Buffalo Creek Bacterial TMDL Report

Wenck File #2366-01

Prepared for:
Minnesota Pollution Control Agency

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2-1
2-2</td></tr>
<tr><td>303(d) Listing Information</td><td>Headwaters to JD-15 07010205-502
JD-15 to South Fork Crow River 07010205-501

The bacteria impaired reaches of Buffalo Creek were listed in 2008. This TMDL was prioritized to begin in 2008 and be completed in 2011.</td><td>1
1-2</td></tr>
<tr><td>Applicable Water Quality Standards/ Numeric Targets</td><td>The most protective use classification assigned to Buffalo Creek is as a 2B water. This classification carries an E. coli numeric target of 126 organisms per 100 mL as a monthly geomean. Also, no more than ten percent of all samples taken during any calendar month may exceed 1,260 organisms per 100 mL as set forth in Minn. R. 7050. The standard applies between April 1st and Oct 31st.</td><td>1-2</td></tr>
<tr><td>Loading Capacity (expressed as daily load)</td><td>The loading capacity is the total maximum daily load for each flow condition. The median load of each flow zone was used to represent the total daily loading capacity (TDLC) for that flow zone.

<table>
<tr><th rowspan="2">Reach</th><th colspan="5">Total Maximum Daily E. coli Load (billions organisms/day)</th></tr>
<tr><th>Very High</th><th>High</th><th>Mid</th><th>Low</th><th>Dry</th></tr>
<tr><td>502</td><td>508.10</td><td>233.61</td><td>53.95</td><td>12.43</td><td>5.31</td></tr>
<tr><td>501</td><td>3301.94</td><td>963.38</td><td>180.97</td><td>25.38</td><td>7.51</td></tr>
</table>
</td><td>4-7
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</table>

TMDL Summary Table

<table>
<tr><th>EPA/MPCA Required Elements</th><th>Summary</th><th>TMDL Page #</th></tr>
<tr><td>Wasteload Allocation</td><td>
Portion of the loading capacity allocated to existing and future permitted sources for each flow condition
Reach 501
<table>
<tr><th rowspan="2">Source</th><th colspan="5">Maximum Daily Permitted E. coli Load (billions organisms/day)</th></tr>
<tr><th>Very High</th><th>High</th><th>Mid</th><th>Low</th><th>Dry</th></tr>
<tr><td>NPDES WWTF</td><td>28.79</td><td>28.79</td><td>28.79</td><td>*</td><td>*</td></tr>
<tr><td>MS4</td><td>85.52</td><td>24.95</td><td>4.69</td><td>0.66</td><td>0.19</td></tr>
<tr><td>Constr. Storm-Water</td><td>33.02</td><td>9.63</td><td>1.81</td><td>0.25</td><td>0.08</td></tr>
<tr><td>Indust. Storm-water</td><td>16.51</td><td>4.82</td><td>0.90</td><td>0.13</td><td>0.04</td></tr>
</table>
Reach 502
<table>
<tr><th rowspan="2">Source</th><th colspan="5">Maximum Daily Permitted E. coli Load (billions organisms/day)</th></tr>
<tr><th>Very High</th><th>High</th><th>Mid</th><th>Low</th><th>Dry</th></tr>
<tr><td>NPDES WWTF</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td></tr>
<tr><td>MS4</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td><td>0.00</td></tr>
<tr><td>Constr. Storm-Water</td><td>5.08</td><td>2.34</td><td>0.54</td><td>0.12</td><td>0.05</td></tr>
<tr><td>Indust. Storm-water</td><td>2.54</td><td>1.17</td><td>0.27</td><td>0.06</td><td>0.03</td></tr>
</table>
</td><td>4-7
4-8</td></tr>
<tr><td>Load Allocations</td><td>
The portion of the loading capacity allocated to existing and future non-permitted sources for each flow condition
<table>
<tr><th rowspan="2">Reach</th><th colspan="5">Maximum Daily Non-Permitted E. coli Load (billions organisms/day)</th></tr>
<tr><th>Very High</th><th>High</th><th>Mid</th><th>Low</th><th>Dry</th></tr>
<tr><td>502</td><td>449.67</td><td>206.75</td><td>47.74</td><td>11.00</td><td>4.70</td></tr>
<tr><td>501</td><td>2807.91</td><td>798.85</td><td>126.68</td><td>21.80</td><td>6.45</td></tr>
</table>
</td><td>4-7
4-8</td></tr>
</table>

TMDL Summary Table

<table>
<tr><th>EPA/MPCA Required Elements</th><th>Summary</th><th>TMDL Page #</th></tr>
<tr><td>Margin of Safety</td><td>An explicit margin of safety equal to 10% of the total load was used for each listed reach of Buffalo Creek. This means 10% of the loading capacity for each flow regime was subtracted before allocations were made among sources.
<table>
<tr><th rowspan="2">Reach</th><th colspan="5">Margin of Safety E. coli load
(billions organisms/day)</th></tr>
<tr><th>Very High</th><th>High</th><th>Mid</th><th>Low</th><th>Dry</th></tr>
<tr><td>502</td><td>50.8</td><td>23.4</td><td>5.4</td><td>1.2</td><td>0.5</td></tr>
<tr><td>501</td><td>330.2</td><td>96.3</td><td>18.1</td><td>2.5</td><td>0.8</td></tr>
</table></td><td>4-5</td></tr>
<tr><td>Public Participation</td><td>Public participation opportunities were provided during the project in the form of public meetings, electronic newsletters, and CROW’s website. In addition a display board was developed to be taken to county fairs, USFW Habitat Days, MN DNR “Our Waters Our Choice” presentations in various counties in the watershed, and McLeod County Corn and Soybean Grower’s Annual Banquets.
Public notice: 6/13/11-7/13/11. Extended to 8/15/11</td><td>6-1</td></tr>
<tr><td>Seasonal Variation</td><td>Seasonal variation is accounted for by developing load duration curves based on average daily flow data to assimilate flow and E. coli data across stream flow regimes.</td><td>5-1</td></tr>
<tr><td>Reasonable Assurance</td><td>The source reduction strategies detailed in the implementation plan section have been shown to be effective in reducing bacteria. Many of the goals outlined in this TMDL study run parallel to objectives outlined in the Local Comprehensive Water Management Plans and supported by area Watershed District’s Watershed Management Plans. The following programs and funding sources will be used to implement this TMDL: Federal Section 319 Grants for watershed improvements, funds ear-marked to support TMDL implementation from the Clean Water, Land, and Legacy constitutional amendment, approved by the state’s citizens in November 2008, local government cost-share funds, Buffalo Creek Watershed District cost-share funds,
Soil and Water Conservation Districts cost-share funds and NRCS cost-share funds.</td><td>7-1
7-2
7-3
7-4</td></tr>
<tr><td>Monitoring</td><td>A detailed monitoring plan will be included in the Implementation Plan which will be completed. Currently there are monitoring efforts in the watershed.</td><td>7-5</td></tr>
</table>

TMDL Summary Table

EPA/MPCA Required Elements	Summary	TMDL Page #
Implementation	A summary of potential management measures is included. More detail will be provided in the implementation plan that will be completed following approval of the TMDL	8-1 8-2 8-3

Executive Summary

Section 303(d) of the Federal Clean Water Act (CWA) requires the Minnesota Pollution Control Agency (MPCA) to identify water bodies that do not meet water quality standards and develop total maximum daily pollutant loads for those water bodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can receive and continue to meet water quality standards for designated beneficial uses. Through a TMDL, pollutant loads are allocated to point and non-point sources within the watershed that discharge to the water body.

This TMDL study was prepared by Wenck Associates, Inc. (Wenck) for the Crow River Organization of Water (CROW). It addresses Buffalo Creek to South Fork Crow River reach IDs 07010205-501 and 07010205-502 located in Kandiyohi, Renville, McLeod, Sibley, and Carver Counties. These waters are impaired and do not meet Minnesota water quality standard for pathogen indicator bacteria. These reaches were placed on the 303(d) list in 2008 because of monitoring data collected between April 1 and October 31 from 2001 through 2009. In addition, data collected from 2001 and 2005 was analyzed for fecal coliform and then *E. coli* beginning in 2006. The data collected revealed that: 1) fecal coliform (FC) concentrations (a class of bacteria which is a good indicator of the potential presence of pathogens) at times exceed 2,000 colony forming units per 100 milliliters (CFU/100ml), and/or 2) the geometric mean FC of a least 5 samples collected within a calendar month across several years of monitoring data at times exceed 200 CFU/100mL. This could pose a risk to swimmers and limit other recreational uses.

In 2008, Minnesota switched from fecal coliform to *E. coli*, a subgroup of fecal coliform as the regulated pathogen indicator bacteria. While fecal coliform was the pathogen indicator used to list both reaches, all bacteria concentrations in this report are expressed in terms of *E. coli*. To do this, fecal coliform data was converted to *E. coli* equivalents using a regression equation developed by the MPCA. This equation establishes a chronic *E. coli* standard of 126 CFU/100mL and an acute standard of 1,260 CFU/100mL.

Required load reductions in terms of fecal coliform and *E. coli* to meet state standards range from 40 to 77% in the listed reaches. Based on the linkage analysis, the primary implementation strategies will focus on runoff driven processes such as manure practices, pasture management and feedlot runoff as well as dry-weather sources such as failing septic systems and direct access of livestock to surface waters.

1.0 Introduction

1.1 PURPOSE

Section 303(d) of the Clean Water Act establishes a directive for developing Total Maximum Daily Loads (TMDLs) to achieve Minnesota water quality standards established for designated uses of State water bodies. Under this directive, the State of Minnesota has directed that a TMDL be prepared to address fecal coliform bacteria exceedances in the Buffalo Creek watershed.

A TMDL is defined as the maximum quantity of a pollutant that a water body can receive and continue to meet water quality standards for designated beneficial uses. Thus, a TMDL is simply the sum of point sources and nonpoint sources in a watershed. A TMDL can be represented in a simple equation as follows:

TMDL = Σ Wasteload Allocation (WLA; Point Sources) + Σ Load Allocation (LA; nonpoint sources) + Margin of Safety (MOS)

The wasteload allocation is the sum of the loads from all permitted sources and the load allocation is the sum of the load from all non-permitted sources. The Margin of Safety represents a load allocation to account for variability in environmental data sets and uncertainty in the assessment of the system. Other factors that must be addressed in a TMDL include seasonal variation, future growth, critical conditions, and stakeholder participation.

The goal of this TMDL is to quantify the pollutant reductions needed to meet the water quality standards for *E. coli* in the watersheds that drain to the bacteria impaired reaches of Buffalo Creek. Ultimately, this TMDL will result in an implementation plan to achieve the identified load reductions needed to attain the state standard for bacteria.

1.2 IMPAIRED REACHES

This TMDL effort applies to the bacteria impairment for Buffalo Creek from its headwaters to its junction with the South Fork of the Crow River (Table 1.1 and Figure 1.1). Data from Buffalo Creek's primary monitoring stations served as the basis of the impairment determination and will be used to support development of the TMDL. This TMDL addresses bacteria impairments in two listed reaches of Buffalo Creek. Each of the reaches is treated independently in this TMDL, however the approach and governance remains the same for both reaches and their watersheds.

Table 1-1 Buffalo Creek Bacteria Impairments.

Reach Name on 303(d) List/Description	*Yr. Listed*	*Assessment Unit ID*[10]	*Affected use*	*Pollutant or stressor*[3]	*Target start// completion*[7]
Buffalo Creek Headwaters to JD-15	2008	07010205-502	Aquatic Recreation	Fecal coliform	2008/2015
Buffalo Creek: JD-15 to South Fork Crow River	2008	07010205-501	Aquatic recreation	Fecal coliform	2008/2015

1.3 APPLICABLE MINNESOTA WATER QUALITY STANDARDS AND ENDPOINTS

All waters of Minnesota are assigned classes based on their suitability for the following beneficial uses:
1. Domestic consumption
2. Aquatic life and recreation
3. Industrial consumption
4. Agriculture and wildlife
5. Aesthetic enjoyment and navigation
6. Other uses
7. Limited resources value

According to Minn. Rules Ch. 7050.0470, the impaired reaches covered in this TMDL are assigned use classifications of 2B, 3B, 4A, 5 and 6 as unlisted water. These classifications include consideration for aquatic life and recreation, industrial consumption, agriculture and wildlife, aesthetic enjoyment and navigation, and other beneficial uses not specifically listed. Chapter 7050 contains general provisions, definitions of water use classes, specific standards of quality and purity for classified waters of the state, and the general and specific standards for point source dischargers to waters of the state.

The most protective use classification assigned to Buffalo Creek is as a 2B water. The designated beneficial use for 2B waters is as follows:

Class 2 waters, aquatic life and recreation.
Aquatic life includes all waters of the state which do or may support fish, other aquatic life, bathing, boating, or other recreational purposes, and where quality control is or may be necessary to protect aquatic or terrestrial life or their habitats, or the public health, safety, or welfare.

Fecal coliform bacteria are an indicator organism, meaning that not all the species of bacteria of this category are harmful but are usually associated with harmful organisms transmitted by fecal contamination. They are found in the intestines of warm-blooded animals, including humans. The presence of fecal bacteria in water suggests the presence of fecal matter and associated bacteria (i.e. some strains of *E. coli*), viruses, and protozoa (i.e. Giardia and Cryptosporidium) that are pathogenic to humans when ingested (USEPA 2001). The decision to list the reaches identified was originally based on a fecal coliform standard, which was in effect prior to the most recent rule revision in 2008.

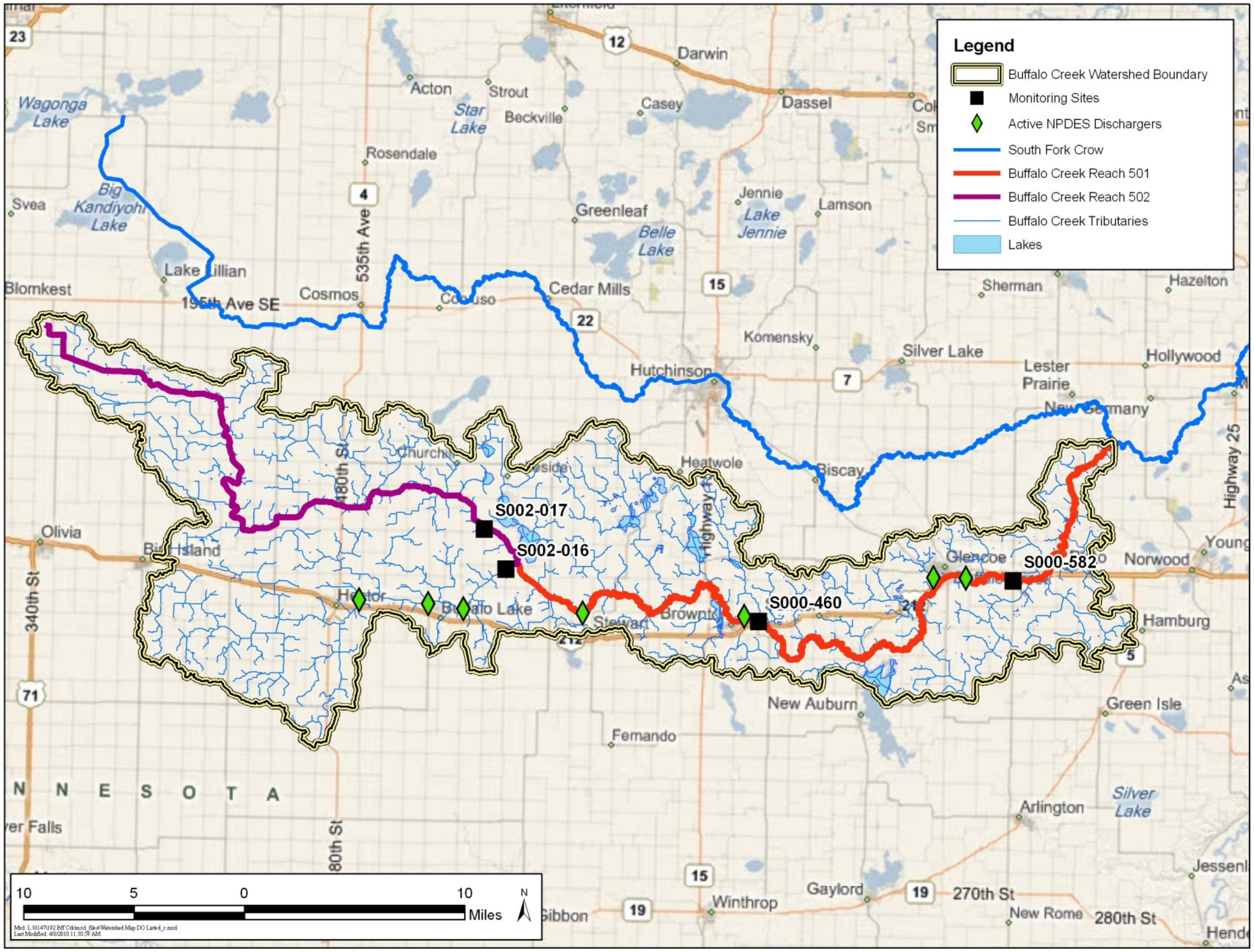

Figure 1.1 *E. coli* impaired reaches of the Buffalo Creek Watershed.

The fecal coliform standard contained in Minn. Rules Ch. 7050.0222 subpart 5, fecal coliform water quality standard for Class 2B waters, states that fecal coliform concentrations shall "not exceed 200 organisms per 100 milliliters as a geometric mean of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 2000 organisms per 100 milliliters. The standard applies only between April 1 and October 31." Impairment assessment is based on the procedures contained in the *Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment* (MPCA 2005).

With the revisions of Minnesota's water quality rules in 2008, the state has changed to an *E. coli* standard because it's a superior potential illness indicator and costs for lab analysis are less (MPCA 2007). The revised standards now state:

"*E. coli* concentrations are not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31"

The *E. coli* concentration standard of 126 cfu/100 ml was considered reasonably equivalent to the fecal coliform standard of 200 cfu/100 ml from a public health protection standpoint. The SONAR (Statement of Need and Reasonableness) section that supports this rationale uses a log plot to show the relationship between these two parameters. The relationship has an R^2 value of 0.69. The regression equation ($E\ Coli = 1.80 * (\text{Fecal Coliform})^{0.81}$) was deemed reasonable to convert fecal coliform data to *E. coli* equivalents.

2.0 Watershed Characterization

2.1 WATERSHED DESCRIPTION

The Crow River Watershed is located in south-central Minnesota and has its confluence with the Mississippi River near Dayton, Minnesota in Wright County. Portions of 10 counties make up the 1.76 million acre watershed. The Crow River Watershed is made up of two major subwatersheds, the North Fork and the South Fork (Figure 2.1.).

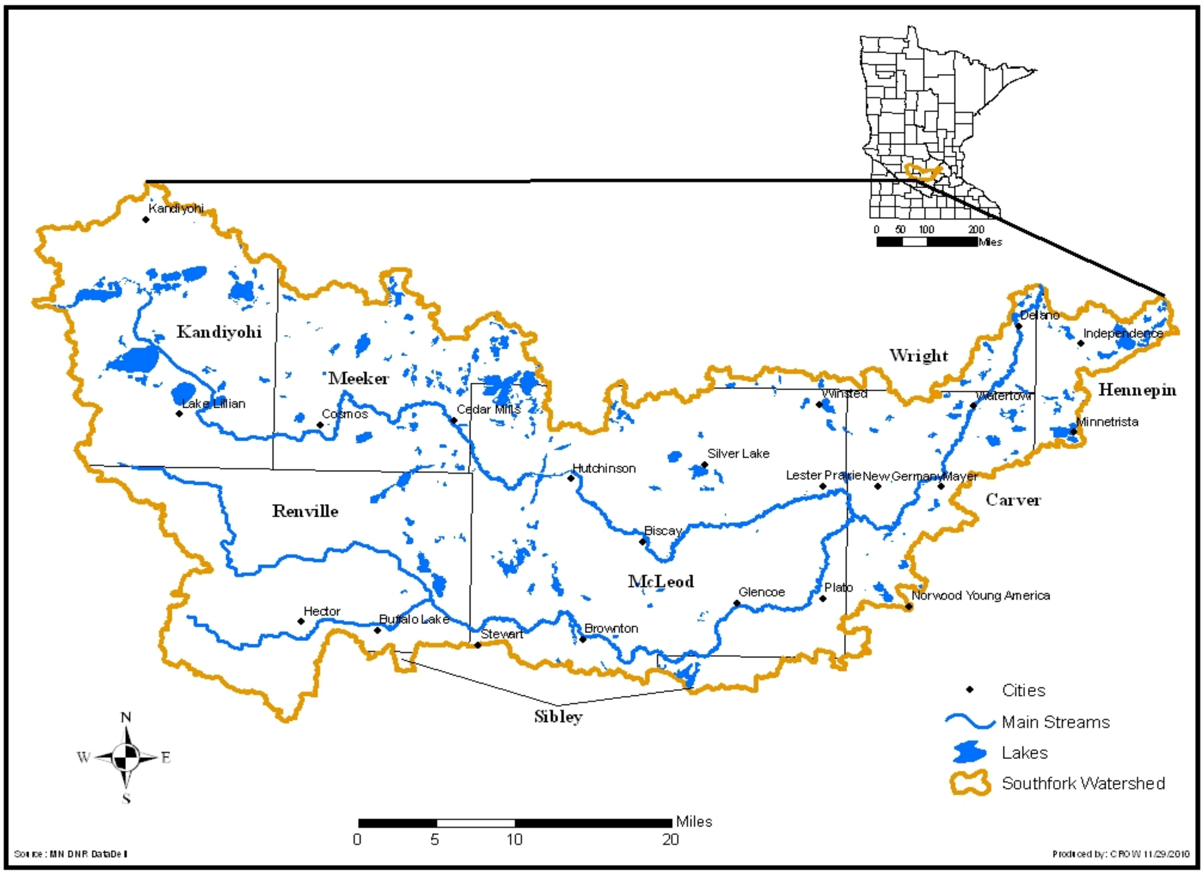

Figure 2-1 Map of the South Fork Crow River Watershed

From the perspective of the Upper Mississippi River Basin, the Crow River is one of the major tributaries to the Mississippi River from a water and nutrient-loading standpoint (Sander et al. 2003). The South Fork Crow River Watershed encompasses all or parts of Kandiyohi, Meeker, Renville, McLeod, Carver, Sibley, Wright, and Hennepin Counties.

The Buffalo Creek Watershed is located in the SF Crow HUC within the Mississippi River Basin in central Minnesota (Figure 2.2). The Creek originates in Kandiyohi County and flows east through Renville County, McLeod County and into Carver County before joining the South Fork Crow River. Most of Renville County's portion of Buffalo Creek has been channelized. The Buffalo Creek watershed is approximately 416 square miles in area and lies within the Western Corn Belt (WCB) ecoregion, characterized by nearly flat to gently rolling topography. The boundaries for this project are essentially the watershed district boundaries of Buffalo Creek at its junction with the South Fork Crow River. Six cities and 28 townships are located within the 266,453 acres with 367 linear miles of watercourses characterized by nearly flat to gently rolling topography. Based on Agro-ecoregion classification system, Buffalo Creek is listed as Rolling Moraine.

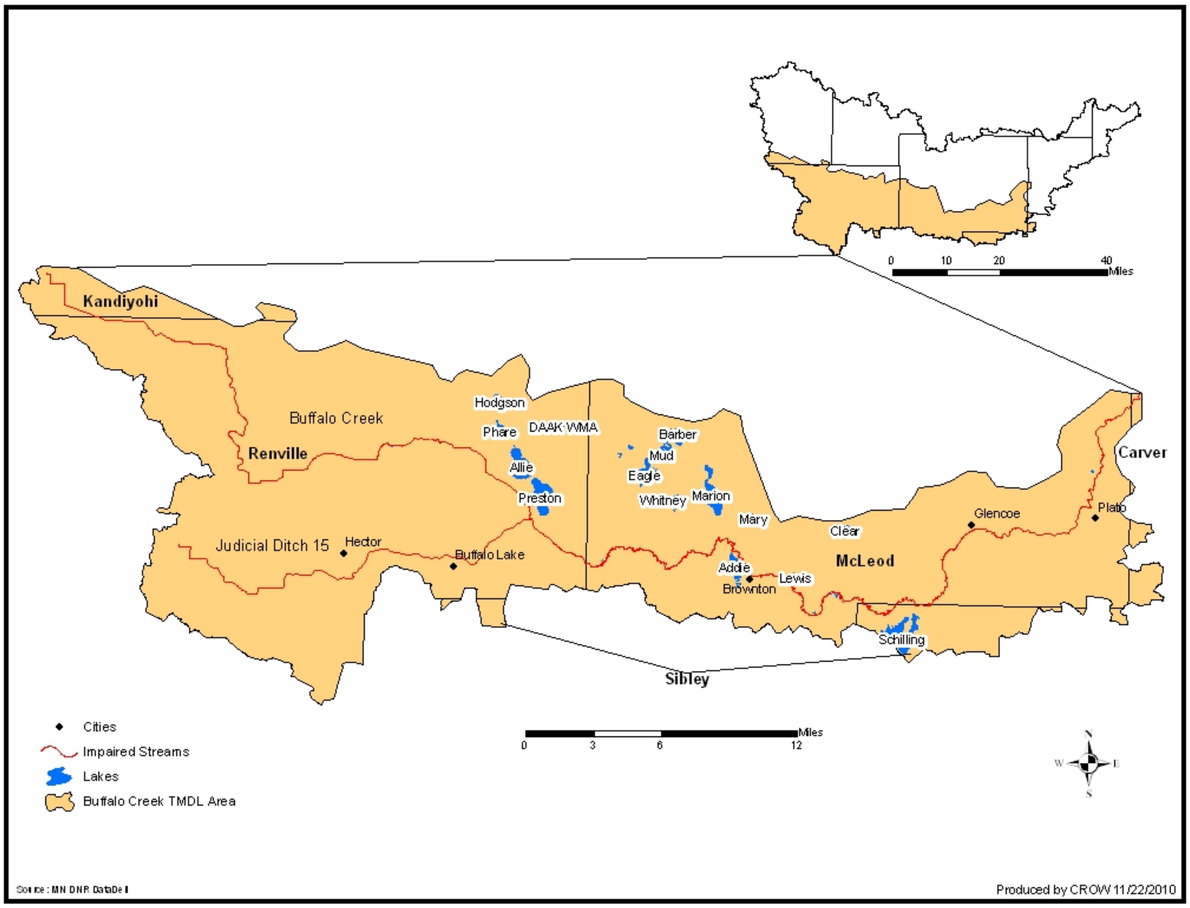

Figure 2-2 Map of Buffalo Creek TMDL Project Area

2.2 LAND COVER

Land cover of the Buffalo Creek watershed is primarily agricultural (Table 2.1 and Figure 2.3). Glencoe, Brownton, Stewart, Buffalo Lake and Hector are the major municipalities located within the watershed (Figure 2.2).

Table 2-1 Land use summary for the entire Buffalo Creek Watershed

Landuse Type	Area (acres)	Percentage
Cultivated Land	222,884	84%
Developed	22,322	8%
Wetlands	7,136	3%
Forest	6,449	2%
Lakes	4,572	2%
Grassland/Pasture	3,096	1%
Total	266,460	100%

2.3 SOILS

The area has been mantled by glacial till, a silty and clayey material commingled with sands, gravels, cobbles and boulders (Sander et al. 2003). Areas proximal to the Crow River and its tributaries are characterized by soils where the finer particles have been washed out of the coarser sands and gravels, resulting in decreased riverbank stability in those areas.

2.4 CLIMATE

The climate of the Crow River watershed is similar to that of most of central Minnesota. The growing season averages about 153 days, with an annual average precipitation of 28.56 inches. The average annual high is 52.6 degrees F and the average low is 32.5 degrees F. The average mean temperature is 42.6 degrees F.

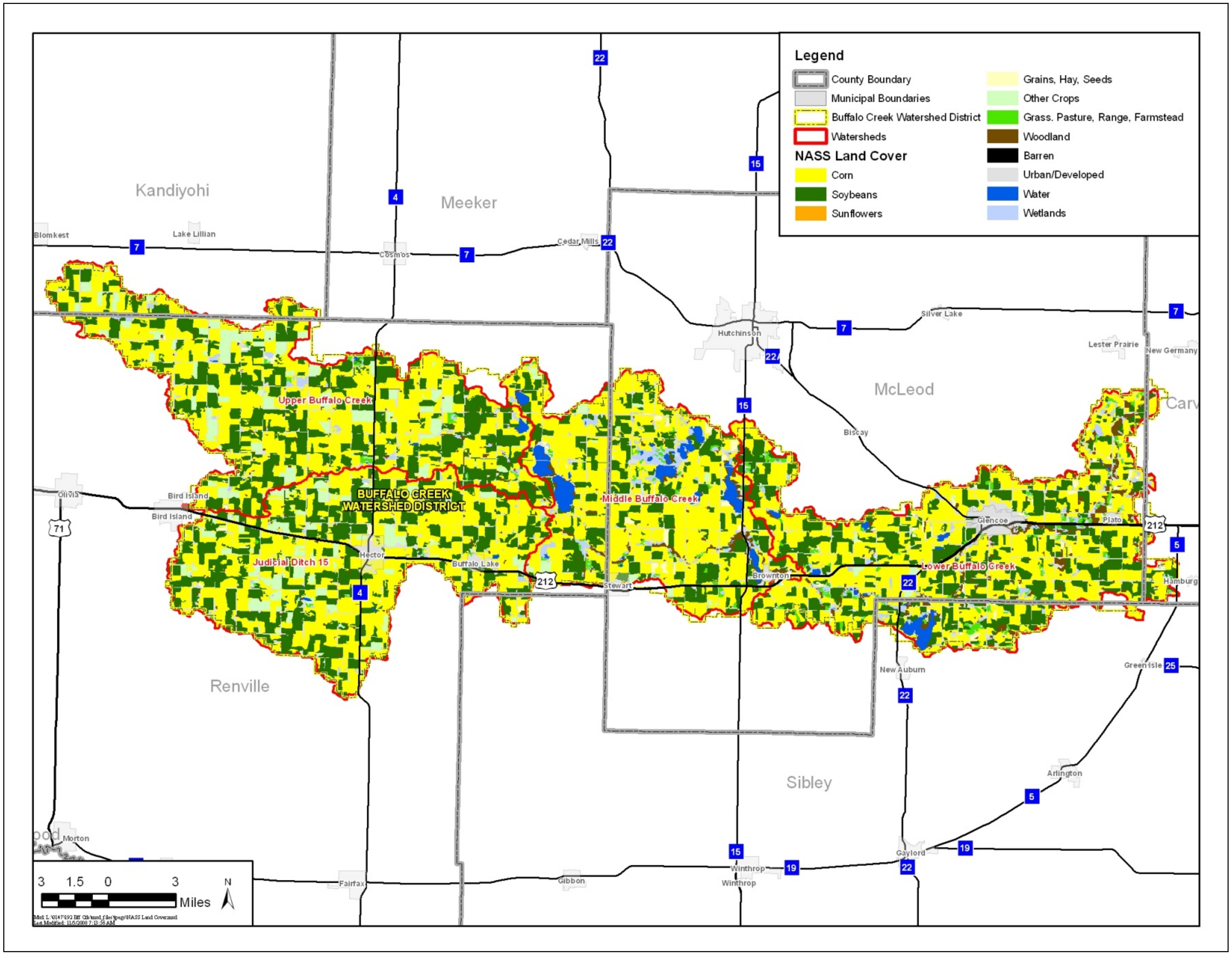

Figure 2-3 Land Cover in the Buffalo Creek Watershed

3.0 Water Quality Data Assessment

3.1 BACTERIA DATA

All bacteria data utilized for the development of this TMDL are grab samples collected by the Crow River Organization of Waters (CROW) between April 1 and October 31 from 2001 through 2009. Although data prior to this period exists, the more recent data better represent current conditions in the watershed. Samples collected between 2001 and 2005 were analyzed for fecal coliform and then *E. coli* beginning in 2006 (Table 3.1). Figure 1.1 shows the location of the monitoring stations at which samples were collected to support this TMDL. All data was obtained through Minnesota Pollution Control Agency's STORET online database.

Table 3-1 Bacteria data collected at each Buffalo Creek monitoring station

Site	*STORET ID*	*Parameter*	*Year(s)*	*N*	*Paired*
CSAH24	S002-017	Fecal Coliform	03	3	none
		E. coli	06-09	49	
JD-15	S002-016	Fecal Coliform	01,03	5	none
		E. coli	06-09	49	
Brownton	S000-460	Fecal Coliform	01,03	5	none
		E. coli	06-09	48	
Glencoe	S000-582	Fecal Coliform	01,03	5	none
		E. coli	06-09	49	

It should be noted that three of the four monitoring sites (Glencoe, Brownton and CSAH24) are located within the two impaired reaches of Buffalo Creek. The JD-15 monitoring site is located outside the listed reaches but appears to be a major contributor to the lower reach (501) impairment. Thus, this reach will be included in the data assessments presented throughout this report.

3.2 FLOW DATA

In order to aid in developing the linkage between bacteria violations and potential sources, streamflow was also important. Flow data was used to develop flow regimes so that bacteria violations for each reach could be characterized based on whether they occurred most frequently during high, medium, or low flow events. This information helps provide insight on potential sources during low/base-flow as well as storm/run-off related events. There are four historic flow monitoring stations within the Buffalo Creek Watershed, three of which are located within the two reaches impaired for bacteria (Table 3.2 and Figure 1.1). The four monitoring stations coincide with the bacteria grab sample sites. Flow was monitored at S000-582 and S000-460 for two sampling seasons (2008-2009) and only one season (2008) at stations S002-017 and S002-

016. Flow data prior to 2008 was needed to analyze the bacteria data collected from 2001-2007. To do this, data from two downstream monitoring stations located outside the listed reaches (S000-050 and S000-165) were included in this report. These stations have long continuous flow records and were used to help fill data gaps and predict non-monitored flow at the Buffalo Creek stations.

Table 3-2 Flow monitoring stations within the Buffalo Creek watershed. Also shown are flow stations located downstream on the South Fork Crow River (Mayer) and Crow River (Rockford).

STORET ID	Location	DNR ID	USGS ID	Provider	Years of Operation since 2000	Flow Record Length (Days)	Notes
S002-017	Buffalo Cr at CSAH24	19069001	--	DNR/PCA	08	193	In listed reach (502)
S002-016	JD-15 west of CSAH20	19073001	--	DNR/PCA	08	173	Not in listed reaches
S000-460	Buffalo Cr at CR25, Brownton	19056001	--	DNR/PCA	08-09	488	In listed reach (501)
S000-582	Buffalo Cr at CSAH1, Glencoe	19043001	--	DNR/PCA	08-09	477	In listed reach (501)
S000-165	S. Fork Crow at St Hwy 7, Mayer	19082001	--	DNR/PCA	06-08	730	Outside of listed area
S000-050	Crow River at St Hwy 55, Rockford	18087001	05280000	USGS	00-09	3611	Outside of listed area

3.3 BACTERIA DATA ASSESSMENT

Data from the four monitoring sites within the Buffalo Creek watershed were analyzed to determine spatial and seasonal variability of bacteria violations. Since the bacteria standard is now expressed as *E. coli*, all fecal coliform data (pre 2006) was converted to *E. coli* “equivalent” values using the equation discussed in Section 1.3 and combined with the *E. coli* data collected (post 2006) to provide the data set for which the assessments are based. Table 3.3 and Figure 3.1 summarize the *E. coli* bacteria data set (by site) available for the project area, showing the total number of samples and monthly geomeans.

Table 3-3 Impairment assessment data for each stream monitoring station (2001-2009 data). Shaded values are those where monthly geomean exceeds the chronic *E coli* standard of 126 organisms per 100 milliliters

Site	Month						
	April	May	June	July	August	September	October
CSAH 24	20	41	292	98	323	249	210
JD-15	72	91	534	528	427	683	920
Brownton	32	53	376	372	420	518	330
Glencoe	25	50	514	281	669	600	140

Figure 3-1 Monthly *E. coli* geomeans for each monitoring station located within the Buffalo Creek Watershed. Numbers above each bar denote the number of samples used in the calculation of the geomean
.

Listing Criteria also requires that no more than 10% of samples for any given month exceed the "acute" standard of 1,260 organisms per 100 milliliters. Table 3.4 summarizes how often the acute standard has been exceeded at the four monitoring stations for each calendar month.

Table 3-4 Acute *E. coli* exceedances at each monitoring station in the Buffalo Creek Watershed.

	CSAH 24			JD-15			Brownton			Glencoe		
Month	N (total)	N (above acute)	Percent	N (total)	N (above acute)	Percent	N (total)	N (above acute)	Percent	N (total)	N (above acute)	Percent
April	7	0	0%	7	0	0%	7	0	0%	14	0	0%
May	6	0	0%	6	0	0%	6	0	0%	12	0	0%
June	14	2	14%	12	3	25%	12	3	25%	25	7	28%
July	8	1	13%	10	1	10%	9	1	11%	18	3	17%
Aug	11	3	27%	13	1	8%	13	2	15%	26	7	27%
Sep	5	0	0%	5	2	40%	5	1	20%	10	3	30%
Oct	1	0	0%	1	0	0%	1	0	0%	2	0	0%

As part of the assessment of the data, it is often helpful to determine the severity of the impairment by calculating a percent reduction needed to meet water quality standards. The reduction percentage is provided here as a general way to characterize the magnitude of exceedance and provide insight of the level of effort needed within the watershed to achieve the standard. It is not a required element of a TMDL. To calculate the percent reduction needed, the following equation is used:

$$\frac{\text{MONTHLY GEOMEAN} - \text{WATER QUALITY STANDARD}}{\text{Monthly geomean}} = \text{PERCENT REDUCTION}$$

For the purposes of this analysis, bacteria data from the Brownton and Glencoe sites on the lower impaired reach were combined into one dataset (Table 3.5). The focus of this TMDL is on reaching the "chronic" standard of 126 cfu/ 100 ml. It is believed that achieving the necessary reductions to meet the chronic standard will also meet the goal for the acute standard (MPCA 2002).

Table 3-5 Estimate of Percent Reduction Needed to Reach Chronic *E coli* Standard, by Month and Reach

Reach	% Reduction Needed						
	April	May	June	July	Aug	Sept	Oct
Headwaters to JD-15	None	None	57%	None	61%	49%	40%
JD-15 to South Fork confluence	None	None	72%	61%	76%	77%	41%

These data show that:

- The reaches of Buffalo Creek listed as impaired do not meet the bacteria standard for the April through October period based on the most recent 10 year period of record.
- Monthly geomeans for bacteria concentrations at monitoring sites on the mainstem of Buffalo Creek are below the standard for the months of April and May and exceed the standard at all stations from June through October. October is the only month for which the minimum five sample threshold cited in the standard is not met.
- The severity of the bacteria impairments on Buffalo Creek appears to increase significantly below the Creek's confluence with JD-15. Further, elevated bacteria concentrations in JD-15 itself may well be a substantial contributor to the impairments on the lower reach of Buffalo Creek, depending on JD-15 discharge.

- At least 10% of the monthly samples at all stations exceed the acute standard violation (1,260 cfu/100mL) on Buffalo Creek from June through September. The magnitude of exceedances of the acute standard in Buffalo Creek for the June-September period increases markedly below JD-15.

3.4 FILLING FLOW DATA GAPS

While bacteria samples were collected throughout Buffalo Creek for 5-6 sampling seasons, there are only 1-2 years of continuous flow data available within the two listed reaches (Table 3.2). Flow regressions between Buffalo Creek stations and downstream monitoring sites were used to fill data gaps and create a continuous 10-year flow record for each reach.

The Rockford station (S000-050) on the main-stem of the Crow River downstream of the junction of the North and South Fork branches has the longest and most complete flow record in the Crow River watershed (Table 3.2 and Figure 3.6). Regressions between the Rockford station and the downstream most station in reach 501 (Glencoe Station S000-582), 502 (CSAH24 Station S002-017) and JD-15 were explored but showed poor correlation during certain sampling seasons and flow regimes. A better relationship was established between the two Buffalo Creek flow stations and the continuous monitoring station on the South Fork Crow River at Mayer (Figures 3.2 through 3.5).

The Mayer station was not established until 2006 so these relationships alone cannot be relied on to complete flow records for the past 10 years. The Rockford-Crow and Mayer-South Fork Crow stations average daily flows showed a very good relationship ($R^2 = 0.96$) which was used to establish a reliable 10-year record for the South Fork Crow Mayer station (Figure 3.5). This 10-year flow record and the regression relationships between the Mayer site and the two Buffalo Creek stations were then used to simulate 10-year flow records at the downstream monitoring station in each listed reach (Figure 3.6).

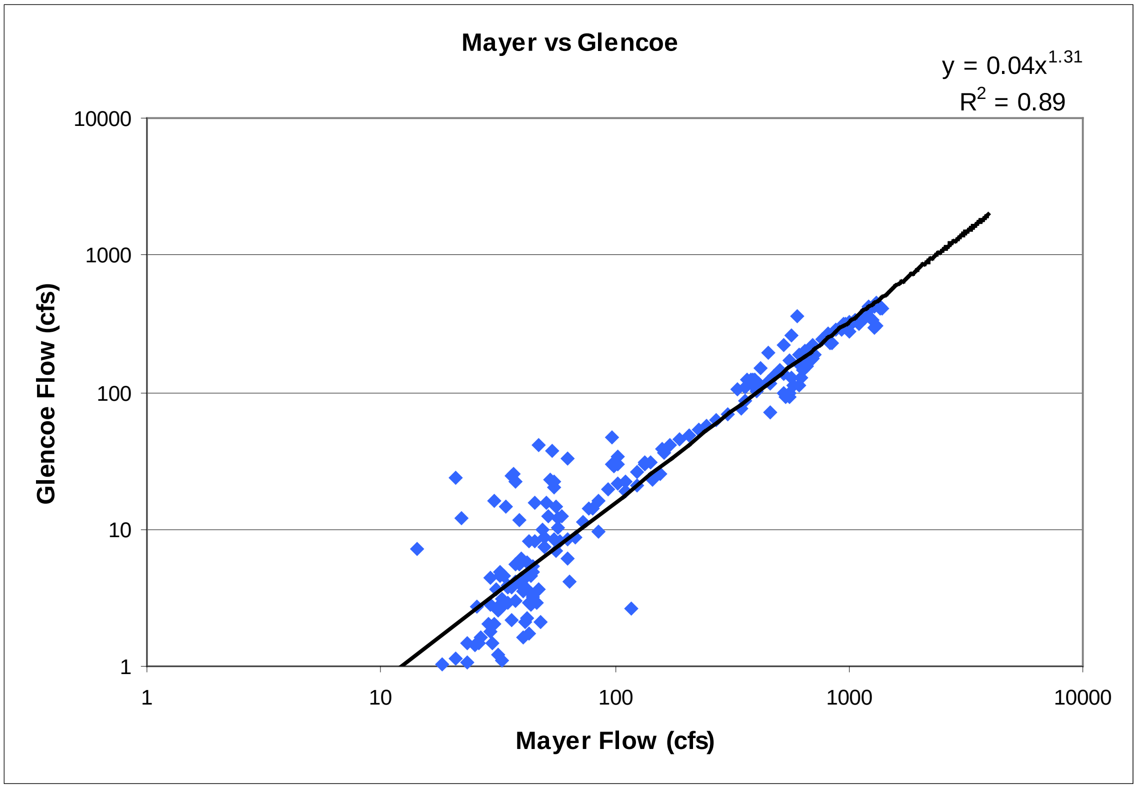

Figure 3-2 Average daily flow regression between the Mayer and Glencoe monitoring stations.

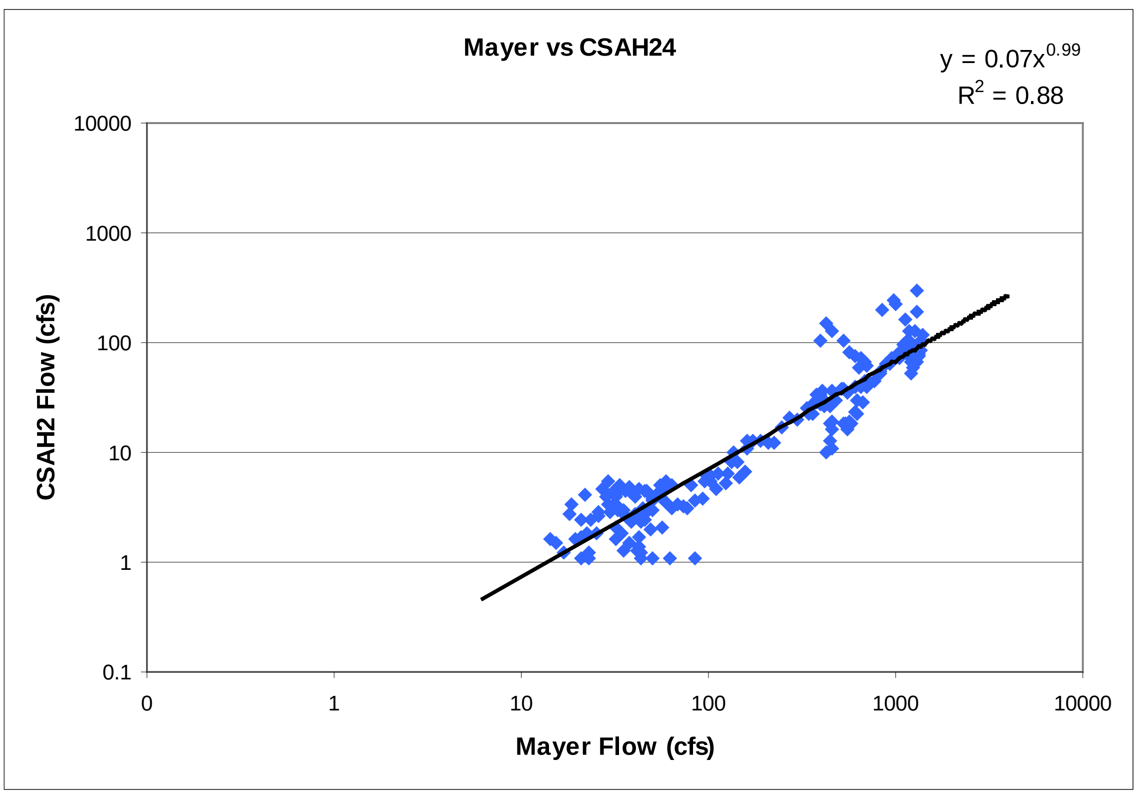

Figure 3-3 Average daily flow regression between the Mayer and CSAH24 monitoring stations.

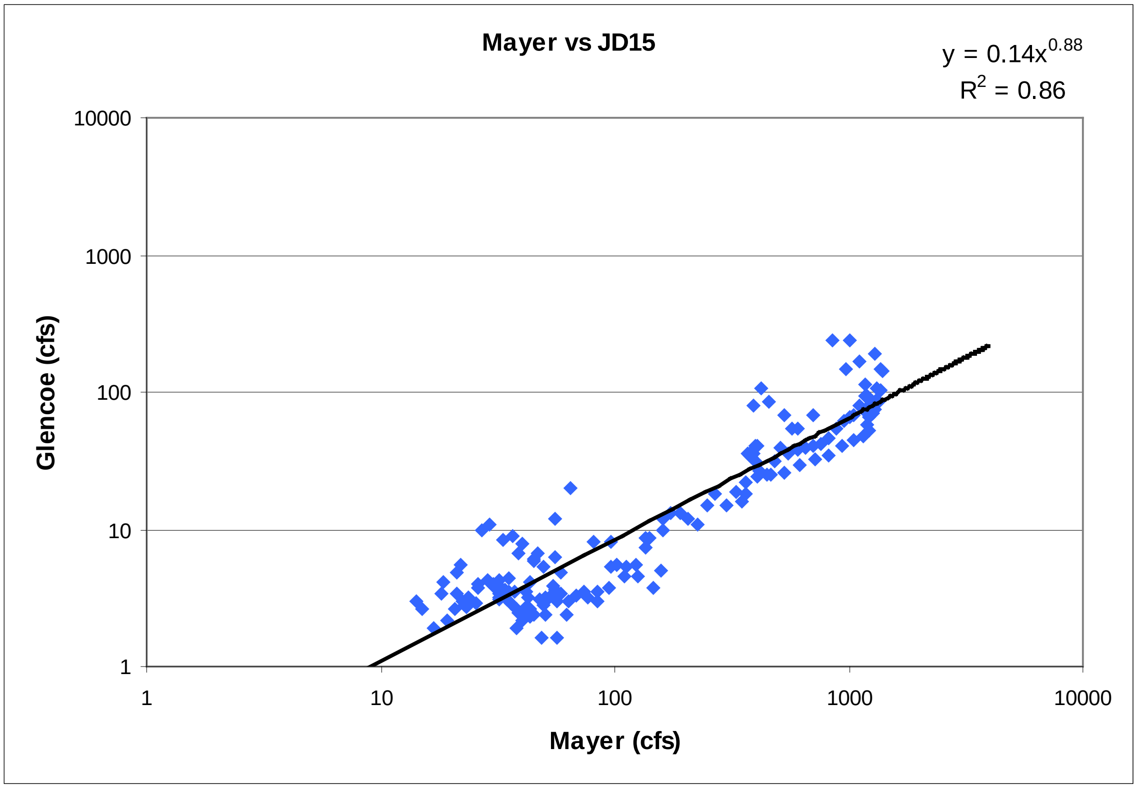

Figure 3-4 Average daily flow regression between the Mayer and JD-15 monitoring stations.

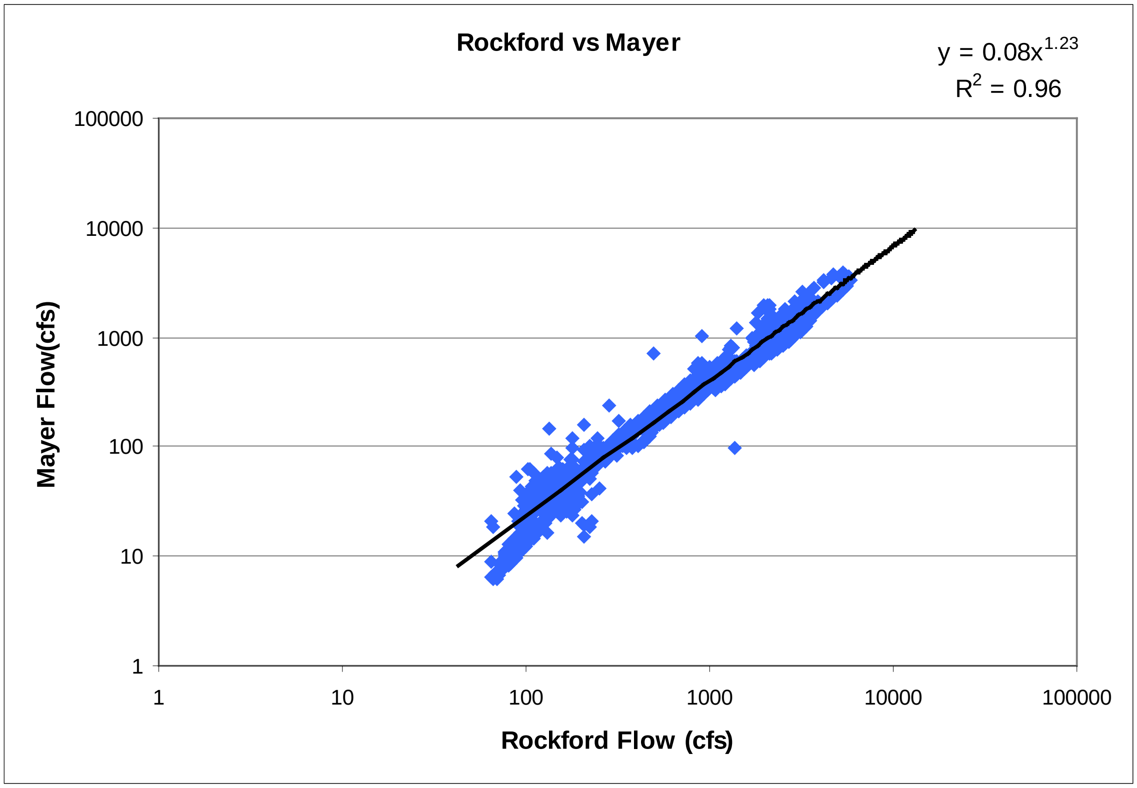

Figure 3-5 Average daily flow regression between the Rockford (lower Crow River) and Mayer (South Fork Crow) monitoring stations

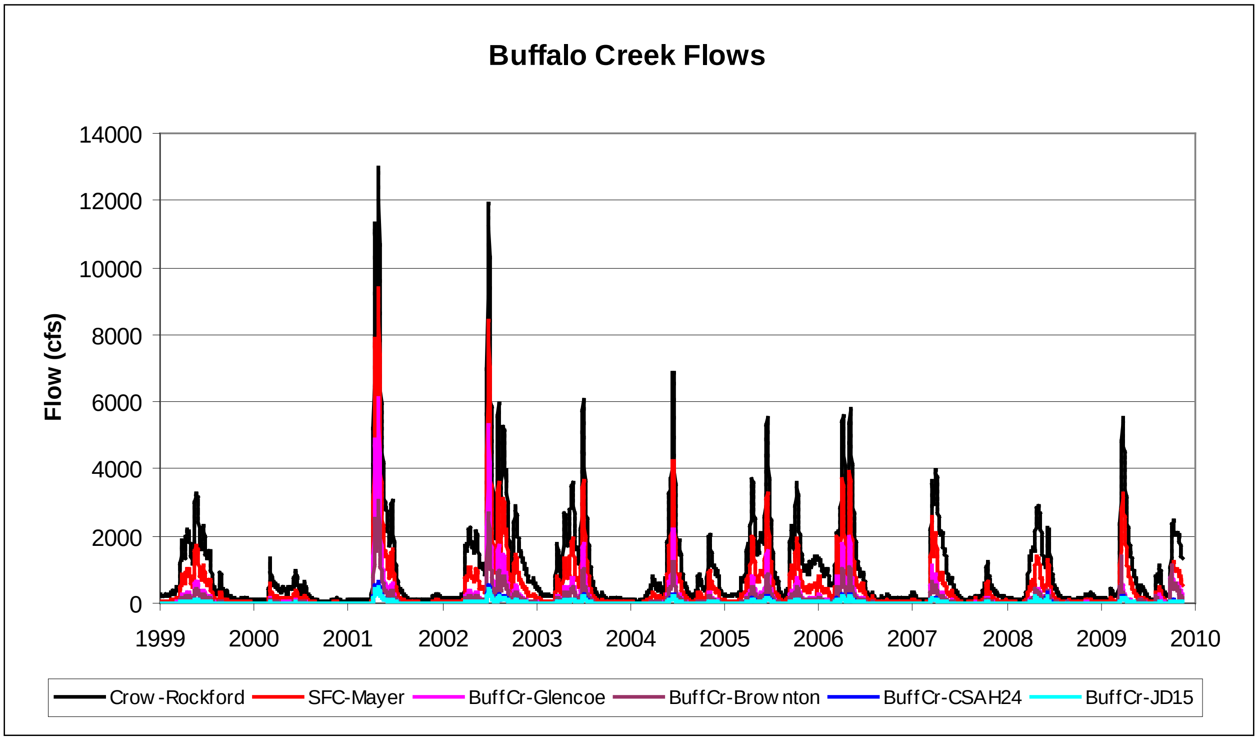

Figure 3-6 Monitored and simulated 10-year flow record for all Buffalo Creek stations. Also shown are the downstream stations (Rockford and Mayer) used to fill data gaps in the Buffalo Creek flow records.

4.0 TMDL Allocation

4.1 ALLOCATION APPROACH

Assimilative capacities for each reach were developed from load duration curves (Cleland 2002). Load duration curves assimilate flow and *E. coli* data across stream flow regimes and provide assimilative capacities and necessary load reductions required to meet water quality standards.

Flow duration curves were developed using the 10-year average daily flow records discussed in Section 3.4. The curved line relates mean daily flow to the percent of time those values have been met or exceeded (Figure 4.1). For example, at the 50% exceedance value for the Glencoe monitoring station (Reach 501), the stream was at 22 cubic feet per second or greater 50% of the time. The 50% exceedance is also the midpoint or median flow value. The curve is then divided into flow zones including very high (0-10%), high (10-40%), mid (40-60%), low (60-90%) and dry (90 to 100%) flow conditions.

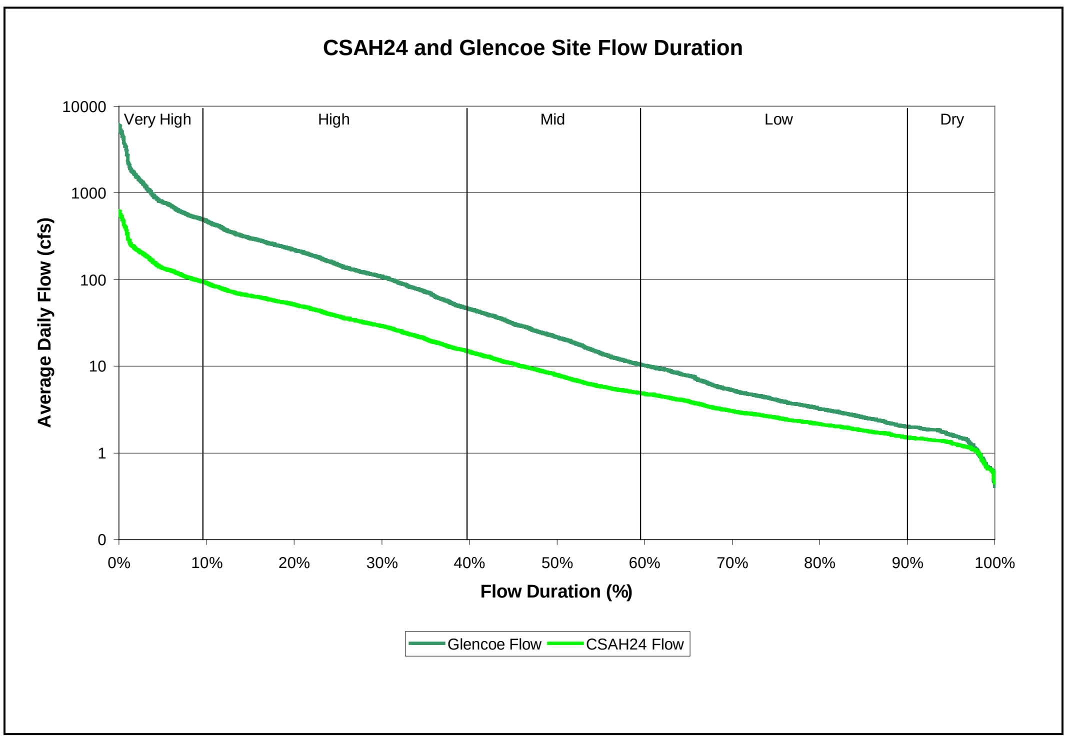

Figure 4-1 Flow duration curves for the Glencoe and CSAH24 monitoring stations. These curves were developed based on continuous average daily flow records over the last ten years (2000-2009).

The *E. coli* listing criteria is based on analyzing monitored grab samples in terms of monthly geomeans from April through October. Thus, it is more appropriate to create load duration curves for this time period using average monthly flow, not average daily flow. To do this, average monthly flows (represented in cfs) for the 10-year flow record were calculated for April through October only and multiplied by the chronic *E. coli* standard (126 cfu/100 mL). This value was then converted to a daily load in billions of organisms per day (Figure 4.2). Now the line represents the assimilative capacity of the stream for each month represented as average daily flow. To develop the TMDL, the median load of each flow zone is used to represent the total daily loading capacity (TDLC) for that flow zone. Necessary reductions to meet current state water quality standards were discussed in Section 3.3.

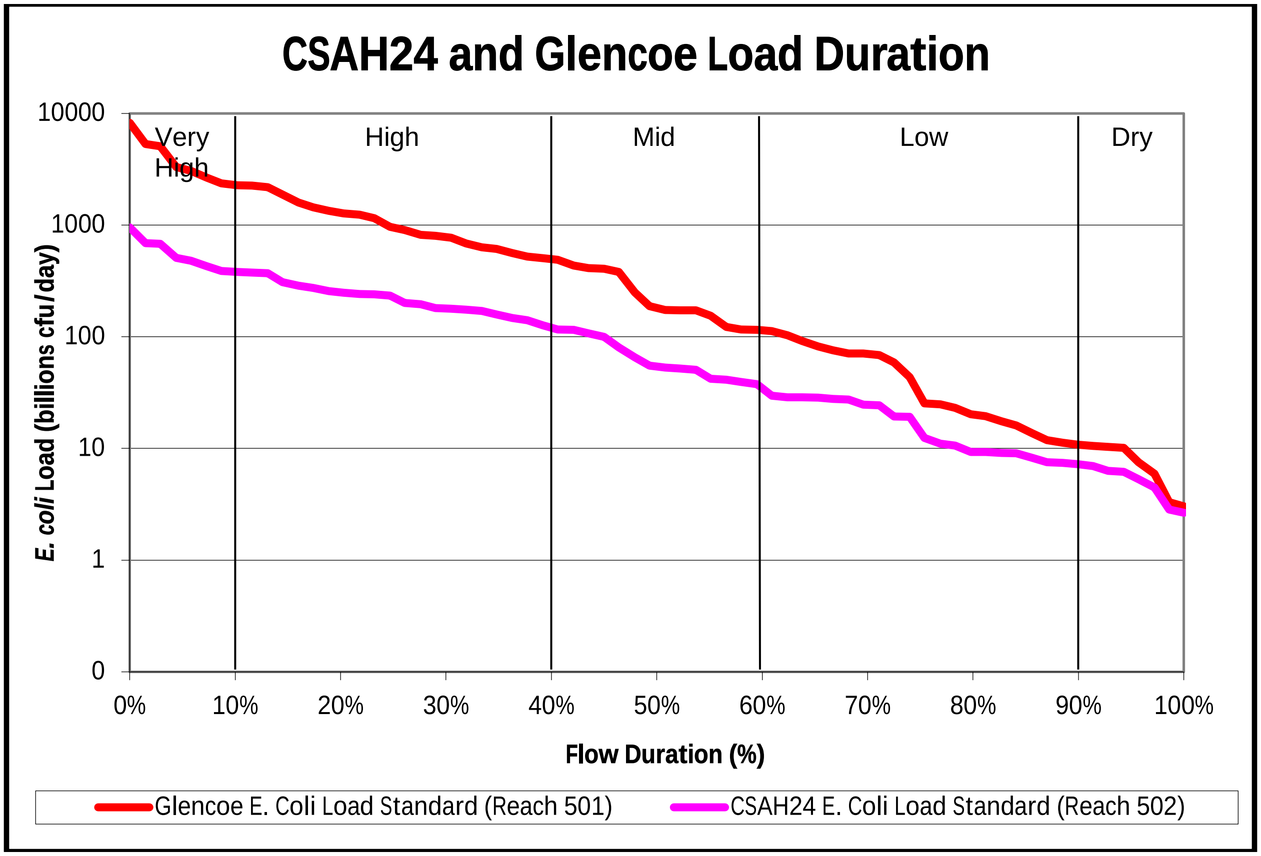

Figure 4-2 CSAH 25 (Reach 502) and Glencoe (Reach 501) station *E. coli* load duration curves. These curves represent the maximum allowable daily *E. coli* load (based on the 126 cfu/100mL *E. coli* standard) and were developed using monthly flows (represented as average daily flow in cfs) from April through October over the past 10 years.

4.2 WASTELOAD AND LOAD ALLOCATIONS

The wasteload allocations were divided into four primary categories including permitted point source dischargers, MS4 permits, and construction and industrial stormwater. The load allocation is the remaining load after the Wasteload Allocations and Margin of Safety are subtracted. Following is a description of how each of these load allocations was estimated.

4.2.1 Point Source Dischargers

There are five wastewater treatment facilities and two industrial wastewater dischargers in the Buffalo Creek watershed (Table 4.1; Figure 4.3). The industrial wastewater dischargers (Seneca Foods Corp. and Minnesota Energy) are presented in Table 4.1 but are not included in the TMDL wasteload allocations since effluent from these facilities are not believed to contain *E. coli*. All of the wastewater treatment facilities discharge to JD-15 or the main-stem of Buffalo Creek below its junction with JD-15 and are therefore included in allocations for Reach 501. Load allocations for continuous point sources were calculated by multiplying the facility's discharge design flow by the *E. coli* standard (126 cfu/100 mL).

For continuous point sources, the facility's daily discharge design flow was assumed to equal its daily inflow capacity. Since stabilization ponds only discharge a few times a year, effluent volumes greatly exceed daily influent flows. Effluent volumes for these systems are calculated by multiplying the ponds' surface area, volume and average daily drawdown (typically 6 inches per day) during discharge. Current discharge design flows for each permitted point source were provided by the MPCA and presented in Table 4-1.

Discharge monitoring reports (DMRs) were downloaded to assess the typical monthly geomean bacteria concentrations at which each facility discharges. It should be noted that NPDES point source permit limits for bacteria are currently expressed in fecal coliform concentrations, not *E. coli*. However, the fecal coliform permit limit for each wastewater treatment facility (200 organisms/100 mL) is thought to be equivalent to this TMDL's 126 organism/100 mL *E. coli* criterion. The fecal coliform-*E. coli* relationship is discussed in Section 1.3 of this TMDL and documented extensively in the SONAR for the 2007-2008 revisions of Minnesota Rule Chapter 7050.

Table 4-1 Description of industrial and wastewater treatment facilities in the Buffalo Creek watershed and allocated loadings for Reach 501.

Facility Name	NPDES ID#	Facility Type	Receiving Water	Design Flow (MGD)	Allocated Load (billions organisms/day)
Glencoe WWTF	MN0022233	Continuous	Main-stem Buffalo Cr	2.60	12.40
Brownton WWTF	MN0022951	Continuous	Main-stem Buffalo Cr	0.20	0.94
Stewart WWTF	MNG580077	3-cell pond	Main-stem Buffalo Cr	0.84	4.01
Buffalo Lake WWTF	MN0050211	3-cell pond	JD-15	1.74	8.30
Hector WWTF	MN0025445	Continuous	JD-15	0.66	3.15
*Seneca Foods Corp	MN0001236	Controlled pond discharge (SD2)	Unnamed ditch to Buffalo Cr	*5.00	NA
*Seneca Foods Corp	MN001236	Continuous but seasonal (SD1)	Unnamed ditch to Buffalo Cr	*0.40	NA
*Minnesota Energy	MN0063151	Detention pond	JD-15	*0.12	NA
Permitted WWTF Totals				**6.04**	**28.79**

*Effluent from the Seneca Foods and Minnesota Energy Industrial facilities are not believed to contain the pollutant of concern and are not included in the TMDL wasteload allocation calculations.

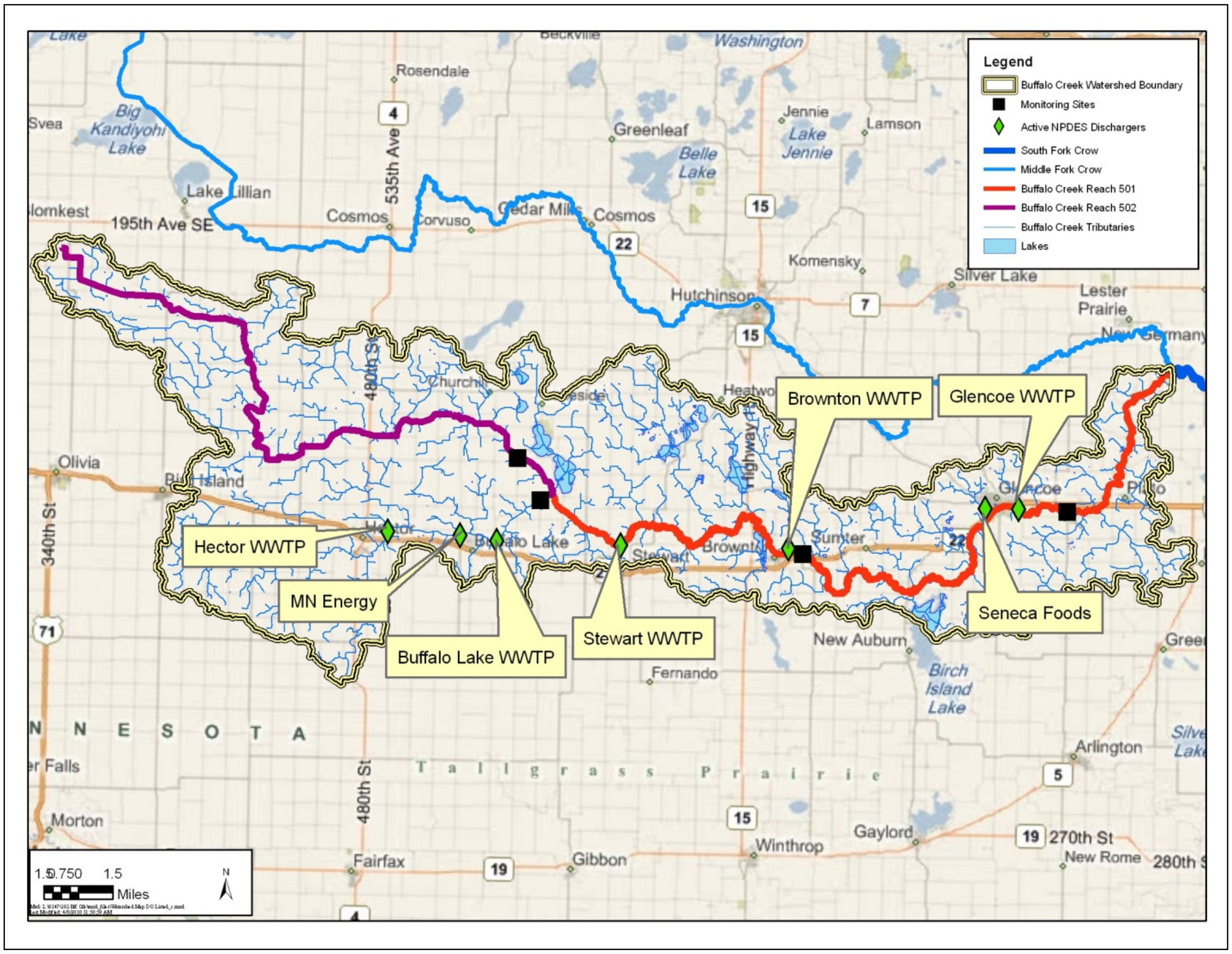

Figure 4-3 Location of active NPDES point source dischargers in the Buffalo Creek Watershed.

4.2.2 MS4

The City of Glencoe (Reach 501) is a designated MS4 community. Other TMDL studies have allocated MS4s by multiplying the municipalities' percent watershed coverage by the total watershed loading capacity after the MOS and wasteload allocation have been subtracted (MPCA, 2006). Applying this method to the Buffalo Creek watershed would result in a conservative allocation given the increased runoff from urban areas and Glencoe's proximity to the main-stem of Buffalo Creek. Instead, Glencoe's MS4 allocation was calculated using the following equation for urban runoff (MPCA, 2008):

$$Q = C\, i\, A$$

Where:
Q = peak runoff rate (in cfs)
C = runoff coefficient
i = rainfall (inches per hour)
A = urbanized area (acres)

This equation is intended to estimate runoff from small sites but is used here because it is a simple equation with minimal inputs that accounts for higher runoff rates in urban areas. A runoff coefficient of 0.75 was chosen to represent a mixture of multi-family and industrial landuse (MPCA, 2008). Monthly rainfall totals for the past 10 years from April through October were downloaded from the Glencoe Municipal Airport. Glencoe MS4 area (A) was calculated in GIS using the MS4 shapefile available through the MPCA's website (www.pca.state.mn.us/). Monthly runoff volumes were calculated for the entire 10-year period in which flow monitoring data was available. Total runoff volumes were divided by total observed flow at the Glencoe monitoring station to estimate MS4 runoff potential as a percent of total observed streamflow in Buffalo Creek. This value (approximately 2.59 %) was then used to calculate the proportion of reach 501's total loading capacity allocated to the Glencoe MS4.

4.2.3 Construction and Industrial Stormwater

Review of National Pollutant Discharge Elimination System (NPDES) construction permits in the watershed showed minimal construction activities (<0.1% of the watershed area). The wasteload allocation was determined based on estimated percentage of land in the impaired reach watersheds. To account for future growth (reserve capacity), allocations in the TMDL were rounded to one percent. Construction storm water activities are considered in compliance with provisions of the TMDL if they obtain a Construction General Permit under the NPDES program and properly select, install and maintain all BMPs required under the permit, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

There are currently no industrial stormwater permits in the Buffalo Creek watersheds. Although there are no permitted industrial facilities, to account for future growth (reserve capacity), allocations for industrial stormwater in the TMDL are set at a half percent. Under all flow regimes, industrial stormwater is allocated less than one percent of the total loading capacity. Industrial storm water activities are considered in compliance with provisions of the TMDL if they obtain an industrial stormwater permit or General Sand and Gravel permit (MNG49) under the NPDES program and properly select, install and maintain all BMPs required under the permit.

4.3 MARGIN OF SAFETY (MOS)

The margin of safety (MOS) accounts for uncertainties in both characterizing current conditions and the relationship between the load, wasteload, monitored flows and in-stream water quality. The purpose of the MOS is to account for uncertainty that the allocations will result in attainment of water quality standards. An explicit MOS equal to 10% of the total load was used for this TMDL report. This means that 10% of the loading capacity for each flow regime was subtracted before allocations were made among sources. A similar MOS approach was applied in the Groundhouse River TMDL (MPCA, 2009).

4.4 TOTAL MAXIMUM DAILY LOADS

Tables 4.2 and 4.3 present the total loading capacity, margin of safety, wasteload allocations and the remaining non-point source load allocations for reaches 501 and 502 of Buffalo Creek. The tables also present load allocations in terms of the percent of total loading capacity in each flow category. The load allocation is the remaining load after the previously described Wasteload Allocations and Margin of Safety are subtracted. All five NPDES wastewater treatment facility dischargers are located in the reach 501 watershed while none are located in reach 502. It is important to point out that total permitted wastewater treatment design flow exceeds the median observed total daily flow for the low and dry flow zones. Thus, it is safe to assume the facilities do not operate at their permitted values during these flow conditions. All point source dischargers will be in compliance of the state standard and this TMDL as long as their effluent *E. coli* concentrations do not exceed 126 cfu/100 mL. Since it is impossible to assign a numeric value for the NPDES dischargers based on permitted design flows for the two low-flow zones, allocations will be represented by the following equation:

Allocation = (flow contribution from source) X (126 organisms/100 mL)

This equation ensures current facilities will meet wasteload allocations if they begin discharging at their permitted design flows during low-flow conditions. Likewise, any new point source discharger will meet wasteload allocations as long as their effluent bacteria concentrations are below the 126 cfu/100mL *E. coli* standard.

Table 4-2 Reach 501 TMDL load allocations for each flow zone

Buffalo Creek 07010205-501		Flow Zones				
		Very High	High	Mid-Range	Low	Dry
		E. coli Load (billions of organisms/day)				
Total Daily Loading Capacity		3301.94	963.38	180.97	25.38	7.51
Margin of Safety (MOS)		330.19	96.34	18.10	2.54	0.75
Wasteload Allocations	Permitted Point Source Dischargers	28.79	28.79	28.79	*	*
	MS4 Communities	85.52	24.95	4.69	0.66	0.19
	Construction Stormwater	33.02	9.63	1.81	0.25	0.08
	Industrial Stormwater	16.51	4.82	0.90	0.13	0.04
Load Allocation	Nonpoint source	2807.91	798.85	126.68	21.80	6.45
Value expressed as percentage of total daily loading capacity						
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Wasteload Allocation	Permitted Point Source Dischargers	0.9%	3.0%	15.9%	*	*
	MS4 Communities (Glencoe)	2.6%	2.6%	2.6%	2.6%	2.6%
	Construction Stormwater	1.0%	1.0%	1.0%	1.0%	1.0%
	Industrial Stormwater	0.5%	0.5%	0.5%	0.5%	0.5%
Load Allocation	Nonpoint source	85.0%	82.9%	70.0%	85.9%	85.9%

*Note - Monthly permitted point source effluent *E. coli* concentrations under this TMDL are not to exceed 126 organisms/100 mL. Permitted point source allocation values were calculated but not factored in to these allocations since facilities do not operate at their permitted design flow under these flow conditions. Instead, point source discharge allocations for the low and dry flow zones are represented by the following equation: Allocation = (flow contribution from source) X (126 organisms/100 mL).

Table 4-3 Reach 502 TMDL allocations for each flow zone.

Buffalo Creek 07010205-502		Flow Zones: Very High	High	Mid-Range	Low	Dry
		E. coli Load (billions of organisms/day)				
Total Daily Loading Capacity		508.10	233.61	53.95	12.43	5.31
Margin of Safety (MOS)		50.81	23.36	5.39	1.24	0.53
Wasteload Allocations	Permitted Point Source Dischargers	0.00*	0.00*	0.00*	0.00*	0.00*
	MS4 Communities	0.00	0.00	0.00	0.00	0.00
	Construction Stormwater	5.08	2.34	0.54	0.12	0.05
	Industrial Stormwater	2.54	1.17	0.27	0.06	0.03
Load Allocation	Nonpoint source	449.67	206.75	47.74	11.00	4.70
Value expressed as percentage of total daily loading capacity						
Total Daily Loading Capacity		100.0%	100.0%	100.0%	100.0%	100.0%
Margin of Safety (MOS)		10.0%	10.0%	10.0%	10.0%	10.0%
Wasteload Allocation	Permitted Point Source Dischargers	0.0%*	0.0%*	0.0%*	0.0%*	0.0%*
	MS4 Communities (Glencoe)	0.0%	0.0%	0.0%	0.0%	0.0%
	Construction Stormwater	1.0%	1.0%	1.0%	1.0%	1.0%
	Industrial Stormwater	0.5%	0.5%	0.5%	0.5%	0.5%
Load Allocation	Nonpoint source	88.5%	88.5%	88.5%	88.5%	88.5%

*Note – There are currently no permitted point source dischargers located within the watershed for this listed reach. If point source(s) are established, their monthly geomean effluent *E. coli* concentrations shall not exceed 126 organisms/100mL under this TMDL. Future permitted point source discharge allocations will be represented by the following equation: Allocation = (flow contribution from source) X (126 organisms/100 mL)

4.5 IMPACT OF GROWTH ON ALLOCATIONS

4.5.1 Point Sources

Additional loads from future dischargers or expansion of existing facilities will be offset by the increased flow associated with the discharge adding to the overall capacity of the receiving water. Consequently, as long as dischargers are held to the current 126 cfu/100mL *E. coli* standard, future point sources will not impact attainment of the water quality standards.

4.5.2 Municipal Storm Sewer Systems

Glencoe is currently the only MS4 community in the watershed although there are several other smaller municipalities. There are no current plans to expand or develop MS4 communities in the watershed for the foreseeable future. However, the MS4 allocation method used for reach 501's TMDL should allow for moderate expansions within the existing boundary of the MS4 watershed.

4.5.3 Agriculture Practices

The amount of land in agricultural land use in the Buffalo Creek watershed is likely to remain fairly constant over the next several decades. The watershed is comprised mainly of row crops (corn and soybeans) with some land used for pasture and hay. While the majority of the landscape is likely to remain in an agricultural land use, it is possible a modest shift between pasture/hay and row crops may occur. Any such shift would likely not affect the loading capacity of the stream, since that capacity is based on long-term flow records over which time land use changes have likely occurred. Thus, slight shifts in land use should not appreciably change the magnitude of the land use runoff variability that the period of record already reflects.

5.0 Linking Impairments and Potential Sources

This section is intended to present information that is helpful in identifying the potential sources of elevated bacteria concentrations in Buffalo Creek. The first section addresses seasonal influences and looks at the relationships between elevated bacteria concentrations and flow. The second section addresses the potential influence of an industrial operation on high bacteria concentrations in JD-15. The final section contains estimates of the potential sources of bacteria available for transport by source category.

5.1 CRITICAL CONDITON AND SEASONAL VARIATION

Seasonal geomeans of bacteria data were calculated for each of the two bacteria-impaired reaches of Buffalo Creek (Table 5.1). These show geomeans for *E. coli* bacteria are consistently above the applicable standard for summer and fall but below the standard in spring. April and May are usually the months with the lowest bacteria concentrations, despite the fact that there is little crop canopy cover, surface runoff is typically high and there is often significant manure application during this time. This suggests seasonality of bacteria concentrations may be influenced by stream water temperature. Fecal bacteria are most productive at temperatures similar to their origination environment in animal digestive tracts. Thus, these organisms are expected to be at their highest concentrations during warmer summer months when streamflow is typically low and water temperatures are highest. High *E. coli* concentrations appear to continue in to the fall which may be attributed to re-application of manure.

Table 5-1 Bacteria data by season in the Buffalo Creek Watershed.

Site	Spring (April-May)		Summer (June-Aug)		Fall (Sept-October)		Total	
	N	Geomean	N	Geomean	N	Geomean	N	Geomean
S000-017 Buffalo Creek at CSAH 24	13	28	33	228	6	242	52	136
S002-016 JD-15 near Buffalo Lake	13	81	35	489	6	718	54	328
S000-460 Buffalo Creek below Brownton	13	40	34	391	6	480	53	229
S000-582 Buffalo Creek below Glencoe	13	34	35	485	6	469	54	255

Figures 5.1 and 5.2 are 10-year flow duration plots for the downstream- most monitoring stations in reaches 501 and 502. The bacteria data are plotted as discrete data points rather than seasonal or monthly geomeans in order to expose specific events (i.e. storms, drought conditions) that can influence streamflow and bacteria concentrations. The *E. coli* points are color coded to show how season and flow regime influence bacteria concentrations.

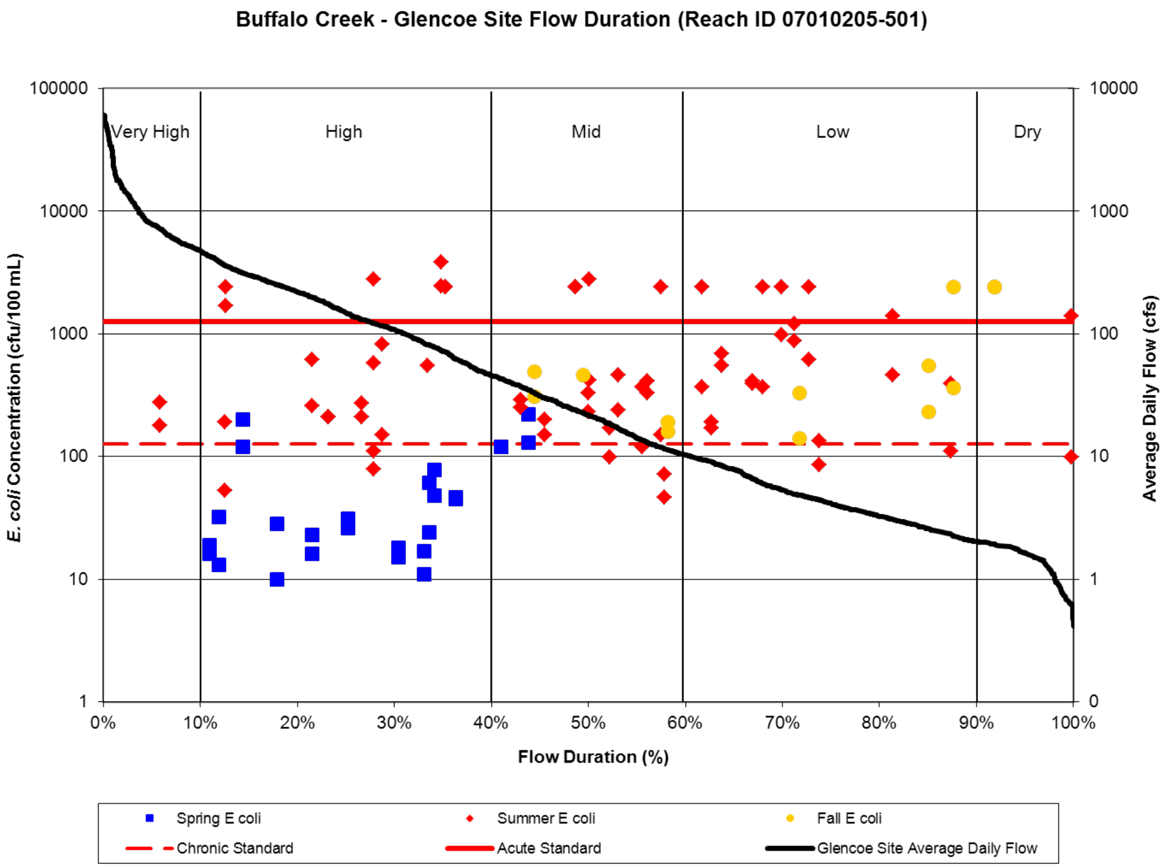

Figure 5-1 Reach 501 *E. coli* concentration by season and flow regime. Flow frequencies were developed using average daily flows over the past 10 years from the Glencoe monitoring station. Bacteria data from the Brownton and Glencoe stations were combined and plotted as one dataset.

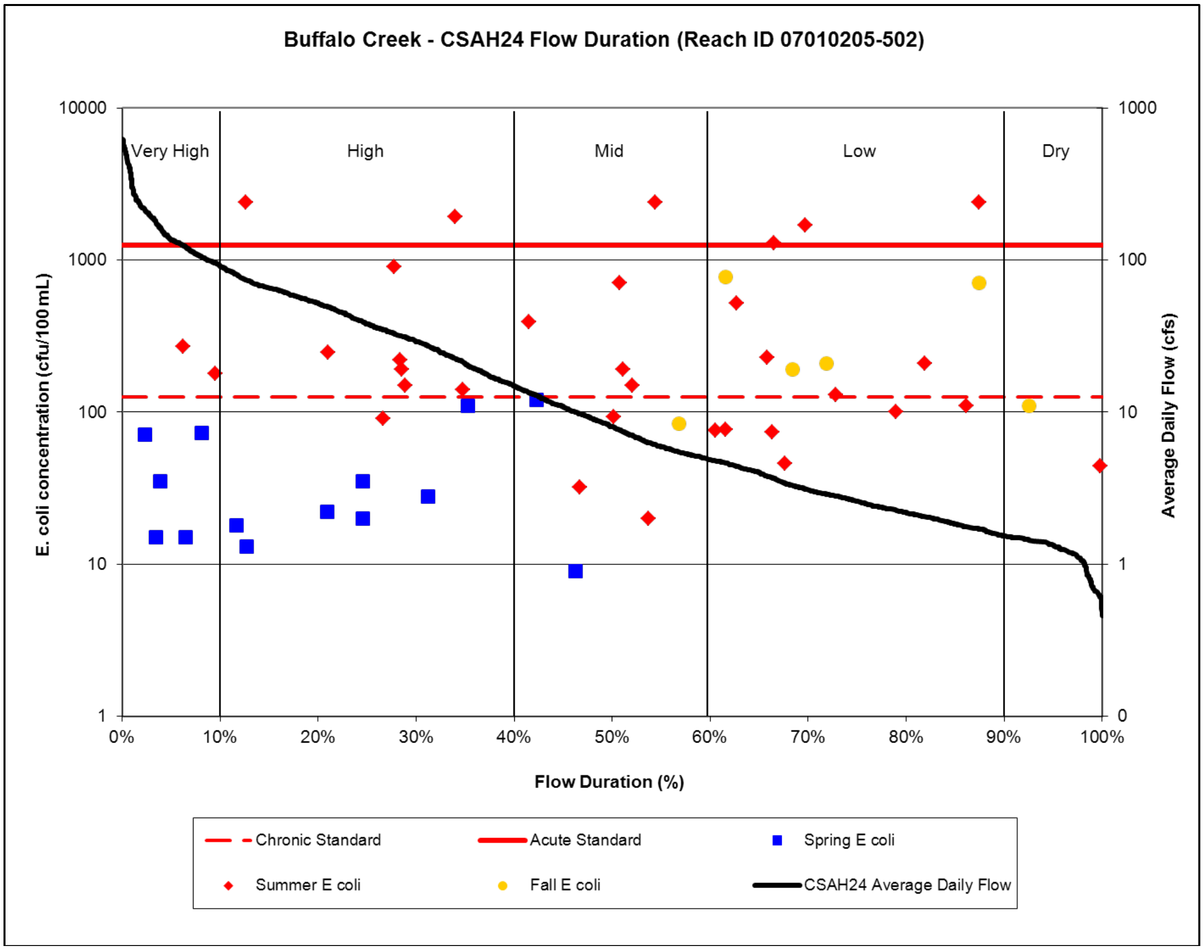

Figure 5-2 Reach 502 *E. coli* concentration by flow regime. Flow frequencies were developed using average daily flows over the past 10 years from the CSAH24 monitoring station.

The relationship between flow and bacteria concentrations helps in identifying potential sources of elevated bacteria concentrations. Table 5.2 shows the conceptual relationship between flow and loading sources under various flow conditions. Under low flows, runoff processes are minimal as bacteria concentrations are often driven by wastewater treatment plants, failing septics, septic systems with "straight pipe" connections to tile or storm drains and animals in or near the receiving water. Conversely, at high flows, runoff from land with bacteria concentrations such as feedlots, urban areas and cropland often dominate.

Table 5-2 Conceptual relationship between flow regime and potential pollutant sources (EPA, 2001).

Point Source Contributing Source Area	Flow Regime				
	Very High	High	Mid	Low	Dry
NPDES Permitted Treatment Facilities				M	H
Septic System w/ "Straight Pipe" Connection				M	H
Livestock in Receiving Water				M	H
Sub-Surface Treatment Systems			H	M	
Stormwater Runoff – Impervious Areas		H	H	H	
Combined Sewer Overflows	H	H	H		
Stormwater Runoff – Pervious Areas	H	H	M		
Bank Erosion	H	H	M		

Note: Potential relative importance of source areas to contribute loads under given hydrologic condition (H: High; M: Medium)

These analyses suggest the following:

- Bacteria data collected at all four stations covers a reasonably good range of flow conditions, with most of the stations showing a good distribution of samples across high, medium, and low flow regimes.
- Data for all stations shows numerous elevated concentrations during low flow conditions. Further, at the JD-15 and Brownton stations, almost all samples collected during low flow regimes showed exceedances of the standard. Violations during low flow conditions suggest concentrations are driven by sources such as septic systems (especially those with straight-pipe connections to drainage systems), pastures which provide livestock with direct access to streams, wastewater treatment system discharges and/or wildlife.
- Numerous exceedances also occur at high flow regimes, though their incidence appears limited to summer high-flow conditions. This reflects the probable role of summer precipitation events generating runoff episodes that deliver bacteria to Buffalo Creek receiving waters.

5.2 ELEVATED BACTERIA LEVELS IN JD-15

Analysis to this point shows JD-15 may be a substantial contributor to bacteria exceedances in the lower reach of Buffalo Creek (501) over the last ten years. One indicator of this is the frequency and magnitude of bacteria exceedances at Buffalo Creek monitoring stations downstream of the JD-15 confluence. MPCA records show one potential source of high bacteria concentrations in JD-15 is the industrial beef processing facility in Buffalo Lake. That facility, initially operating under the name Minnesota Beef Industries and later under the name North Star Beef, discharged high strength wastewater to the City of Buffalo Lake's wastewater treatment pond system which caused periodic operation issues with the treatment system that compromised discharge water quality. Further, the beef facility operation involved the application of paunch manure close to JD-15 and near tile inlets on fields adjacent to JD-15. MPCA has also documented manure applied on top of tile inlets in the immediate area surrounding the processing operations facility and JD-15. Records from MPCA indicate that the facility operated from 2002 through February 2006, then from September 2007 to November 2008, and again from December 2008 to April 2009. The latest closing was due to elevated levels of arsenic in the potable water supply and could cause permanent closure of the facility.

In order to evaluate the degree to which facility operations may have influenced monitored bacteria concentrations in JD-15, the bacteria concentration data set for JD-15 was divided into those samples that were collected during operation of the beef processing facility and those collected while the facility was not operating. Monthly geomeans for each set of data were calculated and compared to see if the magnitude of bacteria concentrations in each month was noticeably higher when the facility was operating than when it was not (Table 5.3).

Table 5-3 Monthly bacteria geomeans for JD-15 relative to Beef Processing Facility Operations. Only months with 4 or more samples are presented in this table while the total geomean is based on all measurements regardless of month.

Condition	June	July	August	Total
Facility Operating	594	866	579	419
(sample #)	7	4	6	23
Facility Not operating	459	381	328	257
(sample #)	5	5	7	29

Based on the above, it appears that:

- There is a high potential that operation of the beef processing facility contributed to high bacteria concentrations in JD-15, especially during the months of June, July, and August.
- Operation of the beef processing facility itself does not appear to be the sole cause for elevated bacteria concentrations in JD-15, since monthly geomeans when the facility was not operating are well above the standard of 126 organisms per 100 ml.

5.3 POTENTIAL BACTERIA SOURCE INVENTORY

The purpose of the bacteria source assessment work conducted for this project was to develop a comparison of the number of bacteria generated by the major known sources in the project area as an aid in focusing source control activities. Since main-stem Buffalo Creek is impaired for bacteria from its headwaters to its confluence with the South Fork Crow River, the potential source inventory was conducted for the entire Buffalo Creek watershed. The source assessment is not directly related to the total maximum loading capacities and allocations, which are a function of the water quality standards, stream flow (i.e., dilution capacity), and NPDES permit limits for point sources. Further, the inventory itself uses fecal coliform concentrations as the metric, not *E coli*. This is because the greatest value of the potential source inventory is to evaluate the relative magnitude of bacteria loads being generated within the major source categories. Those relative source comparisons are expected to be the same, regardless of whether fecal coliform or E coli units are used. The authors of this report acknowledge the substantial uncertainty associated with source identification.

Two Minnesota studies describe the presence and growth of "naturalized" or "indigenous" strains of E. coli in watershed soils (Ishii et al., 2006), and ditch sediment and water (Sadowsky et al., 2010). The latter study, supported with Clean Water Land and Legacy funding, was conducted in the Seven Mile Creek watershed, an agricultural landscape approximately 30 miles to the east of the mouth of the Cottonwood River. DNA fingerprinting of E. coli from sediment and water samples collected in Seven Mile Creek from 2008-2010 resulted in the identification of 1568 isolates comprised of 452 different E. coli strains. Of these strains, 63.5 percent were represented by a single isolate, suggesting new or transient sources of E. coli. The remaining 36.5 percent of strains were represented by multiple isolates, suggesting persistence of specific E. coli. Discussions with the primary author of the Seven Mile Creek study suggest that while 36 percent might be used as a rough indicator of "background" levels of bacteria at this site during the study period, this percentage is not directly transferable to the concentration and count data of E. coli used in water quality standards and TMDLs. Additionally, because the study is not definitive as to the ultimate origins of this bacteria, it would not be appropriate to consider it as "natural" background. Finally, the author cautioned about extrapolating results from the Seven Mile Creek watershed to other watersheds without further studies.

5.3.1 Livestock

Livestock sources include several categories such as feedlots, overgrazed pastures, surface application of manure and incorporated manure. Following is a description of these sources.

5.3.1.1 Feedlots and Overgrazed Pastures Near Streams

An area is considered a feedlot to be a lot or building or a combination of lots or buildings intended for confined feeding, breeding, raising or holding of animals specifically designed as a confinement area in which the concentration of animals is such that a vegetative cover cannot be maintained. These facilities are specifically designed as a confinement area in which manure may accumulate or where the concentration of animals is such that vegetative cover cannot be maintained within the enclosure. Concentrated Animal Feeding Operations (CAFOs) are generally feedlots containing over 1,000 animal units (there are also thresholds based on large animal numbers which alter this threshold somewhat) and must be permitted under both state and federal law. CAFOs are regulated under the NPDES program and are subject to a zero surface discharge requirement from the site. However, the manure generated by these feedlots is often spread on the land and still represents a potential bacterial load that is important to track. Registered feedlots are generally those feedlots that don't qualify as CAFOs but are still capable of holding 50 or more animal units. These operations are not regulated under the NPDES permit program and do not have a discharge requirement. However, they must abide by state rules prohibiting pollution of state waters and may be subject to additional local requirements.

According to the 2003 MPCA database, there are 257 registered feedlots (CAFOs plus registered feedlots) in the Buffalo Creek watershed housing 50,336 animal units. The animals units are expressed as follows: swine (22,661 units) followed by dairy (11,052 units), beef (9,690 units), poultry (6,029 units), and other (904 units). A map showing the location (as points) and approximate size of each feedlot is shown in Figure 5.3. GIS data showing the exact location and feedlot boundary is not available.

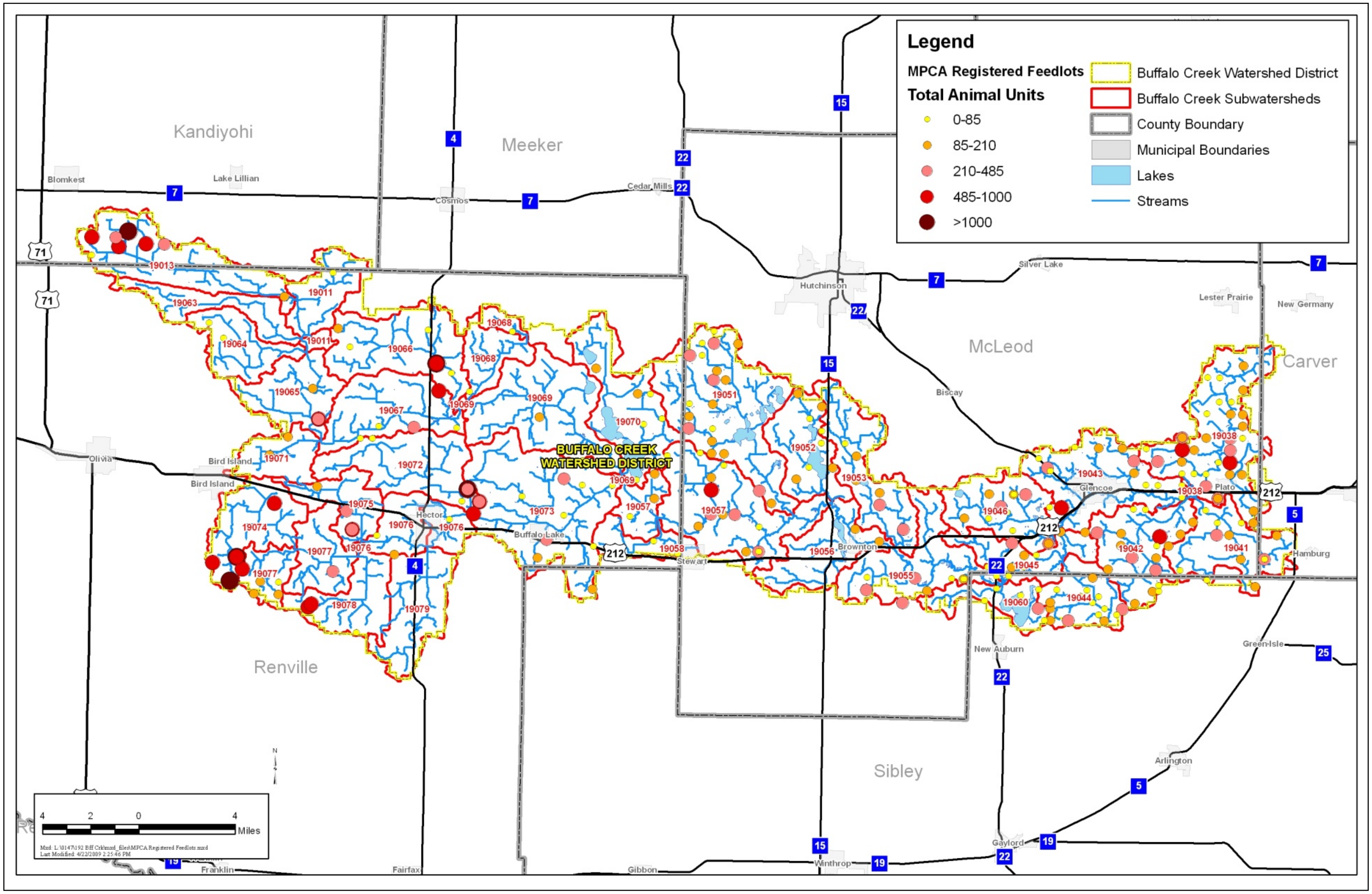

Figure 5-3 2003 MPCA registered feedlots in the Buffalo Creek watershed.

All feedlots and open lot cattle and dairy facilities within 300 ft. of a stream would have a higher likelihood of animal access to the stream and therefore higher likelihood of delivering bacterial loads to the receiving water. In the Buffalo Creek watershed, there are potentially 26 feedlots (3,890 animal units) within 300 feet of a waterway and four (295 animal units) that may be within 100 feet of a stream. To address overgrazed pastures, this report adopts the assumptions made in the Lower Mississippi River Basin Regional Fecal Coliform TMDL that 1% of dairy and beef cattle were in overgrazed pastures (MPCA 2002).

5.3.1.2 Manure Application

Based on information from county staff, a significant portion of the cropland in the Buffalo Creek watershed receives some sort of manure application (Tom Kalahar, Renville County, pers. comm.). Most hog manure is applied as a liquid and is often injected directly into the topsoil or incorporated after surface spreading with agriculture tillage equipment. Application of incorporated manure typically occurs in the fall when waste pits are full and crops have been removed. However, some pits will be emptied earlier in the year if needed. When this happens, it is often done prior to spring planting although many farmers do not rely on application during this time if the top-soil is over-saturated.

Most beef and poultry manure is applied as a solid. Dairy manure is applied as both liquid and solid manure. In most cases, the larger dairy operations have liquid agricultural-waste pits, while the smaller dairies haul manure as a solid. Most liquid manure is injected into the ground or incorporated within 24 hours. Solid manure is spread on the soil surface where it is not immediately incorporated into the ground. Again, a large portion of manure applications occur in the fall when animal waste pits are emptied out. However, some farmers (especially small dairy farmers) will spread this manure year round.

5.3.1.3 Industrial Facilities

There are three industrial dischargers located in the Buffalo Creek watershed: Minnesota Energy, Seneca Food Corporation and Associated Milk Producers Inc. (AMPI) of Glencoe. While there are no bacteria monitoring data available in the DMR for Minnesota Energy or Seneca Foods, it is assumed these facilities discharge below the bacteria standard since neither process material high in human/animal waste. The AMPI processing plant wastewater facility that discharged to Buffalo Creek is no longer in operation.

5.3.2 Human

5.3.2.1 Septic Systems (SSTS)

Failing or nonconforming septic systems can be an important source of bacteria during dry periods when runoff-driven sources are minimal. The MPCA estimated an SSTS failure rate of 44% for the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002). Failure rates as high as 65%

have been estimated for portions of Renville County (Diane Mitchell, Water and HHW Management Coordinator, Renville County, pers. comm.). For the purposes of this study, a septic system failure rate of 55% was assumed.

Based on 2000 census data, rural population in the Buffalo Creek watershed was 4,518 people which are approximately 34% of the total watershed population. Assuming there are approximately 2.8 people per household, there are roughly 1,614 rural households that dispose of wastewater through on-site disposal systems commonly referred to as subsurface sewage treatment systems (SSTS). Using the 55% failure rate discussed previously, one could expect around 887 failing SSTS throughout the watershed. Unless on-site disposal systems are functioning properly, groundwater and surface water contamination can occur. Wastewater from septic systems may include many types of contaminants such as nitrates, harmful bacteria and viruses, and other toxic substances, which can be hazardous to both groundwater and surface water. Properly sited, designed and operated, SSTS do not pose any risk of contamination to surface water or groundwater.

It should be noted that “straight pipe” connections between septic systems and an adjacent tile or stormwater drain system inject bacteria-laden wastewater directly into the receiving water with little or no treatment. These types of systems are illegal in Minnesota and must be fixed when found. While the incidence of straight pipe connections in the project area is potentially high, there is no information that would allow better quantification of an actual number. Elevated bacteria concentrations during low-flow conditions are a strong indicator of straight pipe discharges.

5.3.2.2 NPDES Point Source dischargers

The Buffalo Creek watershed has five active wastewater treatment plants and two industrial point source dischargers. Approximately 66% of the human population (13,300 people) in the watershed generates waste that is handled by one of these facilities. Table 5.4 summarizes monitored bacteria discharge concentrations of each treatment facility. By rule, these facilities may not discharge treated wastewater with fecal coliform concentrations exceeding 200 cfu/100ml as a monthly monitored geometric mean. These dischargers must monitor effluent to ensure compliance with these rules. The monitoring data shows all facilities typically discharge at average bacteria concentrations well below the fecal coliform standard of 200 CFU/100 ml. The Glencoe, Brownton and Stewart WWTP plants were the only facilities that have exhibited monthly geomean effluent concentrations greater than their permitted limit. It is important to point out that effluent violations are rare (less than 6% of total months monitored) and no violations have occurred since 2005.

Table 5-4 Buffalo Creek watershed NPDES point source fecal coliform discharge concentrations. Monthly effluent fecal coliform concentrations for each facility are presented here as the average of all monitored monthly geomeans since 1999. Data for each facility discharge was downloaded from the MPCA website.

Facility	Receiving Water	Months monitored	Months Exceeding Geomean Standard	Mean of Monitored Geomeans (organisms/100 mL)						
				April	May	June	July	Aug	Sep	Oct
Glencoe WWTP	Buffalo Creek	70	2	46	48	70	58	37	34	31
Brownton WWTP	Buffalo Creek	70	4	29	16	75	68	61	108	76
Hector WWTF	JD-15	60	0	NA	9	11	15	10	13	11
Buffalo Lake WWTP	JD-15	25	0	16	13	31	NA	NA	65	11
Stewart WWTP	Buffalo Creek	32	1	13	10	54	NA	NA	15	43
Seneca Foods	Trib to Buffalo Creek	Not Monitored	NA	NA	NA	NA	NA	NA	NA	NA
MN Energy	JD-15	Not Monitored	NA	NA	NA	NA	NA	NA	NA	NA

5.3.3 Wildlife/Natural Background Sources

Wildlife in the watershed encompasses a broad group of animals. For this assessment, deer and geese were assumed to be the main contributors as other wildlife was lumped into one separate category.

The Minnesota Department of Natural Resources (MnDNR) modeled deer population densities for several areas in nearby Carver County. MnDNR staff provided estimates of about 5 deer/mi^2 for most of the watershed, with up to 15 deer/mi^2 closer to the river valleys (Jeff Miller-MnDNR Wildlife Division in Willmar, personal communication). This report assumes an average deer density of 6 deer/mi^2 for the entire watershed.

Goose densities were estimated using the Southeast Minnesota Regional TMDL where they assumed a goose population of 20,000 individuals which equates to a density of approximately 2.8 geese/mi^2.

Section 5.3 discusses the potential of “naturalized” or “indigenous” bacteria in soils, ditch sediment, and water as an additional source. However, the studies cited are not definitive as to the magnitude of this contribution. Additionally, the studies are not definitive as to the ultimate origins of this bacteria, so it may not be appropriate to consider it as “natural” background. From a pragmatic standpoint, this study suggests that there is a fraction of bacteria that may exist regardless of most traditional implementation strategies that are employed to control the sources of E. coli.

5.3.4 Urban Stormwater Runoff

Untreated urban stormwater has demonstrated bacteria concentrations equal to or in some cases higher than grazed pasture runoff, cropland runoff, and feedlot runoff (USEPA 2001, Bannerman et al. 1993, 1996). Only about 8.4% of the Buffalo Creek watershed is identified as developed. Consistent with the methodology outlined in Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002), urban bacteria contributions were assumed to come exclusively from improperly managed waste from dogs and cats. Applying that approach to this study, it was assumed there are 0.58 dogs/household and 0.73 cats/household in urban areas.

Local bacteria loads in some of the municipalities will need to be addressed under NPDES Phase II, which would require surface water receiving stormwater to meet the State standards. EPA guidance states that MS4 stormwater allocations in a TMDL must now be included in the TMDL as a Wasteload Allocation. NPDES Phase II MS4 permit requirements, which regulate urban stormwater discharges, currently apply only to the City of Glencoe, which is a designated MS4 because it has a population of at least 5,000 and is located in close proximity to an impaired water.

5.4 BUFFALO CREEK BACTERIA PRODUCTION BY SOURCE

Table 5.5 summarizes the major sources of fecal coliform in the Buffalo Creek watershed. It is important to note that there is substantial uncertainty associated with the estimates in the table. Estimates of the population with inadequate wastewater treatment are based on an assumed septic failure rate in the watershed. Additionally, pet numbers are derived from a national survey and may not directly reflect conditions in the counties comprising the Buffalo Creek watershed. Deer populations are from model estimates and geese population estimates are based on densities used in the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002). This summary does, however, provide a reasonable estimate of fecal coliform producers in the watershed as well as the comparative densities in each category.

There are 257 registered livestock facilities that house 50,336 animal units, particularly swine and dairy cattle. About two-thirds of the human population in Buffalo Creek watershed discharges to a municipal wastewater treatment facility.

Table 5-5 Inventory of Fecal Coliform Bacteria Producers in Buffalo Creek Watershed

Category	Sub-Category		Animal Units or Individuals
Livestock	The Basin contains an estimated 257 registered livestock facilities ranging in size from a few animal units to several hundred	Dairy	11,052 animal units
		Beef	9,690 animal units
		Swine	22,661 animal units
		Poultry	6,029 animal units
		Other	904 animal units
Human[1]	Rural Population with Inadequate Wastewater Treatment[2]		2,485 people
	Rural Population with Adequate Wastewater Treatment		2,033 people
	Municipal Wastewater Treatment Facilities		13,288 people
Wildlife	Deer (average 6 per square mile)		2,496 deer
	Geese[3]		1,165 geese
	Other		Other wildlife was assumed to be the equivalent of deer and geese combined in the watershed.
Pets	Dogs and Cats in Urban Areas[4]		6,218 dogs and cats
	Dogs and Cats in Rural Areas[4]		2,113 dogs and cats

[1] Based on 2000 census data

[2] Assumes 55% failure rate for septic systems (55% of rural population with inadequate wastewater treatment). This number was estimated based on the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota TMDL (MPCA, 2002) and local knowledge (Diane Mitchell, pers. comm.)

[3] Rough estimate, likely representing maximum numbers; geese densities based on the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002) densities (2.8 per square mile)

[4] People divided by 2.8 people/household multiplied by 0.58 dogs/household, 0.73 cats/household as used in the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002).

5.5 BUFFALO CREEK BACTERIA AVAILABLE FOR TRANSPORT

Each bacteria source was assigned a percentage that attempts to predict the likelihood of that animal's bacteria reaching Buffalo Creek streams and tributaries (Table 5.6). These assumptions are gross approximations that were first developed as part of the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota (MPCA, 2002), altered to reflect average and monitored conditions within the watershed and then reviewed by the watershed's stakeholder and technical groups for applicability in the Buffalo Creek watershed.

Table 5-6 Assumptions used to estimate the amount of daily fecal coliform production available for potential runoff or discharge into the main-stem and tributaries of the Buffalo Creek Watershed

Category	Source	Assumption
Livestock	Overgrazed Pasture near Streams or Waterways	1% of Dairy Manure 1% of Beef Manure
	Feedlots or Stockpiles without Runoff Controls	1% of Dairy 5% of Beef Manure 1% Poultry Manure
	Surface Applied Manure	64% of Dairy Manure 94% of Beef Manure 99% of Poultry Manure 10% Swine Manure; 20% of this manure applied in Spring 20% of this manure applied in Summer 60% of this manure applied in Fall
	Incorporated Manure	34% of Dairy Manure 90% of Swine Manure; 20% of this manure applied in the Spring 80% of this manure applied in Fall
Human	Failing Septic Systems and Unsewered Communities	All waste from failing septic systems and unsewered communities
	Municipal Wastewater Treatment Facilities (excluding bypasses)	Calculated directly from WWTP discharge (April through October) and the geometric mean fecal coliform concentration (2004 data)
Wildlife	Deer	All fecal matter produced by deer in basin
	Geese	All fecal matter produced by geese in basin
	Other Wildlife	The equivalent of all fecal matter produced by deer and geese in basin
Urban Stormwater Runoff	Improperly Managed Waste from Dogs and Cats	10% of waste produced by estimated number of dogs and cats in basin

Next, potential fecal coliform runoff loads were estimated for the watershed (Table 5.7). Daily fecal coliform production estimates for each animal unit or individual were also derived from the Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota and are based on literature values (MPCA, 2002). Some small differences may occur when fecal coliform production is estimated based on animal unit definitions. However, these differences would fall within the standard deviation of production numbers and would not increase the accuracy of the data justifying their use for individuals in McLeod and Renville counties.

Table 5-7 Summary of estimated daily fecal coliform available for potential delivery to Buffalo Creek from Buffalo Creek watershed.

Category	Source	Animal Type	Total Fecal Coliform Available(10^9)	Total Fecal Coliform Available by Source(10^9) (% of total bacteria potentially available)
Livestock	Overgrazed Pasture near Streams or Waterways	Dairy Animal Units	6,433	15,066 (0.6%)
		Beef Animal Units	8,633	
	Feedlots or Stockpiles without Runoff Controls	Dairy Animal Units	6,433	50,836 (2.1%)
		Beef Animal Units	43,168	
		Poultry Animal Units	1,235	
	Surface Applied Manure***	Dairy Animal Units	411,672	1,419,665 (59.2%)
		Beef Animal Units	811,542	
		Swine Units	74,102	
		Poultry Animal Units	122,349	
	Incorporated Manure	Dairy Animal Units	218,702	885,615 (36.9%)
		Beef Animal Units	0	
		Swine Units	666,913	
		Poultry Animal Units	0	
Human	Failing Septic Systems and Unsewered Communities	People	3,975	21,588 (0.9%)
	Municipal Wastewater Treatment Facilities	People	17,613	
Wildlife	Deer	Deer	1,044	2,870 (0.1%)
	Geese	Geese	391	
	Other Wildlife	Equivalent of deer plus dogs and cats	1,435	
Urban Stormwater Runoff	Improperly Managed Waste from Dogs and Cats	Dogs and Cats	1,854	1,854 (0.1%)
Total			6,433	2,397,494

Based on the outcome of the bacteria pollutant source inventory, the results suggest that:

- Livestock are the biggest generator of bacteria in the project area watershed.
- The largest potential sources are those activities associated with application of manure to the land. Generally speaking, mobilization of bacteria from manure spreading activities is most likely to be a problem when runoff processes carry recently applied manure to receiving waters.
- Over-grazed pastures near streams and waterways and failing septic systems/unsewered communities appear to be relatively small sources based on the small load of bacteria generated compared to livestock. However, these sources can be some of the most significant contributors to bacteria impairments in the stream especially under low-flow conditions where dilution is minimal and bacteria can be delivered efficiently to the receiving water (as in the case of straight-pipe connections with septic systems and livestock defecating directly into a stream).

6.0 Public Participation

6.1 PUBLIC PARTICIPATION PROCESS

Public participation opportunities were provided during the project in the form of public meetings, electronic newsletters and CROW's website. A display board was developed to be taken to county fairs, MN DNR "Our Waters Our Choice" presentations in counties in the watershed, and McLeod County Corn and Soybean Grower's Annual Banquets. CROW attended local partner meetings to review the TMDL process and receive input on the project. CROW's Technical Committee is comprised of ten counties within the Crow River Watershed and the following local agencies: SWCD, NRCS, Water Planners, BWSR, MN DNR, USFWS, Metropolitan Council and Cities. The Technical Committee, Buffalo Creek Watershed District, and citizens reviewed project activities and provided comments. CROW has presented information regarding the TMDL project during its regular scheduled Joint Powers Board and Technical Committee meetings.

<u>Meetings</u>

November 2008 – Public Stakeholder Meeting in Litchfield, MN. Meeting provided an overview of the TMDL project and generated discussion that provided information to be used in the models.

July 2009 – Public Stakeholder/Technical Advisory Committee Meeting in Glencoe, MN. Meeting reviewed the TMDL process and bacteria Technical Memorandum and findings from the preliminary source assessment.

September 2009 – Public Stakeholder/Technical Advisory Committee Meeting in Buffalo, MN. Meeting reviewed the TMDL process, timeline and turbidity Technical Memorandum and findings from the preliminary source assessment.

July, November & December 2009 – Buffalo Creek Watershed District Meetings in Glencoe, MN. CROW attended the Board Meetings to discuss the TMDL project and answer questions on the TMDL process and monitoring activities.

The original public notice comment period was 6/13/11 – 7/13/11. Due to the state shutdown, the comment period was extended to 8/15/11. Three (3) comment letters were received within the comment period. One (1) additional comment letter was received 14 days after the close of the extended comment period. Three (3) identical contested case hearing requests (CCHR) were received on 8/15/11. One (1) additional CCHR was received 14 days after the close of the extended comment period. As a result of the CCHR, additional discussion of natural background was added to the TMDL in section 5.3 and section 5.3.3.

7.0 Reasonable Assurance

7.1 INTRODUCTION

When establishing a TMDL, reasonable assurances must be provided demonstrating the ability to reach and maintain water quality endpoints. Several factors control reasonable assurance, including a thorough knowledge of the ability to implement BMPs as well as the overall effectiveness of the BMPs. This TMDL establishes aggressive goals for the reduction of *E. coli* loads and the improvement of fish and invertebrate habitat in Buffalo Creek.

Many of the goals outlined in this TMDL study are consistent with objectives outlined in the Kandiyohi, Renville, Sibley, McLeod, and Carver County Water Plans and the Buffalo Creek Watershed District Watershed Management Plan. These plans have the same objective of developing and implementing strategies to bring impaired waters into compliance with appropriate water quality standards and thereby establish the basis for removing those impaired waters from the 303(d) Impaired Waters List. These plans provide the watershed management framework for addressing water quality issues. In addition, the stakeholder processes associated with this TMDL effort as well as the broader planning efforts mentioned previously have generated commitment and support from the local government units affected by this TMDL and will help ensure that this TMDL project is carried successfully through implementation.

Various technical and funding sources will be used to execute measures that will be detailed in the implementation plan that will be developed within one year of approval of this TMDL. Funding resources include a mixture of state and federal programs, including (but not limited to) the following:

- Federal Section 319 Grants for watershed improvements
- Funds ear-marked to support TMDL implementation from the Clean Water, Land, and Legacy constitutional amendment, approved by the state’s citizens in November 2008.
- Local government cost-share funds
- Buffalo Creek Watershed District cost-share funds
- Soil and Water Conservation Districts cost-share funds
- NRCS cost-share funds

Finally, it is a reasonable expectation that existing regulatory programs such as those under NDPES will continue to be administered to control discharges from industrial, municipal, and construction sources as well as large animal feedlots that meet the thresholds identified in those regulations.

7.2 REGULATORY APPROACHES

NPDES Phase II stormwater permit is in place for the city of Glencoe draining to Buffalo Creek. Under the stormwater program, permit holders are required to develop and implement a Stormwater Pollution Prevention Plan (SWPPP; MPCA, 2004). The SWPPP must cover six minimum control measures:

- Public education and outreach;
- Public participation/involvement;
- Illicit discharge, detection and elimination;
- Construction site runoff control;
- Post-construction site runoff control; and
- Pollution prevention/good housekeeping.

The permit holder must identify BMPs and measurable goals associated with each minimum control measure.

According to federal regulations, NPDES permit requirements must be consistent with the assumptions and requirements of an approved TMDL and associated Wasteload Allocations. See 122.44(d)(1)(vii)(B). To meet this regulation, Minnesota's MS4 general permit requires the following:

> "If a USEPA-approved **TMDL(s)** has been developed, you must review the adequacy of your Storm Water Pollution Prevention Program to meet the **TMDL's Waste Load Allocation** set for storm water sources. If the **Storm Water Pollution Prevention Plan** is not meeting the applicable requirements, schedules and objectives of the **TMDL**, you must modify your **Storm Water Pollution Prevention Plan** as appropriate, within 18 months after the TMDL is approved."

The TMDL implementation plan will identify specific BMP opportunities that may help achieve the required load reductions. Permittees can incorporate information from the implementation plan into their SWPPPs.

7.3 LOCAL MANAGEMENT

7.3.1 Crow River Organization of Waters

Portions of ten counties in Central Minnesota make up the Crow River Watershed. From the perspective of the Upper Mississippi River Basin, the Crow River is one of its major tributaries. The effects of rapid urban growth, new and expanding wastewater facilities and erosion from agricultural lands have been common concerns of many citizens, local, state and regional governments in Central Minnesota. As a result, many groups began meeting in 1998 to discuss management of the Crow River basin consisting of the North Fork and South Fork. The Crow River Organization of Water (CROW) was formed in 1999 as a result of heightened interest in the Crow River. A Joint Powers Agreement has been signed between all ten of the Counties with land in the Crow River Watershed. The CROW Joint Powers Board is made up of one representative from each of the County Boards who signed the agreement. The Counties involved in the CROW Joint Powers include Carver, Hennepin, Kandiyohi, McLeod, Meeker, Pope, Renville, Sibley, Stearns and Wright. The CROW currently focuses on identifying and promoting the following:

- Protecting water quality and quantity
- Protect and enhance fish and wildlife habitat and water recreation facilities
- Public education & awareness
- BMP implementation

In summer of 2010, the CROW began working with the Minnesota Pollution Control Agency's new Major Watershed Restoration & Protection Project (MWRPP) approach in the North Fork Crow River Watershed. The South Fork Crow River Watershed MWRPP will start in 2012. The idea behind the watershed approach is to provide a more complete assessment of the water quality and facilitates data collection for the development of a Total Maximum Daily Loads (TMDLs) and protection strategies. The watershed approach is to intensively monitor the streams and lakes within a major watershed to determine the overall health of the water resources, identify impaired waters, and identify those waters in need of additional protection efforts to prevent impairments. This process is different because monitoring efforts were concentrated in a defined area (a lake or stream reach) address one impairment whereas now all impairments are addressed at the same time. Most importantly this process will provide a communication tool that can inform stakeholders, engage volunteers, and help coordinate local/state/federal monitoring efforts so the data necessary for effective water resources planning is available, citizens and stakeholders are engaged in the process, and citizens and governments across Minnesota can evaluate the progress. Through this new process a Watershed Management Plan for the South Fork Crow Watershed will be created.

7.3.2 Local Comprehensive Water Management Plans

Kandiyohi, Renville, Sibley, McLeod, and Carver Counties, are within the project area where the watershed lies. They have each adopted a county water plan that articulates goals and objectives for water and land-related resource management initiatives. The adopted plans range throughout the following years: Sibley's plan is 2002-2011, Kandiyohi, Renville and McLeod are for the time period 2003-2012 and Carver's plan is for 2010-2020. Completion of TMDL assessments of impaired waters within the counties were identified as one of the top three priorities in each plan. In addition, the implementation section of the plans focus on a number of areas important in restoring impaired waters to a non-impaired status, including;

1. Support and cooperate with local SWCD, County Water Planners and the Buffalo Creek Watershed District and the Minnesota Pollution Control Agency on on-going TMDL projects.
2. Educate feedlot owners on proper feedlot management, including manure storage and field application, for the purpose of meeting regulatory requirements.
3. Assist and provide information, technical and/or financial assistance to landowners implementing agricultural BMPs on working lands to reduce soil erosion, protect streambanks, and improve water resources.

4. Actively promote and market federal/state/local conservation programs to targeted landowners and help prepare them for eligibility in programs such as CSP and EQIP.
5. Promote and market conservation programs that provide cost-share and assistance to livestock producers for the adoption of comprehensive nutrient management plans.
6. Ensure the proper use and abandonment of manure pits.
7. Support owner/operators to bring their facilities into compliance, with those feedlots that are within identified TMDL watersheds having priority.
8. Promote and establish buffers on public and private ditches.
9. Promote the establishment and maintenance of vegetative buffers.
10. Provide low interest loan dollars to fix failing septic systems.

7.3.3 County Soil and Water Conservation Districts

The purpose of the County Soil and Water Conservation District (SWCD) is to plan and execute policies, programs, and projects which conserve the soil and water resources within its jurisdictions. It is particularly concerned with erosion of soil due to wind and water. The SWCD is heavily involved in the implementation of practices that effectively reduce or prevent erosion, sedimentation, siltation, and agricultural-related pollution in order to preserve water and soil as resources. The District frequently acts as local sponsor for many types of projects, including grassed waterways, on-farm terracing, erosion control structures, and flow control structures. The CROW has established close working relationships with the SWCDs on a variety of projects. One example is the conservation buffer strip cash incentives program that provides cash incentives to create permanent grass buffer strips adjacent to water bodies and water courses on land in agricultural use. The CROW currently participates in the program by providing matching grants and will work to target such practices in the Buffalo Creek TMDL watershed so that the practices are implemented as cost effectively as possible to achieve the load reduction required in the TMDL.

7.3.4 Buffalo Creek Watershed District

The Buffalo Creek Watershed District (BCWD) is located in south-central Minnesota, approximately 30 miles west of the Minneapolis-St. Paul Metropolitan Area. The Buffalo Creek watershed is the southernmost subwatershed of the larger South Fork of the Crow River Watershed, which eventually outlets to the Mississippi River near Dayton, Minnesota. There are 5 counties, 6 cities and 28 townships that are wholly or partially encompassed within the District, although the overwhelming majority of the District's land is located within McLeod and Renville Counties (93%). The cities of Brownton, Buffalo Lake, Glencoe, Hector, Plato and Stewart are all located within the District. All of these cities are located along U.S. Highway 212. The City of Glencoe, which is the County Seat of McLeod County, is the largest community in the District.

Soon after its formation, the District developed its first Overall Plan, in accordance with Minnesota Statutes, Section 112.46. The plan, which was eventually adopted on February 8, 1974, provided the District with a basis for making decisions on the management of its water resources. The District continued to function under the original Overall Plan until it was revised in 1991 and then again in 2004. In 2011, the District updated its Rules and Regulations which provide the legal foundation for the District to have permitting authority in a number of key water management areas.

BCWD offers a 75% up to $300 cost-share on filtering inlets, and a $500 cash incentive for voluntary septic upgrades. Also, through the permitting process, the District works to control quantity and quality of water entering the Creek. The Watershed District budgets $30,000 per year for debris removal such as fallen trees and dead-heads.

7.4 MONITORING

Two types of monitoring are necessary to track progress toward achieving the load reduction required in the TMDL and the attainment of water quality standards. The first type of monitoring is tracking implementation of Best Management Practices (BMPs) on the ground. The CROW and the SWCDs will track the implementation of these projects annually. The second type of monitoring is physical and chemical monitoring of the resource. The CROW plans to monitor the affected resources on a ten year cycle in conjunction with the South Fork Crow River Watershed MWRPP process.

This type of effectiveness monitoring is critical in the adaptive management approach (refer to Figure 8-1). Results of the monitoring identify progress toward benchmarks as well as shape the next course of action for implementation. Adaptive management combined with obtainable benchmark goals and monitoring is the best approach for implementing TMDLs.

8.0 Implementation Activities

Bacteria accounting in the Buffalo Creek watershed indicates surface runoff from feedlots and agricultural areas where manure has been applied are the largest potential source of bacteria to surface waters (Table 5.7). However, Buffalo Creek surface water monitoring shows *E. coli* and Fecal Coliform violations occur across all flow regimes during the summer and fall index periods. Thus, BMP implementation activities to achieve this TMDL should focus on runoff driven processes such as manure practices, pasture management and feedlot runoff as well as dry-weather sources such as failing septic systems and direct access of livestock to surface waters. Restoration efforts in similarly sized watersheds in Minnesota with primarily nonpoint source implementation needs indicate overall costs in the $6-8 million range.

8.1 MANURE MANAGEMENT

Minnesota feedlot rules (Minn. R. ch. 7020) now require manure management plans for feedlots greater than 300 animal units that do not employ a certified manure applicator. These plans require manure accounting and record-keeping as well as manure application risk assessment based on method, time and place of application. The following BMPs will be considered in all manure management plans to reduce potential pathogen delivery to surface waters:

- Immediate incorporation of manure into topsoil
- Reduction of winter spreading, especially on slopes
- Pathogen removal through manure composting, anaerobic storage, ultraviolet radiation or chemical treatment
- Eliminate spreading near open inlets and sensitive areas
- Erosion control through conservation tillage and vegetated buffers

8.2 PASTURE MANAGEMENT

Overgrazed pastures, reduction of pastureland and direct access of livestock to streams may contribute a significant amount of bacteria to surface waters throughout all flow conditions. The following livestock grazing practices are for the most part economically feasible and are extremely effective measures in reducing bacteria delivery potential:

- Livestock exclusion from public waters through setback enforcement and fencing
- Creating alternate livestock watering systems
- Rotational grazing
- Vegetated buffer strips between grazing land and surface water bodies

8.3 FEEDLOT MANURE STOCKPILE RUNOFF CONTROLS

This strategy is presently under implementation through the MPCA's Open Lot Agreement (OLA) established in October 2000. The OLA had a full compliance goal to meet effluent limits in Minn. R. 7053.0305 by October 1, 2010. This program encourages producers to seek information and assistance for practical solutions to treat feedlot runoff that discharges into waters of the state from feedlots that do not require permits (less than 300 animal units). There are a variety of options for improving open lot runoff problems that reduce nonpoint source loading of bacteria, including:

- Move fences or altering layout of feedlot
- Eliminate open tile intakes and/or feedlot runoff to direct intakes
- Install clean water diversions and rain gutters
- Install grass buffers
- Maintain buffer areas
- Construct solid settling area(s)
- Prevent manure accumulations
- Manage feed storage
- Manage watering devices
- Total runoff control and storage
- Install roofs
- Runoff containment with irrigation onto cropland/grassland
- Vegetated infiltration areas or tile-drained vegetated infiltration area with secondary filter strips
- Sunny day release on to vegetated infiltration area or filter strip

8.3.1 SSTS

While total bacteria numbers are small relative to livestock production, failing or nonconforming septic systems can be important sources of bacteria loading during low-flow periods when runoff-driven sources are minimal. The counties throughout the Buffalo Creek watershed shall continue to identify and address systems that are not meeting adopted septic ordinances. Special attention shall be given to systems with high bacteria loading potential based on proximity to streams, direct discharge to surface water and those posing an imminent threat to public health.

8.3.2 Stormwater Management

Municipal stormwater throughout the Buffalo Creek watershed is not believed to be a major source of bacteria to Buffalo Creek. That said, urban contributions from domestic and wild animals may be addressed through better site design and BMPs such as infiltration basins, bioretention structures, and pet waste ordinances.

8.4 ADAPTIVE MANAGEMENT

The preceding list of implementation activities and the more detailed implementation plan that will be prepared following this TMDL assessment focuses on adaptive management (Figure 8-1).

As the bacteria dynamics within the watershed are better understood, management activities will be changed or refined to efficiently meet the TMDL and lay the groundwork for de-listing the impaired reaches.

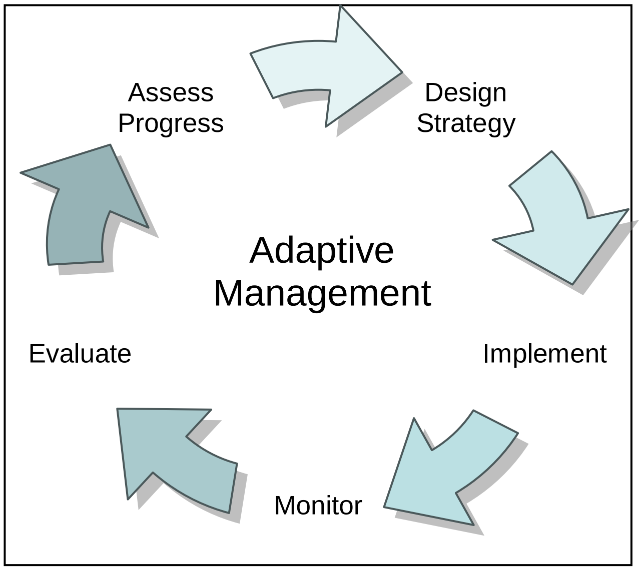

Figure 8-1 Adaptive Management.

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