Escherichia coli Bacteria
Total Maximum Daily Load Evaluations for the West Fork of the Vermillion River South Dakota

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

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Total Maximum Daily Load Summary

West Fork of the Vermillion River - SD-VM-R-VERMILLION_WEST_FORK_01_USGS

Waterbody Type:	River/Stream
Reach Number:	SD-VM-R-VERMILLION_WEST_FORK_01_USGS
303(d) Listing Parameter:	Pathogen (*Escherichia coli*)
Initial Listing Date:	2010 IR
Designated Uses of Concern:	Limited Contact Recreation Waters
Size of Impaired Waterbody:	SD-VM-R-VERMILLION_WEST_FORK_01_USGS - Approximately 103.97 km in length Entire length – Approximately 165.42 km in length
Size of Watershed:	SD-VM-R-VERMILLION_WEST_FORK_01_USGS - 71,799.2 hectares (ha) Entire Subwatershed Size - 101,583.6 hectares (ha)
Indicator(s):	Concentration of *Escherichia coli* (colony forming units per 100ml)
Analytical Approach:	Bacterial Indicator Tool (BIT) with Load Duration Curve Framework
Location:	Hydrologic Unit Codes (8-digit HUC): 10170102
Goal:	Meet applicable water quality standards for *Escherichia coli*
TMDL Priority Ranking:	Priority 1: High Priority (2018 IR)
Target (Water Quality Standards):	*Escherichia coli* - Maximum daily concentration of ≤ 1,178 CFUs/100mL

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High Flow Zone LA:	4.13E+13CFU/day
High Flow Zone WLA Canistota:	2.18E+10CFU/day
High Flow Zone WLA Marion:	3.21E+10CFU/day
High Flow Zone WLA Parker:	4.24E+10CFU/day
High Flow Zone WLA Salem:	7.85E+10CFU/day
High Flow Zone MOS:	4.55E+12CFU/day
High Flow Zone TMDL:	4.60E+13CFU/day

1.0 Objective

The intent of this document is to clearly identify the components of the TMDL, support adequate public participation, and facilitate the US Environmental Protection Agency (US EPA) review. The TMDL was developed in accordance with section 303(d) of the federal Clean Water Act and guidance developed by the US EPA. This TMDL document addresses the pathogen impairment for SD-VM-R-VERMILLION_WEST_FORK_01_USGS (West Fork of the Vermillion River, McCook-Miner County Line to the Vermillion River), which was assigned a high priority (priority 1) in the 2018 SD integrated report.

2.0 Watershed Characteristics

2.1 General

The project area for SD-VM-R-VERMILLION_WEST_FORK_01_USGS is shown in Figure 1. The entire West Fork of the Vermillion River drains approximately 392 miles^2 in southeastern South Dakota (SD). Only 64.6 miles of the entire 102.7 miles length is classified with the limited contact recreation beneficial use. Intermittent tributaries merge with the West Fork prior to its confluence with the East Fork where together they form the mainstem of the Vermillion River near Parker, SD (Figure 1).

SD-VM-R-VERMILLION_WEST_FORK_01_USGS of the West Fork of the Vermillion River is currently classified with the following beneficial uses:

Chapter 74:51:03:01 of the South Dakota Administrative Rules assigns all streams in South Dakota the beneficial uses of:

Beneficial Use Classification 9: Fish and wildlife propagation, recreation, and stock watering waters
Beneficial Use Classification 10: Irrigation waters

Chapter 74:51:03:25 of the South Dakota Administrative Rules assigns the following additional beneficial use classifications to the West Fork of the Vermillion River from the Vermillion River to the McCook-Miner County Line:

Beneficial Use Classification 6: Warmwater marginal fish life propagation waters
Beneficial Use Classification 8: Limited contact recreation waters

The West Fork of the Vermillion River watershed is located in the James River Lowland Level IV ecoregion which is part of the greater Northern Glaciated Plains. A flat to gently rolling landscape composed of glacial drift characterizes the Northern Glaciated Plains ecoregion. This ecoregion is also characterized by dense concentrations of temporary and seasonal wetlands. Native grasses include western wheatgrass, green needlegrass, big bluestem, and blue grama but most areas are extensively tilled to corn and soybeans interspersed with pastureland (Bryce et al., 1996 and Chapman et al., 2001). Wildlife species present in the area include whitetail deer, red fox, beavers, raccoons, ring-necked pheasants, mourning doves, and numerous other species of songbirds, waterfowl, reptiles, and amphibians (SD Game, Fish, and Parks, 2002).

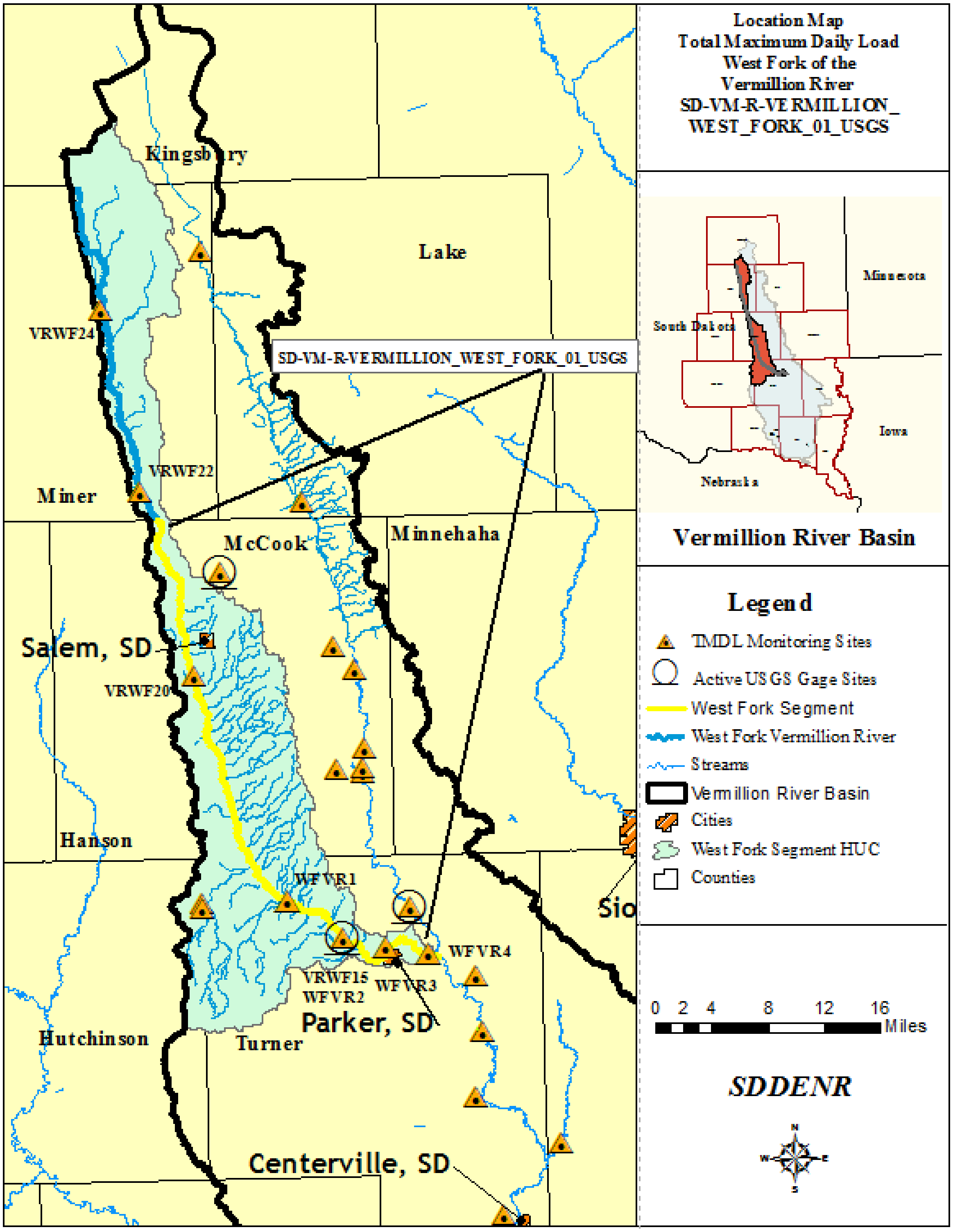

Figure 1. Location of SD-VM-R-VERMILLION_WEST_FORK_01_USGS, West Fork Vermillion River (South Dakota)

The West Fork of the Vermillion River is divided into 10 individual HUC12s ranging in size from 14,196 to 33,885 acres. Land uses within these HUCs are generally similar (Figure 2). The majority of these areas are dominated by a combination of grassland, hay, pasture, corn, and soybeans land uses. There are insignificant amounts of residential and commercial areas within this rural watershed. The impacts from these two land uses are expected to be minimal (Figure 2). In each of the 10 HUCs, approximately 56% or greater of the watershed is dominated by cultivated crops.

The impaired reach of the West Fork of the Vermillion River lies within central McCook County and northwestern Turner County (Figure 1). Common soil associations in the uplands include Clarno-Bonilla-Tetonka, Crossplain-Clarno-Tetonka, Clarno-Ethan, Crossplain-Dudley, Hand-Ethan-Clarno, and Wentworth-Egan associations. Associations found within steep areas are limited to Ethan-Betts. Along the terraces, floodplains, and foot slopes Davis-Bon-Lamo and Delmont-Hand-Chaska associations can be found. Soils range from well drained to poorly drained, and level to steep (NRCS, 1980). There is a large mix of uplands, swales, and wetland depressions.

There are seven communities within the West Fork Watershed. The 2017 populations range from 38 for the city of Dolton, SD to 1,289 for the city of Freeman, SD. Many of these municipalities have discharge permits. The information from these municipal WWTF's was included in the TMDL. Although the city of Freeman, SD is within the watershed boundary the WWTF is located west of the city and falls within the James River Watershed. A WLA was not provided in this TMDL.

Table 1. 2017 City Population within the West Fork Watershed.

City	Canistota	Dolton	Freeman	Howard	Marion	Parker	Salem
2017 Pop.	622	38	1,289	767	771	1,008	1,277

The Vermillion River basin has a sub-humid, continental climate characterized by pronounced seasonal differences in temperature, precipitation, and other climatic variables. Temperature varies slightly from the northern to the southern end of the basin. Annual temperatures are slightly cooler at the northern parts of the basin. January is typically the coldest month (13^{o}F in the north and 19^{o}F in the south). July is typically the warmest month (73^{o}F in the north and 75^{o}F in the south). Figure 1 shows that the West Fork of the Vermillion River is located in the northern part of the basin.

The frost free days at the northern end of the basin are typically from May 17th to September 21st, while the southern frost free days are from May 4th to October 5th. The average annual precipitation in the watershed is somewhat variable, both spatially and temporally, ranging from 22 to 26 inches. Generally, average annual precipitation decreases as you move north within the study watershed. Average seasonal snowfall for this region is approximately 30 inches.

The average rainfall in the West Fork watershed is approximately 22 inches per year with 64% falling during May through September (1949-2006). The average annual snowfall is approximately 34 inches but varies widely from year to year. The mainstem sites and tributary sites are shown in Figure 1 and Table 2.

Table 2. West Fork of the Vermillion River Assessment Reach and Segment Designations.

Segment	Length miles	Description	South Dakota Monitoring Stations for Mainstem River	
			Mainstem Sites	Tributary Sites
SD-VM-R-VERMILLION_WEST_FORK_01_USGS	64.6	Vermillion River to McCook-Miner County Line	VRWF15 VRWF20 WFVR1 WFVR2 WFVR3 WFVR4	VRWFT16 WFVR22 WFVR24

Although the West Fork of the Vermillion River is approximately 102.8 miles in length, the water quality standards only apply from the McCook/Miner County Line to the Vermillion River just southeast of Parker, SD (Figure 1, Table 1). For the remaining part of the West Fork of the Vermillion River, limited contact recreation is not a designated use, therefore *E. coli* criteria do not apply. There are no long-term ambient WQM stations on this segment. The data used to determine impairment were temporary stations installed as part of the overall Vermillion River Basin Watershed Assessment (Appendix A). The data collected from these stations during 2005-2006 and the BMP monitoring project data collected in 2015-2017 indicated an impairment of the limited contact recreational use caused by bacteria on this segment.

The West Fork of the Vermillion River was assessed as an individual portion of the larger Vermillion River Basin Watershed Assessment, which looked at individual streams such as West Fork, as well as the entire drainage basin and the cumulative effects of the individual waterbodies.

South Dakota has adopted *Escherichia coli* criteria for the protection of the limited contact and immersion recreation uses. The data from the West Fork of the Vermillion River indicated that pathogen indicator was causing the limited contact recreational impairment requiring an *E. coli* TMDL.

Segment SD-VM-R-VERMILLION_WEST_FORK_01 was listed for *E. coli* during the 2010 cycle and remains listed in the 2018 Integrated Report (SDDENR,2010,2018). Previous reporting cycles for this segment indicated not-assessed for the limited contact beneficial use. This TMDL document addresses the *E. coli* bacteria impairment.

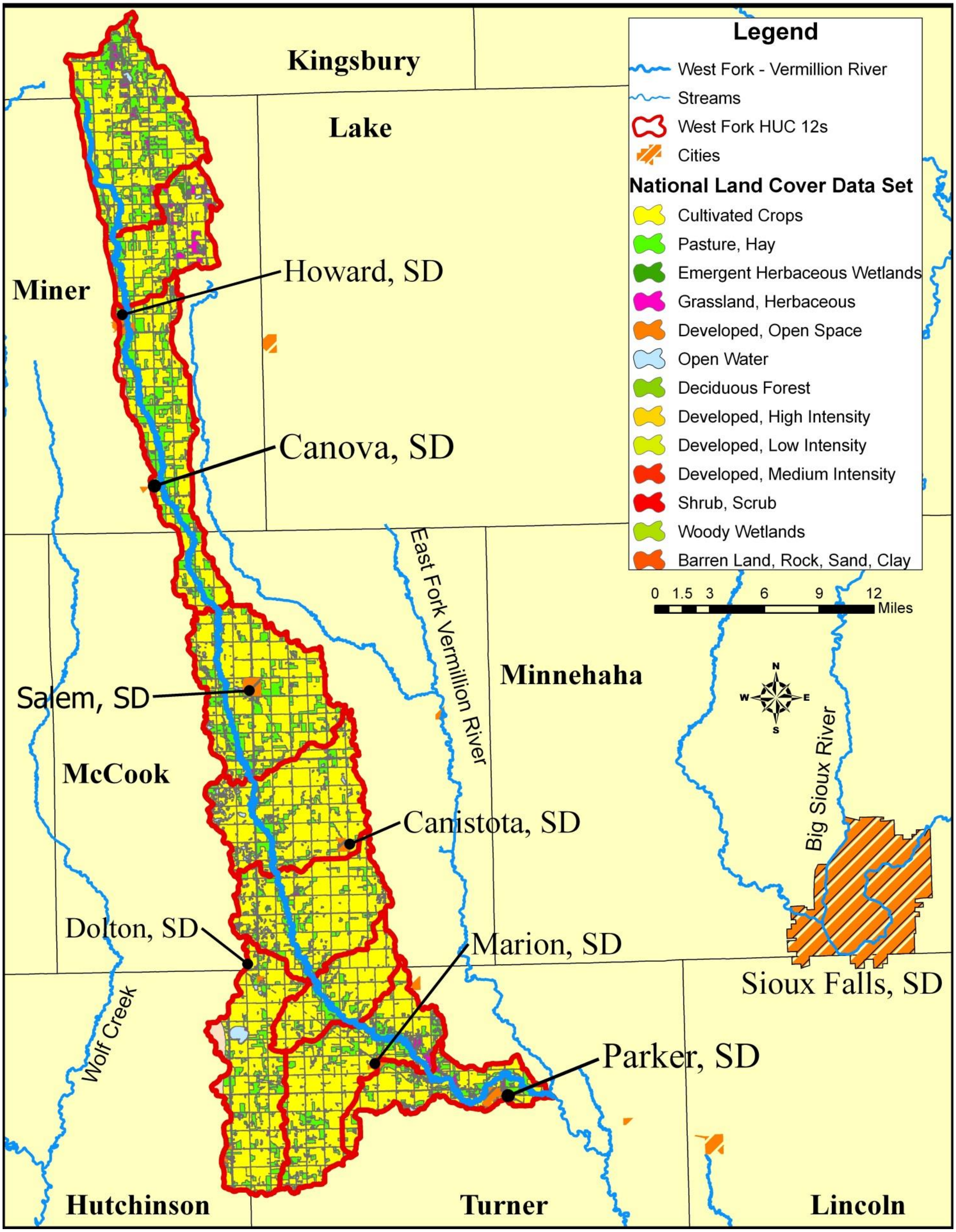

Figure 2. Landuse for the West Fork of the Vermillion River (2011 NLCD).

Land use/land cover, livestock, wildlife, septic tanks and sewerage systems are a determinant in identifying and quantifying sources of pathogens within a watershed. Table 3 shows the significant percentages of the 15-land use categories taken from the 2011 National Land Cover Data set (NLCD, 2011) for the West Fork of the Vermillion River in southeastern SD. This table lists both the total acreage and the percent land uses.

Table 3. Landuse for the West Fork of the Vermillion River using the 2011 National Land Cover Data Set.

	12-digit Hydrologic Units for the West Fork of the Vermillion River									
	101701020501	**101701020502**	**101701020503**	**101701020504**	**101701020601**	**101701020602**	**101701020604**	**101701020603**	**101701020605**	**101701020606**
2011 National Land Cover Data Set Landuse Category	**Headwaters of West Fork Vermillion River**	**West Fork Vermillion River- Howard Creek**	**West Fork Vermillion River- Unityville Slough**	**West Fork Vermillion River- Salem Creek**	**West Fork Vermillion River- Canistota Creek**	**West Fork Vermillion River- Stanley Corner Creek**	**West Fork Vermillion River- Langrock Creek**	**Dolton Township Tributary**	**West Fork Vermillion River- Bethesda Church Creek**	**Mouth of West Fork Vermillion River**
11-Open Water	0.6%	0.5%	0.1%	0.5%	2.2%	0.6%	0.1%	2.1%	0.2%	0.5%
21-Developed, Open Space	3.7%	3.9%	4.2%	5.3%	4.8%	4.7%	4.4%	5.9%	4.8%	5.9%
22-Developed, Low Intensity	0.1%	0.1%	0.5%	1.2%	0.6%	0.4%	0.2%	1.0%	0.4%	2.0%
23-Developed, Medium Intensity	0.0%	0.0%	0.1%	0.4%	0.1%	0.1%	0.0%	0.2%	0.1%	0.6%
24-Developed High Intensity	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
31-Barren Land, Rock, Sand, Clay	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
41-Deciduous Forest	0.5%	0.4%	0.2%	0.2%	0.1%	0.3%	0.2%	0.2%	0.5%	0.6%
52-Shrub, Scrub	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
71-Grassland, Herbaceous	4.9%	9.3%	1.8%	1.3%	1.2%	1.4%	1.2%	1.0%	3.5%	6.0%
81-Pasture, Hay	**31.7%**	**21.8%**	**36.5%**	**23.0%**	**13.5%**	**13.6%**	**13.2%**	**16.3%**	**18.3%**	**22.9%**
82-Cultivated Crops	**56.8%**	**62.7%**	**55.8%**	**66.3%**	**75.2%**	**76.5%**	**80.1%**	**72.2%**	**71.4%**	**60.6%**
90-Woody Wetlands	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
95-Emergent Herbaceous Wetlands	1.6%	1.4%	0.8%	1.5%	2.3%	2.3%	0.6%	1.0%	0.8%	0.7%
Total Acres (251,010)	**32,927**	**16,709**	**28,583**	**33,885**	**29,079**	**25,831**	**14,196**	**25,401**	**29,141**	**15,259**
Total Hectares (101,584)	**13,325**	**6,762**	**11,568**	**13,713**	**11,768**	**10,454**	**5,745**	**10,280**	**11,794**	**6,175**

3.0 Description of Applicable Water Quality Standards & Numeric TMDL Targets

3.1 South Dakota Water Quality Standards

Water quality standards are comprised of three main parts as defined in the Federal Clean Water Act (33 U.S.C. §1251 et seq.) and Administrative Rules of South Dakota (ARSD) Chapter 74:51:01:

- Beneficial Uses – Functions or activities that reflect waterbody management goals
- Criteria – Numeric concentrations or narrative statements that represent the level of water quality required to support beneficial uses
- Antidegradation – Additional policies that protect high quality waters

Each individual waterbody within South Dakota is designated one or more of the following beneficial uses:

(1) Domestic water supply
(2) Coldwater permanent fish life propagation
(3) Coldwater marginal fish life propagation
(4) Warmwater permanent fish life propagation
(5) Warmwater semipermanent fish life propagation
(6) Warmwater marginal fish life propagation
(7) Immersion recreation
(8) Limited contact recreation
(9) Fish and wildlife propagation, recreation, and stock watering
(10) Irrigation
(11) Commerce and industry

All waters (both lakes and streams) within South Dakota are designated the use of fish and wildlife propagation, recreation, and stock watering (9). All streams are designated the uses of (9), and (10) irrigation. Additional uses are designated by the state based on a beneficial use analysis of each waterbody.

The West Fork of the Vermillion River (SD-VM-R-VERMILLION_WEST_FORK_01_USGS) from the confluence of the East and West Fork to the McCook/Miner County line have been assigned the beneficial uses of: warm water marginal fish life propagation, irrigation waters, limited contact recreation, and fish and wildlife propagation, recreation, and stock watering. Table 4 lists the criteria that must be met to support the specified beneficial uses. When multiple criteria exist for a particular parameter, the most stringent criterion is used.

Table 4. South Dakota Surface Water Quality standards for the West Fork of the Vermillion River, McCook, Miner, and Turner Counties, South Dakota.

Parameter	Criteria	Unit of Measure	Special Conditions
Total alkalinity as calcium carbonate	≤ 750	mg/L	30-day average
	≤ 1313	mg/L	daily maximum
Dissolved oxygen (warmwater marginal)	≥ 5.0	mg/L	Daily minimum May 1- Sept. 30
	≥ 4.0	mg/L	Daily minimum Oct 1- April 30
Total ammonia nitrogen as N (warmwater marginal)	Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards	mg/L	30-day average May 1 - October 31
	Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards	mg/L	30-day average November 1 – April 30
	Equal to or less than the result from Equation 2 in Appendix A of Surface Water Quality Standards	mg/L	daily maximum
E. coli (May 1 – September 30) (limited contact recreation)	(*E. coli* ≤ 630)	cfu/100 mL	Geometric mean based on a minimum of 5 samples obtained during separate 24-hour periods for any 30-day period. Single Sample Maximum based on daily samples
	(*E. coli* ≤ 1,178)	cfu/100 mL	in any one sample
Conductivity at 25°C	≤ 2,500	micromhos/cm	30-day average
	≤ 4,375	micromhos/cm	daily maximum
pH (warmwater marginal)	≥ 6.0 and ≤ 9.0	standard units	see § 74:51:01:07
Nitrates as N	≤ 88	mg/L	daily maximum
	≤ 50	mg/L	30-day average
Total dissolved solids	≤ 2,500	mg/L	30-day average
	≤ 4,375	mg/L	daily maximum
Total Suspended Solids (warmwater marginal)	≤ 150	mg/L	30-day average
	≤ 263	mg/L	daily maximum
Temperature (warmwater marginal)	≤ 90	°F	see § 74:51:01:31
Undisassociated hydrogen sulfide	≤ 0.002	mg/L	
Total petroleum hydrocarbon	≤ 10	mg/L	see § 74:51:01:10
Oil and grease	≤ 10	mg/L	see § 74:51:01:10
Sodium adsorption ratio	≤ 10		see definition

3.2 E. coli Water Quality Standards

South Dakota has adopted numeric *E. coli* criteria for the protection of the immersion (7) and limited contact recreation uses (8). Immersion recreation waters are to be maintained suitable for activities such as swimming, bathing, water skiing and other similar activities with a high degree of water contact that make bodily exposure and ingestion more likely. Limited contact recreation waters are to be maintained suitable for boating, fishing, and other water-related recreation other than immersion recreation.

Through the 1970's and 1980's EPA epidemiological studies identified *E. coli* as a good predictor of gastrointestinal illnesses in fresh waters (USEPA, 1986). *E. coli* is a class of bacteria naturally found in the intestinal tract of humans and warm-blooded animals. The presence and concentration of *E. coli* in surface waters, typically measured in colony forming units (cfu) or counts (#) per 100ml, is used to identify fecal contamination and as an indicator for the likely presence of other pathogenic microorganisms. In 1986 EPA recommended states adopt *E. coli* criteria for immersion recreation based on a rate of 8 illnesses per 1,000 swimmers (USEPA, 1986). While it is generally understood that limited contact recreation is associated with a reduced illnesses risk and different routes of exposure, it is difficult to directly relate an illness rate to these activities from epidemiological studies based on immersion recreation. Therefore, to protect downstream uses and establish effluent limitations for limited contact recreation waters, EPA has suggested numeric criteria five times the immersion recreation values (USEPA, 2002). Because of the reduced risk, the multiplier was considered protective of the limited contact recreation use through the EPA and SDDENR water quality standards review and approval process.

The South Dakota *E. coli* criteria for the immersion recreation beneficial use requires that 1) no single sample exceed 235 cfu/100 ml and 2) during a 30-day period, the geometric mean of a minimum of 5 samples collected during separate 24-hr periods must not exceed 126 cfu/100 ml (ARSD 74:51:01:50). The *E. coli* criteria for the limited contact recreation beneficial use requires that 1) no single sample exceed 1,178 cfu/100 ml and 2) during a 30-day period, the geometric mean of a minimum of 5 samples collected during separate 24-hour periods must not exceed 630 cfu/100 ml (ARSD 74:51:01:51). As noted, these limited contact criteria are five times the corresponding immersion criteria. *E. coli* criteria apply from May 1 through September 30, which is considered the recreation season. The numeric *E. coli* criteria applicable to the West Fork Vermillion River (SD-VM-R-VERMILLION_WEST_FORK_01_USGS) are the immersion recreation values listed in Table 4.

3.3 Numeric TMDL Targets

TMDLs are required to identify a numeric target to measure whether or not the applicable water quality standard is attained. A maximum allowable load, or TMDL, is ultimately calculated by multiplying this target with a flow value and a unit conversion factor. Generally, the pollutant causing the impairment and the parameter expressed as a numeric water quality criteria are the same. In these cases, selecting a TMDL target is as simple as applying the numeric criteria.

Occasionally, an impairment is caused by narrative water quality criteria violations or by parameters that cannot be easily expressed as a load. When this occurs, the narrative criteria must be translated into a numeric TMDL target (e.g., nuisance aquatic life translated into a total phosphorus target) or a surrogate target established (e.g., a pH cause addressed through a total nitrogen target) and a demonstration should show how the chosen target is protective of water quality standards.

As seen from Table 4, there are two numeric *E. coli* criteria for TMDL target consideration. When multiple numeric criteria exist for a single parameter, the most stringent criterion is selected as the TMDL target. To judge whether one is more protective of the beneficial use, it is necessary to further elaborate how the criteria were derived.

South Dakota's *E. coli* criteria are based on EPA recommendations originally published in 1986 (USEPA, 1986). EPA issued slightly modified recommendations in 2012 that did not substantially change the underlying analysis or criteria values in South Dakota (USEPA, 2012). As recommended, SDDENR adopted *E. coli* criteria that contain two components: a geometric mean (GM) and a single sample maximum (SSM). The GM was established from epidemiological studies by comparing average summer exposure to an illness rate of 8:1,000. The SSM component was computed using the GM value and the corresponding variance observed in the epidemiological study dataset (i.e., log-standard deviation of 0.4). EPA provided four different SSM values corresponding to the 75th, 82nd, 90th, and 95th percentiles of the expected water quality sampling distribution around the GM to account for different recreational use intensities (Figure 3). South Dakota adopted the most stringent recommendation, the 75th percentile, into state water quality standard regulations as the SSM protective of designated beaches.

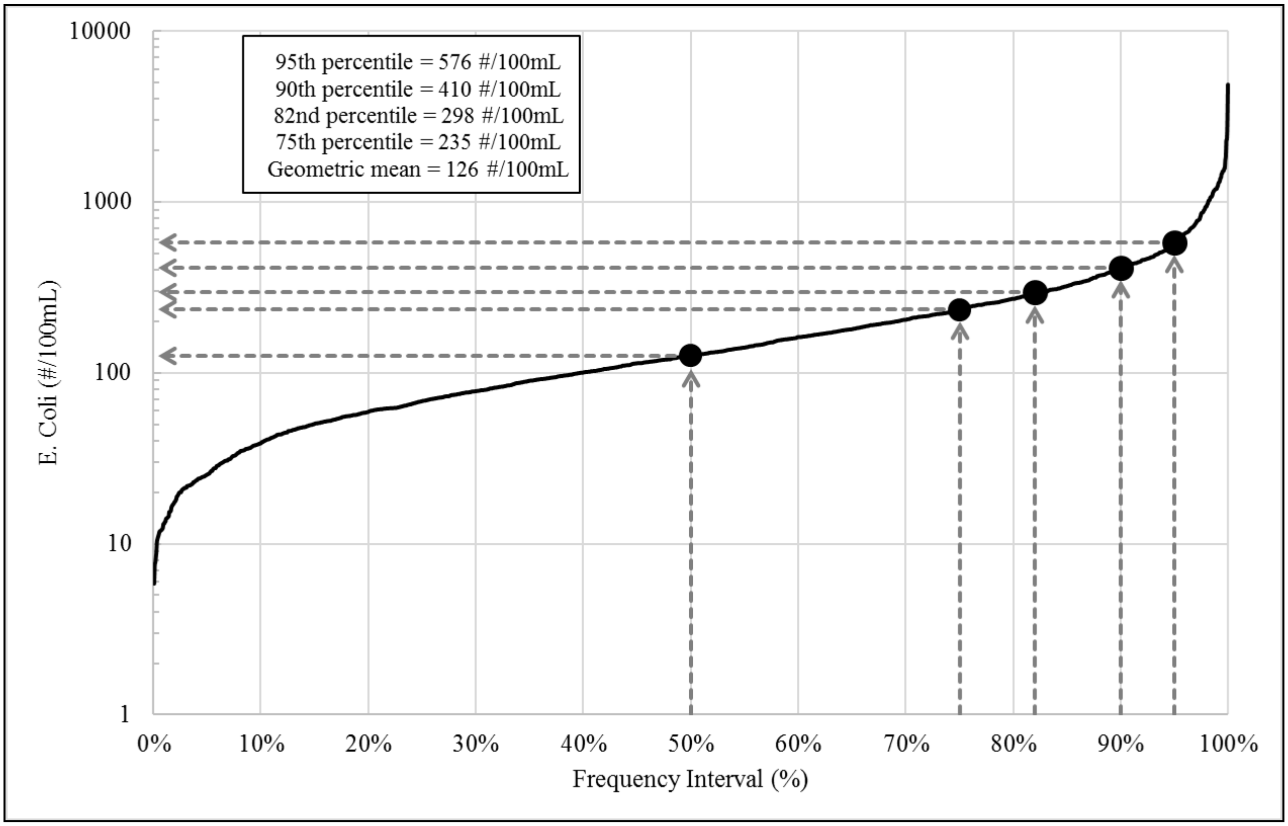

Figure 3. Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation *E. coli* Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).

Dual criteria were established to balance the inherent variability of bacteria data and provide flexibility for handling different sampling routines. Together, the GM and SSM describe a water quality distribution expected to be protective of immersion contact recreation. The GM and SSM are equally protective of the beneficial use because they are based on the same illness rate and differ simply representing different statistical values and sampling timeframes. While this investigation has revealed the GM and SSM *E. coli* criteria to be equally protective of the immersion recreation use, a likewise conclusion can be made for the GM and SSM criteria associated with the limited contact recreation use since those values were simply derived as five times the immersion values.

As described in EPA's *Protocol for Developing Pathogen TMDLs*, the availability of data may dictate which criterion should be used as the TMDL target (EPA, 2001). When a geometric mean of the sampling dataset can be calculated as defined by South Dakota Administrative Rules (i.e., at least five samples separated by a minimum of 24-hours over a 30-day period) and compared to the GM criterion, SDDENR uses the GM criterion as the TMDL target. This establishes a smaller overall loading capacity and is considered a conservative approach to setting the TMDL.

When a proper GM cannot be calculated, as in this case for West Fork Vermillion (SD-VM-R-VERMILLION_WEST_FORK_01_USGS), SDDENR uses the SSM as the TMDL target. This is permissible because the SSM is equally protective of the beneficial use as discussed above. Although this target selection leads to the establishment of a larger allowable load, in some respects it is more appropriate because timeframes align better (i.e., the SSM is associated with a single day and TMDLs establish daily loads, versus the 30-day GM). Additionally, certain aspects of SDDENR's *E. coli* assessment method, when combined with a SSM TMDL target, result in an expected dataset GM more protective than the GM criterion. SDDENR uses assessment methods to define how to interpret and apply water quality standards to 303(d) impairment decisions. These methods are further discussed in Section 3.4, however for this discussion, it is important to note that SDDENR allows a 10% exceedance frequency of both the SSM and GM. In other words, as long as the *E. coli* dataset meets other age and size requirements, a waterbody is considered impaired (i.e., not meeting water quality standards) when greater than 10% of samples exceed either the SSM or GM. Water quality standards are met if the exceedance frequency is 10% or less.

Returning to the original distribution used to establish South Dakota's Immersion Recreation *E. coli* criteria in Figure 3, remember that SDDENR chose to adopt a SSM concentration based on the most stringent recommendation (75^{th} percentile). According to assessment methods in South Dakota, however, the SSM concentration is treated as a 90^{th} percentile (i.e., 10% exceedance frequency). Step #1 in Figure 4 shows how doing so effectively moves the SSM point to the right. If the original log-normal frequency distribution with a log-standard deviation of 0.4 is subsequently re-fitted to this new 90^{th} percentile point at 235 #/100mL (red dotted line), the corresponding 50^{th} percentile (GM) is 72 #/100mL as shown in Step #2 of Figure 4.

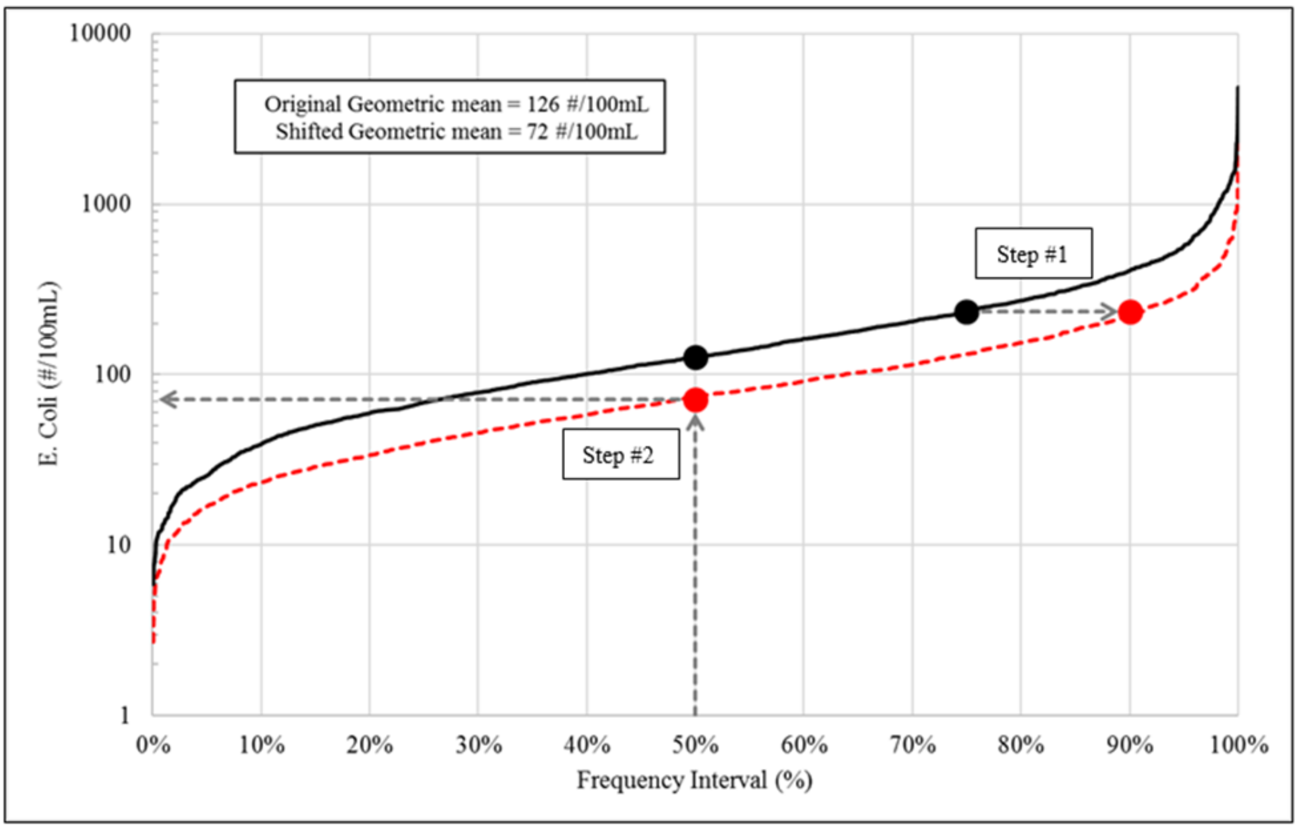

Figure 4. The Effective Impact of South Dakota's *E. coli* Assessment Method on the Criteria's Original Log-Normal Frequency Distribution (Black line = original; red dotted line = shifted)

The GM associated with this shifted distribution is more stringent than the GM of the original distribution (126 #/100mL), thus this demonstrates that attaining a maximum daily SSM target in a TMDL will also achieve the 30-day GM criterion when following South Dakota's assessment method. A similar conclusion was determined by EPA in *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2007) using Michigan criteria as an example. Once again this outcome holds true for South Dakota's limited contact recreation *E. coli* criteria since they were simply derived as five times the immersion values.

Finally, while the SSM is associated with a single day of sampling and the GM is associated with 30 days of sampling, it is not technically appropriate to refer to them as "acute" and "chronic" criteria. Those terms distinguish timeframes over which harm-to-use impacts develop, not the sampling or averaging timeframe as with the SSM and GM. Acute refers to an effect that comes about rapidly over short periods of time. Chronic refers to an effect that can build up over longer periods, sometimes as long as the lifetime of a subject. In the case of *E. coli*, gastrointestinal illness develops within a matter of hours to days. Both the SSM and GM are derived from this same timeframe and based on the same underlying illness rate, thus treating the SSM as an acute criterion and assuming it to be less stringent is incorrect. EPA recommends states use the GM and SSM together, rather than just the GM or just the SSM, to judge whether water quality is protective of recreational uses. SDDENR follows these guidelines and only relies on one criterion when forced by data availability.

The limited contact recreation SSM *E. coli* criterion of 1,178 cfu/100mL was selected as the numeric TMDL target for Long Creek because a proper geometric mean could not be calculated from the available monitoring dataset. Refer to section 4 for a thorough review of West Fork Vermillion sampling and results.

3.4 Assessment Methods

Assessment methods document the decision making process used to define whether water quality standards are met. SDDENR evaluates monitoring data following these established procedures to determine if: 1) one or more beneficial use is not supported, 2) the waterbody is impaired, and 3) it should be placed on the next 303(d) list. Waterbodies impaired by pollutants require TMDLs and these assessment methods are commonly used again in the process sometime after TMDLs have been established and restoration efforts have been implemented. In select cases, attainment is judged instead by comparing current conditions to TMDL loading limits. For example, when certain characteristics of the pollutant (e.g., bioaccumulative) or waterbody (e.g., a reservoir filling with sediment) prioritize loading concerns. Table 5 presents South Dakota's assessment method for *E. coli*, and describes what constitutes a minimum sample size and how an impairment decision is made.

Table 5. Assessment Methods for Determining Support Status for Section 303(d) (SDDENR 2018).

Description	Minimum Sample Size	Impairment Determination Approach
FOR CONVENTIONAL PARAMETERS (such as dissolved oxygen, TSS, *E. coli* bacteria, pH, water temperature, etc.)	STREAMS: a minimum of 10 samples for any one parameter are required within a waterbody reach. A minimum of two chronic (calculated) results are required for chronic criteria (30-day averages and geomeans). LAKES: at least two independent years of sample data and at least two sampling events per year.	STREAMS: >10% exceedance for daily maximum criteria (or 3 or more exceedances between 10 and 19 samples) or >10% exceedance for chronic criteria (or 2 or more exceedances between 2 and 19 samples) LAKES: >10% exceedance when 20 or more samples were available. If < 20 samples were available, 3 exceedances were considered impaired. See lakes listing methodology section for specifics on parameters associated with a vertical profile (i.e., dissolved oxygen, water temperature, pH, and specific conductance).

The assessment method mentions chronic and acute criteria. Although these terms do not directly relate to *E. coli* criteria for reasons previously discussed, the assessment method is organized together with other conventional parameters in the Integrated Report to show that a consistent approach is applied to many pollutants. In this limited definition, chronic refers to the GM and acute refers to the SSM *E. coli* criteria. Different assessment methods have been established for toxic parameters and mercury in fish tissue. In the next section, data collection activities are summarized and monitoring results are evaluated using this assessment method.

4.0 Data Collection and Results

4.1 Water Quality Data and Discharge Information

Personnel from the Vermillion Basin Water Development District, supported and trained by SDDENR, collected water quality data from West Fork of the Vermillion River as part of the larger West Fork BMP Monitoring Project and TMDL Assessment that occurred in 2015-2017. The water quality data that was focused on for these sites was the presence of *E. coli*. The sites that were assessed during this assessment were WFVR1, WFVR2, WFVR3, and WFVR4. This assessment confirmed the initial reporting of impairment for limited contact recreation for West Fork of the Vermillion River in 2005-2006. The sites that were assessed during 2005-2006 were VRWF15, VRWF20, WFVR22, and WFVR24. All data collection conducted during this project followed methods in accordance with the South Dakota *Standard Operating Procedures for Field Samplers* (https://denr.sd.gov/documents/SOP2016VolI.pdf) developed by the Watershed Protection Program. Water samples were sent to the State Health Laboratory in Pierre, SD for analysis.

4.2 Flow Analysis

E. coli data from both assessments (2005-2006 and 2015-2017) were used in the development of this TMDL. Stage record of flow data for the West Fork Vermillion River were acquired from USGS gage 6478690 (site VRWF15) (9/01/1961 to 11/05/2018). The daily flow data from this USGS gage was then paired with *E. coli* samples from the same date to create a load duration curve and develop the TMDL.

4.3 Data Analysis

The West Fork of the Vermillion River was first identified as impaired for limited contact recreation in the 2010 IR with *E. coli* data collected in 2005-2006. *E. coli* data collected in 2015-2017 verified the impairment.

Figure 5 shows the distribution of *E. coli* concentrations for each sampled site. As you can see in the figure, the highest *E. coli* concentration came from site WFVR3, while the lowest concentration came from site VRWF15. The mean *E. coli* values do not change significantly across the different sample sites. The largest variability in *E. coli* values is evident from site VRWF20. When thinking about *E. coli* from a flow perspective, the most significant exceedances were observed during storm events (>50% stormflow). Therefore, higher bacteria concentrations are associated with higher flow in the system. Bacteria exceedances associated with high and mid-range flows are indicative of streambank erosion in both the mainstem and tributaries. This is coupled with sheet and rill erosion from farm field and feedlot runoff experienced during these type of conditions (Cleland, 2003). Lower flow exceedances can be attributed to bacteria delivered from tributaries from smaller storm events, cattle standing in the stream, and septic tank inputs.

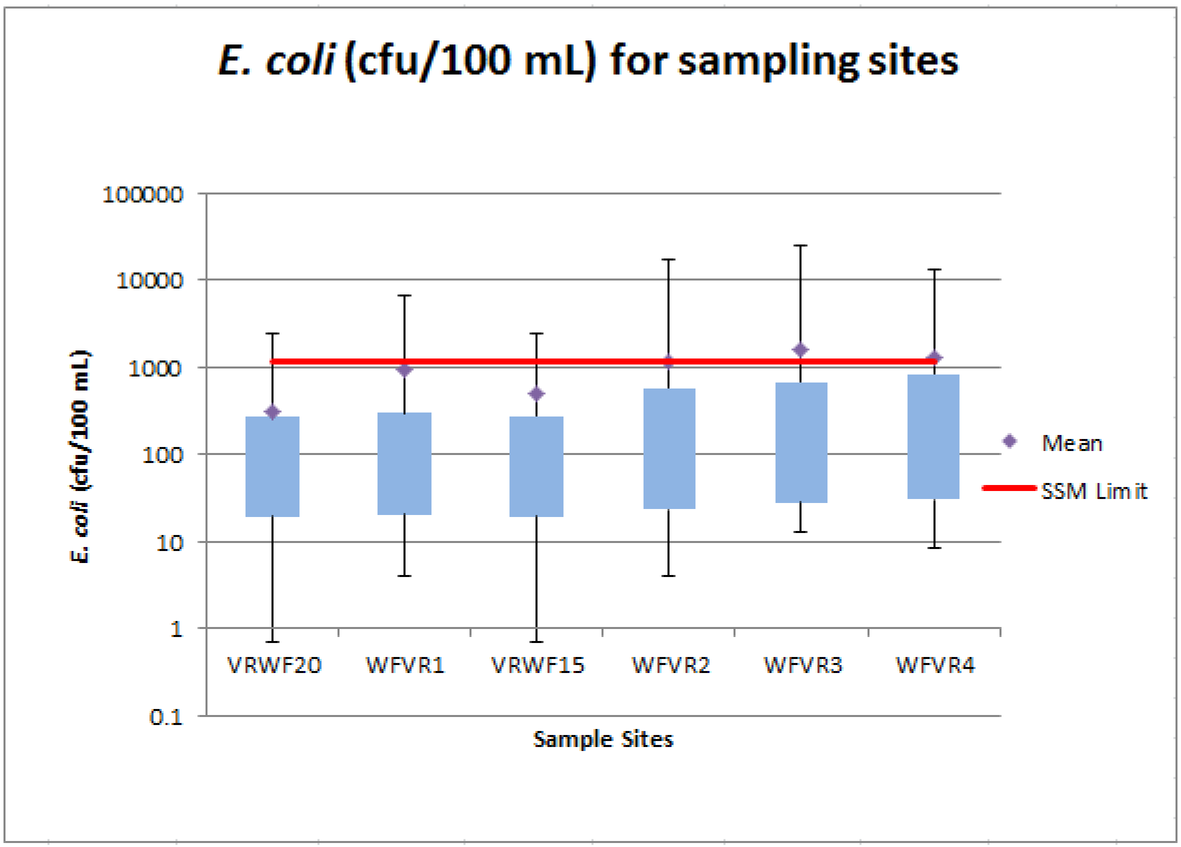

Figure 5. *E. coli* concentrations for each sampling site.

5.0 Source Assessment and Allocation

5.1 Point Sources

There are several documented point sources within this 101,583.6 hectare subwatershed (SDDENR, Surface Water Quality Program). This includes six National Pollutant Discharge Elimination Permitted (NPDES) facilities that may directly contribute *E. coli* to the impaired segment of West Fork of the Vermillion River. These potential sources of *E. coli* bacteria are documented here to provide a watershed scale account of the entities operational characteristics (discharge permits etc.), potential impact and Waste Load Allocation (WLA) consideration for the impaired segment of West Fork of the Vermillion River. There are no concentrated animal feeding operations (CAFOs) present within the watershed.

5.1.1 Wastewater Treatment Facilities

The City of Canistota, SD (NPDES Permit# SD0022497) is located in the southern part of SD-VM-R-VERMILLION_WEST_FORK_01_USGS. It is a small two-pond system that is authorized to discharge one or two times per year to an unnamed tributary of the West Fork of the Vermillion. This WWTF is a non-continuous discharger (seasonal). The WLA for this facility was calculated by using the facilities' *E. coli* permit effluent limit of 1,178 cfu/100mL, and the 80th percentile of daily maximum effluent flow (million gallons per day, MGD) data reported on Discharge Monitoring Reports (DMRs) during the current permit cycle (mid-2012 to present).

The city of Howard, SD (NPDES Permit# SD0020613) is a small two-pond system in the northern part of the watershed. It is authorized to discharge to an intermittent portion of the West Fork of the Vermillion River that is designated the beneficial uses of 9) fish and wildlife propagation; and 10) irrigation waters. This WWTF is a non-continuous discharger (seasonal). There are no *E. coli* limits established for this permit or receiving waterbody. This facility is not included in the WLA due to its position in the watershed and distance to the impaired segment given the fate and transport characteristics of *E. coli*.

The city of Marion, SD (NPDES Permit# SD0020311) is a three-cell waste stabilization lagoon system that requires permission to discharge to the West Fork of the Vermillion River. Stipulations as part of the permit include discharging in the spring and fall when the flow is not at its minimum. Effluent limitations are also outlined in the permit. This WWTF is a non-continuous discharger (seasonal). The WLA for this facility was calculated by using the facilities' *E. coli* permit effluent limit of 1,178 cfu/100mL, and the 80th percentile of daily maximum effluent flow (million gallons per day, MGD) data reported on Discharge Monitoring Reports (DMRs) during the current permit cycle (mid-2012 to present).

The city of Parker, SD (NPDES Permit# SD0020940) is a three-cell pond system that is located in Turner County. This pond system discharges 2 times per year to the West Fork of the Vermillion. This WWTF is a non-continuous discharger (intermittent). The WLA for this facility was calculated by using the facilities' *E. coli* permit effluent limit of 1,178 cfu/100mL, and the 80th percentile of daily maximum effluent flow (million gallons per day, MGD) data reported on Discharge Monitoring Reports (DMRs) during the current permit cycle (mid-2012 to present).

The city of Salem, SD (NPDES Permit# SD0020966) is located in the central part of the West Fork watershed. This WWTF consists of three-ponds and requires permission to discharge to the West Fork of the Vermillion River. This WWTF is a non-continuous discharger (intermittent). The WLA for this facility was calculated by using the facilities' *E. coli* permit effluent limit of 1,178 cfu/100mL, and the 80th percentile of daily maximum effluent flow (million gallons per day, MGD) data reported on Discharge Monitoring Reports (DMRs) during the current permit cycle (mid-2012 to present).

The Salem Rest Area, SD (NPDES Permit# SDGG27359) is located in the central part of the West Fork watershed. This WWTF consists of a 2 cell lagoon & stabilization ponds and is a non-continuous discharger (emergency discharger only). When this WWTF does discharge, it goes to an unnamed tributary of the West Fork Vermillion River. Due to being an emergency discharge only facility, there is no WLA assigned to this WWTF.

Table 6. Permitted Facilities within the West Fork Drainage that have been allotted a WLA for *E. coli*.

Permit Number	Facility Name	System Description	Flow used for WLA (cfs)
SD0022497	CANISTOTA - CITY OF	pond/wetland	0.49
SD0020311	MARION - CITY OF	Pond system	0.72
SD0020940	PARKER - CITY OF	Pond system	0.95
SD0020966	SALEM - CITY OF	Pond system	1.76

Table 6 includes the information used by SDDENR to calculate a maximum allowable discharge for each facility. The WLA calculation was based on the effluent limits included in the surface water discharge permit, multiplied by the 80th percentile maximum flow rate based on DMR records. The normal operation of these systems would typically result in only a small portion of the calculated daily amounts actually being discharged. For the city of Canistota, the peak design is 0.17 cfs, while the flow used in the WLA for Canistota was 0.49 cfs. This is because the peak design flow was an estimate of flow before discharges happened. It is important to note all discharges are required to meet the single sample maximum and geometric mean water quality thresholds (standard) for the West Fork of the Vermillion River, unless an *E. coli* limit is not established for that facility, such as Howard.

Including the WLA in the load duration curve required several factors be taken into account. The total *E. coli* waste load for four systems is 1.75×10^{11} cfu/day based on the cumulative daily flow of 3.92 cfs. A flow of 3.92 cfs is met or exceeded in the West Fork of the Vermillion River only 45.6% of the time. Therefore, 54.4 % of the time the river discharge falls below this flow level. Arbitrarily adding this load to the entire flow regime would be a misrepresentation of how these four intermittent wastewater systems function and over emphasizing their impact on the load capacity. This calculation implies a continuous discharge when, in fact, discharge occurs 1-3 times per year generally for no more than 1-2 week duration. All facilities generally discharge outside of the recreation season (May 1 through September 30) when the *E. coli* standard does not apply.

The WLA for *E. coli* was calculated by multiplying the single sample maximum (1,178 cfu/100ml) by the 80^{th} percentile flow rate calculated for each of the facilities in Table 6. The cumulative *E. coli* wasteload contributed by these four facilities is insignificant and does not contribute to the impairment of the classified segment of the West Fork of the Vermillion River.

Table 7. Discharge Monitoring Report Data for Six WWTF in the West Fork Watershed.

Facility	Total # of Discharges over last 5 years	# of Discharges within recreation Season	% of Discharges within recreation season	Avg. Concentration of available *E. coli* Daily Max Samples (cfu/100ml)
Canistota	15	5	33%	93
Howard	9	5	56%	n/a
Marion	22	13	59%	362
Parker	2	2	100%	n/a
Salem	4	0	0%	10
Salem Rest Area	1	0	0%	n/a
Total	53	25	47%	

The flow record from USGS gage 6478690 provided over 50 years of daily flow data which included all wastewater treatment facility discharges during that time period. The flow variability, as a result of the intermittent operation of these facilities, is fully accounted for in the flow frequency curve.

5.2 Nonpoint Sources

Nonpoint sources of bacteria from the West Fork of the Vermillion River come primarily from agricultural sources. County wide livestock data, from the 2017 National Agricultural Statistic Survey (NASS), and wildlife data, from the 2002 South Dakota Game Fish and Parks county wildlife assessment, were used to derive density estimates for livestock and wildlife densities, respectively.

Statistically derived livestock estimates (beef cattle, hogs, etc.) from the NASS 2017 Agricultural Census was used for each county involved in the SD-VM-R-VERMILLION_WEST_FORK_01_USGS watershed (Appendix B). Livestock animals per acre for each county were then multiplied by the acres from each county within the watershed. Table 10 shows the acres of SD-VM-R-VERMILLION_WEST_FORK_01_USGS watershed that are located within each county. The animals listed in Table 10 (wildlife and livestock) are the most common and densely populated within the involved counties (McCook, Hutchinson, Miner, Turner). The density estimates were then multiplied by the acres of SD-VM-R-VERMILLION_WEST_FORK_01_USGS watershed found within each county (Table 10).

The animal density information was used to estimate relative source contributions of bacteria. For example, based on the 2017 density estimates there were 425 dairy cows in the watershed resulting in an estimated 3.17E+13 cfu/day (425 cows X 7.45E+10 cfus). Fecal coliform can be a surrogate for *E. coli* data when needed to fill gaps due to *E. coli* being a type of fecal coliform bacteria found in the intestines of humans and animals. Fecal coliform data will give a broad idea about the quality of the water, but *E. coli* data is best if available in order to make a precise conclusion. Daily outputs from each animal type were taken from the reference worksheet found on the Bacterial Indicator Tool (BIT). The EPA BIT tool is a spreadsheet that estimates the bacteria contribution from multiple sources.

5.2.1 Agriculture

Manure from livestock is a potential source of bacteria to the stream. Livestock in the basin are predominantly hogs and beef cattle. Livestock can contribute fecal coliform bacteria directly to the stream by defecating while wading in the stream. They also can contribute by defecating while grazing on rangelands, which is washed off during precipitation events. Table 8 allocates the sources for bacteria production in the watershed into four primary categories. The summary is based on several assumptions. Feedlot numbers were calculated as the sum of all dairy, hog, and the NASS estimate of beef in feeding areas. All remaining livestock were assumed to be on grass.

Table 8. Bacteria Source Allocations for the West Fork of the Vermillion River.

Source	Percentage
Feedlots	77.0%
Livestock on Grass	8.5%
Wildlife	2.2%
Septic Tanks	5.6%

The main source of bacteria in the West Fork watershed is livestock from a combination of feedlots and grazing. Bacteria migration from feedlots and upland grazing is most likely occurring during major run-off events. Direct use of the stream by livestock is the most likely source of bacteria at low flows. Evidence of this is available in the load duration curves, which indicate that elevated counts of *E. coli* occur throughout different flow regimes. Beef cattle and hogs were found to contribute the most significant amount of bacteria to the West Fork of the Vermillion River (Table 10 cont).

5.2.2 Human

There are six separate point sources within the West Fork of the Vermillion River watershed which were previously described. Failing onsite septic systems are assumed to be the primary human source not served by the POTW within the watershed. Human fecal production was estimated at 1.88E+11 (Bacterial Indicator Tool Reference Worksheet - USGS estimate). When included as a total load in the table, the remaining population accounted for about 5.6% of all fecal coliforms/*E. coli* produced in the watershed assuming a 25% failure rate for the onsite wastewater systems.

Human inputs were determined through several Geographic Information System (GIS) county wide feature datasets provided by the SD Dept. of Transportation (SDDOT). The dataset was used primarily for assessing county roads and structures along roads, such as rural residences (both occupied and unoccupied). The number of occupied residences for the acres of watershed within each county was used to estimate how many septic tanks were located in the watershed in each county. It was assumed on average that each residence contained two people. It was assumed that 25% of these septic tanks were failing. The daily human output of 1.88E+11 fecal coliform per human was taken from the BIT Tool Reference worksheet, which lists the USGS as the source of the human output estimate (EPA BIT tool). The total estimate of 6.63E+13 fecal coliform from humans in Table 9 was used for Table 10.

Table 9. Human Input Estimates

Column	Variable		Value	Calculation
A	County	McCook	214	N/A
B		Hutchinson	58	N/A
C		Miner	161	N/A
D		Turner	294	N/A
E	Total Occupied Residences		727	= A + B + C + D
F	# Per Household		2	N/A
G	Total Population		1454	= E * F
H	25% Failure Rate for Septic Tank		0.25	N/A
I	USGS Human Daily Estimate		1.88E+11	N/A
J	Total Human Contribution		6.83E+13	= E * F * H * I

5.2.3 Natural background/wildlife

Wildlife within the watershed is a natural background source of fecal coliform and *E. coli* bacteria. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks (Table 10). The contribution of bacteria from wildlife in the West Fork watershed was insignificant (2.2%) in comparison to livestock sources.

Table 10. West Fork of the Vermillion River Potential Nonpoint Sources

Animal Type	FC (#/animal/day)	Type Used for Estimate	HUTCHINSON (animals/acre)	KINGSBURY (animals/acre)	MCCOOK (animals/acre)	MINER (animals/acre)	TURNER (animals/acre)
CATTLE, ON GRASS	4.57E+09	Cow	0.1016	0.1089	0.0961	0.0938	0.0676
CATTLE, COWS, MILK	7.45E+10	Dairy Cow	0.0056	0.0011	0.0077	0.0019	0.0163
CATTLE, ON FEED - IN	7.27E+10	Beef Cow	0.0232	0.0425	0.0175	0.0129	0.0403
CHICKENS, BROILERS -	1.81E+08	Broilers	0.0000	0.0004	0.0027	0.0003	0.0001
CHICKENS, LAYERS - IN	1.37E+08	Layers	0.0015	0.0000	0.0045	0.0005	0.0013
EQUINE, HORSES & PO	2.59E+10	Horse	0.0009	0.0011	0.0018	0.0010	0.0019
GOATS - INVENTORY	1.66E+10	Sheep	0.0004	0.0000	0.0000	0.0000	0.0003
HOGS - INVENTORY	1.02E+10	Hog	0.2251	0.0162	0.1658	0.0364	0.1554
SHEEP, INCL LAMBS - I	1.66E+10	Sheep	0.0057	0.0101	0.0111	0.0108	0.0333
TURKEYS - INVENTORY	1.04E+08	Turkey (Wild	0.5522	0.1140	0.0000	0.0001	0.0001
Badger	1.25E+08	Raccoon	0.0013	0.0029	0.0019	0.0009	0.0014
Beaver	2.50E+08	Beaver	0.0023	0.0006	0.0015	0.0014	0.0028
Cottontail Rabbit	1.25E+08	Raccoon	0.0134	0.0384	0.0177	0.0495	0.0127
Coyote	4.09E+09	Dog	0.0017	0.0014	0.0010	0.0021	0.0013
Fox	1.25E+08	Raccoon	0.0018	0.0019	0.0030	0.0009	0.0018
Jackrabbit	1.25E+08	Raccoon	0.0033	0.0086	0.0052	0.0220	0.0009
Mink	2.50E+07	Muskrat	0.0013	0.0054	0.0045	0.0047	0.0019
Muskrat	2.50E+07	Muskrat	0.0024	0.0144	0.0136	0.0149	0.0020
Nest Canada Geese	4.90E+10	Goose	0.0011	0.0009	0.0020	0.0019	0.0013
Opossum	1.25E+08	Raccooon	0.0023	0.0038	0.0033	0.0033	0.0030
Partridge	1.37E+08	Layers	0.0017	0.0115	0.0041	0.0033	0.0006
Raccoon	1.25E+08	Raccoon	0.0057	0.0115	0.0061	0.0138	0.0058
Skunk	1.25E+08	Raccoon	0.0029	0.0157	0.0060	0.0110	0.0035
Squirrel	1.25E+08	Raccoon	0.0023	0.0067	0.0218	0.0206	0.0203
Turkey	1.04E+08	Turkey (Wild	0.0009	0.0000	0.0000	0.0000	0.0006
Whitetail Deer	5.00E+08	Deer	0.0027	0.0073	0.0082	0.0083	0.0043
		Acres in Segment R9 Watershed	9,878	9,759	97,821	62,873	70,680
Bacteria Indicator Tool Reference Worksheet used for each estimate							

Table 10. cont.

Source	Total Contribution	Percent Contribution
Cattle on Grass	1.04E+14	8.5%
Beef Cattle on Feed	4.49E+14	36.6%
Dairy Cow	1.60E+14	13.0%
Chickens, Turkeys, Goats	1.31E+12	0.1%
Hogs	3.36E+14	27.3%
Sheep	7.29E+13	5.9%
Horses	1.06E+13	0.9%
All Wildlife	2.67E+13	2.2%
Septic Tanks	6.84E+13	5.6%
Total	1.23E+15	100%

5.2.4 Tributary Contributions

There are several small intermittent tributaries that contributed bacteria loads to the West Fork of the Vermillion River. These tributaries drain portions of Kingsbury, Miner, McCook and Turner Counties (Figure 1). The significance of these smaller intermittent streams on the West Fork of the Vermillion was not determined. Most loadings occur along the length of the West Fork and discharge directly into it. Bacteria loading from the mainstem corridors most likely the largest contributor to the impairment.

6.0 TMDL Loading Analysis

The *E. coli* TMDL was developed using a Load Duration Curve (LDC) framework resulting in a flow-variable target that considers the entire flow regime. The LDC is a dynamic expression of the allowable load for any given day. To aid in interpretation of the TMDL, the LDC flow intervals were grouped into four flow zones representing high flows (0–10 percent), moderate conditions (10-30 percent), dry flows (30–50 percent), and low conditions (50–100 percent) based off EPA’s *An Approach for Using Load Duration Curves in the Development of TMDLs* (USEPA, 2006). The flow frequency for these four zones was based on 57 years of flow data from USGS gage 6478690 (1961-2018) and six years of sampling data collected during the recreation season from several stations on the West Fork Vermillion River. The flow zones were set based on breaks in the flow frequency curve and data distribution. However, the low flow zone was set subjectively to incorporate the WLA. There is no long-term ambient Water Quality Monitoring (WQM) site established for this segment.

For the West Fork of the Vermillion River, instantaneous loads were calculated by multiplying the *E. coli* concentrations collected from SD DENR TMDL Site WFVR1, WFVR2, WFVR3, WFVR4, VRWF15 and VRWF20 by the daily average flow (USGS Gage No. 06478690), times a unit conversion factor.

The LDC approach was deemed an appropriate method for identifying possible sources of bacteria at different intervals of the flow regime. When the instantaneous loads are plotted on the LDC, characteristics of the water quality impairment are shown. Instantaneous loads that plot above the curve are exceeding the TMDL standard, while those below the curve are in compliance. *E. coli* samples collected during the recreation season from the West Fork of the Vermillion River exceed the daily maximum criterion within all of the zones (Figure 6). Loads exceeding the criteria in the high flow zone implies storm runoff from livestock in pastures and animal feeding operations. Loads shown in the low flow zone typically indicate point source load or livestock defecating directly in the stream.

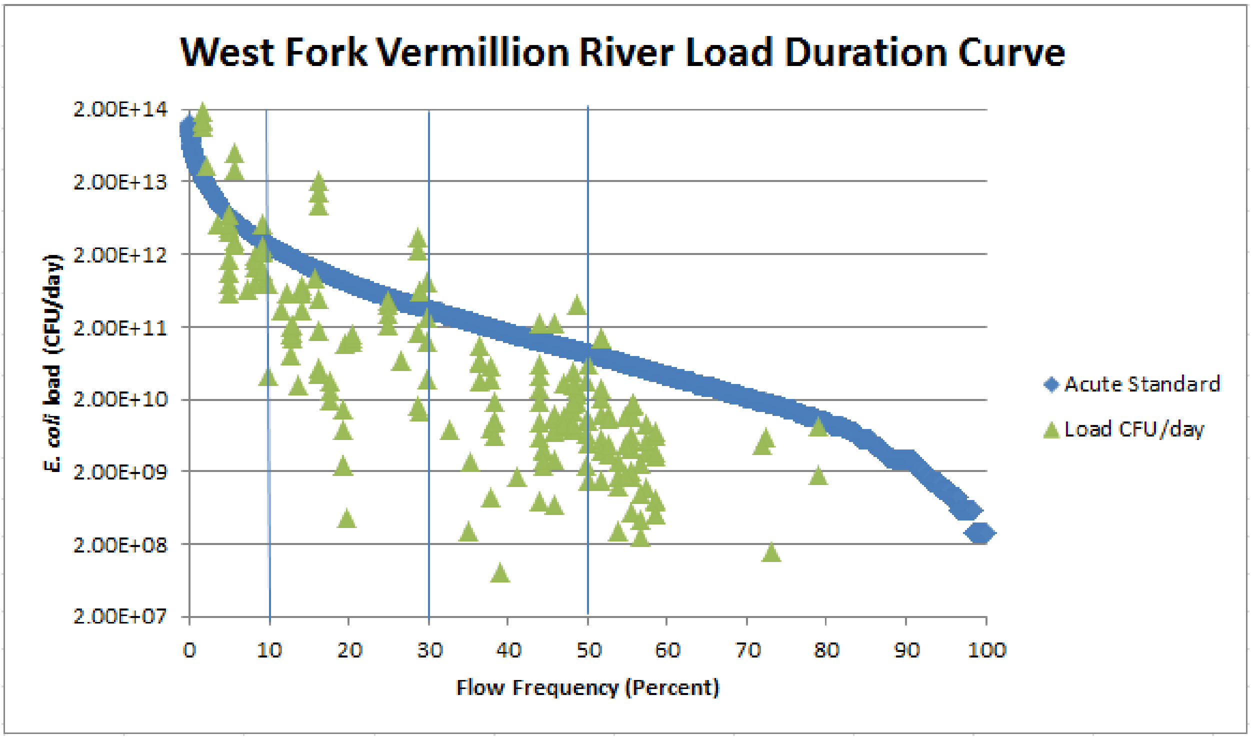

Figure 6. ***Escherichia coli*** **Load Duration Curve, West Fork of the Vermillion River.**

6.1 TMDL Load Duration Curve

The flow frequency curve generated for the West Fork of the Vermillion River characterizes the system as perennial with extreme flow occurring approximately 10% of the time. Flow zones were based off of the flow regime structure and distribution of the observed data, diverging from the guidance recommended by EPA in order to fit the particular data set (USEPA, 2007). Four distinct flow zones were established to facilitate interpretation of the hydrologic conditions and patterns associated with the impairment. The zones were segmented by high flows (0-10 percent), moderate flows (10-30 percent), dry flows (30-50 percent) and low flows (50-100 percent).

The single sample maximum threshold ($\leq$ 1,178 cfu/100ml) was used to develop the TMDLs for each distinct flow zone to be protective and provide assurance that neither water quality standard will be exceeded. The 95th percentile concentration was used to calculate current loadings and associated reductions for the moderate and low flow zones to allow for variability in the small datasets. The relatively high *E. coli* concentrations and associated exceedance rate of the single sample maximum (SSM) across flow zones suggests that the source is continual. The most significant source of bacteria produced in the watershed is from beef livestock and hogs with over 70% residing in confinement operations. The WLA provides a relatively large portion of the allocation because it is based on permit levels that assume continuous discharge. The most likely source of *E. coli* contamination to the West Fork of the Vermillion River is run-off from feedlot operations especially in the high and moderate flow zones with livestock grazing in the lower end of the moderate and low flow zone.

6.1.1 High Flows (0-10%)

Flows in the high zone are extremely variable ranging from a maximum of 4,410 cfs to a low of 91.2 cfs. Flows represented in this zone occur on an infrequent basis and are characteristic of significant run-off events. The 95th percentile bacteria concentration was calculated at 8,750 counts/100 ml. An *E. coli* load reduction of 86% is required to achieve compliance with the single sample maximum threshold. All components of the TMDL for the high flow zone including the current load and calculated reductions are presented in Table 11.

6.1.2 Moderate Flows (10-30%)

The moderate flow zone includes flows that range from 91.2 cfs to 12 cfs. Flows in this zone are likely generated from moderate to small run-off events. Bacteria sources from this zone are expected to be closer to the channel and easier to mitigate than that of the high flow zone. The 95th percentile *E. coli* concentration was calculated at 12,150 counts/100ml. An *E. coli* load reduction of 90% is required to achieve compliance with the single sample maximum threshold. All components of the TMDL for the moderate flow zone including the current load and calculated reductions are presented in Table 11.

6.1.3 Dry Conditions (30-50%)

The dry condition flow zone includes flows that range from 12 cfs to 2.99 cfs. Flows from this zone are base flows resulting from decreased surface run-off and groundwater inputs. The 95th percentile flow and *E. coli* concentration were used to calculate the current load. The 95th percentile bacteria concentration was calculated at 1,190 counts/100ml. An *E. coli* load reduction of 1.008% is required to achieve compliance with the single sample maximum threshold. All components of the TMDL for the low flow zone including the current load and calculated reductions are presented in Table 11.

6.1.4 Low Flows (50-100%)

Flows in the low zone ranged from 2.99 cfs to 0.0 cfs. Flows from this zone occur during winter or drought conditions recorded over the last 50 years. Most often they occur during the winter months. The 95th percentile flow and *E. coli* concentration were used to calculate the current load. The 95th percentile bacteria concentration was calculated at 1,420 counts/100ml. An *E. coli* load reduction of 17% is required to achieve compliance with the single sample maximum threshold. All components of the TMDL for the low flow zone including the current load and calculated reductions are presented in Table 11.

The TMDL for SD-VM-R-VERMILLION_WEST_FORK_01_USGS results in a unique maximum daily load that corresponds to a measured average daily flow. Table 11 presents a combination of allocations for each of the four flow zones. Methods used to calculate the TMDL components are discussed below. This TMDL is applicable to the recreation season defined as May 1 through September 30 and is based on daily flow and the single sample maximum threshold.

Table 11. SD-VM-R-VERMILLION_WEST_FORK_01_USGS – *Escherichia Coliform* Total Maximum Daily Load (TMDL) allocations by flow zone

TMDL Component	West Fork Vermillion River Flow Zones Expressed as (CFU/100ml)			
	High Flows	Moderate flows	Dry Conditions	Low Flows
	> 91.2 CFS	> 12 CFS	> 2.99 CFS	< 2.99 CFS
LA	4.13E+13	1.90E+12	1.14E+11	2.45E+10
WLA-Canistota SD	2.18E+10	2.18E+10	2.18E+10	5.04E+09
WLA-Marion SD	3.21E+10	3.21E+10	3.21E+10	7.42E+09
WLA-Parker SD	4.24E+10	4.24E+10	4.24E+10	9.76E+09
WLA-Salem SD	7.85E+10	7.85E+10	7.85E+10	1.81E+10
10% Explicit MOS	4.55E+12	2.30E+11	3.17E+10	7.20E+09
TMDL @ 1,178 #/ 100 mL	4.60E+13	2.30E+12	3.20E+11	7.20E+10
Current Load*	3.38E+14	2.37E+13	3.20E+11	8.69E+10
Load Reduction	86%	90%	1%	17%

6.2 TMDL Allocations

6.2.1 Waste Load Allocation (WLA)

There are eight facilities or NPDES Permit holders located within the SD-VM-R-VERMILLION_WEST_FORK_01_USGS watershed. Out of these eight facilities, 6 have the potential to contribute *E. coli,* and 4 of them were assigned WLA's. Each of these wastewater treatment facilities are comprised of retention pond systems that may periodically require a portion of the final pond to be discharged. The WLA calculation was based on the SSM, multiplied by the 80th percentile flow rate recorded in the discharge monitoring reports (DMR) from each municipal WWTFs identified in this TMDL. The cumulative wasteload of all facilities is based on a total flow of 3.92 cfs and an *E. coli* concentration of 1,178 cfu/100ml. For the low flow zone, the WLA was adjusted to fit the flow range by splitting the allocations proportionately. Half of the flow for the low flow zone (1.49 cfs) was given to the WLA's (percent contribution of each WWTF flow to the total WLA flow) and the remaining load was given to the LA, reserving 10% for the MOS and then splitting the remaining load between the WLA and LA. This resulted in a flow of 2.99 cfs for the low flow zone and a concentration of 1,178 cfu/100ml, respectively.

The WLA ensures that water quality standards for *E. coli* will be attained. Operation of these systems is conducted in a manner so that discharges are short in duration (several days to two weeks) one or two times per year. They do not provide a continuous discharge to the stream and account for less than 1% of the annual water load, collectively as well as individually. Each WLA was included in the flow zone as a part of the daily load. The WLA in the lower two flow zones would account for 43% and 38% of the maximum flow within each flow zone, respectively. Bacteria concentrations from the effluent are likely to be an order of magnitude less than the permit limit allowing for additional NPS load allocation in the overall load capacity. In addition, if the flow is at or above 3.92 cfs, which is the total flow used in the WLAs, then the receiving stream would shift to a higher flow regime of the TMDL. When permitted facilities are not discharging during the low flow zone, the WLA is conceptually zero and the entire loading capacity can be attributed to the LA and the MOS.

The Canistota WWTF (SD0022497) is a pond/wetland system that discharges to an unnamed tributary to the West Fork of the Vermillion River. This facility has been assigned a WLA of 2.18E+10 in all zones except the low flow zone and makes up 12.5% of the total WLA for all facilities. This facility is required to monitor *E. coli* and meet the SSM criteria (1,178 cfu/100 mL) and GM criteria (630 cfu/100mL) outlined in the NPDES permit.

The Marion WWTF (SD0020311) is a pond system that discharges directly to the West Fork of the Vermillion River. This facility has been assigned a WLA of 3.21E+10 in all zones except the low flow zone and makes up 18.4% of the total WLA for all facilities. This facility is required to monitor *E. coli* and meet the SSM criteria (1,178 cfu/100 mL) and GM criteria (630 cfu/100mL) outlined in the NPDES permit.

The Parker WWTF (SD0020940) is a pond system discharges directly to the West Fork of the Vermillion River. This facility has been assigned a WLA of 4.24E+10 in all zones except the low flow zone and makes up 24.2% of the total WLA for all facilities. This facility is required to monitor *E. coli* and meet the SSM criteria (1,178 cfu/100 mL) and GM criteria (630 cfu/100mL) outlined in the NPDES permit.

The Salem WWTF (SD0020966) is a pond system discharges into Snake Creek and then into the West Fork of the Vermillion River. This facility has been assigned a WLA of 7.85E+10 and makes up 44.9% of the total WLA for all facilities. This facility is required to monitor *E. coli* and meet the SSM criteria (1,178 cfu/100 mL) and GM criteria (630 cfu/100mL) as outlined in its NDPES permit.

All the NPDES facilities identified in these TMDLS have mechanisms in place that reduce fecal coliform and E. coli bacteria. Bacteria in the wastewater lagoons and ponds are viable for short periods due to extended retention time and resultant exposure to the ultraviolet light. This is evident in the bacteria data collected as part of the permit requirement. The relative assumption is *E. coli* bacteria contributions from these facilities are minor and not significantly contributing to the impairment. Emphasis should be placed on reducing bacteria inputs from livestock sources (feedlots and grazing) to bring the recreational use of the classified segment of the West Fork of the Vermillion River into compliance.

6.2.2 Margin of Safety (MOS) – *E. coli*

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 the West Fork of the

Vermillion River, the latter approach was used to establish a safety margin for the *E. coli* TMDLs.

An explicit MOS was calculated within the duration curve framework to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc.). Ten percent (10%) of the overall load capacity was allocated to each flow zone to the MOS as part of the TMDL. The remaining assimilative capacity was allocated to non-point sources (LA) and point sources (WLA).

6.2.3 Load Allocation (LA)

To develop the *E. coli* load allocation (LA), the loading capacity (LC) was first determined. The LC for SD-VM-R-VERMILLION_WEST_FORK_01_USGS (Vermillion River to McCook-Miner County Line) was calculated by multiplying the single sample maximum (1,178 cfu/100ml) criterion by the 95th percentile flow for each zone calculated from flow data obtained from USGS gage 06478690 (VRWF15). VRWF15 is the most downstream site within this segment. There were eight mainstem sites located on the West Fork of the Vermillion River but only six were located within this segment and used for the TMDL (Site WFVR1, WFVR2, WFVR3, WFVR4, VRWF15 and VRWF20).

Portions of the LC were allocated to point sources as a waste-load allocation (WLA) and nonpoint sources as a load allocation (LA). A fraction of the LC was also reserved as a margin of safety (MOS) to account for uncertainty in the calculations of the load allocations. The method used to calculate the MOS is discussed in section 6.2.2. The LA was determined by subtracting the WLA and MOS from the LC. Thus, the TMDL (and LC) is the sum of WLA, LA, and MOS.

7.0 Seasonal Variation

Discharge in the West Fork of the Vermillion River, USGS gage# 06478690 (VRWF15) displayed seasonal variation for the period of record (10/1/61 to 11/5/18). Highest stream flows typically occur during spring with highest monthly average stream flow reported in April (4,410 cfs), and lowest stream flows occur during the winter months with lowest monthly average stream flow reported in January (427.0 cfs). Although there is some relation to flow with most of the higher concentrations in the high flow zones occurring during spring and summer storm events. The lower flow zones displayed seasonal variation in concentrations possibly due to cattle grazing in the summer during lower flow periods where they access the stream to cool and drink. By using the LDC approach to develop the TMDL allocations, seasonal variability due to storm events or summer low flow periods are taken into account. Although the TMDL displays seasonality through flow, it is effective throughout the entire year.

8.0 Critical Conditions

Critical conditions occur within the basin during the spring and summer storm events. Typically, during severe thunderstorms, the largest concentrations are highest in the basin during the summer months. Combined with the peak in grazing, high-intensity rainstorm events, which are common during the spring and summer, can produce significant amounts of sheet and rill erosion from animal feeding areas. The excessive flows can transport waste material throughout the West Fork of the Vermillion and impair the recreational beneficial use.

9.0 Adaptive Management and Monitoring Strategy

The Department (or EPA) may adjust the load and/or waste load allocations in this TMDL to account for new information or circumstances that are developed or come to light during the implementation of the TMDL and a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment of the load and waste load allocation will only be made following an opportunity for public participation. New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information and land use information. The Department 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. The Department will follow EPA guidance for revising or withdrawing TMDLs in accordance with considerations documented in EPA's 2012 draft memo before taking action (http://www.epa.gov.sites.production/files/2015-10/documents/draft-tmdl 32212.pdf

During and after the implementation of management practices, monitoring will be necessary to assure attainment of the TMDL. Stream water quality monitoring will be accomplished through SD DENR's ambient water quality monitoring stations.

Additional monitoring and evaluation efforts will be targeted toward the effectiveness of implemented BMPs. Sample sites will be based on BMP site selection and parameters will be based on a product-specific basis.

10.0 Public Participation

Efforts taken to gain public education, review, and comment during development of the TMDL involved:

1. Monthly meetings were held during the assessment phase (2005-2006) through the Vermillion Basin Water Development District (VBWDD) which was the local sponsor for the TMDL project. Meeting minutes are available upon request.
2. A webpage was developed and used during the course of the assessment.
3. Presentations to local groups on the findings of the assessment.
4. 30-day public notice (PN) period for public review and comment.

The findings from these public meetings, the webpage, and 30-day PN comments have been taken into consideration in development of the previous Vermillion River Basin TMDLs as well as this TMDL targeting SD-VM-R-VERMILLION_WEST_FORK_01_USGS.

11.0 Reasonable Assurance

The West Fork Vermillion River (SD-VM-R-VERMILLION_WEST_FORK_01_USGS) receives *E. coli* loadings from both point and non-point sources. When a TMDL is developed for impaired waters that receive pollutant loadings from 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 West Fork Vermillion River 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 the TMDL established for SD-VM-R-VERMILLION_WEST_FORK_01_USGS can be met with proper planning between state and local regulatory agencies, stakeholders, BMP implementation, and access to adequate financial resources. The waste load allocations used in the TMDL were obtained from regulations defined in the NPDES permits administratively assigned to the different communities within the watershed (WWTF).

11.1 Point Sources

The City of Canistota, Marion, Parker and Salem WWTFs are located in the watershed for West Fork and discharge directly to the impaired segment. It is imperative that all facilities operate in compliance with their NPDES permits and WLA's set forth in the TMDL. Below are some recommendations for the facilities to consider to ensure high operational effectiveness of wastewater treatment.

City of Canistota WWTF

- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continue *E. coli* monitoring to assure compliance with water quality standards.
- Encourage WWTF Personnel to attend annual wastewater training courses sponsored by the state.

City of Marion WWTF

- Continue scheduled replacement of sanitary pumps, replacing riprap, and repairing inter-pond valves.
- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continued maintenance of the existing facility.
- Continue upgrading treatment system as new technologies become available.

- Encourage WWTF Personnel to attend annual wastewater training courses sponsored by the state.

City of Parker WWTF
- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continue *E. coli* monitoring to assure compliance with water quality standards.
- Encourage WWTF Personnel to attend annual wastewater training courses sponsored by the state.

City of Salem WWTF
- Continue scheduled sanitary sewer lines and storm sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continue *E. coli* monitoring to assure compliance with water quality standards.
  Encourage WWTF Personnel to attend annual wastewater training courses sponsored by the state.

11.2 Non-point Source

There are several entities that provide watershed stewardship and have vested interest in a Vermillion River Basin Watershed Implementation Project which includes West Fork. These include the various municipalities within the river basin including the cities listed above. The various county conservation districts, South Dakota GFP, Natural Resource Conservation Service, and the Vermillion Basin will also have involvement in any kind of restoration project.

There is one project currently engaged with the Vermillion Basin and the Lower James River Watersheds that focuses on implementation efforts to reduce bacteria loading from nonpoint sources. These projects provide reasonable assurance that bacteria loading from nonpoint sources will be targeted through measures outlined in Section 12.0 Implementation Strategy.

12.0 Implementation Strategy

Currently, there is an implementation project targeting areas of sediment and bacterial sources within the Vermillion River Basin. Several types of BMPs have been considered in the development of a water quality management implementation plan for the impaired segments of the West Fork of the Vermillion River. The results shown in the Load Duration Curves indicate that significant reductions are required in both high flow and moderate flow zones. Because of the rural area and the number of point sources (WWTF), most of the implementation measures should focus on the following:

- Livestock access to streams should be reduced, and livestock should be provided sources of water away from streams.
- Control point sources (WWTF) and insure that correct procedures are being followed.
- Unstable stream banks should be protected by enhancing the riparian vegetation that provides erosion control and filters runoff of pollutants into the stream.
- Filter strips should be installed along the stream bordering cropland and pastureland.

- Animal confinement facilities should implement proper animal waste management systems.

Funds to implement watershed water quality improvements can be obtained through SD DENR. SD DENR administers three major funding programs that provide low interest loans and grants for projects that protect and improve water quality in South Dakota. They include: Consolidated Water Facilities Construction program, Clean Water State Revolving Fund (SRF) program, and the Section 319 Nonpoint Source program. There are also non-DENR funding sources such as the NRCS Environmental Quality Incentives Program (EQIP) and other USDA programs.

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12.0 APPENDIX A: Water Quality Data

Site	Nearest Town	Date	Time	Event	E. Coli to be used in TMDL	Flow (cfs)	Flow Rank
VRWF15	Parker	3/23/2005	11:00	Baseflow			
VRWF15	Parker	4/1/2005	14:45	Storm			
VRWF15	Parker	4/19/2005	14:45	Storm	27.8	47	14%
VRWF15	Parker	5/10/2005	9:30	Baseflow	55.0	10	29%
VRWF15	Parker	5/19/2005	11:30	Storm	345.0	89	9%
VRWF15	Parker	6/6/2005	14:00	Storm	1286.2	553	2%
VRWF15	Parker	6/29/2005	16:00	Baseflow	36.8	29	18%
VRWF15	Parker	6/29/2005	16:20	Baseflow	49.7	29	18%
VRWF15	Parker	9/22/2005	15:30	Baseflow	687.0	0.35	70%
VRWF15	Parker	11/2/2005	16:00	Baseflow	48.1	0.32	70%
VRWF15	Parker	1/26/2006	12:45	Spring Runoff	18.7	6.2	34%
VRWF15	Parker	3/1/2006	13:15	Spring Runoff	11.0	4.7	38%
VRWF15	Parker	3/15/2006	12:15	Spring Runoff	2.0	6.3	34%
VRWF15	Parker	3/29/2006	15:00	Spring Runoff	11.0	24	20%
VRWF15	Parker	4/13/2006	10:45	Storm	21.6	81	10%
VRWF15	Parker	5/4/2006	16:00	Baseflow	30.1	28	18%
VRWF15	Parker	5/30/2006	14:45	Baseflow	155.7	4.6	38%
VRWF15	Parker	6/26/2006	14:15	Baseflow	433.6	0.97	57%
VRWF15	Parker	7/25/2006	12:00	Storm	526.0	0.14	77%
VRWF15	Parker	7/26/2006	12:30	Storm	818.8	0.15	76%
VRWF15	Parker	8/7/2006	14:45	Storm	65.5	1.9	50%
VRWF15	Parker	9/5/2006	13:15	Storm	256.3	12	27%
VRWF15	Parker	9/19/2006	11:00	Storm	455.2	15	25%
VRWF15	Parker	11/20/2006	16:15	Baseflow	11.0	3	44%
VRWF20	Salem	3/22/2005	11:00	Baseflow			
VRWF20	Salem	3/31/2005	11:00	Storm	214.0	64	11%
VRWF20	Salem	4/18/2005	10:15	Storm	397.0	58	12%
VRWF20	Salem	5/10/2005	10:45	Baseflow	2736.4	10	29%
VRWF20	Salem	5/10/2005	10:45	Baseflow	4819.4	10	29%

Site	Nearest Town	Date	Time	Event	E. Coli to be used in TMDL	Flow (cfs)	Flow Rank
VRWF20	Salem	5/19/2005	15:00	Storm	2180.1	89	9%
VRWF20	Salem	6/16/2005	12:00	Storm	649.0	319	4%
VRWF20	Salem	6/29/2005	11:15	Baseflow	27.5	29	18%
VRWF20	Salem	9/23/2005	8:30	Baseflow	548.0	0.36	69%
VRWF20	Salem	1/31/2006	10:15	Spring Runoff	214.0	13	26%
VRWF20	Salem	3/2/2006	12:00	Spring Runoff	17.1	4	40%
VRWF20	Salem	3/16/2006	9:15	Spring Runoff	41.6	7.6	32%
VRWF20	Salem	3/30/2006	10:45	Spring Runoff	1050.0	37	16%
VRWF20	Salem	4/24/2006	15:00	Storm	192.0	24	20%
VRWF20	Salem	5/4/2006	17:15	Baseflow	131.7	28	18%
VRWF20	Salem	5/30/2006	12:30	Baseflow	74.0	4.6	38%
VRWF20	Salem	6/14/2006	10:30	Baseflow	695.0	1.8	51%
VRWF20	Salem	7/25/2006	13:00	Storm	7326.8	0.14	77%
VRWF20	Salem	7/26/2006	13:00	Storm	3041.0	0.15	76%
VRWF20	Salem	8/7/2006	16:30	Storm	65.5	1.9	50%
VRWF20	Salem	9/19/2006	13:00	Storm	5455.5	15	25%
VRWF20	Salem	11/29/2006	12:00	Baseflow	11.0	2.2	48%

Site	Date	*E.coli* (cfu/100ml)	Flow (cfs)
WFVR3	09/15/2015	32.8	1.56
WFVR4	09/15/2015	70.8	1.56
WFVR2	09/15/2015	46	1.56
WFVR1	09/15/2015	8.2	1.56
WFVR4	09/09/2015	439	1.89
WFVR3	09/09/2015	119	1.89
WFVR2	09/09/2015	84	1.89
WFVR1	09/09/2015	262	1.89
WFVR4	09/02/2015	50.4	3.16
WFVR3	09/02/2015	31.2	3.16
WFVR2	09/02/2015	52.6	3.16
WFVR1	09/02/2015	37	3.16
WFVR1	09/23/2015	32.8	1.84
WFVR3	10/06/2015	39.9	2.9
WFVR1	10/13/2015	45.9	2.11
WFVR2	10/13/2015	687	2.11
WFVR3	10/13/2015	127	2.11
WFVR4	10/13/2015	197	2.11
WFVR2	09/23/2015	615	1.84
WFVR4	09/23/2015	3110	1.84
WFVR3	09/23/2015	3080	1.84
WFVR4	04/12/2016	24.4	24.6
WFVR3	05/05/2016	203	217
WFVR4	05/05/2016	850	217
WFVR1	05/05/2016	143	217
WFVR2	05/05/2016	109	217
WFVR1	04/28/2016	6130	749
WFVR2	04/28/2016	7700	749
WFVR3	04/28/2016	9800	749
WFVR4	04/28/2016	7270	749
WFVR1	05/11/2016	305	107
WFVR2	05/11/2016	512	107
WFVR3	05/11/2016	717	107
WFVR4	05/11/2016	650	107
WFVR1	05/19/2016	52	35
WFVR2	05/19/2016	61	35
WFVR3	05/19/2016	211	35
WFVR4	05/19/2016	52	35
WFVR1	09/29/2015	7.2	5.1
WFVR2	09/29/2015	299	5.1
WFVR3	09/29/2015	457	5.1
WFVR4	09/29/2015	63.6	5.1
WFVR4	10/06/2015	3080	2.9
WFVR1	10/06/2015	98.7	2.9
WFVR2	10/06/2015	109	2.9
WFVR3	04/12/2016	12.6	24.6

Site	Date	*E.coli* (cfu/100ml)	Flow (cfs)
WFVR1	04/12/2016	4	24.6
WFVR2	04/12/2016	4	24.6
WFVR1	06/07/2016	131	51.5
WFVR4	06/07/2016	108	51.5
WFVR1	06/14/2016	61	10.7
WFVR2	06/14/2016	629	10.7
WFVR3	06/14/2016	8660	10.7
WFVR4	06/14/2016	13000	10.7
WFVR1	06/22/2016	155	52.5
WFVR2	06/22/2016	121	52.5
WFVR3	06/22/2016	63	52.5
WFVR4	06/22/2016	121	52.5
WFVR1	07/05/2016	10	3.24
WFVR2	07/05/2016	121	3.24
WFVR3	07/05/2016	73	3.24
WFVR4	07/05/2016	2760	3.24
WFVR2	05/07/2016	216	123
WFVR3	06/07/2016	169	51.5
WFVR1	05/25/2016	521	91.6
WFVR2	05/25/2016	1110	91.6
WFVR3	05/25/2016	987	91.6
WFVR4	05/25/2016	959	91.6
WFVR1	06/02/2016	336	207
WFVR2	06/02/2016	788	207
WFVR3	06/02/2016	1050	207
WFVR4	06/02/2016	1380	207
WFVR1	07/12/2016	30	2.05
WFVR4	07/26/2016	794	2.43
WFVR1	08/02/2016	84	1.74
WFVR2	08/02/2016	108	1.74
WFVR3	08/02/2016	288	1.74
WFVR4	08/02/2016	250	1.74
WFVR2	07/12/2016	204	2.05
WFVR3	07/12/2016	98	2.05
WFVR4	07/12/2016	1170	2.05
WFVR1	07/19/2016	10	2.9

Site	Date	*E.coli* (cfu/100ml)	Flow (cfs)
WFVR2	07/19/2016	161	2.9
WFVR3	07/19/2016	148	2.9
WFVR4	07/19/2016	169	2.9
WFVR1	07/26/2016	132	2.43
WFVR2	07/26/2016	226	2.43
WFVR3	07/26/2016	128	2.43
WFVR1	08/09/2016	185	1.38
WFVR4	08/17/2016	16.6	1.36
WFVR1	09/01/2016	130	1.19
WFVR2	09/01/2016	41	1.19
WFVR3	09/01/2016	305	1.19
WFVR4	09/01/2016	183	1.19
WFVR1	09/07/2016	504	2.32
WFVR2	09/07/2016	323	2.32
WFVR3	09/07/2016	7270	2.32
WFVR4	09/07/2016	414	2.32
WFVR1	09/13/2016	240	1.09
WFVR2	09/13/2016	121	1.09
WFVR3	09/13/2016	31	1.09
WFVR4	09/13/2016	272	1.09
WFVR2	08/09/2016	52	1.38
WFVR3	08/09/2016	122	1.38
WFVR4	08/09/2016	52	1.38
WFVR1	08/23/2016	15	1.21
WFVR2	08/23/2016	88.8	1.21
WFVR3	08/23/2016	32.8	1.21
WFVR4	08/23/2016	8.5	1.21
WFVR1	08/17/2016	158	1.36
WFVR2	08/17/2016	63	1.36
WFVR3	08/17/2016	125	1.36
WFVR1	09/20/2016	1120	14.5
WFVR4	10/06/2016	288	2.44
WFVR1	10/12/2016	178	2.7
WFVR2	10/12/2016	131	2.7
WFVR3	10/12/2016	140	2.7
WFVR4	10/12/2016	517	2.7
WFVR2	09/20/2016	1280	14.5
WFVR3	09/20/2016	823	14.5
WFVR4	09/20/2016	609	14.5
WFVR3	09/29/2016	354	3.25
WFVR4	09/29/2016	546	3.25
WFVR1	09/29/2016	749	3.25

Site	Date	*E.coli* (cfu) (cfu/100ml)	Flow (cfs)
WFVR2	09/29/2016	228	3.25
WFVR1	10/06/2016	152	2.44
WFVR1	06/21/2017	155	9.7
WFVR2	06/21/2017	520	9.7
WFVR3	06/21/2017	3450	9.7
WFVR4	06/21/2017	1120	9.7
WFVR1	07/05/2017	51	4.97
WFVR2	07/05/2017	148	4.97
WFVR3	07/05/2017	85	4.97
WFVR4	07/05/2017	81	4.97
WFVR2	10/06/2016	520	2.44
WFVR3	10/06/2016	309	2.44
WFVR1	05/03/2017	6490	179
WFVR3	07/19/2017	538	1.31
WFVR2	05/03/2017	11200	179
WFVR3	05/03/2017	717	179
WFVR4	05/03/2017	627	179
WFVR1	06/01/2017	233	21.5
WFVR1	08/22/2017	578	34.1
WFVR2	08/22/2017	17300	34.1
WFVR3	08/22/2017	24200	34.1
WFVR4	08/22/2017	11300	34.1
WFVR2	06/01/2017	259	21.5
WFVR3	05/01/2017	399	80.8
WFVR4	06/01/2017	292	21.5
WFVR1	09/21/2017	134	1.43
WFVR2	09/21/2017	318	1.43
WFVR3	09/21/2017	331	1.43
WFVR4	09/21/2017	52	1.43
WFVR3	08/02/2017	143	1.06
WFVR2	10/02/2017	798	5.64
WFVR3	10/02/2017	457	5.64
WFVR4	10/02/2017	480	5.64
WFVR4	08/02/2017	31	1.06
WFVR1	08/02/2017	20	1.06
WFVR2	08/02/2017	20	1.06
WFVR1	07/19/2017	512	1.31
WFVR2	07/19/2017	359	1.31
WFVR4	07/19/2017	529	1.31
WFVR1	10/02/2017	253	5.64

Site	Date	*E.coli* (cfu) (cfu/100ml)	Flow (cfs)
WFVR1	10/17/2017	657	44.9
WFVR2	10/17/2017	591	44.9
WFVR3	10/17/2017	512	44.9
WFVR4	10/17/2017	305	44.9

13.0 APPENDIX B: County Livestock Data

Progam	Year	Domain	Domain Category	County	acres	Data Item	**Value**	# per acre
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CATTLE, COWS - INVENTORY	**27,578**	0.053
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CATTLE, COWS, BEEF - INVENTORY	**24,678**	0.047
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CATTLE, COWS, MILK - INVENTORY	**2,900**	0.006
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CATTLE, INCL CALVES - INVENTORY	**67,875**	0.130
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CATTLE, ON FEED - INVENTORY	**12,068**	0.023
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	cattle on grass	**52,907**	0.102
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CHICKENS, BROILERS - INVENTORY		0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	CHICKENS, LAYERS - INVENTORY	**764**	0.001
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	EQUINE, HORSES & PONIES - INVENTORY	**462**	0.001
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	GOATS - INVENTORY	**196**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	HOGS - INVENTORY	**117257**	0.225
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	SHEEP, INCL LAMBS - INVENTORY	**2965**	0.006
CENSUS	2017	TOTAL	NOT SPECIFIED	HUTCHINSON	520,911	TURKEYS - INVENTORY	**287665**	0.552
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CATTLE, COWS - INVENTORY	**19,503**	0.049
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CATTLE, COWS, BEEF - INVENTORY	**13,068**	0.033
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CATTLE, COWS, MILK - INVENTORY	**6,435**	0.016
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CATTLE, INCL CALVES - INVENTORY	**49,050**	0.124
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CATTLE, ON FEED - INVENTORY	**15,904**	0.040
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	cattle on grass	**26,711**	0.068
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CHICKENS, BROILERS - INVENTORY	**35**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	CHICKENS, LAYERS - INVENTORY	**509**	0.001
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	EQUINE, HORSES & PONIES - INVENTORY	**732**	0.002
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	GOATS - INVENTORY	**133**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	HOGS - INVENTORY	**61412**	0.155
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	SHEEP, INCL LAMBS - INVENTORY	**13145**	0.033
CENSUS	2017	TOTAL	NOT SPECIFIED	TURNER	395,067	TURKEYS - INVENTORY	**41**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CATTLE, COWS - INVENTORY	**27,889**	0.050
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CATTLE, COWS, BEEF - INVENTORY	**27,271**	0.049
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CATTLE, COWS, MILK - INVENTORY	**618**	0.001
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CATTLE, INCL CALVES - INVENTORY	**84,267**	0.153
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CATTLE, ON FEED - INVENTORY	**23,468**	0.042
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	cattle on grass	**60,181**	0.109
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	CHICKENS, BROILERS - INVENTORY	**225**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY		EQUINE, HORSES &	**621**	0.001

					552,500	PONIES - INVENTORY		
Progam	Year	Domain	Domain Category	County	acres	Data Item	**Value**	# per acre
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	HOGS - INVENTORY	**8,932**	0.016
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	SHEEP, INCL LAMBS - INVENTORY	**5,591**	0.010
CENSUS	2017	TOTAL	NOT SPECIFIED	KINGSBURY	552,500	TURKEYS - INVENTORY	**63,005**	0.114
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CATTLE, COWS - INVENTORY	**18,620**	0.050
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CATTLE, COWS, BEEF - INVENTORY	**15,791**	0.043
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CATTLE, COWS, MILK - INVENTORY	**2,829**	0.008
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CATTLE, INCL CALVES - INVENTORY	**44,776**	0.121
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CATTLE, ON FEED - INVENTORY	**6,478**	0.018
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	cattle on grass	**35,469**	0.096
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CHICKENS, BROILERS - INVENTORY	**1,000**	0.003
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	CHICKENS, LAYERS - INVENTORY	**1,647**	0.004
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	EQUINE, HORSES & PONIES - INVENTORY	**680**	0.002
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	HOGS - INVENTORY	**61,228**	0.166
CENSUS	2017	TOTAL	NOT SPECIFIED	MCCOOK	369,238	SHEEP, INCL LAMBS - INVENTORY	**4,115**	0.011
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CATTLE, COWS - INVENTORY	**19,101**	0.052
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CATTLE, COWS, BEEF - INVENTORY	**18,396**	0.050
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CATTLE, COWS, MILK - INVENTORY	**705**	0.002
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CATTLE, INCL CALVES - INVENTORY	**39,776**	0.109
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CATTLE, ON FEED - INVENTORY	**4,734**	0.013
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	cattle on grass	**34,337**	0.094
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CHICKENS, BROILERS - INVENTORY	**105**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	CHICKENS, LAYERS - INVENTORY	**175**	0.000
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	EQUINE, HORSES & PONIES - INVENTORY	**384**	0.001
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	HOGS - INVENTORY	**13,335**	0.036
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	SHEEP, INCL LAMBS - INVENTORY	**3,953**	0.011
CENSUS	2017	TOTAL	NOT SPECIFIED	MINER	365,887	TURKEYS - INVENTORY	**36**	0.000

14.0 APPENDIX C: Public Notice Comments including EPA and Response to Comments

The draft TMDl report was made available for download on the SD DENR website from May 16 to June 17, 2019, for public review. The notice for the public review period was published on May 13 in the *Sioux Falls Argus Leader, the Canistota Clipper, the Miner County Pioneer, and the Salem Special.* No comments were received during the public notice period.

15.0 APPENDIX D: EPA TMDL Approval Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

AUG 0 1 2019

Ref: 8WD-CWS

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

Re: Approval of *Escherichia coli* Bacteria Total Maximum Daily Load Evaluation for the West Fork of the Vermillion River

Dear Mr. Pirner,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily load (TMDL) submitted by your office on July 3, 2019. In accordance with the Clean Water Act (33 U.S.C. §1251 *et. seq.*) and the EPA's implementing regulations at 40 C.F.R Part 130, the EPA hereby approves South Dakota's TMDL for the West Fork Vermillion River. The EPA has determined that the separate elements of the TMDL listed in the enclosure adequately address the pollutant of concern, are designed to attain and maintain applicable water quality standards, consider seasonal variation and includes a margin of safety. The EPA's rationale for this action is contained in the enclosure.

Thank you for submitting this TMDL for our review and approval. If you have any questions, please contact Peter Brumm on my staff at 406-457-5029.

Sincerely,

Darcy O'Connor, Director
Water Division

Enclosure
West Fork Vermillion River *E. coli* TMDL EPA Review Summary

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) REVIEW SUMMARY

TMDL: *E. coli* Bacteria Total Maximum Daily Load Evaluation for the West Fork of the Vermillion River

ATTAINS TMDL ID: R8-SD-2019-03

LOCATION: McCook and Turner Counties, South Dakota

IMPAIRMENTS/POLLUTANTS: The TMDL document addresses one river segment whose limited contact recreation use is impaired due to high concentrations of *E. coli* bacteria.

Waterbody/Pollutant Addressed in this TMDL Action

Assessment Unit ID	Waterbody Description	Pollutants Addressed
SD-BS-R-VERMILLION_WEST_FORK_01_USGS	West Fork Vermillion River (Vermillion River to McCook-Miner County Line)	Escherichia coli (*E. coli*)

BACKGROUND: The South Dakota Department of Environment and Natural Resources (DENR) submitted to EPA the final *E. coli* TMDL for the West Fork of the Vermillion River with a letter requesting review and approval dated July 3, 2019. DENR sent an updated version of the TMDL document on July 26, 2019 that corrected several minor errors and requested EPA act on the newer version, which EPA agreed to do.

The submittal included:
- Letter requesting EPA's review and approval of the TMDL
- Final TMDL document

APPROVAL RECOMMENDATIONS: Based on the review presented below, the reviewer recommends approval of the final West Fork Vermillion River *E. coli* TMDL. All the required elements of an approvable TMDL have been met.

TMDL Approval Summary	
Number of TMDLs Approved:	1
Number of Causes Addressed by TMDLs:	1

REVIEWERS: Peter Brumm, EPA

The following review summary explains how the TMDL submission meets the statutory and regulatory requirements of TMDLs in accordance with Section 303(d) of the Clean Water Act (CWA), and EPA's implementing regulations in 40 C.F.R. Part 130.

EPA TMDL REVIEW FOR WEST FORK VERMILLION E. COLI TMDL

This TMDL review document includes EPA's guidelines that summarize the currently effective statutory and regulatory requirements relating to TMDLs (CWA Section 303(d) and 40 C.F.R. Part 130). These TMDL review guidelines are not themselves regulations. Any differences between these guidelines and EPA's regulations should be resolved in favor of the regulations themselves. The italicized sections of this document describe the information generally necessary for EPA to determine if a TMDL submittal fulfills the legal requirements for approval. The sections in regular type reflect EPA's analysis of the state's compliance with these requirements. Use of the verb "must" below denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation.

1. Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking

The TMDL submittal must clearly identify (40 C.F.R. §130.7(c)(1)):

- *the waterbody as it appears on the State's/Tribe's 303(d) list;*
- *the pollutant for which the TMDL is being established; and*
- *the priority ranking of the waterbody.*

The TMDL submittal must include (40 C.F.R. §130.7(c)(1); 40 C.F.R. §130.2):

- *an identification of the point and nonpoint sources of the pollutant of concern, including location of the source(s) and the quantity of the loading (e.g., lbs. per day);*
- *facility names and NPDES permit numbers for point sources within the watershed; and*
- *a description of the natural background sources, and the magnitude and location of the sources, where it is possible to separate natural background from nonpoint sources.*

This information is necessary for EPA's review of the load and wasteload allocations, which are required by regulation.

The TMDL submittal should also contain a description of any important assumptions made in developing the TMDL, such as:

- *the spatial extent of the watershed in which the impaired waterbody is located;*
- *the assumed distribution of land use in the watershed (e.g., urban, forested, agriculture);*
- *population characteristics, wildlife resources, and other relevant information affecting the characterization of the pollutant of concern and its allocation to sources;*
- *present and future growth trends, if taken into consideration in preparing the TMDL (e.g., the TMDL could include the design capacity of a wastewater treatment facility); and*
- *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 West Fork Vermillion River is located in south-eastern South Dakota and is part of the larger Missouri River basin. The impaired waterbody segment subject to this TMDL extends upstream from the Vermillion River mainstem to the McCook-Miner County Line and is identified as SD-BS-R-VERMILLION_WEST_FORK_01_USGS. Figure 1 displays the general location of the West Fork Vermillion River, the impaired segment, and monitoring stations where data was collected to support TMDL development.

This segment was first listed as impaired by *E. coli* on South Dakota's 2010 303(d) List and was assigned a high priority for TMDL development on the most recent 303(d) list in 2018. This priority ranking information is contained in Section 1.0 (Objective). No other impairment causes have been identified and no previous TMDLs have been established for this segment.

Table 3 summarizes land uses draining into the impaired segment and Section 5.2 characterizes nonpoint sources into categories of agriculture, septic systems, wildlife and tributaries. Natural background is represented by the wildlife category. DENR quantified *E. coli* production from these sources using human and animal population estimates from various sources. Point sources are identified by facility name and permit number in Table 6 and their discharge is characterized in Table 7.

Assessment: EPA concludes that DENR adequately identified the impaired waterbody, the pollutant of concern, the priority ranking, the identification, location and magnitude of the pollutant sources, and the important assumptions and information used to develop the TMDL.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

The TMDL submittal 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 antidegradation policy (40 C.F.R. §130.7(c)(1)); and*
- *a numeric water quality target for each TMDL. If the TMDL is based on a target other than a numeric water quality criterion, then a numeric expression must be developed from a narrative criterion and a description of the process used to derive the target must be included in the submittal (40 C.F.R. §130.2(i)).*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation.

Section 3.0 (Description of the Applicable Water Quality Standards and Numeric Water Quality Target) describes the water quality standards applicable to the impaired segment with citations to relevant South Dakota regulations. SD-BS-R-VERMILLION_WEST_FORK_01_USGS is designated for the following beneficial uses:

- warmwater marginal fish life propagation,
- limited contact recreation,
- irrigation,
- fish and wildlife propagation, recreation, and stock watering.

All numeric criteria applicable to these uses are presented in Table 4. DENR determined that *E. coli* is preventing the river's limited contact recreation use from being supported. The numeric *E. coli* criteria for limited contact recreation waters are applied directly as water quality targets for the TMDL and are comprised of a 30-day geometric mean criterion (≤ 630 cfu/100mL) and a single sample maximum criterion (≤ 1,178 cfu/100mL). These criteria are seasonally applicable from May 1 to September 30.

The TMDL and allocations were developed using the single sample maximum criterion because geometric means could not be calculated from the monitoring dataset in accordance with South Dakota water quality standard regulations (i.e., minimum five samples separated by at least 24-hours within a

30-day period). DENR demonstrates in Section 3.3 (Numeric TMDL Targets) that attaining the single sample maximum target will also achieve the geometric mean criterion.

Assessment: EPA concludes that DENR adequately described the applicable water quality standards and numeric water quality target for this TMDL.

EPA notes two errors in the TMDL submittal where criteria and targets are discussed. EPA understands DENR intended to communicate the following:

- Underlined text on page 10 "The numeric *E. coli* criteria applicable to the West Fork Vermillion River (SD-VM-R-VERMILLION_WEST_FORK_01_USGS) are the immersion recreation values listed in Table 4" should read limited contact recreation values.
- Underlined text on page 14 "The limited contact recreation SSM *E. coli* criterion of 1,178 cfu/100mL was selected as the numeric TMDL target for Long Creek because a proper geometric mean could not be calculated from the available monitoring dataset" should read West Fork Vermillion River.

3. Loading Capacity - Linking Water Quality and Pollutant Sources

The TMDL submittal must include the loading capacity for each waterbody and pollutant of concern. 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 TMDL submittal must:

- *describe the method used to establish 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;*
- *contain documentation supporting the TMDL analysis, including the basis for any assumptions; a discussion of strengths and weaknesses in the analytical process; and results from any water quality modeling; and*
- *include a description and summary of the water quality data used for the TMDL analysis.*

EPA needs this information to review the loading capacity determination, and load and wasteload allocations, which are required by regulation (40 C.F.R. §130.2).

The full water quality dataset should be made available as an appendix to the TMDL or as a separate electronic file. Other datasets used (e.g., land use, flow), if not included within the TMDL submittal, should be referenced by source and year. The TMDL analysis should make use of all readily available data for the waterbody unless the TMDL writer determines that the data are not relevant or appropriate.

The pollutant loadings may be expressed as either mass-per-time, toxicity or other appropriate measure (40 C.F.R. §130.2(i)). Most TMDLs should be expressed as daily loads (USEPA. 2006a, USEPA. 2007a). If the TMDL is expressed in terms other than a daily load (e.g., annual load), the submittal should explain why it is appropriate to express the TMDL in the unit of measurement chosen.

The TMDL submittal must describe the critical conditions and related physical conditions in the waterbody as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). The critical condition can be thought of as the "worst case" scenario of environmental conditions (e.g.,
, temperature, loads) in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. TMDLs should define the applicable critical conditions and describe the approach used to estimate both point and nonpoint source loads under such critical conditions.

DENR relied on the load duration curve approach to define the *E. coli* loading capacity of the West Fork Vermillion River. A load duration curve is a graphic representation of pollutant loads across various flows. The approach helps correlate water quality conditions to stream flow and provides insight into the variability of source contributions. EPA has published guidance on the use of duration curves for TMDL development (USEPA. 2007b) and the practice is well established. Using this approach, DENR set the TMDL equivalent to the loading capacity and expressed the TMDL in colony forming units per day at four different flow zones (i.e., high, moderate, dry, low), as listed in Table 11. The load duration curve, and TMDL based on the curve, is shown visually in Figure 6 with instantaneous loads calculated from the monitoring dataset. All ambient water quality data used in the analysis is contained in Appendix A (Water Quality Data). No data was converted from fecal coliform because all samples were originally analyzed for *E. coli*. While the loading capacity is defined for multiple stream flow conditions, DENR determined critical conditions occur during spring and summer storm events when the in-stream concentrations of *E. coli* are the highest.

Assessment: EPA concludes that the loading capacity was calculated using an acceptable approach, used water quality targets consistent with water quality criteria, and has been appropriately set at a level necessary to attain and maintain the applicable water quality standards. The pollutant loads have been expressed as daily loads. The critical conditions were described and factored into the calculations and were based on a reasonable approach to establish the relationship between the target and pollutant sources.

4. Load Allocation

The TMDL submittal must include load allocations (LAs). EPA regulations define LAs as the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution and to natural background sources. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Where possible, separate LAs should be provided for natural background and for nonpoint sources.

In the rare instance that a TMDL concludes that there are no nonpoint sources or natural background for a pollutant, the load allocation must be expressed as zero and the TMDL should include a discussion of the reasoning behind this decision.

As described in Section 6.2.3 (Load Allocation), DENR established a single LA as the allowable load remaining after the WLAs and explicit MOS have been accounted for (i.e., LA = TMDL – ∑WLA – MOS). Table 11 presents the LA across the TMDL's four flow zones. This composite LA represents all nonpoint source contributions, both human and natural, as one allocation, however, individual nonpoint source categories were characterized in greater depth in Section 5.2 (Nonpoint Sources).

Assessment: EPA concludes that the LA provided in the TMDL is reasonable and will result in attainment of the water quality standards.

5. Wasteload Allocations

The TMDL submittal must include wasteload allocations (WLAs). EPA regulations define WLAs as the portion of a receiving water's loading capacity that is allocated to existing and future point sources (40 C.F.R. §130.2(h)). If no point sources are present or if the TMDL recommends a zero WLA for point sources, the WLA must be expressed as zero. If the TMDL recommends a zero WLA after considering all pollutant sources, there must be a discussion of the reasoning behind this decision, since a zero WLA implies an allocation only to nonpoint sources and natural background will result in attainment of the applicable water quality standards, and all point sources have no measurable contribution.

The individual WLAs may take the form of uniform percentage reductions or individual mass based limitations for dischargers where it can be shown that this solution meets WQSs and does not result in localized impairments. In some cases, WLAs may cover more than one discharger (e.g., if the source is contained within a general permit).

Section 5.1.1 (Wastewater Treatment Facilities) identifies and describes the six point sources located within the drainage area that are permitted to discharge through the National Pollutant Discharge Elimination System (NPDES) program. These are the wastewater treatment facilities for the towns of Canistota (Permit #SD0022497), Howard (Permit #SD0020613), Marion (Permit #SD0020311), Parker (Permit #SD0020940) and Salem (Permit #SD0020966), as well as the Salem Transportation Rest Area (Permit #SDGG27359). There are no Concentrated Animal Feeding Operations (CAFOs) within the drainage area.

After reviewing the specifics of each facility, DENR established individual WLAs for each point source except Howard and the Salem Transportation Rest Area. Howard was not assigned a WLA because it is a non-continuous discharger located more than 11 linear miles upstream of the impaired segment. DENR assumed that Howard does not contribute *E. coli* to the impaired segment given the fate and transport characteristics of *E. coli*. Discharge from the Salem Transportation Rest Area is only permitted in the case of an emergency, which has occurred once in the last five years, therefore no portion of the TMDL was reserved for loading from this source.

WLAs for the other point sources were typically calculated using the *E. coli* permit limit of 1,178 cfu/100mL and the 80th percentile of each facility’s daily maximum effluent flow based on discharge monitoring report (DMR) data from 2012 to 2019. Table 6 displays the selected effluent flows and Table 11 presents the WLAs for each flow zone. WLAs across the high, moderate and dry flow zone are equivalent and were calculated as just described. This uniformity changes during the low flow zone because the WLAs were adjusted to fit within the reduced loading capacity of the river during low flow conditions. Low flow WLAs were calculated by evenly splitting the low flow TMDL between the WLA and LA, minus the 10% explicit MOS.

Assessment: EPA concludes that the WLAs provided in the TMDL are reasonable, will result in the attainment of the water quality standards and will not cause localized impairments. The TMDL accounts for all point sources contributing loads to the impaired segment.

6. Margin of Safety

The TMDL submittal must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load allocations, wasteload allocations and water quality (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). The MOS may be ***implicit*** *or* ***explicit****.* *If the MOS is* ***implicit****, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is* ***explicit****, the loading set aside for the MOS must be identified.*

The West Fork Vermillion River *E. coli* TMDL includes an explicit MOS derived as 10% of the TMDL. The explicit MOS is included in Table 11 and varies by flow zone.

Assessment: EPA concludes that the TMDL incorporates an adequate explicit margin of safety.

7. Seasonal Variation

The TMDL submittal must be established with consideration of seasonal variations. The method chosen for including seasonal variations in the TMDL must be described (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

The load duration curve method used to establish the TMDL incorporates variations in stream flow, which in turn, is influenced by other climatic and human factors that change throughout the year. To account for these variations, DENR developed the TMDL at four different flow zones (i.e., high, moderate, dry, low) as listed in Table 11.

The variability of measured stream flows and monitored *E. coli* concentrations are summarized in Section 7.0 (Seasonal Variation). Typically, the highest stream flows occur during spring, the lowest stream flows occur during the winter and the highest *E. coli* concentrations are associated with storm events during the spring and summer.

Assessment: EPA concludes that seasonal variations were adequately described and considered to ensure the TMDL allocations will be protective of the applicable water quality standards throughout any given year.

8. Reasonable Assurances

When a TMDL is developed for waters impaired by both point and nonpoint sources, EPA guidance (USEPA. 1991) and court decisions say that the TMDL must provide reasonable assurances that nonpoint source control measures will achieve expected load reductions in order for the TMDL to be approvable. This information is necessary for EPA to determine that the TMDL, including the load and wasteload allocations, has been established at a level necessary to implement the applicable water quality standards (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)). *EPA guidance (USEPA. 1997) also directs Regions to work with States to achieve TMDL load allocations in waters impaired only by nonpoint sources. However, EPA cannot disapprove a TMDL for nonpoint source-only impaired waters, which do not have a demonstration of reasonable assurance that LAs will be achieved, because such a showing is not required by current regulations.*

As verified through the TMDL analysis, the West Fork Vermillion River is impaired by both point and nonpoint sources of *E. coli* therefore DENR provided reasonable assurances that source control measures will be achieved in Section 11.0 (Reasonable Assurance).

WLAs were established based on facilities meeting *E. coli* water quality criteria in their effluent (i.e., criteria end-of-pipe). Reasonable assurances are addressed for point sources through NPDES permits, which require these facilities to have effluent limits consistent with the assumptions and requirements of WLAs. The submittal also outlines recommendations to ensure effective treatment at each facility such as, "Continue scheduled sanitary sewer lines and storm sewer replacement and repairs."

Nonregulatory, voluntary-based reasonable assurances are provided for the LA where the submittal discusses DENR's adaptive management approach to the TMDL process, the monitoring strategy that will be used to gage TMDL effectiveness in the future, and the core aspects of a TMDL implementation strategy. These assurances include the more detailed characterization of nonpoint sources that will guide restoration planning beyond what is summarized in the composite LA representing all nonpoint source categories, the recommendation of specific activities to focus implementation, the identification of watershed partners with shared interests in water quality, and the identification of several potential funding sources. The submittal also mentions one implementation project addressing bacteria already underway.

Assessment: EPA considered the reasonable assurances contained in the TMDL submittal and concludes that they are adequate to meet the load reductions.

9. Monitoring Plan

The TMDL submittal should include a monitoring plan for all:

- *Phased TMDLs; and*
- *TMDLs with both WLA(s) and LA(s) where reasonable assurances are provided.*

Under certain circumstances, a phased TMDL should be developed when there is significant uncertainty associated with the selection of appropriate numeric targets, estimates of source loadings, assimilative capacity, allocations or when limited existing data are relied upon to develop a TMDL. EPA guidance (USEPA. 2006b) recommends that a phased TMDL submittal, or a separate document (e.g., implementation plan), include a monitoring plan, an explanation of how the supplemental data will be used to address any uncertainties that may exist when the phased TMDL is prepared and a scheduled timeframe for revision of the TMDL.

For TMDLs that need to provide reasonable assurances, the monitoring plan should describe the additional data to be collected to determine if the load reductions included in the TMDL are occurring and leading to attainment of water quality standards.

EPA guidance (USEPA. 1991, USEPA. 2008a) recommends post-implementation monitoring for all TMDLs to determine the success of the implementation efforts. Monitoring plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

Section 9.0 (Adaptive Management and Monitoring Strategy) acknowledges that additional monitoring will be necessary to judge progress towards achieving the goals outlined in the TMDL and states that DENR's network of ambient water quality monitoring stations will be relied upon for this type of data in the future. DENR also maintains the ability to modify the TMDL and allocations as new data becomes available using an adaptive management approach in accordance with the TMDL revision process recommended by EPA (USEPA. 2012).

Assessment: Monitoring plans are not a required element of EPA's TMDL review and decision-making process. The TMDL submitted by DENR include a monitoring strategy written to encourage future monitoring to measure progress toward attainment of water quality standards. EPA is taking no action on the monitoring strategy included in the TMDL submittal.

10. Implementation

EPA policy (USEPA. 1997) encourages Regions to work in partnership with States/Tribes to achieve nonpoint source load allocations established for 303(d)-listed waters impaired by nonpoint sources. Regions may assist States/Tribes in developing implementation plans that include reasonable assurances that nonpoint source LAs established in TMDLs for waters impaired solely or primarily by nonpoint sources will in fact be achieved. The policy recognizes that other relevant watershed management processes may be used in the TMDL process. EPA is not required to and does not approve TMDL implementation plans.

EPA encourages States/Tribes to include restoration recommendations (e.g., framework) in all TMDLs for stakeholder and public use to guide future implementation planning. This could include identification of a range of potential management measures and practices that might be feasible for addressing the main loading sources in the watershed (see USEPA. 2008b, Chapter 10). Implementation plans are not a required part of the TMDL and are not approved by EPA but may be necessary to support the decision rationale for approval of the TMDL.

In Section 12.0 (Implementation Strategy) DENR encourages, based on the makeup and contribution of pollutant sources within the watershed, that future implementation activities focus on:

- Limiting livestock access to streams and providing alternative water sources.
- Controlling point sources by ensuring existing permit requirements are followed.
- Protecting unstable stream banks by enhancing riparian vegetation to provide erosion control and filter runoff of pollutants into the stream.
- Installing filter strips along the stream bordering cropland and pastureland.
- Implementing proper waste management systems at animal confinement facilities.

DENR further guides restoration planning by identifying funding sources that partners could use to implement projects that improve water quality.

Assessment: Although not a required element of the TMDL approval, DENR discussed how information derived from the TMDL analysis process can be used to support implementation of the TMDL. EPA is taking no action on the implementation portion of the TMDL submittal.

11. Public Participation

EPA policy is that there must be full and meaningful public participation in the TMDL development process. Each State/Tribe must, therefore, provide for public participation consistent with its own continuing planning process and public participation requirements (40 C.F.R. §25.3 and §130.7(c)(1)(ii)).

The final TMDL submittal must describe the State/Tribe's public participation process, including a summary of significant comments and the State/Tribe's responses to those comments (40 C.F.R. §25.3 and §25.8). Inadequate public participation could be a basis for disapproving a TMDL; however, where EPA determines that a State/Tribe has not provided adequate public participation, EPA may defer its approval action until adequate public participation has been provided for, either by the State/Tribe or by EPA.

Section 10.0 (Public Participation) explains the public engagement process DENR followed during development of the TMDL. DENR held monthly meetings with the Vermillion Basin Water Development District, a local sponsor of the TMDL project, during the assessment phase in 2005 and 2006. During that same timeframe DENR gave presentations to local groups and created a project website.

Subsequently, as stated in Appendix C, the draft TMDL report was made available for public download and review on DENR's website from May 16 to June 17, 2019. The 30-day public review period was announced in several area newspapers on May 13 including the Sioux Falls Argus Leader, the Canistota Clipper, the Miner County Pioneer, and the Salem Special. No comments were received during the public notice period.

Assessment: EPA has reviewed DENR's public participation process and concludes that DENR involved the public during the development of the TMDL and provided adequate opportunities for the public to comment on the draft report.

12. Submittal Letter

The final TMDL submittal must 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 (40 C.F.R. §130.7(d)(1)). The final submittal letter should contain such identifying information as the waterbody name, location, assessment unit number and the pollutant(s) of concern.

A transmittal letter with the appropriate information was included with the final TMDL report submission from DENR, dated July 3, 2019, and signed by Paul Lorenzen, Environmental Scientist Manager 1, Water Protection Program. DENR sent an updated version of the TMDL document on July 26, 2019 that corrected several minor errors and requested EPA act on the newer version, which EPA agreed to do.

Assessment: EPA concludes that the state's submittal package clearly and unambiguously requested EPA to act on the TMDL in accordance with the Clean Water Act and the submittal contained all necessary supporting information.

References

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USEPA. 2006a. *Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit.* Office of Water, Office of Wetlands, Oceans, and Watersheds, U.S. Environmental Protection Agency, Washington, DC.

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USEPA. 2017. *Water Quality Standards Handbook: Chapter 3: Water Quality Criteria.* EPA-823-B-17-001. EPA Office of Water, Office of Science and Technology, Washington, DC.