# *ESCHERICHIA COLI* TOTAL MAXIMUM DAILY LOAD EVALUATION FOR WOLF CREEK, HUTCHINSON COUNTY, SOUTH DAKOTA

South Dakota Department of
Environment and Natural Resources

Protecting South Dakota's Tomorrow ... Today

## SOUTH DAKOTA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

## April 2020

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## *Wolf Creek Segment 1 Total Maximum Daily Load Summary Table*

| | |
|---|---|
| ***Entity ID:*** | SD-JA-R-WOLF_01 |
| ***Location:*** | HUC Code: 1016001115 |
| ***Size of Watershed:*** | 255,600 acres total |
| ***Waterbody Type:*** | Stream |
| ***303(d) Listing Parameter:*** | *Escherichia coli* |
| ***Initial Listing date:*** | 2012 IR |
| ***TMDL Priority Ranking:*** | 1 |
| ***Listed Stream Miles:*** | 41 miles from just above the Wolf Creek colony to S5, T103N, R56W |
| ***Designated Use of Concern:*** | Limited contact recreation |
| ***Analytical Approach:*** | Aquarius, Load Duration Curve Framework |
| ***Target:*** | Meet all applicable water quality standards |
| ***Indicators:*** | *Escherichia coli* Concentration |
| ***Threshold Value***: | maximum single sample concentrations of <1,178 cfu/100 ml |

*E. coli* (cfu/day)

| | **Extreme Flow Zone** | **High Flow Zone** |
|---|---|---|
| ***Load Allocation:*** | $4.11 \times 10^{13}$ | $2.71 \times 10^{12}$ |
| ***Waste Load Allocation:*** | | |
| ***Bridgewater*** | $5.35 \times 10^{10}$ | $5.35 \times 10^{10}$ |
| ***Emery*** | $7.49 \times 10^{10}$ | $7.49 \times 10^{10}$ |
| ***Margin Of Safety:*** | $4.81 \times 10^{12}$ | $4.28 \times 10^{11}$ |
| ***TMDL:*** | $4.60 \times 10^{13}$ | $3.27 \times 10^{12}$ |

## *Wolf Creek Segment 2 Total Maximum Daily Load Summary Table*

| | |
|---|---|
| ***Entity ID:*** | SD-JA-R-WOLF_02 |
| ***Location:*** | HUC Code: 1016001115 |
| ***Size of Watershed:*** | 255,600 acres total |
| ***Waterbody Type:*** | Stream |
| ***303(d) Listing Parameter:*** | *Escherichia coli* |
| ***Initial Listing date:*** | 2012 IR |
| ***TMDL Priority Ranking:*** | 1 |
| ***Listed Stream Miles:*** | 3.35 miles from the mouth to just above the Wolf Creek Colony |
| ***Designated Use of Concern:*** | Limited contact recreation |
| ***Analytical Approach:*** | Aquarius, Load Duration Curve Framework |
| ***Target:*** | Meet all applicable water quality standards |
| ***Indicators:*** | *Escherichia coli* Concentration |
| ***Threshold Value***: | maximum single sample concentrations of <1,178 colonies/100 ml |

*E. coli* (cfu/day)

| | **Extreme Flow Zone** | **High Flow Zone** |
|---|---|---|
| ***Load Allocation:*** | $4.12 \times 10^{13}$ | $2.84 \times 10^{12}$ |
| ***Waste Load Allocation:*** | 0 | 0 |
| ***Margin Of Safety:*** | $4.81 \times 10^{12}$ | $4.28 \times 10^{11}$ |
| ***TMDL:*** | $4.60 \times 10^{13}$ | $3.27 \times 10^{12}$ |

# 1.0 Objective

The intent of this document is to clearly identify the components of the TMDL submittal to support adequate public participation and facilitate United States Environmental Protection Agency (EPA) review and approval. The TMDL was developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by EPA. This TMDL document addresses the total *Escherichia coli* (*E. coli*) impairments of Wolf Creek from just above the Wolf Creek Colony to S5, T103N, R56W (SD-JA-R-WOLF_01) and from the mouth of Wolf Creek to just above the Wolf Creek Colony (SD-JA-R-WOLF_02) (SDDENR, 2018).

# 2.0 Watershed Characteristics

Wolf Creek drains about 255,600 acres in southeast South Dakota (Figure 1) and discharges to the James River southwest of the community of Bridgewater (Figure 2). The stream receives runoff from agricultural operations. During the assessment and monthly monitoring as part of the ambient water quality program, data was collected indicating the creek experiences periods of degraded water quality as a result of *E. coli* loads. The land use in the watershed is predominately agricultural consisting of 59% row crops, 23% grass, 6% developed (including farmsteads, roads, and small communities), 4% herbaceous, 4% close seeded/small grain, and 3% water and wetlands.

There are four small communities within the watershed that have permitted wastewater treatment facilities: Canova, Spencer, Emery and Bridgewater. There are also two water distribution systems that have permits: Howard Water Distribution and Hanson Rural Water.

The Wolf Creek watershed lies within Hutchinson (23%), Hanson (10%), McCook (52%), and Miner (15%) counties. In Hutchinson County, common soil associations on the uplands in this section of the drainage include the Clarno-Tetonka-Prosper and the Hand-Clarno-Davison associations. Soil associations found in the floodplain of the stream include the Ethan-Betts-Chaska association. Most areas of this association are maintained as pasture land. Some bottomland is used for agricultural production (USDA, 1978). McCook County upland soil associations include Clarno-Bonilla-Tetonka, Crossplain-Clarno-Tetonka, and Clarno-Ethan associations. Associations found in the floodplain of the section located in McCook County include the Ethan-Betts and Delmont-Hand-Chaska soil associations (USDA, 1980).

Wolf Creek's climate is considered humid continental and approaches semi-arid in some years. Temperatures range from over 100° F to -30° F. Most of the precipitation falls during the warm period, and rainfall is normally heaviest late in spring and early in summer. Average annual precipitation is 23 inches, of this, 18 inches usually falls in April through September. Snowfall accumulations typically total 36.6 inches annually (USDA, 1978).

Wolf Creek was assessed as an individual portion of the larger Lower James River Watershed Assessment, which looked at individual streams such as Wolf Creek as well as the entire drainage basin and the cumulative effects of the individual waterbodies. There are also two ambient water quality monitoring stations located on Wolf Creek. Segments SD-JA-R-WOLF_01 and SD-JA-R-WOLF_02 were listed for *E. coli* in the 2012, 2014, 2016, and 2018 Integrated Report (SDDENR, 2012; SDDENR, 2014; SDDENR, 2016; SDDENR, 2018). This TMDL will address the *E. coli* listings.

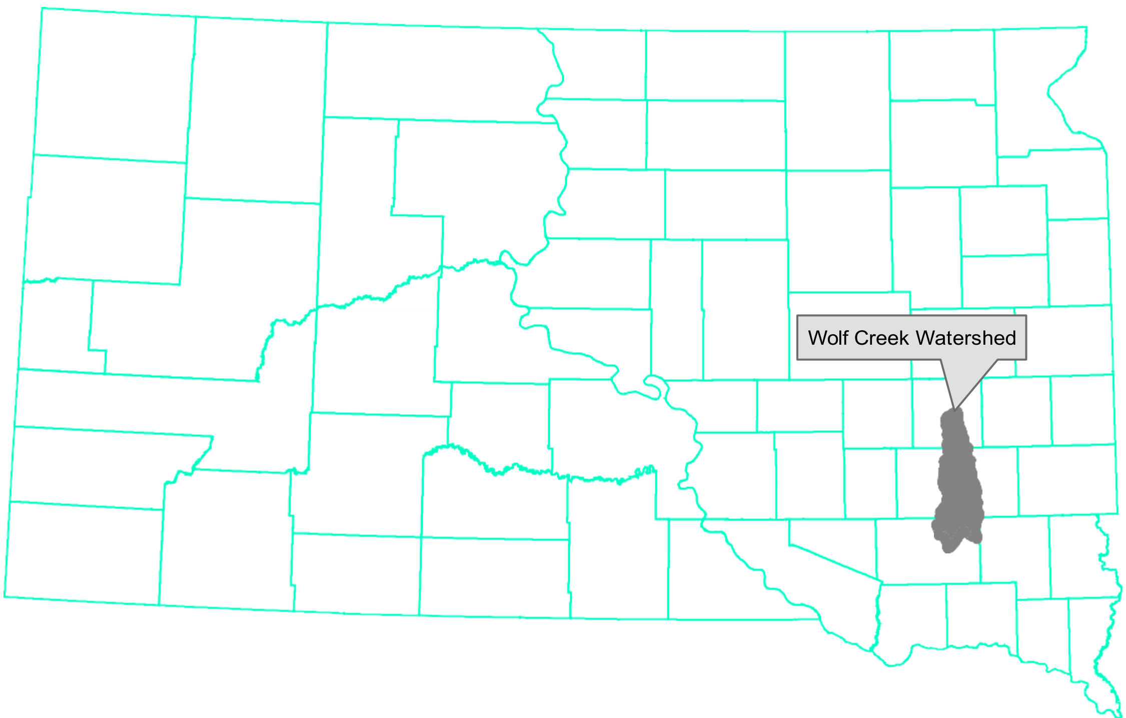


**Figure 1. Wolf Creek Watershed Location in South Dakota.**

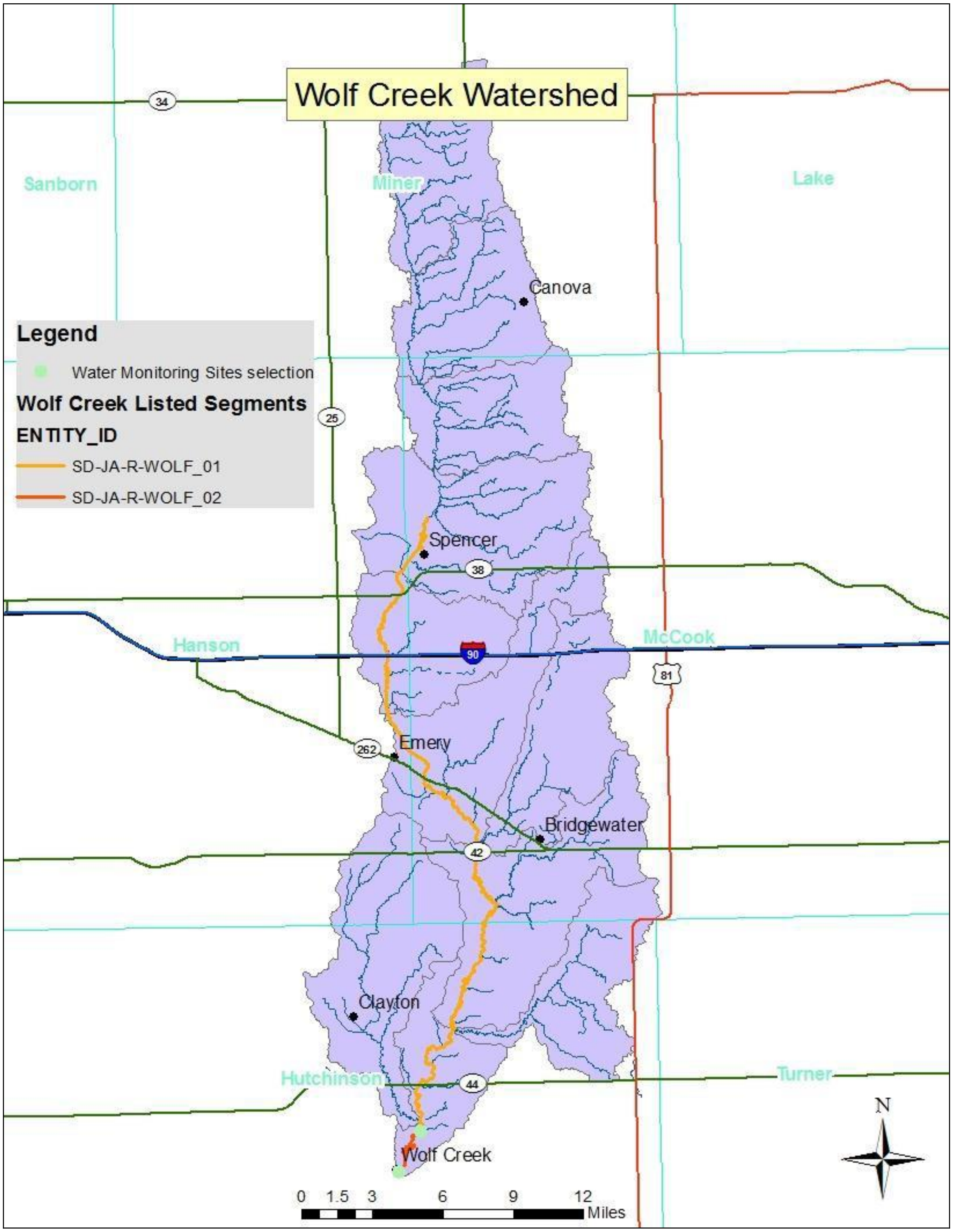


**Figure 2. Wolf Creek Watershed.**

# 3.0 Water Quality Standards

## *3.1 South Dakota Water Quality Standards*

Each waterbody within South Dakota is assigned beneficial uses. All waters (both lakes and streams) are designated the use of fish and wildlife propagation, recreation and stock watering. All streams are assigned the use of irrigation. Additional uses may be assigned by the state based on a beneficial use attainability assessment of each waterbody. Water quality standards have been defined in South Dakota state statutes in support of these uses. These standards consist of suites of numeric criteria that provide physical and chemical benchmarks from which management decisions can be developed.

Both segments of Wolf Creek have been assigned the beneficial uses of: warmwater marginal fish life propagation; irrigation waters, limited contact recreation; and fish and wildlife propagation, recreation, and stock watering. Table 1 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.

Additional "narrative" standards that may apply can be found in the "Administrative rules of South Dakota: Articles 74:51:01:05; 06; 08; and 09". These contain language that generally prohibits the presence of materials causing pollutants to form, visible pollutants, nuisance aquatic life, and maintain biological integrity.

**Table 1. State Water Quality Standards for Wolf Creek.**

| Parameters | Criteria | Unit of Measure | Beneficial Use Requiring this Standard |
|---|---|---|---|
| Total ammonia nitrogen as N | Equal to or less than the result from Equation 3 in Appendix A of Surface Water Quality Standards | mg/L<br>30 average<br>May 1 to October 31 | Warmwater Marginal Fish Propagation |
| | Equal to or less than the result from Equation 4 in Appendix A of Surface Water Quality Standards | mg/L<br>30 average<br>November 1 to April 31 | |
| | Equal to or less than the result from Equation c in Appendix A of Surface Water Quality Standards | mg/L<br>Daily Maximum | |
| Dissolved Oxygen | ≥4.0 (October-April)<br>≥5.0 (May-September) | mg/L | Warmwater Marginal Fish Propagation<br>Limited Contact Recreation |
| Total Suspended Solids | ≤150(mean)<br>≤263 (single sample) | mg/L | Warmwater Marginal Fish Propagation |
| Temperature | ≤32 | °C | Warmwater Marginal Fish Propagation |
| *Escherichia coli* Bacteria<br>(May 1- Sept 30) | ≤630 (geometric mean)<br>≤1178 (single sample) | cfu/100 mL | Limited Contact Recreation |
| Alkalinity ($CaCO_3$) | ≤750 (mean)<br>≤1,313 (single sample) | mg/L | Fish and Wildlife Propagation, Recreation and Stock Watering |
| Conductivity | ≤2,500 (mean)<br>≤4,375 (single sample) | µmhos/cm @ 25° C | Irrigation Waters |
| Nitrogen, nitrate as N | ≤50 (mean)<br>≤88 (single sample) | mg/L | Fish and Wildlife Propagation, Recreation and Stock Watering |
| pH (standard units) | ≥6.0 to ≤9.0 | units | Warmwater Marginal Fish Propagation |
| Solids, total dissolved | ≤2,500 (mean)<br>≤4,375 (single sample) | mg/L | Fish and Wildlife Propagation, Recreation and Stock Watering |
| Total Petroleum Hydrocarbon<br>Oil and Grease | ≤10<br>≤10 | mg/L | Fish and Wildlife Propagation, Recreation and Stock Watering |
| Sodium Adsorption Ratio | <10 | ratio | Irrigation Waters |

## 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. *E.coli* bacteria standards in South Dakota are expressed as a count/100mL. Laboratory results for *E. coli* were expressed as Most Probable Number (MPN) and Colony Forming Units (CFU), respectively. Both units are considered equivalent and representative of the number or count of bacteria/100mL.

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 SD DENR water quality standards review and approval process.

The South Dakota *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 TMDL target established for Wolf Creek is 1,178 cfu/100 ml, which is based on the single sample maximum standard for the limited contact recreation beneficial use.

## 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 criterion are the same.

As seen from Table 1, 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 75$^{th}$, 82$^{nd}$, 90$^{th}$, and 95$^{th}$ 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 75$^{th}$ percentile, into state water quality standard regulations as the SSM protective of designated beaches.

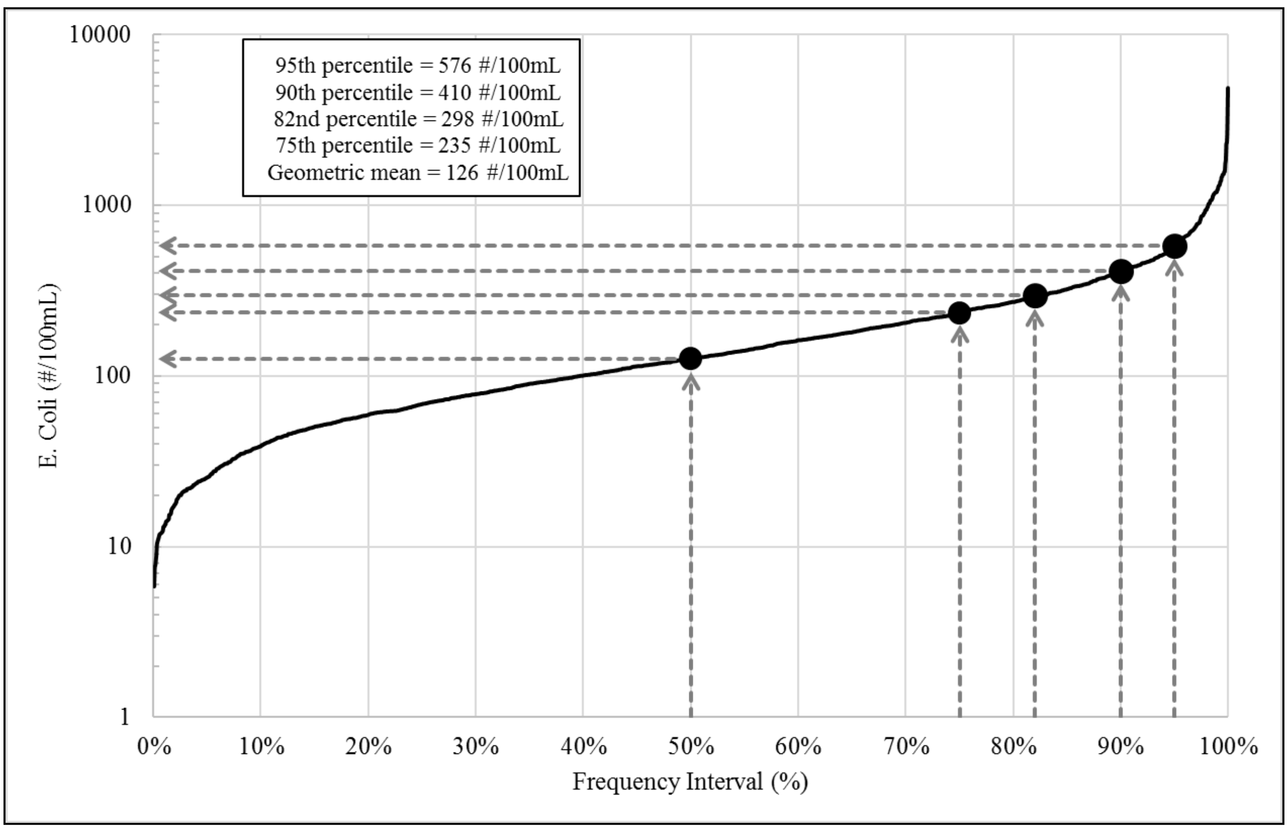


**Figure 3. Log-Normal Frequency Distribution Used to Establish South Dakota's Immersion Recreation E. coli Criteria of 126 (GM) and 235 (SSM) #/100mL (EPA, 1986).**

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 (USEPA, 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 Wolf Creek, 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. 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 (SDDENR, 2018).

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.

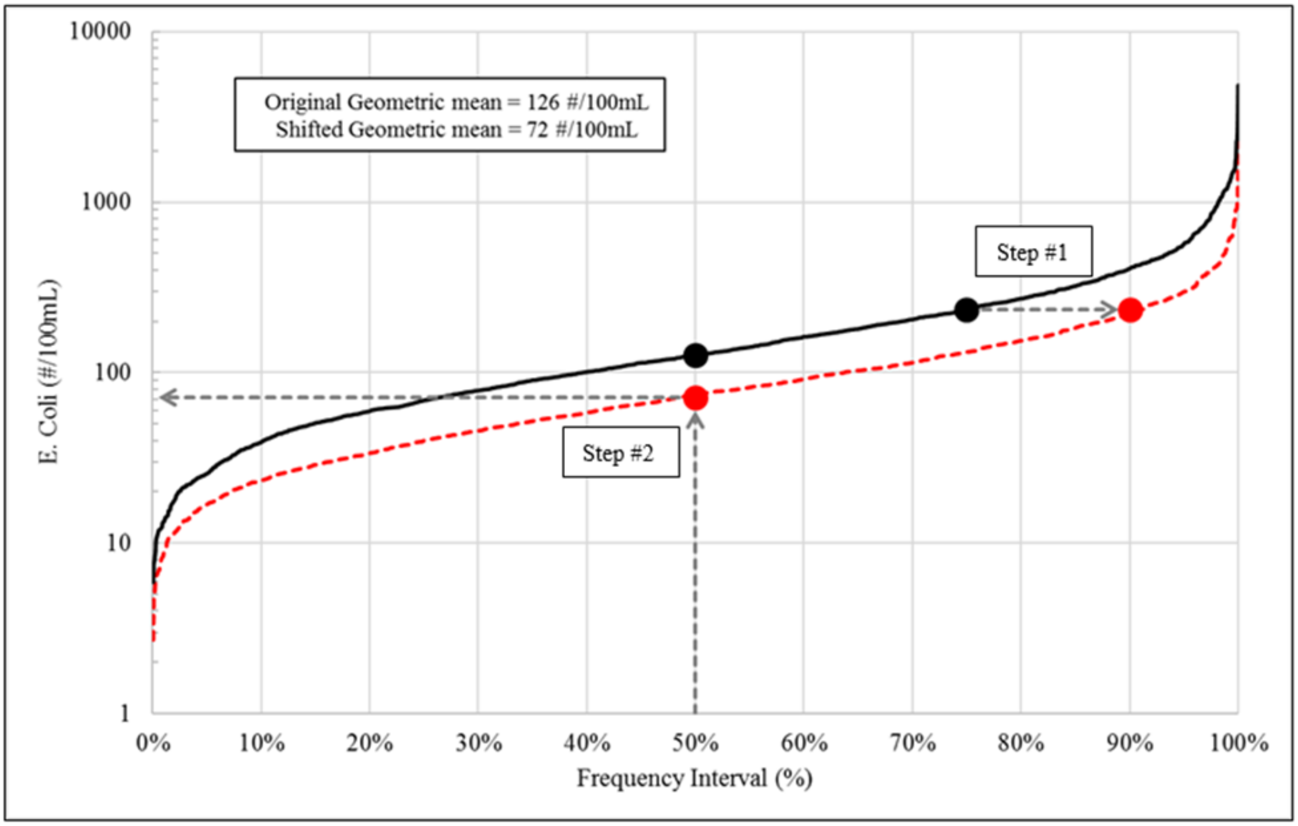


**Figure 4. The Effective Impact of South Dakota's E. coli Assessment Method on the Criteria's Original Log-Normal Frequency Distribution (Black line = original; red dotted line = shifted)**

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 the standards were simply derived as five times the immersion recreation 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 Wolf Creek because a proper geometric mean could not be calculated from the available monitoring dataset.

# 4.0 Data Collection

## *4.1 Water Quality Data and Discharge Information*

Sample data on Wolf Creek was collected from SD DENR ambient water quality monitoring sites, WQM 157 and WQM 158. Supplemental data was used from the Lower James River Watershed Assessment from multiple sampling points located throughout the watershed. On two occasions (May 31, 2007 and June 18, 2007) samplers took event based samples at multiple locations throughout the watershed. Those samples in the upper portions of the watershed were not used in the analysis of the TMDL loadings but will be discussed in the Nonpoint Source section (Section 5.2). Samples taken at LOWJIMJRT15 and LOWJIMJRT15A taken on those same two days were used in the analysis because they were sampled in the same locations as other samples used in analysis. Figure 5 shows the locations of the sampling sites used in the analysis of the TMDL as well as the locations of the two listed segments.

Water quantity data for the two segments is incomplete. The USGS operated a daily station from 1975 through 1988 (06478390) located on Wolf Creek near Clayton, South Dakota. This station was downgraded to an annual peak flow site (only records the maximum flow each calendar year) and is still managed this way presently. This site is co-located at SD DENR WQM station 157 and was used to calculate the flow frequencies to develop the load duration curve. SD DENR installed a stage gauge at this site in the spring of 2012 which coupled with discharge measurements collected by the USGS at the peak flow gauge were used to calculate daily flows after 2012.

Water chemistry data collected after the USGS gauge transitioned to an annual station but prior to the installation of the SD DENR gauge required modeling to fill the flow data gap. The James River has 3 USGS gauges relatively close to Wolf Creek that were in operation through the period of interest. Station 06477000 located at Forestburg, SD was used as the upstream station. A closer site located in Mitchell (06478000) was not used due to problems with the accuracy of the site at low flows (personal communication with USGS staff). Station 06478500 located at Scotland, SD was used as the downstream control. The Aquarius Empirical Modeling Toolbox was used to complete the estimation. The modeling tool used a linear regression with a phase shift (travel time for water in the system) to train a model that could be applied to gaps in the data record. In the case of Wolf Creek, the period from 1975 through 1988 was used to train the model that was used to calculate flows during the gap from 1988 through spring of 2012. Following the installation of a water level sensor in the spring of 2012, the model was applied to the water levels recorded from spring of 2012 through the spring of 2018. So the entire period of flow record is from 1975 through 2018. No comparable dataset is available for SD DENR WQM station 158. WQM 158 is located immediately downstream of WQM 157 and drains a 2% larger watershed with no significant tributary contributions. As a result, SD DENR chose to use the flow data set from WQM 157 for WQM 158.

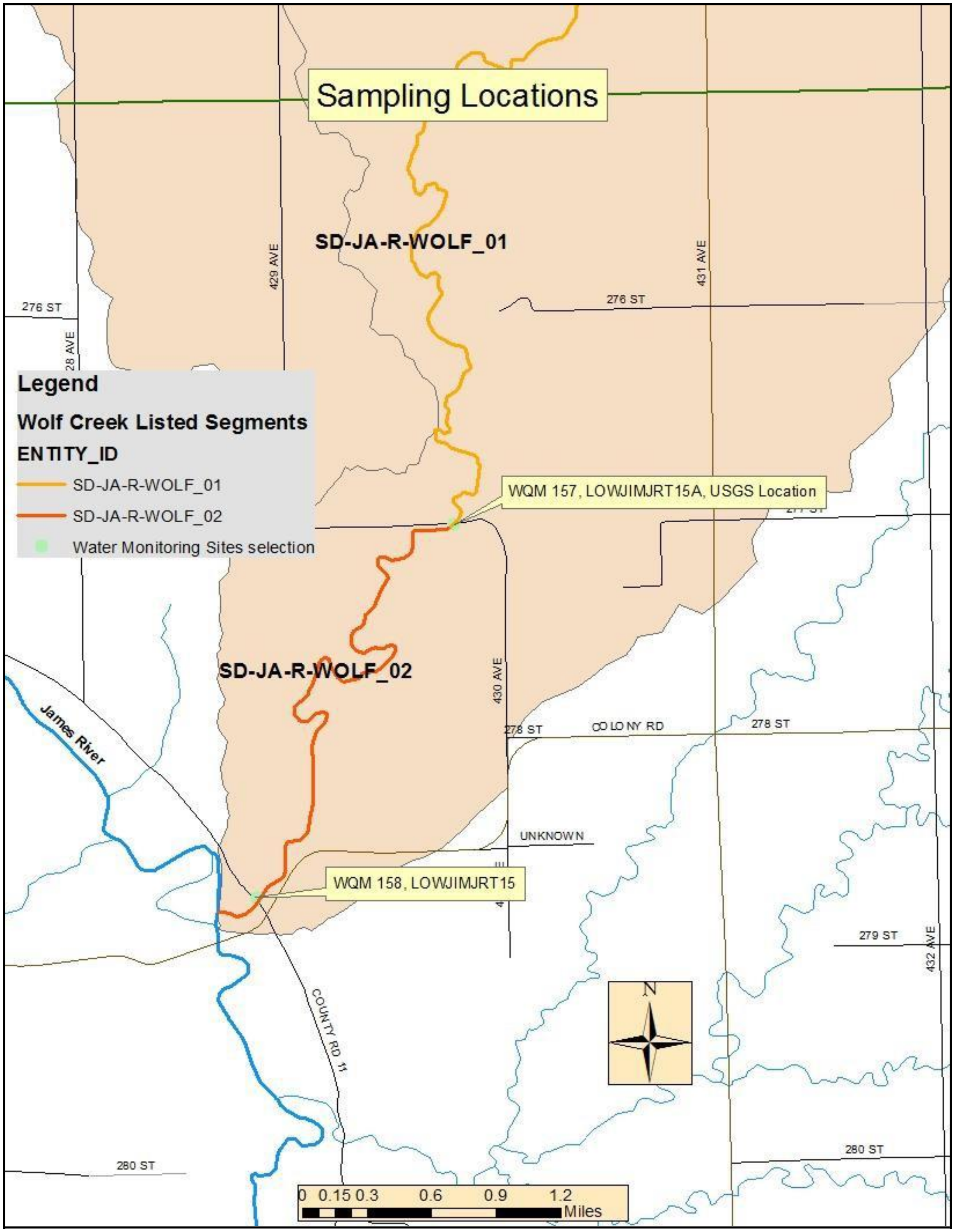


**Figure 5. Sampling locations and listed segments of Wolf Creek.**

# 5.0 Source Assessment and Allocation

## *5.1 Point Sources*

There are several documented point sources within the Wolf Creek watershed (Table 2). These include four wastewater treatment facilities and two water distribution facilities that may directly contribute to the impaired segments of Wolf Creek. These point sources were investigated further for their potential impact and waste load allocation consideration. Additionally, there are six concentrated animal feeding operations (CAFOs) present within the watershed as well. These potential sources of *E. coli* bacteria are documented here to provide a watershed scale account of the entities operational characteristics (discharge permits, etc.) and potential impact to the impaired segments of Wolf Creek.

### 5.1.1 Wastewater Treatment Facilities

The city of Spencer wastewater treatment facility (Permit # SDG820397) is operated as a no-discharge facility but discharged once in 2010. The facility consists of a two-cell stabilization pond system followed by an artificial wetland. The wetland is equipped with a Parshall flume to measure flow of discharge out of the system. If discharge is necessary, water is pumped into an unnamed tributary of Wolf Creek. The Spencer facility, which serves a population of 165, is designed as an entire retention system and is only allowed to discharge in emergencies.

The city of Canova's facility (Permit # SDG821521) is operated as a no-discharge facility but has discharged five times since 2000. The facility drains into one main lift station. Wastewater is then pumped into a 2.9 acre, single-cell, circular stabilization pond. The facility does not have a discharge structure. If discharge is necessary, water is pumped over the pond dikes using a pump into an unnamed tributary of Wolf Creek. The Canova facility, which serves a population of 105, is designed as an entire retention system and is only allowed to discharge in emergencies.

If an emergency discharge was to occur out of either the Spencer or Canova facilities, the permit requires sampling of the water being released.

The city of Emery's facility (Permit # SD0021741) reported discharging nine times since 2001. This is a facility consisting of three-cell stabilization ponds in series. In 2009, the city constructed Cells #2 and #3 and reconstructed Cell #1. Cell #3 is equipped with a valve controlled discharge structure. Any discharge from this facility will enter Wolf Creek. The facility serves the city of Emery with a population of 447 people.

The city of Bridgewater's facility (Permit # SD0021512) discharged sixteen times since 2000. This system consists of a three-cell stabilization pond followed by two artificial wetlands. Discharge is valve-controlled and measured using a V-notch weir. Any discharge from this facility will enter an unnamed tributary and flow 2 miles to Wolf Creek. This facility serves a population of 607 people.

Results from pre-discharge monitoring of lagoon cell water and permission to discharge must be granted by SD DENR prior to discharging water for both the Emery and Bridgewater facilities.

The two water distribution systems: Howard Water Distribution (Permit # SDG860039) and Hanson Rural Water System (Permit # SDG860052), are both drinking water systems that are covered under minor water treatment and distribution general permits and are not sources of *E. coli*.

Table 2 includes information used by SD DENR to calculate a wasteload allocation (WLA) for each facility. The 80th percentile wastewater flow as calculated from discharge monitoring reports is multiplied times the single sample maximum water quality standard and then converted to cfu/day. It is important to note that discharges are required to meet all applicable state water quality standards.

**Table 2. Waste Load Allocation for Facilities in the Wolf Creek Drainage.**

| Permit # | Facility Name | 80th % Flow (gpd) used in WLA | *E. coli* permit limit (cfu/100 mL) | *E. coli* permit limit converted to cfu/g | *E. coli* WLA (cfu/day) |
|---|---|---|---|---|---|
| SD0021512 | Bridgewater | 1,200,000 | 1,178 | 44,621 | 5.35E+10 |
| SDG821521 | Canova | 0 | No discharge | 0 | 0 |
| SD0021741 | Emery | 1,680,000 | 1,178 | 44,621 | 7.49E+10 |
| SDG820397 | Spencer | 0 | No discharge | 0 | 0 |
| SDG860039 | Hanson Rural Water System | Water Distribution System- Not a source of *E. coli* | | | |
| SDG860052 | Howard Water Distribution | Water Distribution System- Not a source of *E coli* | | | |

### 5.1.2 Concentrated Animal Feeding Operations

There are six permitted CAFOs within the Wolf Creek watershed (Table 3). All CAFOs are required to maintain compliance with provisions of the SD Water Pollution Control Act (SDCL 34A-2). SDCL 34A-2-36.2 requires each concentrated animal feeding operation, as defined by Title 40 Codified Federal Regulations Part 122.23 dated January 1, 2007, to operate under a general or individual water pollution control permit issued pursuant to § 34A-2-36. The general permit ensures that all CAFOs in SD have permit coverage regardless if they meet conditions for coverage under a NPDES permit. All six operations are covered under the 2003 *General Water Pollution Control Permit for Concentrated Animal Feeding Operations*, which requires housed lots to have no discharge of solid or liquid manure to waters of the state, and allows open lots to only have a discharge of manure or process wastewater from properly designed, constructed, operated and maintained manure management systems in the event of 25-year, 24-hour or 100-year, 24-hour storm event if they meet the permit conditions.

The general permit was reissued and became effective on April 15, 2017. All CAFOs with coverage under the 2003 general permit have a deadline to apply for coverage under the 2017 general permit.

The 2017 general permit allows no discharge of manure or process wastewater from operations with state permit coverage or NPDES permit coverage for new source swine, poultry, and veal operations, and other housed lots with covered manure containment systems. Operations also have the option to apply for a state issued NPDES permit. Operations covered by the 2017 general permit or NPDES permit for open or housed lots with uncovered manure containment systems can only discharge manure or process wastewater from properly designed, constructed, operated and maintained manure management systems in the event of 25-year, 24-hour storm event if they meet the permit conditions.

Both the 2003 and 2017 general permits have nutrient management planning requirements based on EPA's regulations and the South Dakota Natural Resources Conservation Services 590 Nutrient Management Technical Standard to ensure the nutrients are applied at agronomic rates with management practices to minimize the runoff of nutrients. Additionally, the general permits include design standards, operation, maintenance, inspection, record keeping, and 13 reporting requirements. For more information about South Dakota's CAFO requirements and general permits visit: http://denr.sd.gov/des/fp/cafo.aspx

As long as these facilities comply with the general CAFO permit requirements ensuring their discharges are unlikely and indirect loading events, the TMDL assumes their *E. coli* contribution is minimal, and unless found otherwise, no additional permit conditions are required by this TMDL.

**Table 3. Description of CAFOs within the Wolf Creek Watershed. * Wolf Creek Colony only CAFO located in lower segment of Wolf Creek.**

| Name of Facility | Type of Operations | SD General Permit # |
|---|---|---|
| Farmers Pork, LLC | Production Swine (housed lot) | SDG-0100131 |
| Goldenview Colony | Farrow to Finish Swine (housed lot) | SDG-0100290 |
| Hillside Enterprises, LTD | Production Swine (housed lot) | SDG-0100462 |
| JT Swine Finisher | Finisher Swine (housed lot) | SDG-0100520 |
| Les Rensink AWMS | Farrow to Finish Swine (housed lot) | SDG-0100190 |
| Wolf Creek Colony * | Multiple Animal Operation (housed lot) | SDG-0109094 |

## 5.2 Nonpoint Sources

Nonpoint sources of *E. coli* bacteria in the Wolf Creek watershed come primarily from agricultural sources. Data from the 2010 National Agricultural Statistic Survey (NASS) and the 2002 South Dakota Game Fish and Parks county wildlife assessment (Huxoll, 2002) were utilized for livestock and wildlife densities, respectively. Animal density information was used to estimate relative source contributions of bacteria loads (Table 4). Fecal coliform bacteria numbers are used in Table 4. Fecal coliform bacteria can provide a useful surrogate for *E. coli* in TMDL development. *E. coli* is a fecal coliform bacterium and both indicators originate from common sources in relatively consistent proportions. The percentages of the load should be similar between fecal coliform bacteria numbers and *E. coli* numbers and the purpose of the table is to demonstrate what the most likely sources of bacteria are.

**Table 4. Animal Sources in Wolf Creek watershed.**

| Animal | Totals | Acres of Population Estimate | Animals/acre | Acres in Wolf Creek Watershed | Estimated animals in Wolf Creek Watershed | Individual Animal Daily FC Production Rates | Estimated Daily FC Loading in Wolf Creek Watershed | Percentage of Total Fecal Bacteria Load |
|---|---|---|---|---|---|---|---|---|
| Dairy cow | 7500 | 1531309 | 0.0049 | 255600 | 1252 | 1.00E+11 (1) | 1.25E+14 | 3.55% |
| Beef | 176032 | 1531309 | 0.1150 | 255600 | 29383 | 1.00E+11 (1) | 2.94E+15 | 83.22% |
| Hog | 233613 | 1531309 | 0.1526 | 255600 | 38994 | 1.10E+10 (1) | 4.29E+14 | 12.15% |
| Sheep | 12480 | 1531309 | 0.0081 | 255600 | 2083 | 1.20E+10 (1) | 2.50E+13 | 0.71% |
| Horse | 1785 | 1531309 | 0.0012 | 255600 | 298 | 4.20E+08 (1) | 1.25E+11 | 0.00% |
| All Wildlife | | | | | | | | 0.20% |
| Turkey (Wild) | 191 | 1531309 | 0.0001 | 255600 | 32 | 9.50E+07 (1) | 3.03E+09 | 0.00% |
| Sharptail Grouse, prairie chicken and Partridge | 10914 | 1531309 | 0.0071 | 255600 | 1822 | 1.40E+08 (2) | 2.55E+11 | 0.01% |
| Deer | 6666 | 1531309 | 0.0044 | 255600 | 1113 | 5.00E+08 (3) | 5.56E+11 | 0.02% |
| Beaver | 2680 | 1531309 | 0.0018 | 255600 | 447 | 2.50E+08 (3) | 1.12E+11 | 0.00% |
| Raccoon | 11248 | 1531309 | 0.0073 | 255600 | 1877 | 1.25E+08 (3) | 2.35E+11 | 0.01% |
| Coyote/Fox | 5116 | 1531309 | 0.0033 | 255600 | 854 | 4.09E+09 (3) | 3.49E+12 | 0.10% |
| Muskrat | 15946 | 1531309 | 0.0104 | 255600 | 2662 | 1.25E+08 (4) | 3.33E+11 | 0.01% |
| *Opossom* | 4910 | 1531309 | 0.0032 | 255600 | 820 | 1.25E+08 (4) | 1.02E+11 | 0.00% |
| *Mink* | 4172 | 1531309 | 0.0027 | 255600 | 696 | 1.25E+08 (4) | 8.70E+10 | 0.00% |
| *Skunk* | 9312 | 1531309 | 0.0061 | 255600 | 1554 | 1.25E+08 (4) | 1.94E+11 | 0.01% |
| *Badger* | 2311 | 1531309 | 0.0015 | 255600 | 386 | 1.25E+08 (4) | 4.82E+10 | 0.00% |
| *Jackrabbit* | 12746 | 1531309 | 0.0083 | 255600 | 2128 | 1.25E+08 (4) | 2.66E+11 | 0.01% |
| *Cottontail* | 32641 | 1531309 | 0.0213 | 255600 | 5448 | 1.25E+08 (4) | 6.81E+11 | 0.02% |
| *Squirrel* | 27255 | 1531309 | 0.0178 | 255600 | 4549 | 1.25E+08 (4) | 5.69E+11 | 0.02% |

(1) USEPA 2001

(2) FC/Animal/Day copied from Chicken (USEPA 2001) to provide an estimate of background effects of wildlife

(3) Bacteria Indicator Tool Worksheet

(4) FC/Animal/Day copied from Raccoon from the Bacteria Indicator Tool Worksheet to provide an estimate of background effects of wildlife

### 5.2.1 Agricultural

Manure from livestock is a potential source of *E. coli* bacteria to the stream. Livestock in the basin are predominantly beef cattle and hogs. Livestock can contribute bacteria directly to the stream by defecating while wading in the stream. They can also contribute by defecating while grazing on rangelands that get washed off during precipitation events. Table 5 allocates sources of bacteria production in the watershed into four primary categories. 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 grazing land.

**Table 5. Bacteria source allocation for the Wolf Creek watershed.**

| Source | Percentage of Bacteria Load |
|---|---|
| Feedlots not covered under permits | 28.4% |
| Grazing livestock | 71.3% |
| Wildlife | 0.2% |
| Human | 0.1% |

Small feeding operations are present in the watershed and are not covered under the general CAFO permit. Manure generated from smaller operations is considered nonpoint source and are included in the source percentage under feedlots. The main source of *E. coli* bacteria in the Wolf Creek 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 Wolf Creek watershed (Table 4).

On two occasions (May 31, 2007 and June 18, 2007) during the Lower James River Watershed Assessment, event based sampling occurred throughout the watershed. Figure 6 shows the locations that were sampled for *E. coli* during those events.

Results of those sample efforts are shown in Table 6. These results demonstrate some areas that may need to be focused on for implementation efforts. The topography of Wolf Creek valley is used as a pasturing area for livestock as the slopes are too steep for agricultural crop production. This allows for direct access and watering for livestock in the creek, which may lead to higher concentrations of *E. coli*, as well as higher levels of TSS, in areas utilized by livestock.

**Table 6. *E. coli* (cfu/100 mL) results for event-based sampling in Wolf Creek.**

| Site | Date: 5/31/07 | Date: 6/18/07 |
|---|---|---|
| LOWJIMJRT15 | 272 | NA |
| LOWJIMJRT15A | 261 | 124 |
| LOWJIMJRT15B | 60.9 | 78 |
| LOWJIMJRT15C | 921 | 117 |
| LOWJIMJRT15D | NA | 83.8 |
| LOWJIMJRT15E | 517 | 135 |
| LOWJIMJRT15G | 1120 | 447 |
| LOWJIMJRT15H | NA | 323 |
| LOWJIMJRT15J | 613 | 821 |

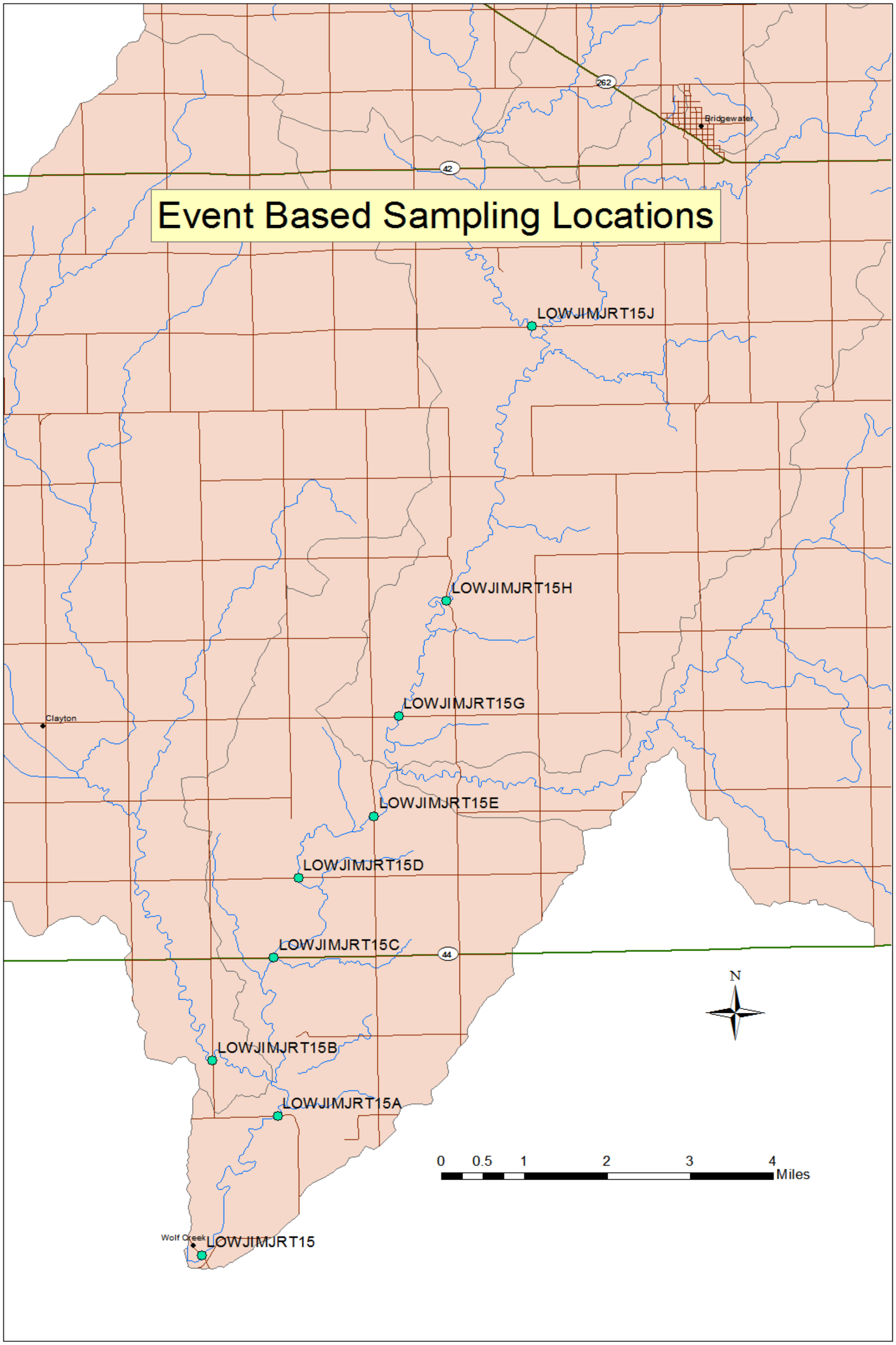


**Figure 6. Event Based Sampling Locations.**

### 5.2.2 Human

Canova, Spencer, Emery and Bridgewater are communities located in the Wolf Creek watershed. Their wastewater treatment systems account for about 1,325 of the approximate 3,200 people in the watershed. Septic systems are the primary depository for human waste in rural populations in the watershed. Human fecal coliform bacteria production may be estimated at 1.95E+9 cfu/Animal Unit (Yagow et al., 2001). These potential sources of bacteria should all be delivered to a septic system, which if functioning correctly would result in minimal fecal coliform entering the creek. If these systems were all faulty, which is highly unlikely, the remaining population would produce fecal coliform bacteria loads accounting for less than 1% of all fecal coliform produced in the watershed. Table 7 shows the estimates of human production loads of fecal coliform bacteria.

**Table 7. Human Source estimates in Wolf Creek Watershed**

| Source | Estimated people in Wolf Creek Watershed using Septic Systems | Individual Human Daily Fecal Coliform Production Rates (cfu/person) | Estimated Daily Fecal Coliform Loading in Wolf Creek Watershed | Percentage of Total Fecal Bacteria Load |
|---|---|---|---|---|
| Human | 2,000 | 1.95E+09 | 3.90E+12 | 0.11% |
| Total Fecal Coliform Bacteria Loading | | | 3.53E+15 | |

### 5.2.3 Natural Background/Wildlife

Wildlife within the watershed is a natural background source of fecal coliform bacteria. Wildlife population density estimates were obtained from the South Dakota Department of Game, Fish, and Parks (Huxoll, 2002) (Table 4). The contribution of bacteria from wildlife in the Wolf Creek watershed was insignificant (0.2%) in comparison to livestock sources (Table 6).

# 6.0 TMDL Loading Analysis

The TMDL was developed using a Load Duration Curve (LDC) approach 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 flow. To aid in interpretation and implementation of the TMDL, the LDC flow intervals were grouped into four flow zones representing extreme flows (0–10 percent), high flows (10-45 percent), mid range flows (45–75 percent), and low flows (75–100 percent). Flow zones were defined according to the flow regime structure and distribution of the observed data following guidance recommend by EPA (USEPA, 2007).

Wolf Creek instantaneous bacteria loads (CFU/day) were calculated by multiplying individual *E. coli* concentrations by the associated average daily flow value multiplies by a unit conversion factor (24451200). Only samples from the recreational season (May 1-Sept 30) were used in load calculations for the TMDL. For Wolf Creek, Figures 7 and 8 show violations occurring within the two highest flow zones.

The LDC approach was deemed an appropriate method for identifying possible sources of bacteria based on the flow zone. 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, while those below the curve are in compliance. As the plots show, pathogen samples collected from Wolf Creek exceed the single sample maximum criterion within the two upper flow zones. Loads exceeding the criteria in the high flow zones imply storm runoff from animal feeding operations, upland grazing runoff, or storm sewer runoff. Loads shown in the low flow zone typically indicate a point source load or livestock defecating in the stream.

## 6.1 Upper Segment – SD-JA-R-Wolf_01

### 6.1.1 TMDL Load Duration Curve

The Load Duration Curve represents a dynamic expression of the TMDL for Wolf Creek, resulting in a maximum daily load for *E. coli* that corresponds to average daily flow. Table 8 presents a combination of allocations for each of four flow zones and estimated reductions needed. Methods used to calculate the TMDL components are discussed below. This TMDL is based on daily flow and the SSM threshold from the water quality standard as outlined in Section 3.3.

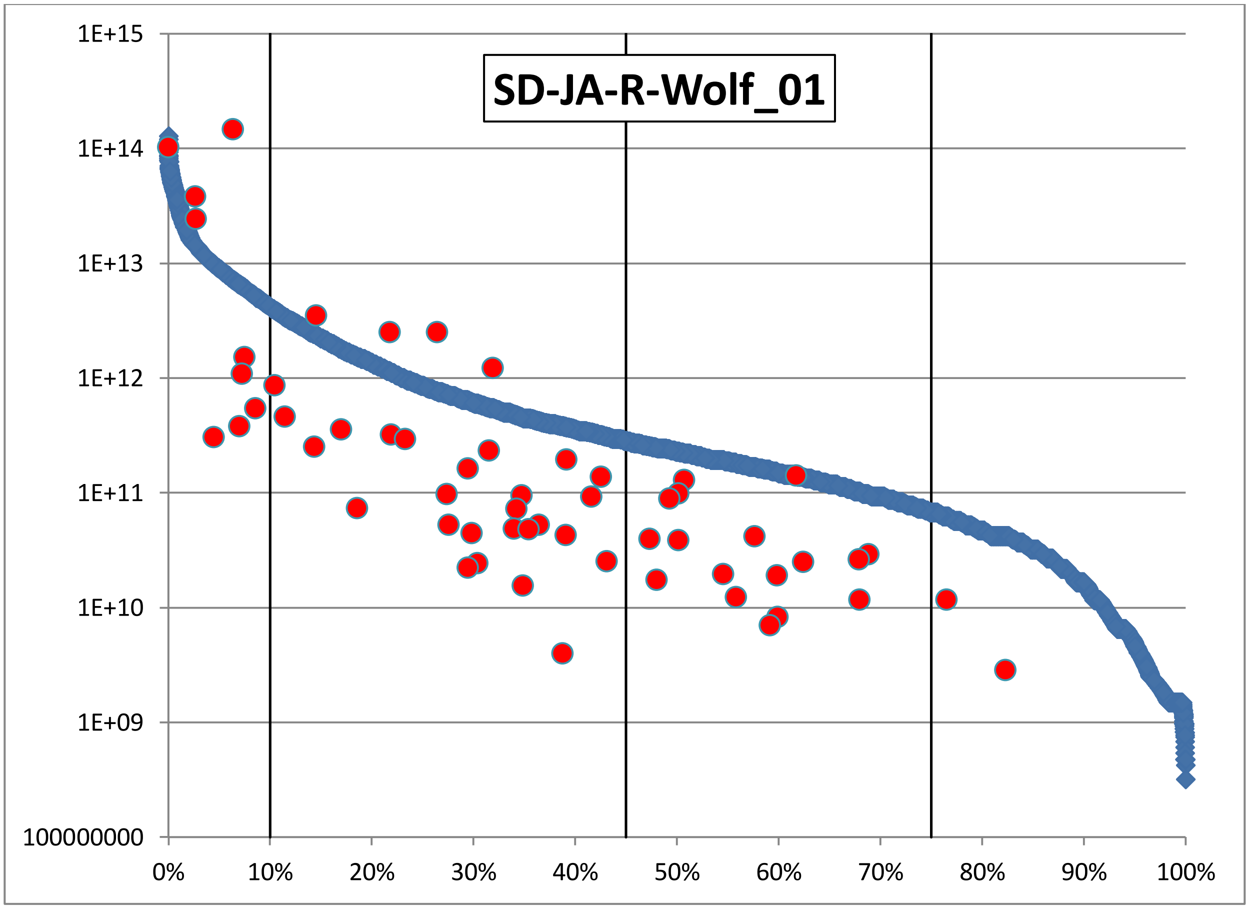


**Figure 7. Load Duration Curve of the Upper Segment of Wolf Creek (SD-JA-R-Wolf_01).**

**Table 8. Upper Segment of Wolf Creek TMDL Allocations.**

| | Upper Segment of Wolf Creek - SD-JA-R-Wolf_01 | | | |
|---|---|---|---|---|
| | High Flows | Moist Conditions | Mid Range Flows | Dry Conditions |
| | >144 cfs | 144-10 cfs | 10-2.3 cfs | 2.3-0.0 cfs |
| LA | 4.11E+13 | 2.71E+12 | 5.52E+10 | 2.49E+10 |
| | | | | |
| Bridgewater WLA | 5.35E+10 | 5.35E+10 | 5.35E+10 | 1.30E+10 |
| Emery WLA | 7.49E+10 | 7.49E+10 | 7.49E+10 | 1.81E+10 |
| | | | | |
| MOS | 4.81E+12 | 4.28E+11 | 8.10E+10 | 6.22E+09 |
| TMDL @ 1178 cfu | 4.60E+13 | 3.27E+12 | 2.65E+11 | 6.22E+10 |
| | | | | |
| Current Load** | 6.16E+14 | 7.21E+12 | 1.76E+11 | 1.12E+10 |
| Load Reduction | 93% | 55% | 0% | 0% |

#### *6.1.1.1 Extreme Flows*

The Extreme Flow zone is comprised of flows exceeding 144 cfs. Flows in this zone only occur 10% of the time. A total of nine samples (Table 9) were collected in this zone and four exceeded the *E. coli* single sample maximum standard (1,178 cfu/100ml). Using the 95$^{th}$ percentile flow (1,598 cfs) with the single sample maximum standard (1,178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. A single concentration was reported as greater than 24,200 cfu/100mL. During calculations of loadings a concentration of 24,201 cfu/100 mL was used in place of the >24,200 cfu/100mL. Using the 95$^{th}$ percentile concentration (15,765 cfu/100mL) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 93% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 8).

**Table 9. Data collected from the Extreme Flow Zone in the Upper Segment of Wolf Creek.**

| Sample Date | Station ID | Flow (cfs) | *E. coli* Concentration (cfu/100mL) |
|---|---|---|---|
| 06/15/2010 | WQM 157 | 3030 | 1370 |
| 08/10/2010 | WQM 157 | 495 | 3110 |
| 05/08/2012 | WQM 157 | 487 | 2014 |
| 07/13/2010 | WQM 157 | 337 | 36.6 |
| 09/16/2016 | WQM 157 | 247 | >24200 |
| 07/21/2009 | WQM 157 | 226 | 68.2 |
| 09/10/2013 | WQM 157 | 218 | 202 |
| 09/12/2016 | WQM 157 | 212 | 291 |
| 06/18/2007 | LOWERJIMJRT15A | 177 | 124 |

#### *6.1.1.2 High Range Flows*

The High Range Flow zone is comprised of flows between 144 cfs and 10 cfs. Out of the 30 samples (Table 10) collected in this zone, four exceeded the *E. coli* single sample maximum standard (1,178 cfu/100 ml). Using the $95^{th}$ percentile flow (113 cfs) with the single sample maximum standard (1,178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. Using the $95^{th}$ percentile concentration (2,600 cfu/100 ml) with the $95^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 55% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 8).

**Table 10. Data collected from the High Flow Zone in the Upper Segment of Wolf Creek.**

| Sample Date | Station ID | Flow (cfs) | *E. coli* concentration |
|---|---|---|---|
| 05/31/2007 | LOWJIMJRT15A | 135 | 261 |
| 09/08/2010 | WQM 157 | 117 | 159 |
| 08/11/2009 | WQM 157 | 84 | 121 |
| 06/23/2009 | WQM 157 | 82 | 1730 |
| 05/13/2015 | WQM 157 | 62 | 231 |
| 05/10/2018 | WQM 157 | 53 | 56.3 |
| 07/12/2011 | WQM 157 | 39 | 2600 |
| 07/12/2016 | WQM 157 | 39 | 336 |
| 06/02/2015 | WQM 157 | 34 | 350 |
| 06/03/2016 | WQM 157 | 26 | 3870 |
| 06/03/2014 | WQM 157 | 25 | 158 |
| 05/05/2009 | WQM 157 | 25 | 86.7 |
| 05/10/2017 | WQM 157 | 22 | 41 |
| 09/19/2017 | WQM 157 | 22 | 299 |
| 06/04/2012 | WQM 157 | 21 | 85 |
| 05/19/2010 | WQM 157 | 21 | 47.2 |
| 07/13/2015 | WQM 157 | 19 | 496 |
| 06/14/2011 | WQM 157 | 19 | 2600 |
| 08/30/2017 | WQM 157 | 17 | 119 |
| 09/15/2015 | WQM 157 | 16 | 179 |
| 06/06/2017 | WQM 157 | 16 | 244 |
| 05/14/2013 | WQM 157 | 16 | 40.8 |
| 05/10/2011 | WQM 157 | 16 | 125 |
| 08/04/2016 | WQM 157 | 15 | 146 |
| 08/02/2011 | WQM 157 | 13 | 12.2 |
| 05/17/2017 | WQM 157 | 13 | 134 |
| 08/10/2016 | WQM 157 | 13 | 613 |
| 08/17/2017 | WQM 157 | 12 | 323 |
| 06/22/2016 | WQM 157 | 11 | 504 |
| 06/15/2016 | WQM 157 | 11 | 97 |

#### *6.1.1.3 Mid-Range Flows*

The Mid-Range Flow zone is comprised of flows between 10 cfs and 2.3 cfs. Out of the 18 samples (Table 11) collected in this zone, one exceeded the *E. coli* single sample maximum standard (1,178 cfu/100 ml). Using the 95$^{th}$ percentile flow (9.2 cfs) with the single sample maximum standard (1,178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. Using the 95$^{th}$ percentile concentration (784 cfu/100 ml) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 0% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 8).

**Table 11. Data collected from the Mid Range Flow Zone in the Upper Segment of Wolf Creek.**

| Sample Date | Station ID | Flow (cfs) | *E. coli* concentration |
|---|---|---|---|
| 09/13/2017 | WQM 157 | 9 | 183 |
| 08/11/2015 | WQM 157 | 9 | 82.8 |
| 05/18/2016 | WQM 157 | 8 | 435 |
| 08/09/2017 | WQM 157 | 8 | 504 |
| 05/10/2016 | WQM 157 | 8 | 199 |
| 07/03/2012 | WQM 157 | 8 | 683 |
| 07/15/2014 | WQM 157 | 7 | 119 |
| 08/06/2013 | WQM 157 | 6 | 80 |
| 07/11/2017 | WQM 157 | 6 | 291 |
| 08/07/2012 | WQM 157 | 5 | 52 |
| 09/11/2012 | WQM 157 | 5 | 148 |
| 05/06/2014 | WQM 157 | 5 | 64.6 |
| 06/11/2013 | WQM 157 | 5 | 1190 |
| 09/13/2011 | WQM 157 | 5 | 214 |
| 09/09/2014 | WQM 157 | 4 | 299 |
| 08/12/2014 | WQM 157 | 4 | 134 |
| 07/09/2013 | WQM 157 | 3 | 354 |

#### 6.1.1.4 Low Flows

The Low Flow zone is composed of flows below 2.3 cfs. The flows typically occur during late summer and can persist through late fall. Neither of the two samples (Table 12) collected from this zone exhibited concentrations higher than the single sample maximum standard (1,178 cfu/100 ml). Using the 95$^{th}$ percentile flow (2.16 cfs) with the single sample maximum standard (1,178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. Using the 95$^{th}$ percentile concentration (212 cfu/100 ml) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 0% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 8).

**Table 12. Data collected from the Low Flow Zone in the Upper Segment of Wolf Creek.**

| Sample Date | Station ID | Flow (cfs) | *E. coli* concentration |
|---|---|---|---|
| 05/07/2002 | WQM 157 | 2.16 | 219 |
| 09/14/2009 | WQM 157 | 1.46 | 79.2 |
| | | | |

### 6.1.2 TMDL Allocations

#### *6.1.2.1 Waste Load Allocation*

The waste load allocation (WLA) is constant in the three higher flow zones. The WLA calculation was based on the Single Sample Maximum (SSM), multiplied by the 80$^{th}$ percentile flow rate recorded in the discharge monitoring reports (DMR) from each municipal WWTF identified in this TMDL. Combined since 2000, the two systems have discharged a total of 25 times. Seven of those discharges were outside the recreational season (October 1-April 30). The normal operation of both municipal systems would typically result in only a small portion of the calculated daily amounts actually being discharged.

The WLA for the low flow zone was adjusted to fit the flow range by splitting the flows proportionately between the WLA and Load Allocation (LA), while accounting for the margin of safety (MOS). The low flow zone's 95$^{th}$ percentile flow (2.16 cfs) was divided so that the WLA was allocated 50% of the flow. The Load Allocation (LA) was then allocated 40% and the Margin of Safety (MOS) was allocated the remaining 10%. Flow for each facility was divided proportionately based on each facilities relative contribution. The Bridgewater facility's 80$^{th}$ percentile flow is 1.86 cfs and the Emery facility's 80$^{th}$ percentile flow is 2.60 cfs. As a result, Bridgewater was allocated 0.45 cfs, or 41.7% of the 1.08 cfs and Emery was allocated 0.63 cfs or 58.3% of the 1.08 cfs. The respective flow allocations were multiplied by the SSM standard to derive the WLAs for the low flow zone. Because of each facilities infrequent discharge, emphasis should be placed on reducing bacteria inputs from livestock sources to bring the recreational use of the classified segments of Wolf Creek into compliance.

#### *6.1.2.2 Margin of Safety*

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

For the low flow zone, an explicit MOS was calculated using ten percent (10%) of the overall load capacity. The remaining assimilative capacity (40%) was allocated to nonpoint sources (LA).

#### *6.1.2.3 Load Allocation*

To develop the bacterial load allocation (LA), the loading capacity (LC) was first determined. The LC for Wolf Creek was calculated by multiplying the single sample maximum concentration (1,178 cfu/100 ml) *E. coli* threshold by the 95$^{th}$% flow estimated for WQM 157.

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 these load allocations. The method used to calculate the MOS is discussed above. 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.

## *6.2 Lower Segment – SD-JA-R-Wolf_02*

### 6.2.1 TMDL Load Duration Curve

The Load Duration Curve represents the dynamic expression of the TMDL for Wolf Creek, resulting in a unique maximum daily load for *E. coli* that corresponds to a measured average daily flow. To aid in the implementation of the TMDL and estimation of needed *E. coli* load reductions, Table 14 presents a combination of allocations for each of four flow zones. Methods used to calculate the TMDL components are discussed below. This TMDL is based on daily flow and the SSM threshold from the water quality standard as outlined in Section 3.3.

The lower segment of Wolf Creek (SD-JA-R-Wolf_02) is around 3.35 stream miles long, from the confluence with the James River to just upstream of a Hutterite colony located on Wolf Creek ending at the road crossing of 277th Street. There are no significant tributaries or inputs into the creek in these 3.35 miles. For this reason, the same flow data set was utilized to calculate the TMDL for the lower segment of Wolf Creek.

The lower segment of Wolf Creek will benefit from reductions required by the TMDL that occur in the upper segment of Wolf Creek. Table 13 was created to account for necessary reductions needed in the upper segment of Wolf Creek. First, samples that were not paired, meaning *E. coli* samples taken from one of the two sites but not both, were removed. Then, we calculated the reduction needed at WQM 157 by subtracting the single sample maximum (1,178 cfu/100 mL) from the sample results (i.e., D=C-1178). Next, negative values, or samples where reductions are not needed, were replaced with zeros. After replacing negative values with zeros, subtractions from the concentrations of samples collected at WQM 158 (i.e., F=E-D) were made to account for the remaining reductions needed in the upper segment that would also benefit the lower segment. Finally, the 95th percentile in each flow zone of the "expected" WQM 158 concentrations was used to calculate the current loads for the higher three flow zones. Because the low flow zone only had one paired sample, the 95th percentile of four "original" samples that were in the low flow zone was used.

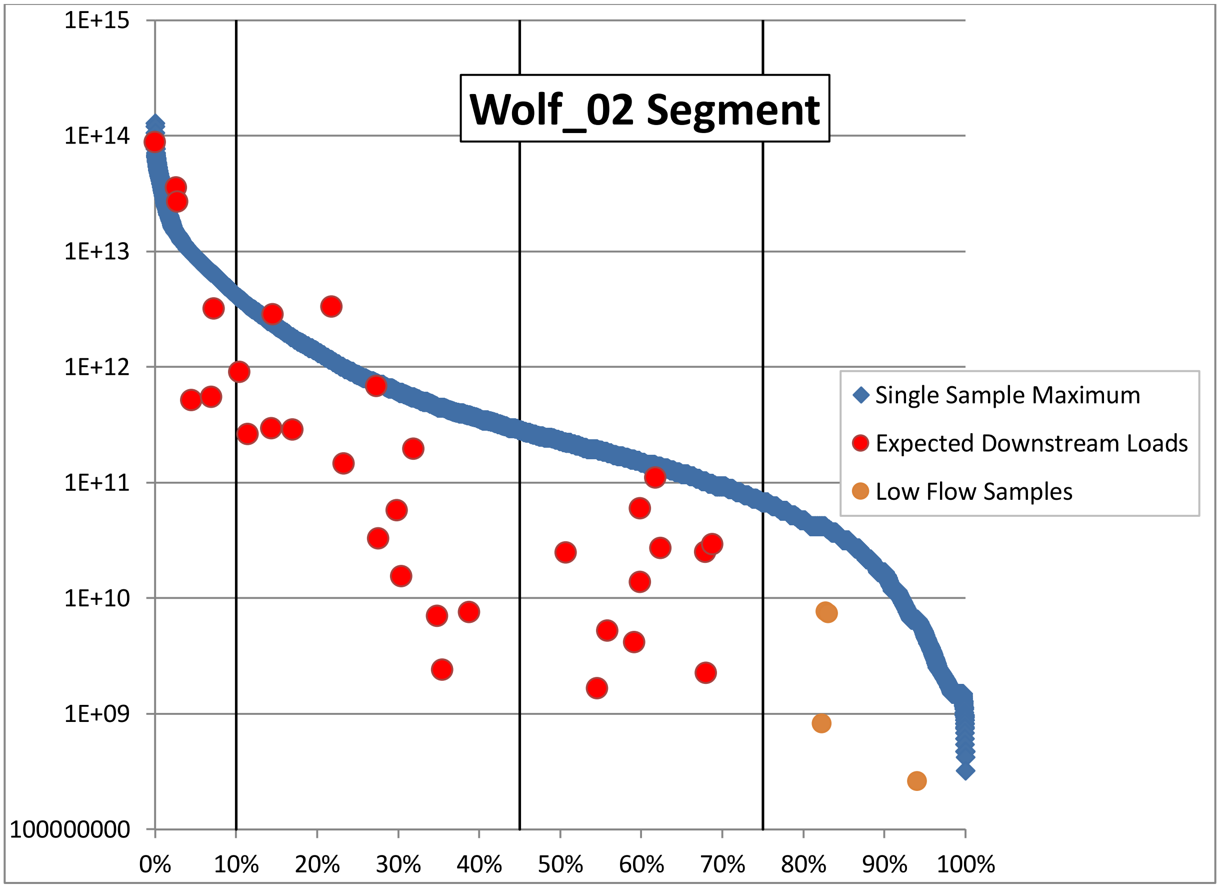


**Figure 8. Load Duration Curve of the Lower Segment of Wolf Creek (SD-JA-R-Wolf_02).**

**Table 13. Expected downstream reductions and concentrations used for the TMDL calculations. Samples marked with (*) were reported to be >4840 cfu/100 mL. To include them into the calculations they were assigned a concentration of 4841 cfu/100 mL.**

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| Flow Zone | Calculated Flow (cfs) | Upstream *E. coli* Sample Concentration (WQM 157) | Reduction needed to meet the single sample maximum (1178 cfu/100 mL) | Downstream *E. coli* concentration before upstream reductions | Expected downstream *E. coli* concentration after upstream reductions | 95th Percentile expected downstream *E. coli* concentration |
| Extreme | 3030 | 1370 | 192 | 1370 | 1178 | 2741.75 |
| | 495 | 3110 | 1932 | *4841 | 2909 | |
| | 487 | 2014 | 836 | 3076 | 2240 | |
| | 337 | 36.6 | 0 | 62.2 | 62.2 | |
| | 226 | 68.2 | 0 | 98 | 98 | |
| | 218 | 202 | 0 | 596 | 596 | |
| High Range | 135 | 261 | 0 | 272 | 272 | 2011.3 |
| | 117 | 159 | 0 | 91 | 91 | |
| | 84 | 121 | 0 | 142 | 142 | |
| | 82 | 1730 | 552 | 1960 | 1408 | |
| | 62 | 231 | 0 | 187 | 187 | |
| | 39 | 2600 | 1422 | *4841 | 3419 | |
| | 34 | 350 | 0 | 175 | 175 | |
| | 25 | 158 | 0 | 1100 | 1100 | |
| | 25 | 86.7 | 0 | 53.7 | 53.7 | |
| | 21 | 85 | 0 | 109 | 109 | |
| | 21 | 47.2 | 0 | 30.1 | 30.1 | |
| | 19 | 2600 | 1422 | 1840 | 418 | |
| | 16 | 40.8 | 0 | 18.3 | 18.3 | |
| | 16 | 125 | 0 | 6.3 | 6.3 | |
| | 13 | 12.2 | 0 | 23.2 | 23.2 | |

| Flow Zone | Calculated Flow (cfs) | Upstream *E. coli* Sample Concentration (WQM 157) | Reduction needed to meet the single sample maximum (1178 cfu/100 mL) | Downstream *E. coli* concentration before upstream reductions | Expected downstream *E. coli* concentration after upstream reductions | 95th Percentile expected downstream *E. coli* concentration |
|---|---|---|---|---|---|---|
| Mid Range | 7.6 | 683 | 0 | 132 | 132 | 692.5 |
| | 6.7 | 119 | 0 | 10 | 10 | |
| | 6.2 | 80 | 0 | 33.8 | 33.8 | |
| | 5.4 | 52 | 0 | 31 | 31 | |
| | 5.2 | 148 | 0 | 464 | 464 | |
| | 5.2 | 64.6 | 0 | 107 | 107 | |
| | 4.8 | 1190 | 12 | 933 | 921 | |
| | 4.7 | 214 | 0 | 231 | 231 | |
| | 3.6 | 299 | 0 | 285 | 285 | |
| | 3.5 | 134 | 0 | 25.6 | 25.6 | |
| | 3.3 | 354 | 0 | 354 | 354 | |
| Low Flow | 1.5 | 79.2 | 0 | 23 | 23 | 23 |

**Table 14. Lower Segment of Wolf Creek TMDL Allocations.**

| | Lower Segment of Wolf Creek - SD-JA-R-Wolf_02 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Extreme Flows** | | **High Range Flows** | | **Mid Range Flows** | | **Low Flows** | |
| | **>144 cfs** | | **144-10 cfs** | | **10-2.3 cfs** | | **2.3-0.0 cfs** | |
| **LA** | **4.12E+13** | | **2.84E+12** | | **1.84E+11** | | **5.60E+10** | |
| **WLA** | **0** | | **0** | | **0** | | **0** | |
| | | | | | | | | |
| **MOS** | **4.81E+12** | | **4.28E+11** | | **8.10E+10** | | **6.22E+09** | |
| **TMDL @ 1178 cfu** | **4.60E+13** | | **3.27E+12** | | **2.65E+11** | | **6.22E+10** | |
| | | | | | | | | |
| **Current Load** | **1.07E+14** | | **5.58E+12** | | **1.56E+11** | | **1.17E+10** | |
| **Load Reduction** | **57%** | | **41%** | | **0%** | | **0%** | |

#### *6.2.1.1 Extreme Flows*

The Extreme Flow zone is composed of the highest flows exceeding 144 cfs. The flows in this range are greater than 144 cfs only 10% of the time. A total of six paired samples (Table 13) were collected in this zone and three were expected to exceed the *E. coli* single sample maximum standard (1,178 cfu/100ml). Using the 95$^{th}$ percentile flow (1,598 cfs) with the single sample maximum standard (1,178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. One of the samples is listed as having great than 4,840 cfu/100mL. During calculations of loadings a number of 4,841 cfu/100 mL was used in place of the >4,840 cfu/100mL. Using the 95$^{th}$ percentile of expected downstream concentration (2,742 cfu/100mL) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 57% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 14).

#### *6.2.1.2 High Range Flows*

The High Range Flow zone is comprised of flows between 144 cfs and 10 cfs. Fifteen paired samples (Table 13) were collected in this zone, two were expected to exceed the *E. coli* single sample maximum standard (1178 cfu/100 ml). Using the 95$^{th}$ percentile flow (113 cfs) with the single sample maximum standard (1178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. One of the samples is listed as having greater than 4,840 cfu/100mL. During calculations of loadings a number of 4,841 cfu/100 mL was used in place of the >4,840 cfu/100mL. Using the 95$^{th}$ percentile of expected downstream concentration (2,011 cfu/100mL) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 41% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 14).

#### *6.2.1.3 Mid Range Flows*

The Mid-Range Flow zone is comprised of flows between 10 cfs and 2.3 cfs. Out of the 11 paired samples (Table 13) collected in this zone, zero were expected to exceed the *E. coli* single sample maximum standard (1178 cfu/100 ml). Using the 95$^{th}$ percentile flow (9.2 cfs) with the single sample maximum standard (1178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. Using the 95$^{th}$ percentile of expected downstream concentration (693 cfu/100mL) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 0% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 14).

#### *6.2.1.4 Low Flows*

The Low Flow zone is comprised of flows below 2.3 cfs. The flows typically occur during late summer and can persist through late fall. Four samples taken at the WQM 158 sampling location were used by themselves, because there was only one paired sample for this flow zone. None of the four samples (Table 15) collected from this zone exhibited concentrations higher than the single sample maximum standard (1178 cfu/100 ml). Using the 95$^{th}$ percentile flow (2.16 cfs) with the single sample maximum standard (1178 cfu/100 ml) from this zone to calculate the TMDL goal is appropriate and provides assurance that the water quality criteria will not be exceeded. Using the 95$^{th}$ percentile concentration of the four samples taken from this location (221 cfu/100mL) with the 95$^{th}$ percentile flow for this flow zone, an *E. coli* load reduction of 0% is required in this flow zone to fully support this segments limited contact recreation beneficial use (Table 14).

**Table 15. Data collected from the Low Flow Zone in the Lower Segment of Wolf Creek.**

| Sample Date | Station ID | Flow (cfs) | *E. coli* concentration |
|---|---|---|---|
| 09/14/2009 | WQM 158 | 1.46 | 23 |
| 06/06/2006 | LOWJIMJRT15 | 1.41 | 222 |
| 05/23/2006 | LOWJIMJRT15 | 1.37 | 219 |
| 07/26/2006 | LOWJIMJRT15 | 0.23 | 46.8 |

### 6.2.2 TMDL Allocations

#### *6.2.2.1 Waste Load Allocation*

Because the waste load allocation is accounted for in the upper segment of Wolf Creek, the lower segment has zero allocations in the waste load.

#### *6.2.2.2 Margin of Safety*

An explicit MOS using a duration curve framework is basically a reserved load intended to account for uncertainty (e.g., loads from tributary streams, effectiveness of controls, etc). For the three higher flow zones, an explicit MOS was calculated as the difference between the loading capacity at the mid-point of each of the flow zones and the loading capacity at the minimum flow in each zone.

A substantial MOS is provided using this method as the loading capacity is typically much less at the minimum flow of a zone as compared to the mid-point. Because the allocations are a direct function of flow, accounting for potential flow variability is an appropriate way to address the MOS. For the low flow zone, an explicit MOS was calculated using ten percent (10%) of the overall load capacity as part of the TMDL.

#### *6.2.2.3 Load Allocation*

To develop the bacterial load allocation (LA), the loading capacity (LC) was first determined. The LC for Wolf Creek was calculated by multiplying the single sample maximum concentration (1,178 cfu/100 ml) *E. coli* threshold by the $95^{th}$% flow estimated for WQM 158 (same as WQM 157).

Since the WLA was accounted for in the upper segment of Wolf Creek there was no WLA in the lower segment. A fraction of the LC was also reserved as a margin of safety (MOS) to account for uncertainty in the calculations of these load allocations. The method used to calculate the MOS is discussed above. 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

Different seasons of the year can yield differences in water quality due to changes in precipitation and agricultural practices. Some seasonal variation in the *E. coli* load would be expected.

These TMDLs exclusively address the recreational season which is defined as May 1 through September 30. Because there are two WQM locations that were sampled monthly, 97 *E. coli* samples were collected outside the recreation season from Wolf Creek. Only one *E. coli* sample exceeded the single sample maximum standard. There were 105 *E. coli* samples collected during the recreation season and 16 *E. coli* samples exceeded the single sample maximum standard. This indicates that Wolf Creek is most vulnerable to elevated bacteria counts during the recreation season. During this time period, livestock are more likely to be located in the stream corridor.

# 8.0 Monitoring Strategy

During and after the implementation of best 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 found within the watershed. Monthly water quality samples will be collected from Site WQM157 – Wolf Creek above Wolf Creek Colony, which is one of the locations used to develop load duration curves and flow information. WQM158 – Wolf Creek below Wolf Creek Colony was discontinued in 2015. Supplemental sampling is also taking place at WQM157 through the South Central Watershed Implementation Project.

The Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances identified during the implementation of the TMDL. If a review of the new information or circumstances indicates that an adjustment to the Load

Allocation (LA) and Waste Load Allocation (WLA) is appropriate than the TMDL will be updated following SD DENR programmatic steps including public participation. 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 and will reflect the water quality standards found in the ARSD. The Department will correspond with EPA if any adjustments to this TMDL are made.

# 9.0 Public Participation

STATE AGENCIES
South Dakota Department of Environment and Natural Resources (SD DENR) was the primary state agency involved in completion of this assessment. SD DENR's water quality monitoring (WQM) network provided much of the data used in this TMDL. SD DENR also provided technical support and equipment throughout the course of the Lower James River Assessment project.

FEDERAL AGENCIES
Environmental Protection Agency (EPA) provided the primary source of funds for the completion of the Lower James River Assessment project.

LOCAL GOVERNMENT, INDUSTRY, ENVIRONMENTAL, AND OTHER GROUPS, AND PUBLIC AT LARGE
The primary local sponsor for the Lower James River Assessment project was the James River Water Development District. The district held bi-monthly board meetings in which, short updates on the progress of the assessment project were presented. The updates were followed by a question and answer session for board members and public attendees. TMDL activities in the district were presented and discussed at nearly every meeting since project planning began in 2005.

During the summer sampling seasons, project personnel frequently met with landowners in the field. These meetings were most often initiated by landowners stopping to ask questions while coordinators were engaged in data collection. Although informal in nature, these meetings provide an important medium for obtaining local landowner views and opinions.

A 30-day public comment period was issued for the original draft TMDL in April 2012. A public notice letter was published in the following local newspapers: The Mitchell Daily Republic, Freeman Courier, Bridgewater Tribune, and the Parkston Advance. The draft TMDL document and ability to comment was made available on DENRs One-Stop Public Notice Page at: https://denr.sd.gov/public/default.aspx. No public comments were received during the initial 30-day comment period. The original draft TMDL was not submitted to EPA for final approval following the initial comment period and a significant amount of time passed.

This updated TMDL represents a second draft and incorporates significant revisions from the original version. A new 30-day public comment period (February 7, 2020 to March 13, 2020) was issued following the same public comment process described for the original draft TMDL (April 2012). Again, no comments were received during the public comment period.

# 10.0 Reasonable Assurance

The upper segment of Wolf Creek (SD-JA-R-Wolf_01) 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 waste load allocation (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 (nonpoint sources) are properly calibrated to meet the applicable water quality standards.

Reasonable assurance of the TMDL established for the upper segment of Wolf Creek will require a comprehensive approach that addresses:

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

There is reasonable assurance that the goals of the TMDL 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 City of Bridgewater and Emery waste water treatment facilities (WWTF).

## *10.1 Point Sources*

The City of Bridgewater and Emery WWTFs are located in the watershed for Wolf Creek. Emery discharges directly to the impaired segment. It is imperative that both facilities operate in compliance with their NPDES permits and WLA's set forth in the TMDL. Below are some recommendations for both facilities to consider ensuring high operational effectiveness of wastewater treatment.

City of Bridgewater WWTF

- Continue scheduled sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continue maintenance of freeboard levels of lagoons and holding ponds.
- Continue bacteria monitoring to assure compliance with water quality standards.
- Encourage WWTF Personnel to attend annual wastewater training courses sponsored by the state.

City of Emery WWTF

- Continue scheduled sewer replacement and repairs.
- Continue upgrading treatment system as new technologies become available.
- Continue maintenance of freeboard levels of lagoons and holding ponds.
- Continue bacteria monitoring to assure compliance with water quality standards.
- Encourage WWTF Personnel to attend annual state wastewater training courses

### *10.2 Nonpoint Sources*

The South Central Watershed Implementation Project, sponsored by the James River Water Development District (JRWDD), has a vested interest in the Wolf Creek watershed. Along with the JRWDD, Hutchinson, Miner, and McCook Conservation Districts will be involved in restoration projects that involve Wolf Creek. The South Central Watershed Implementation Project is the only project that is focusing on implementation efforts to reduce bacteria loading in the Wolf Creek watershed. This project provides reasonable assurance that bacteria loading from nonpoint sources will be targeted through best management practices implemented in the watershed.

## 11.0 Implementation Strategy

The South Central Implementation Project is targeting areas of impairment in several watersheds in the Lower James River Basin, Vermillion River Basin, and the Lewis and Clark Lake watershed of the Missouri River basin. For the Wolf Creek watershed, emphasis has been given to riparian area management practices. Pastures that abut or transect Wolf Creek will be a priority.

Along with this emphasis, many best management practices (BMPs) have been installed already in the watershed (Figure 9). They include one agricultural waste system, one grazing management plan, 50 acres of cropland BMPs, around 2600 acres of riparian restoration/protection and also some BMP developments and plans.

The results shown in the Load Duration Curves indicate reductions are required in the higher flow zones. Because of the rural area most of the implementation measures should focus on the following:

- Livestock access to streams should be reduced, and off-stream sources of water should be provided to livestock.
- Unstable stream banks should be protected by enhancing riparian vegetation that provides erosion control and filters runoff of pollutants into the stream.
- Filter strips should be installed along the stream corridor that borders cropland and pastureland.
- Animal confinement facilities should implement proper animal waste management systems.
- An assessment of progress will be part of every Section 319 implementation segment, and revisions to the plan will be made with watershed stakeholders.

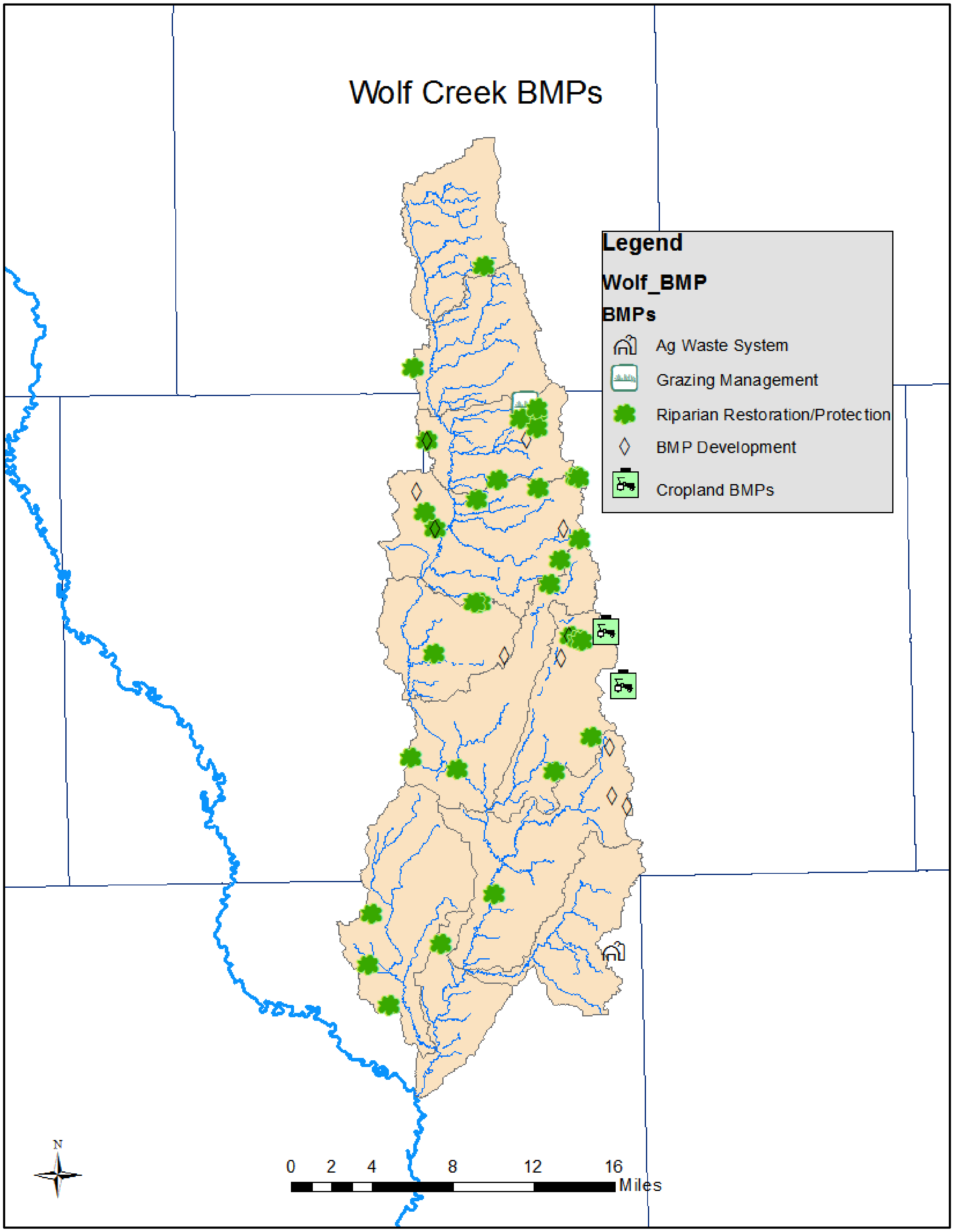


**Figure 9. Wolf Creek Best Management Practices.**

The city of Bridgewater is also preparing to construct a stormwater retention pond and installing new sewer pipe and upsizing other sewer pipes in the city. The retention pond will collect storm water from the city before it reaches Wolf Creek. This project is scheduled to be completed in 2020.

# 12.0 Literature Cited

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Ref: 8WD-CWS

Mr. Hunter Roberts
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 Evaluations for Wolf Creek Segments 1 and 2

Dear Mr. Roberts,

The U.S. Environmental Protection Agency (EPA) has completed review of the total maximum daily loads (TMDLs) submitted by your office on April 3, 2020. 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 TMDLs for Wolf Creek. The EPA has determined that the separate elements of the TMDLs listed in the enclosure adequately address the pollutant of concern, are designed to attain and maintain applicable water quality standards, consider seasonal variation and include a margin of safety. The EPA's rationale for this action is contained in the enclosure.

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

Sincerely,

JUDY BLOOM Digitally signed by JUDY BLOOM Date: 2020.04.17 12:49:38 -06'00'

Judy Bloom, Manager
Clean Water Branch

Enclosure
Wolf Creek *E. coli* TMDL EPA Review Summary

# EPA TOTAL MAXIMUM DAILY LOAD (TMDL) REVIEW SUMMARY

**TMDL:** *Escherichia coli* Total Maximum Daily Load Evaluation for Wolf Creek Segments 1 and 2

**ATTAINS TMDL ID:** R8-SD-2020-01

**LOCATION:** Hutchinson County, South Dakota

**IMPAIRMENTS/POLLUTANTS:** The TMDL document addresses two Wolf Creek segments 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-JA-R-WOLF_01 | WOLF CREEK, Wolf Creek Colony to S5, T103N, R56W | Escherichia coli (*E. coli*) |
| SD-JA-R-WOLF_02 | WOLF CREEK, Just above Wolf Creek Colony to the mouth | Escherichia coli (*E. coli*) |

**BACKGROUND:** The South Dakota Department of Environment and Natural Resources (DENR) submitted to EPA the final *E. coli* TMDLs for Wolf Creek with a letter requesting review and approval dated March 27, 2020. DENR sent an updated version of the TMDL document on April 3, 2020 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 Wolf Creek *E. coli* TMDLs. All the required elements of an approvable TMDL have been met.

| TMDL Approval Summary | |
|---|---|
| Number of TMDLs Approved: | 2 |
| Number of Causes Addressed by TMDLs: | 2 |

**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 WOLF CREEK 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.*

Wolf Creek is located in south-eastern South Dakota and is part of the larger James River basin. The impaired waterbody segments subject to these TMDLs extend 44 miles upstream from the mouth of the creek at the James River and are identified as upper Wolf Creek (SD-JA-R-WOLF_01) and lower Wolf Creek (SD-JA-R-WOLF_02). Figure 1 displays the general location of the Wolf Creek watershed, Figure 2 displays the impaired segments and Figure 5 displays the monitoring stations where data was collected to support TMDL development.

These segments were first listed as impaired by *E. coli* on South Dakota's 2012 303(d) List and were assigned a high priority for TMDL development on the most recent 303(d) list approved by EPA in 2020. This information is contained in Section 1.0 (Objective). A total suspended solids (TSS) TMDL was developed for lower Wolf Creek (SD-JA-R-WOLF_02) in 2011 (SDDENR, 2011). Following completion of these *E. coli* TMDLs, no other impairment causes have been identified as requiring TMDLs at this time.

Section 2.0 (Watershed Characteristics) summarizes land uses draining into the impaired segments and Section 5.2 characterizes nonpoint sources into categories of agricultural, human, and natural background. Natural background is represented as wildlife sources. DENR quantified *E. coli* production from these sources using human and animal population estimates from various studies. Point sources are characterized and identified by facility name and permit number in Table 2. Concentrated Animal Feeding Operations (CAFOs) in the Wolf Creek watershed that are regulated under South Dakota's general permit are summarized in Table 3.

***Assessment:*** EPA concludes that DENR adequately identified the impaired waterbodies, the pollutant of concern, the priority rankings, the identification, location and magnitude of the pollutant sources, and the important assumptions and information used to develop the TMDLs.

## 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 (Water Quality Standards) describes the water quality standards applicable to the impaired segments with citations to relevant South Dakota regulations. Upper and lower Wolf Creek are both designated for the following beneficial uses:

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

All numeric criteria applicable to these uses are presented in Table 1. DENR determined that *E. coli* is preventing the creek's limited contact recreation uses from being fully 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 these TMDLs.

## 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). 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 Wolf Creek. 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. 2007) 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., extreme, high, mid, low), as listed in Table 8 for upper Wolf Creek and Table 14 for lower Wolf Creek. The load duration curves, and TMDLs based on the curves, are shown visually in Figures 7 and 8 with instantaneous loads calculated from the monitoring dataset. All ambient water quality data used in the analysis is provided in multiple tables organized by waterbody segment and flow zone. No data was converted from fecal coliform because all water quality samples were originally analyzed for *E. coli*. While the loading capacity is defined for multiple stream flow conditions, DENR determined critical conditions occur during the recreation season when livestock are more likely to be located in the stream corridor.

***Assessment:*** EPA concludes that the loading capacities were calculated using an acceptable approach, used water quality targets consistent with water quality criteria, and have been appropriately set at levels 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 Sections 6.1.2.3 and 6.2.2.3, DENR established a single LA for both waterbody segments as the allowable load remaining after the WLAs and explicit MOS have been accounted for (i.e., LA = TMDL – ∑WLA – MOS). Tables 8 and 14 present the LAs 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 LAs provided in these TMDLs are 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 identifies and describes the six traditional point sources located within the drainage area that are permitted to discharge through the National Pollutant Discharge Elimination System (NPDES) program. These include the wastewater treatment facilities for the towns of Bridgewater (Permit #SD0021512), Canova (Permit #SDG821521), Emery (Permit #SD0021741), and Spencer (Permit #SDG820397). Two rural drinking water distribution systems are also permitted, Hanson (Permit #SDG860039) and Howard (Permit #SDG860052), but *E. coli* discharges from these facilities is unlikely given the nature of their operations. Section 5.1.2 identifies and describes six Concentrated Animal Feeding Operations (CAFOs) within the drainage area that are covered under DENR's general CAFO permit. These permits require compliance with various design, construction, operation and maintenance requirements such as being able to retain up to a 25-yr, 24-hr storm event.

After reviewing the specifics of each facility, DENR established individual WLAs for the Bridgewater and Emery wastewater treatment facilities. Canova and Spencer were not assigned WLAs because they are only permitted to discharge in the rare case of an emergency and are small systems collectively serving less than 300 people. Similarly, no WLAs were established for CAFOs because DENR considers the general CAFO permit conditions adequate to control *E. coli* loading from these sources.

Discharges from Bridgewater and Emery have occurred a combined total of 25 times since 2000 (i.e., they are non-continuous dischargers). Both flow into upper Wolf Creek, therefore no portion of lower Wolf Creek's loading capacity was reserved for WLAs as they were addressed in the upper Wolf Creek allocations. WLAs for Bridgewater and Emery were typically calculated using existing *E. coli* permit limits, which are consistent with the TMDL target and single sample maximum criterion of 1,178 cfu/100mL, and the 80th percentile of each facility's effluent flow based on discharge monitoring report (DMR) data. Table 8 displays the Bridgewater and Emery WLAs on upper Wolf Creek for each flow zone. WLAs across the extreme, high, and mid flow zones 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 as one half of the low flow TMDL.

***Assessment:*** EPA concludes that the WLAs provided in these TMDLs are reasonable, will result in the attainment of the water quality standards and will not cause localized impairments. The TMDLs account 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.*

An explicit MOS is established in the same manner for both Wolf Creek *E. coli* TMDLs. In the upper three flow zones (i.e., extreme, high and mid), an explicit MOS was calculated as the difference between the loading capacity at the mid-point of each flow zone and the loading capacity at the minimum flow of each zone. For the low flow zone, an explicit MOS was established as 10% of the overall load capacity. These flow zone-specific MOSs are included in Tables 8 and 14.

***Assessment:*** EPA concludes that these TMDLs incorporate 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., extreme, high, mid, low) as listed in Tables 8 and 14. The greatest load reductions are required during the extreme and high flow zones.

The variability of measured stream flows and monitored *E. coli* concentrations are summarized in Section 7.0 (Seasonal Variation).

***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, upper Wolf Creek 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 10.0 (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 maintenance of freeboard levels of lagoons and holding ponds.”

Nonregulatory, voluntary-based reasonable assurances are provided for the LAs where the submittal discusses the ongoing South Central Implementation Project and DENR’s monitoring strategy that will be used to gage nonpoint source Best Management Practice (BMP) effectiveness in the future. 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, and the identification of watershed partners with shared interests in water quality.

***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) 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 8.0 (Monitoring Strategy) acknowledges that additional monitoring will be necessary to judge progress towards achieving the goals outlined in the TMDL report 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 previously recommended by EPA.

***Assessment:*** Monitoring plans are not a required element of EPA’s TMDL review and decision-making process. The TMDLs 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. 2008, 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 11.0 (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.
- 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.
- Assessing and sharing progress achieved through CWA §319 implementation projects with watershed stakeholders.

In addition, the TMDL report mentions implementation work already underway that will help address Wolf Creek's *E. coli* impairments. The South Central Implementation Project, sponsored by the James River Water Development District and several local conservation districts, is targeting the Wolf Creek Watershed and plans to support future implementation projects that emphasize riparian pasture management practices. The city of Bridgewater is also preparing to construct a stormwater retention pond, installing new sewer pipe and upsizing other sewer pipes in the city. The retention pond will collect stormwater before it reaches Wolf Creek and is scheduled to be completed in 2020.

***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 and documents ongoing implementation efforts in the watershed. 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 9.0 (Public Participation) explains the public engagement process DENR followed during development of the TMDLs. DENR has kept the James River Water Development District, a local sponsor of the TMDL project, apprised of assessment and TMDL development work dating back to 2005. DENR field personnel also frequently interacted with area landowners.

A draft TMDL report was initially released for public comment from April 23, 2012 to June 3, 2012. Following additional data collection and significant revisions to the document, the TMDL report was public noticed again from February 7, 2020 to March 13, 2020. Both opportunities for public review and comment were posted on DENR's website and announced in four area newspapers: the Mitchell Daily Republic, Freeman Courier, Bridgewater Tribune and Parkston Advance. No comments were received during either comment period.

***Assessment:*** EPA has reviewed DENR's public participation process and concludes that DENR involved the public during the development of the TMDLs 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 March 27, 2020, and signed by Paul Lorenzen, Environmental Scientist Manager 1, Water Protection Program. DENR sent an updated version of the TMDL document on April 3, 2020 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 TMDLs in accordance with the Clean Water Act and the submittal contained all necessary supporting information.

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