***High Flow (29-1750 cfs)***	***Moist Conditions (6-28 cfs)***	***Mid -Range Flow (3.4-5.9 cfs)***	***Dry Conditions (1.4 -3.3 cfs)***	***Low Flow (0.01 - 1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.03×10^{13} cfu/day*	*1.1×10^{12} cfu/day*	*2.2×10^{11} cfu/day*	*1.2×10^{11} cfu/day*	*2.9×10^{10} cfu/day*
E. coli	*1178cfu/100mL*	*6.1×10^{12} cfu/day*	*6.6×10^{11} cfu/day*	*1.3×10^{11} cfu/day*	*6.9×10^{10} cfu/day*	*1.6×10^{10} cfu/day*

Although specific LAs are not provided for each identified non point sources within the Battle Creek watershed, the TMDL document states that the major non point sources of fecal coliform during base flow include wildlife, domestic animals, livestock and septic systems. The majority of loading from non point sources during moderate to high flows is from livestock and manure management on agricultural cropland, pastureland and rangeland. Based on the available data, the area just upstream of Highway 79 appears to be contributing the largest amount of bacteria loading to Battle Creek from non point sources.

***Comments**: No comments.*

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).

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

For each segment and each pollutant, an explicit margin of safety (MOS) of 10% of the total loading capacity was reserved to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, limitations of monitoring data).

The following tables provide a summary of the MOS allocations for each segment and each pollutant.

Summary of Fecal Coliform and E. Coli MOS Allocations for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***TMDL Water Quality Target***	***High Flow (46-1760 cfs)***	***Moist Conditions (19-45 cfs)***	***Mid-Range Flow (7-18 cfs))***	***Dry Conditions (1.4- 6 cfs)***	***Low Flow (0.01-1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{12} cfu/day*	*2×10^{11} cfu/day*	*8.3×10^{10} cfu/day*	*2.8×10^{10} cfu/day*	*6×10^{9} cfu/day*
E. coli	*1178cfu/100mL*	*1×10^{12} cfu/day*	*1.2×10^{11} cfu/day*	*4.9×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*4×10^{9} cfu/day*

Summary of Fecal Coliform and E. Coli MOS Allocations for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***TMDL Water Quality Target***	***High Flow (29-1750 cfs)***	***Moist Conditions (6-28 cfs)***	***Mid -Range Flow (3.4-5.9 cfs)***	***Dry Conditions (1.4 -3.3 cfs)***	***Low Flow (0.01 - 1.3 cfs)***
Fecal coliform	*2000 cfu/100mL*	*1.2×10^{12} cfu/day*	*1.3×10^{11} cfu/day*	*2.7×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*6×10^{9} cfu/day*
E. coli	*1178cfu/100mL*	*6.8×10^{12} cfu/day*	*7.5×10^{10} cfu/day*	*1.6×10^{10} cfu/day*	*1×10^{10} cfu/day*	*4×10^{9} cfu/day*

Comments: *No comments*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

By using the load duration curve approach to develop the TMDLs for Battle Creek, seasonal variability is taken into account. The TMDL, WLA, LAs and MOS are provided for all flow regimes thus, all seasons.

Based on the available monitoring data, the critical flow periods for fecal coliform and E. coli loading in segment SD-CH-R-BATTLE_01_USGS are during high flow and moist conditions. For segment SD-CH-R-BATTLE_02, the critical flow periods are during mid-range flow, moist conditions, and low flow. The majority of bacteria loading in this segment occurs in the lower portion of the segment, just upstream of Highway 79.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

SD DENR provided several opportunities for stakeholders and members of the general public to participate in the development of the TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02. These activities indicate that SD DENR developed the TMDLs in a process that was open to the public.

The following specific public participation activities were undertaken:

- *In 2011 and 2012, SD DENR held discussions with stakeholders and landowners about the Battle Creek project and sampling results for Battle Creek.*
- *During an inspection of the Hermosa WWTF, the project was discussed with the Town of Hermosa engineer.*
- *In June 2012, SD DENR issued a public notice that the draft TMDL document was available for public review and comment. The public notice provided information about how to obtain a copy of the draft document as well as instructions on how to submit comments to SD DENR. The deadline for submittal of comments by the public was July 1, 2012.*
- *In April of 2013, SD DENR presented the results of the Battle Creek assessment project and TMDLs at a public meeting in Hermosa. Approximately 20 people attended.*
- *Due to significant changes to the draft TMDL document as a result of EPA informal comments and the request from one citizen for an additional public comment period, SD DENR provided another opportunity for public review and comment on the revised draft TMDL document in August 2013.*
- *DENR provided another opportunity for the public to disucss commentst on the revised TMDL document during the 2013 public comment period at a public meeting in Keystone, SD on September 26, 2013.*

Comments received from EPA on the June 2012 public notice draft version of the TMDL document were addressed in the July 2013 revised public notice draft version.

SD DENR considered the input provided during the public meetings and comments from the public provided during the two 30-day public notice periods as well the additional comments from EPA on the July 2013 public notice draft in the development of the final fecal coliform and E. coli TMDLs for Battle Creek. SD DENR's responses to written comments are included in Appendix C of the final TMDL document.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

Section 10, "Monitoring Strategy" (page 51) presents a monitoring strategy that describes the additional data to be collected.

The TMDL document states that in order to demonstrate attainment of the TMDLs, monitoring of Battle Creek will be necessary during and after the implementation of management practices. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring at station WQM17 on Battle Creek. SD DENR anticipates that the frequency of this monitoring will be monthly. The TMDL document recommends that during the recreation season, bacterial monitoring should be increased to collect at least 5 samples per month in order to have sufficient data to evaluate whether fecal coliform and E. coli bacteria levels achieve the water quality standards based on the 30-day geometric mean geometric mean.

The TMDL document also recommends that the monitoring program should include supplemental exploratory sampling to better define and target areas of concern. Monitoring to support the selection of locations of BMPs and to aid in the design of BMPs should be based on the type of BMPs installed.

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

Comments: *The monitoring strategy appears to rely on the ambient water quality monitoring station WQM17, located in the upper reach of segment SD--CH-R-BATTLE_02. While this location will be important to monitor, particularly since the historical data available at this location will support an assessment of trends, we believe that BATTLE01 and BATTLE02 are important to include in a long term monitoring program. We believe that at a minimum, monitoring at all three locations should continue throughout implementation and demonstration of TMDL attainment.*

Additional monitoring locations will likely be needed to determine the optimal locations for BMPs, the specific type of BMP, and the effectiveness of BMPs in achieving the TMDLs. Please include a description of these additional monitoring components in Section 10 of the TMDL document.

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

Section 12.0, "Restoration Strategy" (page 53) describes the strategy for achieving the fecal coliform and E.coli, TMDLs for Battle Creek.

Implementation of BMPs will be required. The highest priority area for implementation projects is the lower end of segment SD-CH-R-BATTLE_02, followed by segment SD-CH-R-BATTLE_01_USGS.

Within segment SD-CH-R-BATTLE_02, BMPs that reduce fecal coliform/E. coli loads will likely include:

- *improve and protect the riparian buffer zone through grazing management practices with off-stream watering and residential zoning,*
- *implement septic system inspection program within Battle Creek to document the condition of existing septic tank systems, identify failing systems and develop a mechanism/program to repair or replace failing systems*
- *investigate the survival, longevity and decay rate of pathogens in the sediments of Battle Creek over extended periods of time.*

For segment SD-CH-R-BATTLE_01_USGS, BMPs will likely include:

- *improve and protect the riparian buffer zone through grazing management practices with off-stream watering and vegetation development,*
- *riparian and stream bank erosion control measures, and*
- *development of cattle crossing areas for reduced stream access and erosion.*

Implementation projects for Battle Creek should be supported by and done within the context of a comprehensive watershed model for bacteria and Total Suspended Solids covering the entire Battle Creek watershed.

The Town of Keystone WWTF NPDES permit allows discharge of high concentrations of fecal coliform from October through April. There is limited knowledge on the survival of fecal coliform bacteria and associated pathogens in the stream and bank sediments. With survival, these pathogens are subject to re-suspension with high flows or other channel disturbances in spring and summer. As part of an implementation plan, it would be beneficial to supply funds to investigate the survival, longevity and decay rate of pathogens in the sediments of Battle Creek over extended periods of time.

The Lower Cheyenne River Watershed Assessment Project has recently been completed and broad support to begin an implementation project is evident. Battle Creek is part of the Cheyenne River watershed and could be included in a larger, basin-wide implementation project. Major entities that should be involved in planning, funding and supporting this project as it pertains to Battle Creek are the West Dakota Water Development District, Pennington County, Pennington County Conservation District, Cheyenne River Partnership and the Natural Resource Conservation Service.

Funds to implement watershed water quality improvements can be obtained through the SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Non-point Source Program.

The broad support for implementation and the availability of funding provide reasonable assurance that the load allocations required by the fecal coliform and E. coli TMDLs for Battle Creek will be achieved.

Comments: *No comments.*

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.

Review Elements:

☒ 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:

This TMDL document contains sufficient information to satisfactorily address the review elements for this section.

The fecal coliform and E.coli TMDLs for Battle Creek segments SD-CH-R-BATTLE_01_USGS and SD-CH-R-BATTLE_02 are expressed in terms of a daily load i.e., in cfu per day.

Since the TMDLs were developed using the load duration curve approach, for each flow zone, the TMDL was selected as the 95th percentile of the range of values along the continuous loading capacity curve. Using the load duration curve approach, a TMDL is provided for any given flow condition.

The following tables summarize the fecal coliform and E. coli TMDLs.

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_01_USGS						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.8×10^{13} cfu/day*	*2.0×10^{12} cfu/day*	*8.3×10^{11} cfu/day*	*2.8×10^{11} cfu/day*	*5.9×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*1.1×10^{13} cfu/day*	*1.2×10^{12} cfu/day*	*4.9×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*$3.5 x10^{10}$ cfu/day*

Fecal Coliform and E. Coli TMDLs for Battle Creek Segment SD-CH-R-BATTLE_02						
Pollutant	***Water Quality Target***	***High Flow TMDL***	***Moist Conditions TMDL***	***Mid-Range Flow TMDL***	***Dry Conditions TMDL***	***Low Flow TMDL***
Fecal coliform	*2000 cfu/100mL*	*1.2×10^{13} cfu/day*	*1.3×10^{12} cfu/day*	*2.7×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*6.4×10^{10} cfu/day*
E. coli	*1178 cfu/100mL*	*6.8×10^{12} cfu/day*	*7.5×10^{11} cfu/day*	*1.6×10^{11} cfu/day*	*9.5×10^{10} cfu/day*	*$3.7 x10^{10}$ cfu/day*

***Comments**: No comments.*

9. References

EPA, 2007. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006, August 2007. Office of Wetlands, Oceans, and Watersheds. http://www.epa.gov/owow/tmdl/techsupp.html

EPA, 1986. Ambient Water Quality Criteria for Bacteria – 1986. EPA 440/5-84-002. January 1986. Office of Water Regulations and Standards, Criteria and Standards Division.