Mississippi River - Lake Pepin Tributaries Total Maximum Daily Loads (TMDL)

Minnesota Pollution Control Agency

February 2015

wq-iw9-15e

Legislative Charge

Minn. Stat. § 116.011, Annual Pollution Report

A goal of the Pollution Control Agency is to reduce the amount of pollution that is emitted in the state. By April 1 of each year, the MPCA shall report the best estimate of the agency of the total volume of water and air pollution that was emitted in the state the previous calendar year for which data are available. The agency shall report its findings for both water and air pollution, etc., etc.

HIST: 1995 c 247 art 1 s 36; 2001 c 187 s 3

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Minnesota Pollution Control Agency

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This report is available in alternative formats upon request, and online at www.pca.state.mn.us.

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Acronyms

ac-ft	acre feet
ac-ft/yr	acre feet per year
AUID	Assessment Unit ID
BALMM	Basin Alliance for the Lower Mississippi in Minnesota
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
cfu	colony-forming unit
CN	Curve number
CWLA	Clean Water Legacy Act
DNR	Minnesota Department of Natural Resources
E. coli	Escherichia Coli
EPA	Environmental Protection Agency
EQuIS	Environmental Quality Information System
FWMC	Flow weighted mean concentration
GW	Groundwater
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
in/yr	inches per year
IWM	intensive watershed monitoring
km^2	square kilometer
LA	Load Allocation
LGU	Local Government Unit
LIDAR	Light Detection and Ranging
m	meter
mg/L	milligrams per liter
mg/m^2-day	milligram per square meter per day
mL	milliliter
MMP	Manure Management Plan
MOS	Margin of Safety
MPCA	Minnesota Pollution Control Agency
MPN	Most Probable Number
MRLP	Mississippi River Lake Pepin (HUC8 watershed)
MS4	Municipal Separate Storm Sewer Systems
MST	Microbial Source Tracking
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
SCS	Soil Conservation Service
SID	Stressor Identification
SRO	Surface runoff
SONAR	Statement of Need and Reasonableness
SSTS	Subsurface Sewage Treatment Systems
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan

TDLC	Total Daily Loading Capacity
TMDL	Total Maximum Daily Load
UAL	Unit-area Load
µg/L	microgram per liter
WLA	Wasteload Allocation
WRAP	Watershed Restoration and Protection

Executive Summary

The Mississippi River-Lake Pepin (MRLP) Watershed includes 205,747 acres that drain several small, cold-water streams in bedrock-dominated bluff country. The largest of these streams is Wells Creek (45,954 acres), which winds through 18 miles of bluff lands and joins the Mississippi near Old Frontenac, southeast of Red Wing. Hay Creek is a popular trout stream (30,405 acres) that flows from south to north, joining the Cannon River bottoms at Red Wing. Most of the other streams in the watershed are also trout waters, and drain directly to the Mississippi River. The five MRLP streams addressed in this study were placed on the State of Minnesota's 303(d) list of impaired waters due to documented excess Escherichia coli (*E. coli)* concentrations in 2012.

The presence of fecal pathogens in surface water is a regional problem in southeast Minnesota. The issue was well-described in a stakeholder driven process that culminated in approval of 39 approved fecal coliform Total Maximum Daily Loads (TMDLs) for streams and rivers in the region (*Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota*, approved in 2006). According to its findings and strategies, numerous projects have been executed in efforts to reduce pathogen loading to the region's surface waters. Feedlot runoff, unsewered communities and over-grazed pastures (among others) have all been addressed via grant funding. It is within this greater planning context that *E. coli* TMDLs for the MRLP watershed are executed.

The impaired waters addressed in this document are located in Goodhue and Wabasha counties, along the west bank of the Mississippi River between Red Wing and Lake City (Figure 3.2). The goal of this TMDL is to (1) describe the frequency and magnitude of exceedances of the State of Minnesota's *E. coli* water quality standard (in terms of allowable and observed pollutant loads), (2) summarize pathogen sources in the watersheds of Wells, Hay, Gilbert, Miller and Bullard creeks.

The pathogen sources of greatest presence are livestock manure (feedlots and land applied manure as discussed) and septic systems, neither of which demonstrate good correlations between their respective subwatershed densities and the corresponding downstream *E. coli* concentrations. However, the general strategies for approaching reductions in pathogen loading to surface waters have already been well described. The MRLP Watershed Restoration and Protection (WRAP) work will draw on both the Regional TMDL and the MRLP *E. coli* TMDLs to describe focus areas and implementation strategies.

1.0 Introduction

1.1 *Planning Context and Project Purpose*

The passage of Minnesota's Clean Water Legacy Act (CWLA) in 2006 provided a policy framework and resources to state and local governments to accelerate efforts to monitor, assess and restore impaired waters and to protect unimpaired waters. The result has been a comprehensive watershed approach that integrates water resource management efforts with local government and local stakeholders and develops restoration and protection studies for Minnesota's 81 major watersheds. For the MRLP major watershed (Figure 3.2), the process began with intensive watershed monitoring (IWM) in 2008. For planning purposes, the watershed was split: the Vermillion River Watershed was apportioned to the Metro area and its stakeholders, while the watersheds for Wells, Hay, Gilbert, Miller and Bullard creeks (and contiguous smaller, unnamed streams) were addressed by stakeholders in southeast Minnesota. The subsequent assessment of collected chemical and biological data examined designated use support in each of the streams in the watershed. The results of the assessment are documented in detail at the State's MRLP web page (see document *Mississippi River Lake Pepin Watershed Monitoring and Assessment Report,* hereafter "assessment report"): http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/mississippi-river-lake-pepin.html

One biota impairment (Gilbert Creek, fish index of biotic integrity (IBI)), was subsequently examined via a stressor identification process, which determined that the low fish IBI is not due a pollutant stressor, and therefore is not addressed with a TMDL computation (the impairment will nonetheless be addressed in the watershed planning process). The stressor identification report: *Mississippi River-Lake Pepin Tributaries Biotic Stressor Identification* can be reviewed at the MRLP web page cited previously. The assessment process also documented aquatic life use support for eight of the nine stream segments examined (see table 20 of the assessment report). Surface waters that meet standards and support designated uses are addressed via protection planning, apart from this TMDL (which focuses on impaired waters).

This TMDL study addresses the five *E. coli* impairments in the MRLP Watershed documented in the assessment report. These impaired waters are located in Goodhue and Wabasha counties, along the west bank of the Mississippi River between Red Wing and Lake City (Figure 3.2). The goal of this TMDL is to (1) describe the frequency and magnitude of exceedances of the State of Minnesota's *E. coli* water quality standard (in terms of allowable and observed pollutant loads), (2) summarize pathogen sources in the watersheds of Wells, Hay, Gilbert, Miller and Bullard creeks. These TMDLs are established in accordance with Section 303(d) of the Clean Water Act and provide wasteload allocations (WLAs) and load allocations (LAs) for the watershed areas as appropriate.

The presence of fecal pathogens in surface water is a regional problem in southeast Minnesota. The issue was well-described in a stakeholder driven process that culminated in approval of 39 approved fecal coliform TMDLs for streams and rivers in the region. The *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota*, approved in 2006, can be reviewed at the MPCA web site: http://www.pca.state.mn.us/index.php/view-document.html?gid=8006. Subsequent to TMDL approval, stakeholders completed an implementation plan: http://www.pca.state.mn.us/index.php/view-document.html?gid=8013. According to the findings and strategies summarized in these documents, numerous projects have been executed in efforts to reduce pathogen loading to the region's surface waters. Feedlot runoff, unsewered communities and over-grazed pastures (among others) have all been addressed via grant funding. It is within this greater planning context that *E. coli* TMDLs for the MRLP watershed are executed. At the time of the Regional TMDL initiation, there were no data available to allow for examination of these streams. The IWM provided sufficient information for assessment. Thus, these five TMDLs should be considered (for planning purposes) an addendum to the Regional TMDL work. Source assessment specific to these streams will be executed to the extent possible per available information. The general strategies for approaching reductions in pathogen loading to surface waters have already been well described. The MRLP WRAP work will draw on both the Regional TMDL and the MRLP *E. coli* TMDLs to describe focus areas and implementation strategies.

It should be noted that Hay Creek aquatic life impairment, based on turbidity and transparency tube data (the segment addressed herein for *E. coli* impairment) is recommended for delisting in the 2014 reporting cycle. Therefore that impairment is not addressed in this document.

1.2 *Problem Identification*

The streams addressed in this study were first placed by the Minnesota Pollution Control Agency (MPCA) on the State of Minnesota's 303(d) list of impaired waters due to documented excess *E. coli* concentrations in 2012.

Table 1.1 Impairments addressed in this report

Listed Water body Name	AUID#	Listed Pollutant	Impaired Use	Year Placed in Impairment Inventory	303(d) List Scheduled Start & Completion Dates
Hay Creek	07040001-518	*Escherichia coli*	Aquatic Recreation	2012	2011-2014
Bullard Creek	07040001-526	*Escherichia coli*	Aquatic Recreation	2012	2011-2014
Gilbert Creek	07040001-530	*Escherichia coli*	Aquatic Recreation	2012	2011-2014
Miller Creek	07040001-534	*Escherichia coli*	Aquatic Recreation	2012	2011-2014
Wells Creek	07040001-708	*Escherichia coli*	Aquatic Recreation	2012	2011-2014

1.3 *Priority Ranking*

The MPCA's projected schedule for TMDL completions on the 303(d) impaired waters list implicitly reflects Minnesota's priority ranking of this TMDL. TMDL scheduling is based on the watershed approach sequencing and the approximate time required to progress from initiation (intensive watershed monitoring) to TMDL completion.

2.0 Impaired Waters and Minnesota Water Quality Standards

2.1 *State of Minnesota Designated Uses*

The impaired waters addressed in this TMDL are Class 2B waters for which aquatic life and recreation are the protected beneficial uses and Class 2A for which aquatic life and recreation and drinking water are the protected beneficial uses.

2.2 *State of Minnesota Standards and Criteria for Listing*

E. coli are fecal coliform bacteria that are present in human and animal waste. *E. coli* levels aid in the determination of whether or not fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of *E. coli*.

Per Minn. R. ch. 7050.0150 and Minn. R. ch. 7050.0222, *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 10% of all samples taken during any calendar month individually exceed 1,260 organisms/100 mL. The standard applies only between April 1 and October 31."

2.3 *Analysis of Impairment*

The criteria used for determining impairments are outlined in the MPCA document Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment – 305(b) Report and 303(d) List, January 2010. The applicable water body classifications and water quality standards are specified in Minn. R. ch. 7050.0407 and Minn. R. ch. 7050.2222 (5), respectively.

3.0 Mississippi River – Lake Pepin Watershed

The MRLP Watershed includes 205,747 acres that drain several small, cold-water streams in bedrock-dominated bluff country. The largest of these streams is Wells Creek (45,954 acres), which winds through 18 miles of bluff lands and joins the Mississippi near Old Frontenac, southeast of Red Wing. Hay Creek is a popular trout stream (30,405 acres) that flows from south to north, joining the Cannon River bottoms at Red Wing. Most of the other streams in the watershed are also trout waters, and drain directly to the Mississippi River.

Figure 3.1. Photo of Mississippi River-Lake Pepin, Frontenac State Park (T. Schauls)

The WRLP Watershed consists of forests, bluff lands, and cultivated lands. The top of the watershed is rolling cropland interspersed by many small tributaries that drop steeply through forested valleys with scattered goat prairies atop cliffs. The tributaries form the named streams, which drain directly into the Mississippi River.

Table 3.1 Summary data for streams addressed in this report.

Stream	AUID#	Stream Miles	Watershed Area Square Miles	Designated Trout Stream?
Hay Creek	07040001-518	18.48	47.94	Yes
Bullard Creek	07040001-526	6.27	16.03	Yes
Gilbert Creek	07040001-530	3.65	24.86	Yes
Miller Creek	07040001-534	5.39	17.47	Yes
Wells Creek	07040001-708	24.3	67.95	No

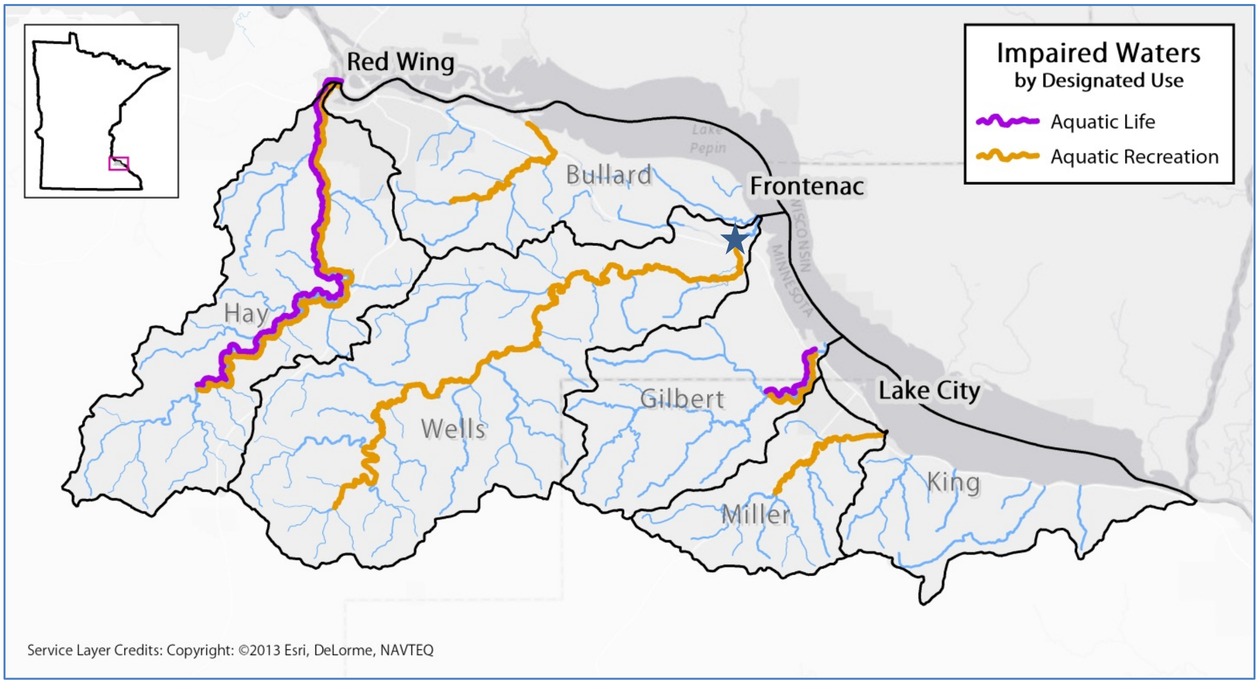


Figure 3.2. Mississippi River-Lake Pepin watershed and impaired waters (MPCA 2012). The blue star indicates the location of the flow gauge that was used to create the flow and load duration curves (Hydstra site ID H38006002).

3.1 *Watershed land use.*

Pasture/grassland (noted as rangeland in Figure 3.3) and cropland are the primary land uses in the watershed (approximately 63%). Corn and soybeans account for most of the tilled acreage of the area. Forage production is strong because of the large number of dairy cows in the region. Of the grassland, 90% is in pasture and a small percentage (less than 10%) is in a management intensive rotational grazing system. Most of the remaining acreage is deciduous forest. Frontenac State Park, Lake Pepin and the coldwater fisheries are significant natural resources that provide recreation and revenue in the region (Boody & Krinke). The character of the MRLP Watershed is described in detail in the assessment report, which discusses hydrology, land use and climate.

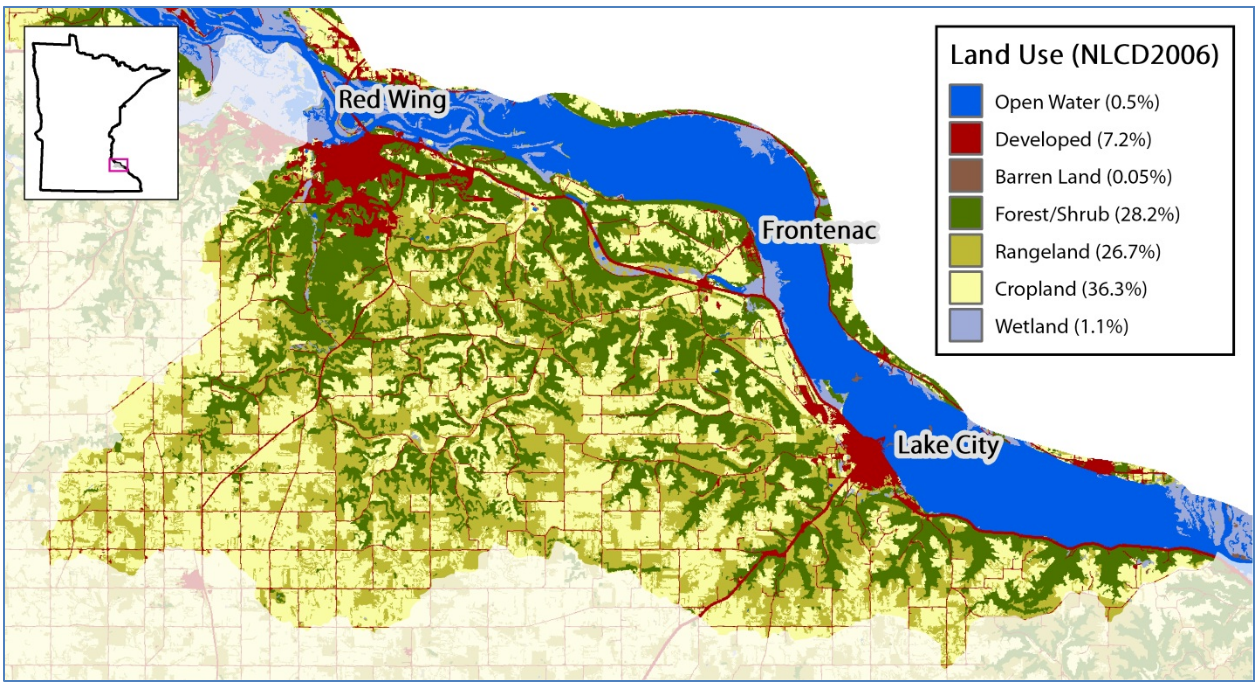


Figure 3.3. Land use map for the Mississippi River Lake Pepin watershed (MPCA 2012)

3.2 *E. coli Data Summary*

E. coli counts in exceedance of the water quality standard were documented with regularity at all five monitoring sites in the MRLP Watershed. The assessment report includes summary information for each stream, some of which is in table 3.2 below. Follow up monitoring in 2012 and 2013 showed similar results. While *E. coli* counts were generally higher during sampled event flows, the data show many values greater than 126 org/100ml during low flow, clear-water conditions. Figure 3.4 illustrates the relationship between water clarity and *E. coli* at Miller Creek.

Table 3.2 Summary of IWM *E. coli* data.

Listed Water body Name	AUID#	Number *E. coli* samples	Number >126 org/100ml	Geometric Mean (org/100ml)
Hay Creek	07040001-518	15	11	249
Bullard Creek	07040001-526	15	15	681
Gilbert Creek	07040001-530	15	15	647
Miller Creek	07040001-534	15	15	1063
Wells Creek	07040001-708	15	11	469

A stream reach is reported as impaired if the geometric mean (or "geomean") of the aggregated monthly *E. coli* concentrations for one or more months exceed 126 organisms per 100 mL. A water body is also considered impaired if more than 10% of the individual samples within a month exceed 1,260 organisms per 100 mL.

Table 3.2 shows the monthly geometric means for April to October for sample stations located on the impaired stream reaches. Geometric means are often used to describe bacteria data over arithmetic means as the geometric mean normalizes the ranges being averaged.

$$Geometric\ mean\ =\ \sqrt[n]{x_1 *\ x_2 * \ldots . x_n}$$

Available data from 2008 to 2012 were used for TMDL construction, the majority of which are the 2008-2009 data collected during IWM.

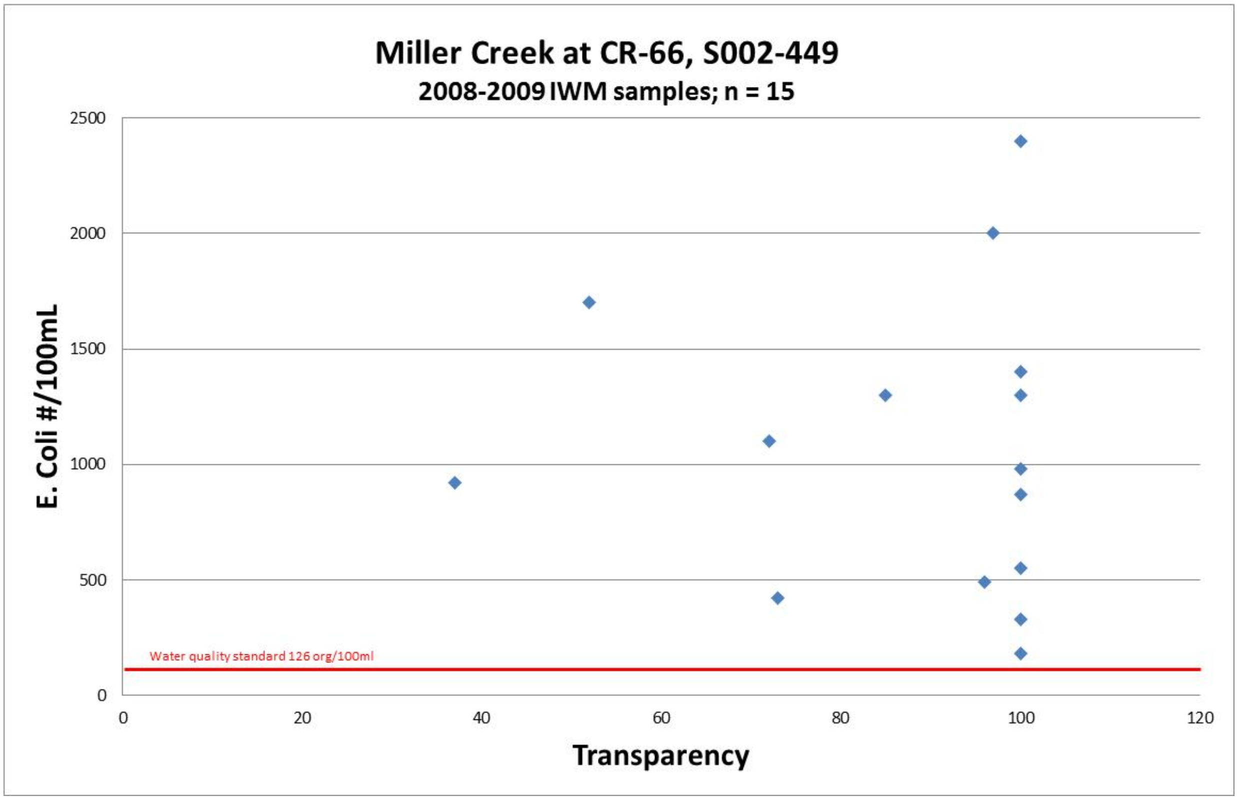


Figure 3.4. Relationship between *E. coli* and stream transparency at Miller Creek site.

3.3 *Pollutant Source Summary*

Water-borne pathogens pose a potential health risk to those who come into contact with inoculated surface water. These pathogens – bacteria, protozoa, viruses and others – come from a variety of sources, including agricultural runoff, inadequately treated domestic sewage, and wildlife. Some of these pathogens may cause disease. The following discussion addresses probable point and nonpoint sources of fecal pathogens and the associated indicators: fecal coliform and *E. coli*, the latter being the indicator currently used in Minnesota's water quality standard.

3.3.1 *Point Sources*

Fecal pathogen loading can occur from both permitted and non-permitted sources. Permitted sources of bacteria include industrial wastewater effluent, municipal wastewater treatment plant effluent, and municipal stormwater runoff. Review of the MRLP Watershed indicates that there are no current permitted municipal or industrial wastewater discharges present. Regarding municipal stormwater, approximately five square miles of the city of Red Wing MS4 regulated boundary intersects the watersheds of Hay and Bullard Creeks (see Table 4.1); this is the only permitted discharger in the MRLP Watershed. The land area of the MS4, most of which is near the mouth of Hay Creek, comprises only 3% of the total land area in the MRLP Watershed.

3.3.2 *Nonpoint Sources*

The following text, which provides an overview of nonpoint sources of fecal coliform and *E. coli* bacteria and associated pathogens, is excerpted and adapted from the *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota* (MPCA, 2006). At the time, Minnesota's water quality standard was described in terms of fecal coliform colonies as indicators of fecal pathogens; it has since changed to make use of *E. coli* counts (the water quality standard used in these TMDLs) for the same purpose. While the specific indicator has changed, the discussion of likely pathogen sources at a southeast Minnesota regional scale applies well to the MRLP Watershed; source information specific to MRLP is inserted where appropriate.

The relationship between land use and fecal coliform concentrations found in streams is complex, involving both pollutant transport and rate of survival in different types of aquatic environments. Intensive sampling at numerous sites in southeastern Minnesota shows a strong positive correlation between stream flow, precipitation, and fecal coliform bacteria concentrations. In the Vermillion River Watershed, storm-event samples often showed concentrations in the thousands of organisms per 100 milliliters, far above non-storm-event samples. A study of the Straight River Watershed divided sources into continuous (failing individual sewage treatment systems, unsewered communities, industrial and institutional sources, wastewater treatment facilities) and weather-driven (feedlot runoff, manured fields, urban stormwater categories). The study hypothesized that when precipitation and stream flows are high; the influence of continuous sources is overshadowed by weather-driven sources, which generate extremely high fecal coliform concentrations. However, during drought, low-flow conditions continuous sources can generate high concentrations of fecal coliform, the study indicated. Besides precipitation and flow, factors such as temperature, livestock management practices, wildlife activity, fecal deposit age, and channel and bank storage also affect bacterial concentrations in runoff (Baxter-Potter and Gilliland, 1988). Fine sediment particles in the streambed can serve as a substrate harboring fecal coliform bacteria. "Extended survival of fecal bacteria in sediment can obscure the source and extent of fecal contamination in agricultural settings," (Howell et. al., 1996). Sadowsky et. al. studied growth and survival of *E. coli* in ditch sediments and water in the Seven Mile Creek Watershed; their work concluded that while cattle are likely major contributors to fecal pollution in the sediments of Seven Mile Creek, it is also likely that some *E. coli* strains grow in the sediments and thus some sites probably contain a mixture of newly acquired and resident strains (Sadowsky et. al., 2008-2010).

Hydrogeologic features in southeastern Minnesota may favor the survival of fecal coliform bacteria. Cold groundwater, shaded streams, and sinkholes may protect fecal coliform from light, heat, drying, and predation (MPCA 1999). Sampling in the South Branch of the Root River Watershed showed concentrations of up to 2,000 organisms/100 ml coming from springs, pointing to a strong connection between surface water and ground water (Fillmore County 1999 & 2000). The presence of fecal coliform bacteria has been detected in private well water in southeastern Minnesota. However, many detections have been traced to problems of well construction, wellhead management, or flooding, not from widespread contamination of the deeper aquifers used for drinking water. One study from Kentucky showed that rainfall on well-structured soil with a sod surface could generate fecal coliform contamination of the shallow ground water through preferential flow (McMurry et. al., 1998). Finally, fecal coliform survival appears to be shortened through exposure to sunlight. This is purported to be the reason why, at several sampling sites downstream of reservoirs, fecal coliform concentrations were markedly lower than at monitoring sites upstream of the reservoirs. This has been demonstrated at Lake Byllesby on the Cannon River and the Silver Creek Reservoir on the South Branch of the Zumbro River in Rochester. Despite the complexity of the relationship between sources and in-stream concentrations of fecal coliform, the following can be considered major source categories:

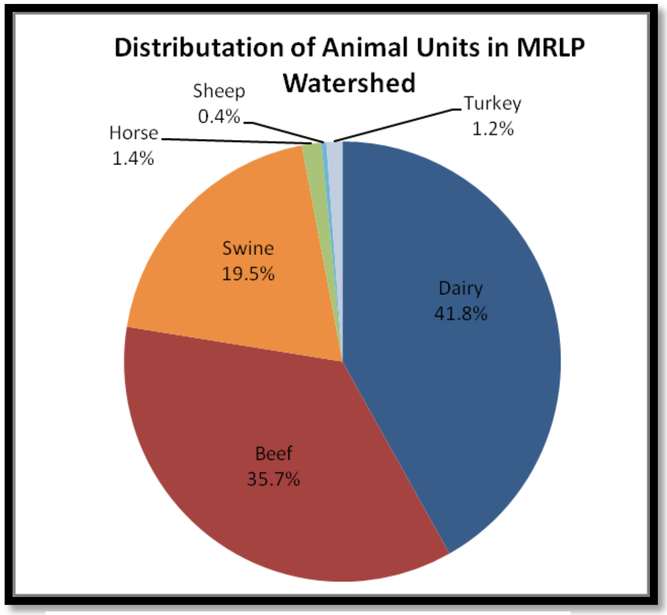
Urban and Rural Stormwater

Untreated stormwater from cities, small towns, and rural residential or commercial areas can be a source for many pollutants including fecal coliform bacteria and associated pathogens. Fecal coliform concentrations in urban runoff can be as great as or greater than those found in cropland runoff, and feedlot runoff (EPA 2001). Sources of fecal coliform in urban and residential stormwater include pet and wildlife waste that can be directly conveyed to streams and rivers via impervious surfaces and storm sewer systems. Newer urban development often includes stormwater treatment in the form of such practices as sedimentation basins, infiltration areas, and vegetated filter strips. Smaller communities or even rural residences not covered by Municipal Separate Storm Sewer Systems (MS4) Permits may be sources of stormwater and associated pollutants. Regarding the MRLP streams, the city of Red Wing MS4 has only a small intersection with the impaired reach watersheds for Hay and Bullard Creeks; it presents limited possibilities regarding pathogen sources.

Livestock Facilities and Manure Application

The MPCA currently uses the federal definition of a Concentrated Animal Feeding Operations (CAFO) in its regulation of animal feedlots. In Minnesota, the following types of livestock facilities are issued, and must operate under, a National Pollutant Discharge Elimination System (NPDES) Permit: a) all federally defined (CAFOs), some of which are under 1000 animal units in size; and b) all CAFOs and non-CAFOs which have 1000 or more animal units.

The vast majority of livestock facilities in the Lower Mississippi River Basin in Minnesota are not CAFOs subject to NPDES Permit requirements (there are only two CAFOs in the MRLP Watershed). Nevertheless, they are subject to state feedlot rules which include provisions for registration, inspection, permitting, and upgrading. Much of this work is accomplished through delegation of authority from the state to county government.



There are approximately 37,000 animal units in the MRLP Watershed (29,236 AU in Goodhue County as of 2009 registration and 7,766 AU in Wabasha as of 2005 registration).

The majority of livestock waste applied in the MRLP Watershed is from cattle and swine. Swine accounts for 19% of the overall animal units within the MRLP. The large majority of swine feedlots are large confined facilities (under a roof), with a pit for liquid manure beneath a slated floor. Thus, feedlot runoff is not a common occurrence with most confined facilities. Dairy and beef cattle are prevalent throughout the MRLP, together accounting for 77% of the animal units in the watershed. The majority of cattle operations are relatively small, with open feedlots near streams and along bluffland areas. Where over-grazing occurs, serious erosion and manure runoff can result.

Land application of manure can be a major source of nonpoint pollution. Liquid swine manure is commonly incorporated into the soil during or shortly after land application, which greatly reduces the pollution potential. The steep landscape lends itself to smaller, segmented fields and provides opportunities for contour farming with hay in rotation and pastureland. Where properly managed, pasture land can increase infiltration rates, improve forage productivity, improve soil health and offer a form of habitat for wildlife. See Appendix B: Feedlots of the MRLP Watershed.

Individual Sewage Treatment Systems

Nonconforming septic systems are an important source of fecal coliform bacteria, particularly during periods of low precipitation and runoff when this continuous source may dominate fecal coliform loads. Unsewered or undersewered communities include older individual systems that are generally failing, and/or collection systems that discharge directly to surface water. This may result in locally high concentrations of wastewater contaminants in surface water, including fecal coliform bacteria, in locations close to population centers where risk of exposure is relatively high.

Approximately 1,910 septic systems were identified within the MRLP Watershed by Goodhue County Environmental Health inspection/installation records and a GIS review of homestead sites in Wabasha County. Appendix B (Septic System Overview MRLP Watershed) depicts the MRLP Watershed septic systems and applies subwatershed coloring to denote the number of septic systems per square mile. In general septic systems are an important potential source of pathogens; however the majority of the areas with the greatest density of septic systems per square mile are located along Highway 61 and Lake Pepin. There is very little concentrated flow from these subwatersheds, and thus collecting water quality samples would be difficult (none have been collected to date). Further, these land areas do not drain to the impaired reaches addressed in this TMDL.

3.3.3 *Microbial source tracking data*

Microbial source tracking (MST) was paired with standard *E. coli* grab samples on three days in 2013, at two different monitoring locations (S002-449 and S007-121). Low flow, clear water (typical baseflow) conditions were targeted in an attempt to further investigate the high *E. coli* counts that have been recorded during such conditions. Analysis and reporting were provided by Source Molecular Corporation in Florida. The results (summarized in Appendix C), paired with corresponding *E. coli* counts, confirm that more information is required to understand the relationships between pathogen sources, DNA markers and *E. coli* presence in surface waters (as discussed in 3.3.2). Appendix B includes maps of watersheds that drain to the pour points at S002-449 and S007-121.

4.0 TMDL Development

4.1 Data Sources

The *E. coli* data used for TMDL development were obtained via grab samples collected by MPCA and Goodhue County Soil and Water Conservation District (SWCD) between 2008 and 2012; they represent current conditions in the watershed.

Stream flow data used to construct duration curves and estimate *E. coli* loads were recorded (2008 to 2012) near the outlet of Wells Creek (Hydstra site ID H38006002, see Figure 3.2).

4.1.1 Loading Capacity Methodology

Loading capacities for the impaired streams were developed using the duration curve methodology supported by the Environmental Protection Agency (EPA). Load duration curves incorporate flow and *E. coli* data across stream flow regimes and provide loading capacities and a means of estimating load reductions necessary to meet water quality standards.

4.1.1.1 Flow Duration Curve Development

Flow duration was examined using discrete 2008 to 2012 flow data collected seasonally at station H38006002, the permanent gauge site located on Wells Creek at Highway 61. Given the proximity of the other impaired reaches and the similar watershed land uses and terrain, this flow duration character was used as the basis for load duration curves for all five of the impaired stream reaches. Flow duration summaries for Hay, Gilbert, Miller and Bullard Creeks were developed using ratios of their respective drainage areas with that of the Wells Creek gauge location.

4.1.1.2 Load Duration Curve Development

To develop a load duration curve (LDC), all average daily flow values were multiplied by the 126 cfu/100 mL standard and converted to a daily load to create a “continuous” load duration curve (see Appendix A). The LDC represents the loading capacity of the stream for each daily flow. The curve is divided into flow zones including Very High (0-10%), High (10-40%), Mid-range (40-60%), Low (60-90%) and Very Low (90 to 100%) flow conditions. In the TMDL equation tables (Table 4.2), for simplicity only the median (or midpoint) load of each flow zone is used to show the TMDL equation components. The loading capacity can also be compared to current conditions by plotting the measured load for each water quality sampling event. Each value that is above the curve represents an exceedance of the water quality standard while those below the line are below the water quality standard.

4.1.2 Load Allocation Methodology

Non-point sources include all non-permitted sources in the watershed such as runoff from some agricultural land and non-regulated areas. This category also includes any *E. coli* considered “natural background.”

4.1.3 Wasteload Allocation Methodology

For bacteria TMDLs, sources of bacteria that require WLAs may include wastewater dischargers, regulated MS4s, and sometimes others. There are currently no permitted wastewater dischargers in the impaired reach watersheds that require *E. coli* WLAs. Table 4.1 lists the permitted MS4s receiving individual WLAs for the Hay and Bullard Creek TMDLs.

Table 4.1 MRLP Permitted MS4s.

ID Number	Name	Intersection with Hay Ck Watershed	Intersection with Bullard Ck Watershed
MS400235	Red Wing	4.89 square miles (10.2%)	0.37 square miles (2.3%)

The WLA was determined based on land area under the jurisdiction of MS4s according to their current regulated boundary. None of the land uses within the intersection of the MS4 regulated boundary and the impaired watersheds were excluded, per discussions with the city of Red Wing staff.

4.1.4 Margin of Safety

The MOS for the bacteria TMDL accounts for uncertainties in both characterizing current conditions and the relationship between the load, wasteload, monitored flows and in-stream water quality so the TMDL allocations result in attainment of water quality standards. An explicit MOS equal to 10% of the total load was applied whereby 10% of the loading capacity for each flow regime was subtracted before allocations were made among wasteload and load. The use of the LDC approach minimized variability associated with the development of the TMDLs because the calculation of the loading capacity was a function of flow multiplied by the target value. The MOS was set at 10% to account for uncertainty due to field sampling error.

4.1.5 Seasonal Variation

The flow duration approach utilized in this TMDL captures the full range of flow conditions over the April-October period when the fecal coliform water quality standard applies.

4.1.6 New and Expanding Discharges

The MPCA, in agreement with the EPA Region 5, have developed a streamlined process for WLAs for new and expanding wastewater discharges to waterbodies with EPA approved TMDL (MPCA, 2012). This procedure will be used to update WLAs in approved TMDLs for new or expanding wastewater dischargers whose permitted effluent limits are at or below the instream target to ensure that the effluent concentrations will not exceed applicable water quality standards or surrogate measures. The process for modifying any and all WLAs after TMDL approval will be handled by the MPCA, with input and involvement of the EPA, once a permit request or reissuance is submitted. The overall process will use the permitting public notice process to allow for the public and EPA to comment on the changes and recommendations based on the proposed WLA modification(s). Once any comments or concerns are addressed, and the MPCA determines that new or expanded WWTF is consistent with the applicable water quality standards, the permit will be issued and any updates to the TMDL WLA(s) will be made.

4.1.7 Load Transfers

Future transfer of watershed runoff loads in this TMDL may be necessary if any of the following scenarios occur within the project watershed boundaries:

1. New development occurs within a regulated MS4. Newly developed areas that are not already included in the WLA must be transferred from the LA to the WLA to account for the growth.

2. One regulated MS4 acquires land from another regulated MS4. Examples include annexation or highway expansions. In these cases, the transfer is WLA to WLA.

3. One or more non-regulated MS4s become regulated. If this has not been accounted for in the WLA, then a transfer must occur from the LA.

4. Expansion of a U.S. Census Bureau Urban Area encompasses new regulated areas for existing permittees. An example is existing state highways that were outside an Urban Area at the time

the TMDL was completed, but are now inside a newly expanded Urban Area. This will require either a WLA to WLA transfer or a LA to WLA transfer.

5. A new MS4 or other stormwater-related point source is identified. In this situation, a transfer must occur from the LA.

Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL (basic area apportionment). In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

4.1.8 Individual Stream TMDL Summaries

The following tables describe the total loading capacity, MOS, WLAs, and LAs for each impaired stream in the MRLP Watershed. Values are reported in billions of organisms/day using only the whole number values from the load duration curve flow zone midpoints.

Table 4.2. *E. coli* TMDL summaries.

		Flow Regime				
		VHigh	High	Mod	Low	VLow
Hay Creek TMDL Summary		Billions of Organisms/day				
Loading Capacity (TMDL)		102	80	73	65	53
Wasteload Allocation	Total WLA	9.3	7.3	6.7	5.9	4.8
	Red Wing MS4 (MS400235) 10.2%	9.3	7.3	6.7	5.9	4.8
Load Allocation		82.5	64.7	59.0	52.6	42.9
Margin of Safety		10.2	8.0	7.3	6.5	5.3
90th Percentile Value from WQ Data		3406	1238	1416	222	190
Bullard Creek TMDL Summary		Billions of Organisms/day				
Loading Capacity (TMDL)		34	26	24	21	17
Wasteload Allocation	Total WLA	0.7	0.5	0.4	0.4	0.3
	Red Wing MS4 (MS400235) 2.3%	0.7	0.5	0.4	0.4	0.3
Load Allocation		29.9	22.9	21.2	18.5	15
Margin of Safety		3.4	2.6	2.4	2.1	1.7
90th Percentile Value from WQ Data		NA	194	285	115	40
Gilbert Creek TMDL Summary		Billions of Organisms/day				
Loading Capacity (TMDL)		53	41	38	33	27
Wasteload Allocation		-	-	-	-	-
Load Allocation		47.7	36.9	34.2	29.7	24.3
Margin of Safety		5.3	4.1	3.8	3.3	2.7
90th Percentile Value from WQ Data		NA	281	241	281	79
Miller Creek TMDL Summary		Billions of Organisms/day				
Loading Capacity (TMDL)		37	29	26	23	19
Wasteload Allocation		-	-	-	-	-
Load Allocation		33.3	26.1	23.4	20.7	17.1
Margin of Safety		3.7	2.9	2.6	2.3	1.9
90th Percentile Value from WQ Data		NA	341	494	305	147
Wells Creek TMDL Summary		Billions of Organisms/day				
Loading Capacity (TMDL)		144	114	104	92	75
Wasteload Allocation		-	-	-	-	-
Load Allocation		129.6	102.6	93.6	82.8	67.5
Margin of Safety		14.4	11.4	10.4	9.2	7.5
90th Percentile Value from WQ Data		309	642	703	579	125

5.0 Reasonable Assurance

Reasonable assurance that the water quality of the MRLP will be improved is formulated on the following points:

- Availability of reliable means of addressing pollutant loads (i.e. Best Management Practices (BMPs), NPDES Permits);
- A means of prioritizing and focusing management;
- Development of a strategy for implementation;
- Availability of funding to execute projects;
- A system of tracking progress and monitoring water quality response.

Accordingly, the following summary provides reasonable assurance that implementation will occur and result in phosphorus load reductions in the Byllesby Reservoir Watershed.

- The BMPs outlined in the implementation plan for the *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota* have all been demonstrated to be effective in reducing transport of pathogens to surface water. This suite of practices is supported by the basic programs administered by the SWCDs and the Natural Resources Conservation Service (NRCS). Local resource managers are well-trained in promoting, placing and installing these BMPs. Some watershed counties have shown significant levels of adoption of these practices. Thus, these BMPs constitute the standard means of addressing nonpoint source pollutant loads in the MRLP Watershed.
- The MPCA's MS4 General Permit requires MS4 Permittees to provide reasonable assurances that progress is being made toward achieving all WLAs in TMDLs approved by EPA prior to the effective date of the permit. In doing so, they must determine if they are currently meeting their WLA(s). If the WLA is not being achieved at the time of application, a compliance schedule is required that includes interim milestones, expressed as BMPs, that will be implemented over the current five-year permit term to reduce loading of the pollutant of concern in the TMDL. Additionally, a long-term implementation strategy and target date for fully meeting the WLA must be included.

- Various projects and tools provide means for identifying priority pollutant sources and focusing implementation work in the watershed:

    - The State of Minnesota funded a shoreland mapping project to inventory land use in riparian areas in southeast Minnesota. The project is complete, and the results are available here: http://www.crwp.net/shoreland-mapping/. This information will be used in the implementation planning process to examine riparian land use in the MRLP Watershed, and prioritize potential BMP installation.

    - Light Detection and Ranging (LIDAR) data are available for all of southeast Minnesota, and being increasingly used by local government units to examine landscapes, understand water flow and dynamics, and accordingly prioritize BMP targeting.

    - IWM was initiated in the Cannon River Watershed in 2011. Inherent in its design is geographic prioritization and focus. Encompassing site placement across the watershed will allow for a full examination of designated use support, which will be the foundation for subsequent steps, ultimately leading to focused management efforts.

- The State of Minnesota (Clean Water Fund) funded development of a WRAPS for the MRLP Watershed. This effort constitutes a foundational planning piece that supports and informs local government plans (e.g. local water plans). The document includes strategies and tools specific to the watersheds. It will be revised and maintained as further prioritization and understanding of pollutant dynamics are made available.

- On November 4, 2008, Minnesota voters approved the Clean Water, Land & Legacy Amendment to the constitution to:

    - protect drinking water sources;

    - protect, enhance, and restore wetlands, prairies, forests, and fish, game, and wildlife habitat;

    - preserve arts and cultural heritage;

    - support parks and trails;

    - and protect, enhance, and restore lakes, rivers, streams, and groundwater.

This is a secure funding mechanism with the explicit purpose of supporting water quality improvement projects.

- Monitoring components in the MRLP Watershed are diverse and constitute a foundational means for focusing work, tracking progress and supporting adaptive management. In addition to condition monitoring, research will continue to further understanding of pathogens in surface water, thereby supporting both future TMDL studies and implementation efforts.

Further, preliminary results of MPCA trend analysis have documented decreasing total suspended solids and total phosphorus concentrations at numerous milestone monitoring sites across southeast Minnesota. This provides reasonable assurance in that it suggests that long-term, enduring efforts to decrease nonpoint source pollutant loading (including pathogen loading, which is typically delivered via transport mechanisms similar to those for sediment and phosphorus) to surface waters have the potential for positive impacts.

6.0 Implementation Strategy Summary

6.1 *Implementation Framework*

According to the findings and strategies summarized in the *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota* and its implementation plan, numerous projects have been executed in efforts to reduce pathogen loading to the region's surface waters. Feedlot runoff, unsewered communities and over-grazed pastures (among others) have all been addressed via grant funding. It is within this greater planning context that *E. coli* TMDLs for the MRLP Watershed are executed. These five TMDLs should be considered (for planning purposes) an addendum to the Regional TMDL work. Source assessment specific to these streams will inform to the extent possible focused implementation. The general strategies for approaching reductions in pathogen loading to surface waters have already been well described. The MRLP WRAP work will draw on both the Regional TMDL and the MRLP *E. coli* TMDLs to describe focus areas and implementation strategies.

6.2 *MS4 Implementation*

The NPDES Permit requirements must be consistent with the requirements of an approved TMDL and associated WLAs. Regarding this TMDL there are no load reductions required of the permitted MS4 community (city of Red Wing). If the MS4 boundary should expand in the future, transfer of load may be necessary and WLA compliance will be revisited.

For the purposes of this TMDL, the baseline year for implementation will be the mid-range year (2010) of the data years used (2008-2012) for development of the bacteria load duration curves. The rationale for this is that projects undertaken recently may take a few years to influence water quality. Any load-reducing BMP implemented after the baseline year will be eligible to "count" toward an MS4's load reductions.

Table 6.1. Planning sequence for Red Wing MS4.

Document	Direction & Content
TMDL (2014)	Loading capacities and MS4 wasteload allocations described.
WRAP (2014)	Discussion of goals (i.e. maintenance of current pathogen BMPs); if necessary, list of more focus areas and/or BMPs.
SWPPP (on-going)	At the time of permit reissuance review SWPPP and incorporate goals, action items if necessary.

6.3 *Nonpoint Reduction Strategies*

The following text, which provides an overview of nonpoint sources strategies to address pathogen loading to surface waters, is excerpted and adapted from the *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota* (MPCA, 2006). These strategies were originally conceptualized and described by the Basin Alliance for the Lower Mississippi in Minnesota (BALMM), a regional planning entity that has embraced basinwide water quality goals; they provide the planning foundation for the MRLP Watershed, from which detail can be added according to local source inventories, monitoring and experience.

Feedlot Runoff Reduction: provide counties with technical, educational and financial support to enroll eligible livestock farmers in the Open Lot Agreement, and ensure that effective feedlot fixes are designed and implemented.

Residential Wastewater Treatment: increase the percentage of the population with properly functioning systems. This strategy is being implemented through several Section 319 grants. The projects address the impact of human sources of bacteria through a combination of education, technical assistance, and financial assistance to owners of failing ISTS. To this end, the BALMM, the Southeast Minnesota Water Resources Board, the Cannon River Watershed Partnership, and the University of Minnesota Extension Service have formed a partnership that will involve 12 of the 14 counties in the basin. The goal is to double the average rate at which ISTS classified as Imminent Public Health Threats (straight-pipes) are being corrected through local efforts across the basin, from 300 to 600 per year.

Accelerated Adoption of Rotational Grazing: Assist producers in the writing of managed rotational grazing plans. Train local resource managers to continue helping beef and dairy farmers to convert from conventional to rotational grazing, with the goal of the latter becoming the dominant pasture management practice in the region.

Manure Management Planning: new feedlot rules require that manure management plans be developed for any feedlots that need a permit. These include the following categories of feedlots:

- Those with more than 300 animal units that are planning new construction or expansion;
- Those with a pollution hazard that has not been corrected through the Open Lot Agreement;
- Those designated as a CAFO (more than 1000 animal units or direct man-made conveyance to waters);
- Those with more than 300 animal units, applying manure in sensitive areas, including: a) soil phosphorus levels exceeding 120/150 ppm Olsen/Bray, or half those values within 300 feet of public waters; b) vulnerable drinking water supply management areas; or c) slopes exceeding 6% within 300 feet of waters.

The Minn. R. 7020.2225, LAND APPLICATION OF MANURE, governs the application of manure in the State of Minnesota. Requiring a Manure Management Plan (MMP) from farmers is intended to minimize the potential of misapplication of manure that can negatively impact Waters of the State. An MMP should inform both the farmer and the regulatory agency how specific management practices will meet the requirements in Minn. R. 7020.2225. The MPCA feedlot program along with our county partners, County Feedlot Officers, review land application records that farmers are required to maintain. This record review allows for verification that the MMP has been implemented correctly.

Landscape Buffer Initiative: target grass buffers on agricultural fields that have been designated for manure application.

Conservation Tillage Strategy: Conservation tillage is a cost-effective way to reduce field runoff. Where manure is applied to cropland, the need for prompt incorporation must be balanced against the need to maintain surface residue cover for erosion control. With support from a Section 319 Grant, the University of Minnesota in spring 2002 published a document entitled, "Tillage BMPs for Water Quality Protection in Southeastern Minnesota." This publication is being used to promote conservation tillage in the context of manure management to reduce field runoff.

6.3.1 Implementation Underway

These strategies have been founded and in varying degrees implemented in southeast Minnesota by local governments and other partners (many of which are members of BALMM). Federal 319 nonpoint source money has been a primary funding mechanism. These efforts should continue to be supported, funded and further focused.

6.4 *Adaptive Management*

The MRLP WRAP work will draw on both the Regional TMDL and the MRLP *E. coli* TMDLs to describe implementation strategies. Going forward, an adaptive management approach (Figure 6.1) will be employed. Continued research and monitoring and subsequent “course corrections” are the most appropriate approach for pursuing water quality goals.

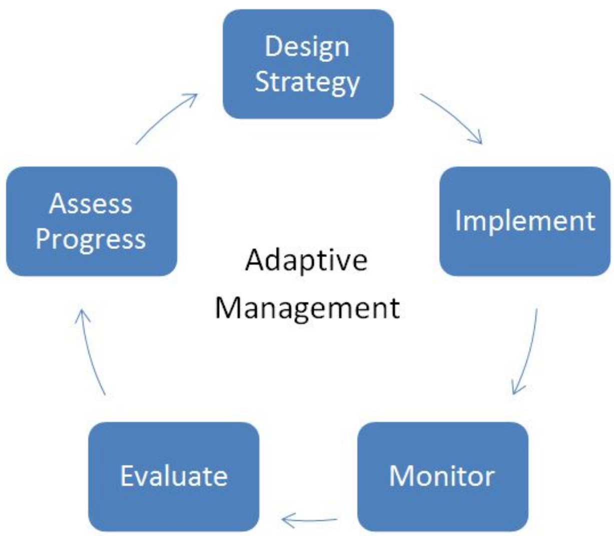


Figure 6.1. Adaptive Management.

7.0 Monitoring Plan

Future monitoring in the MRLP Watershed will be according to the watershed approach framework. The IWM strategy utilizes a nested watershed design allowing the aggregation of watersheds from a coarse to a fine scale. The foundation of this comprehensive approach is the 81 major watersheds within Minnesota. Streams are segmented by hydrologic unit codes (HUC). Sampling occurs in each major watershed once every 10 years (MPCA, 2012). The *Mississippi River Lake Pepin Watershed Monitoring and Assessment Report* provides detailed discussion of IWM and how it will be applied going forward (it will be repeated in MRLP in 2018). Monitoring of *E. coli* will continue on the assessment units noted in this document (see Table 1.1); this will provide trend information at intervals.

The *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota* includes a monitoring section that describes activities and responsibilities pertaining to the greater regional examination of pathogens in surface water, of which MRLP is a part.

7.1 Focused Monitoring & Research Needs

In addition to monitoring for both assessment and effectiveness purposes, there are research needs pertaining to pathogens in surface water. The *Revised Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments In the Lower Mississippi River Basin in Minnesota Implementation Plan* notes that these points of need include, but are not limited to:

- Study of sources of pathogens in cities and urban areas;
- Better understanding of load reduction capabilities for applicable structural and non-structural BMPs;
- Models to evaluate loading sources and track load reductions;
- Methods to evaluate pollutant migration pathways and delivery mechanisms from pathogen sources to surface waters;
- DNA “fingerprinting” to identify pathogen sources.

Such research would further understanding of pathogens in surface water, and greatly support both future TMDL studies and implementation efforts by allowing for more quantified approaches to both. In the MRLP, this focused work is needed to better understand high *E. coli* counts observed during relatively calm, low flow and clear water conditions in trout streams

8.0 Public Participation

8.1 Preceding Stakeholder and Public Process

Numerous studies, a regional TMDL and implementation plan and many implementation projects have been executed in efforts to reduce pathogen loading to southeast Minnesota's surface waters. Feedlot runoff, unsewered communities and over-grazed pastures (among others) have all been addressed via grant funding. It is within this greater planning context, founded on a significant stakeholder process, that *E. coli* TMDLs for the MRLP Watershed are executed.

8.2 Stakeholder Process Specific to these TMDLs

Stakeholder interactions regarding these TMDLs were focused on Goodhue and Wabasha Counties, the city of Red Wing, Lake City and other partner agencies. On March 13, 2014, these partners met in Goodhue to discuss the TMDL, examine MS4 requirements and look ahead to the WRAP completion. Information was exchanged via Wells Creek Partnership meetings, Goodhue County Water Plan meetings, phone conversations and various meetings with agencies and local partners. The MRLP Professional Judgment Group meeting (at which assessment results are discussed and finalized) was held on August 22, 2011, and attended by MPCA, Minnesota Department of Natural Resources (DNR) Fisheries, Wabasha County, Goodhue County and city of Red Wing. The *E. coli* impairments addressed in this TMDL were subject to public notice as part of the 2012 impaired waters list.

8.3 Subsequent Stakeholder and Public Process

Public process and engagement will continue as the MRLP WRAP moves forward; these TMDLs were on public notice from August 11, 2014 through September 10, 2014.

9.0 Literature Cited

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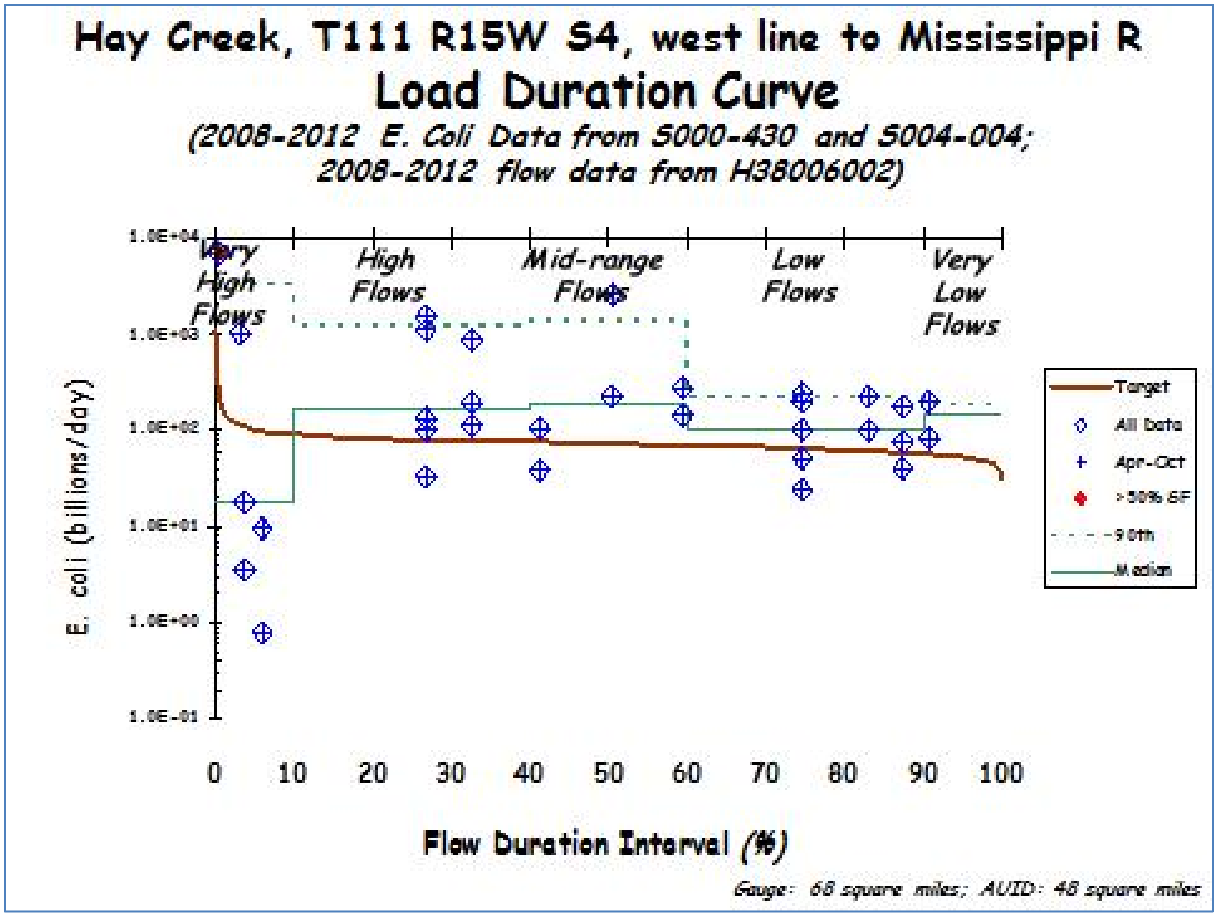
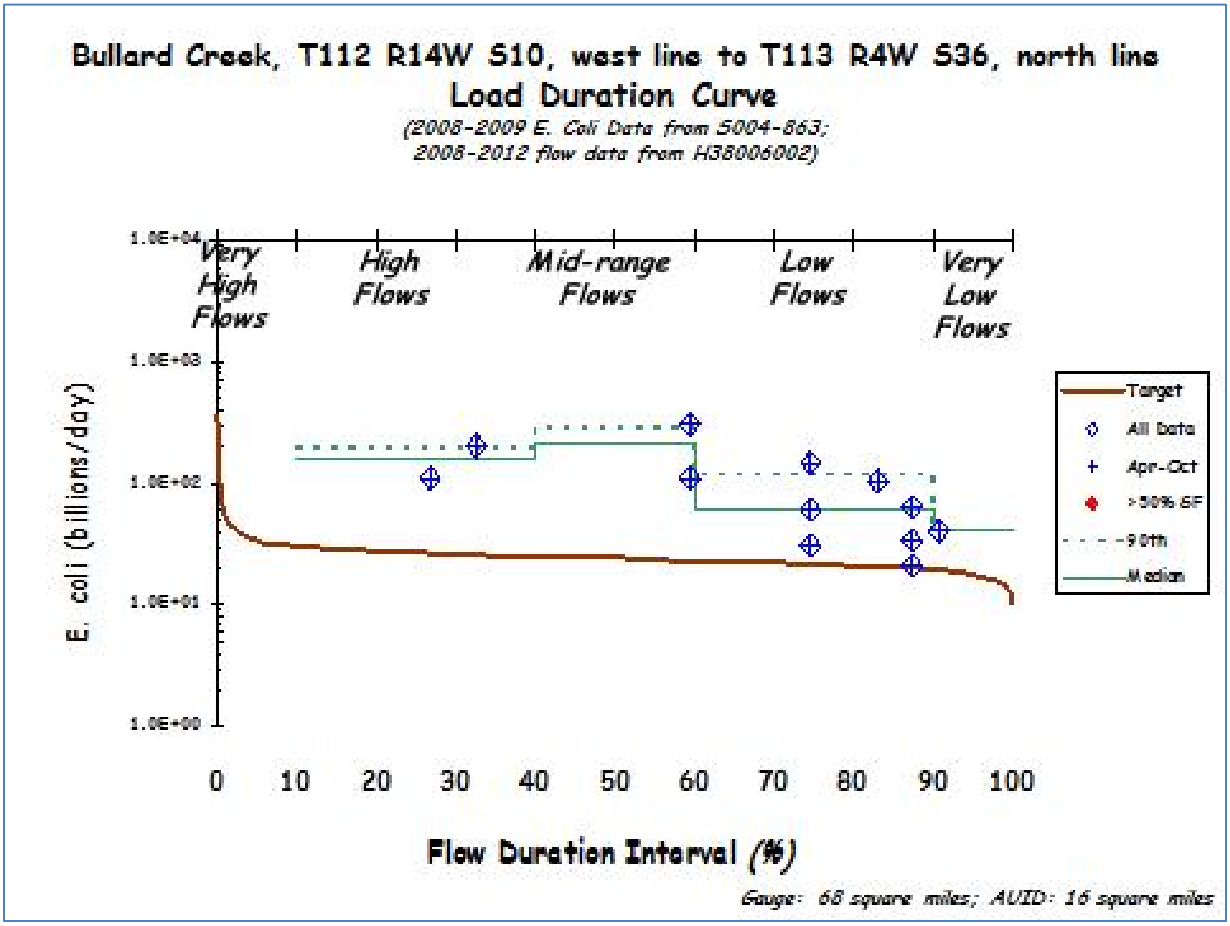
10.0 Appendices

10.1 *Appendix A: Load Duration Curves*

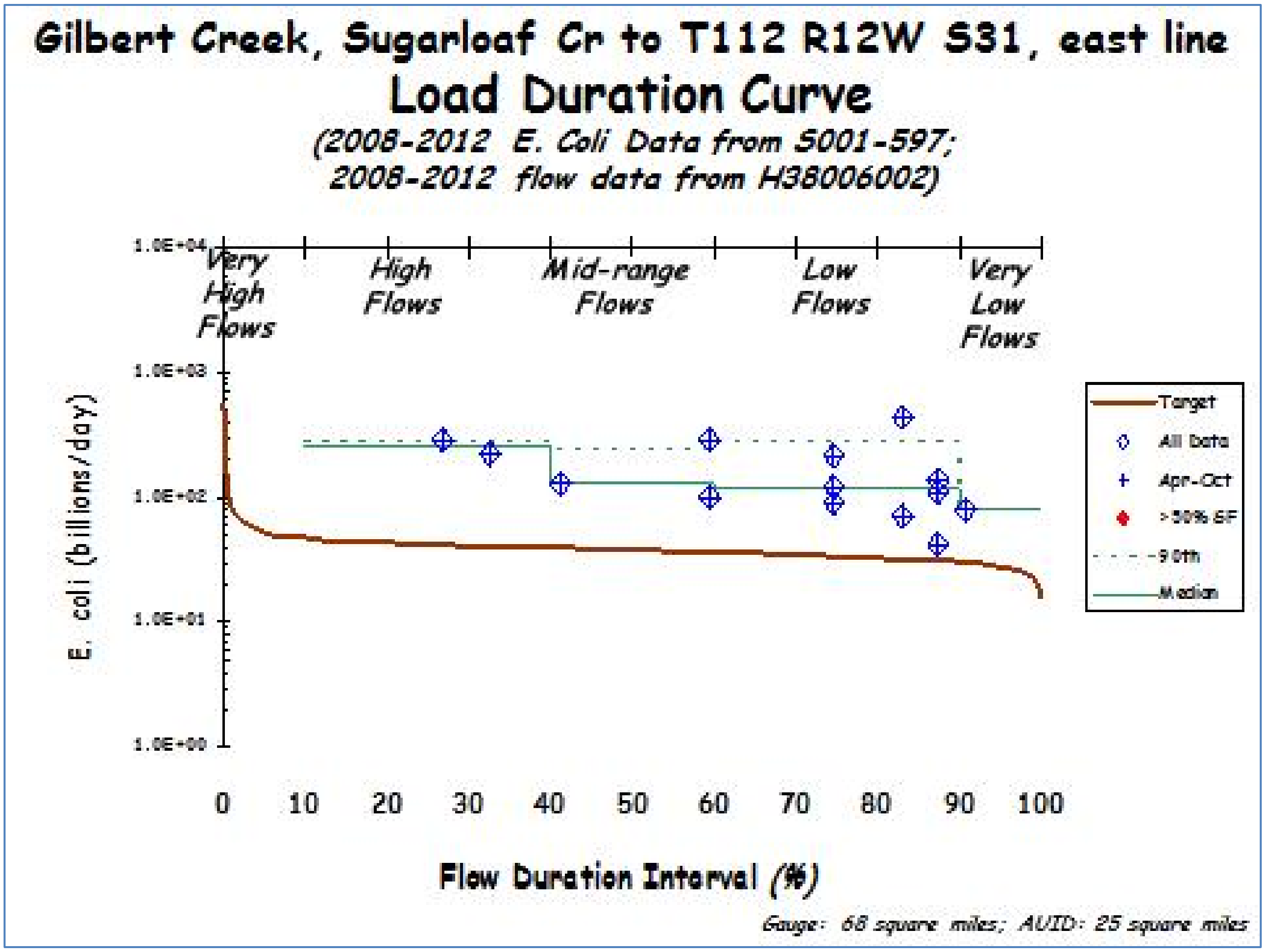
10.1.1 Hay Creek.



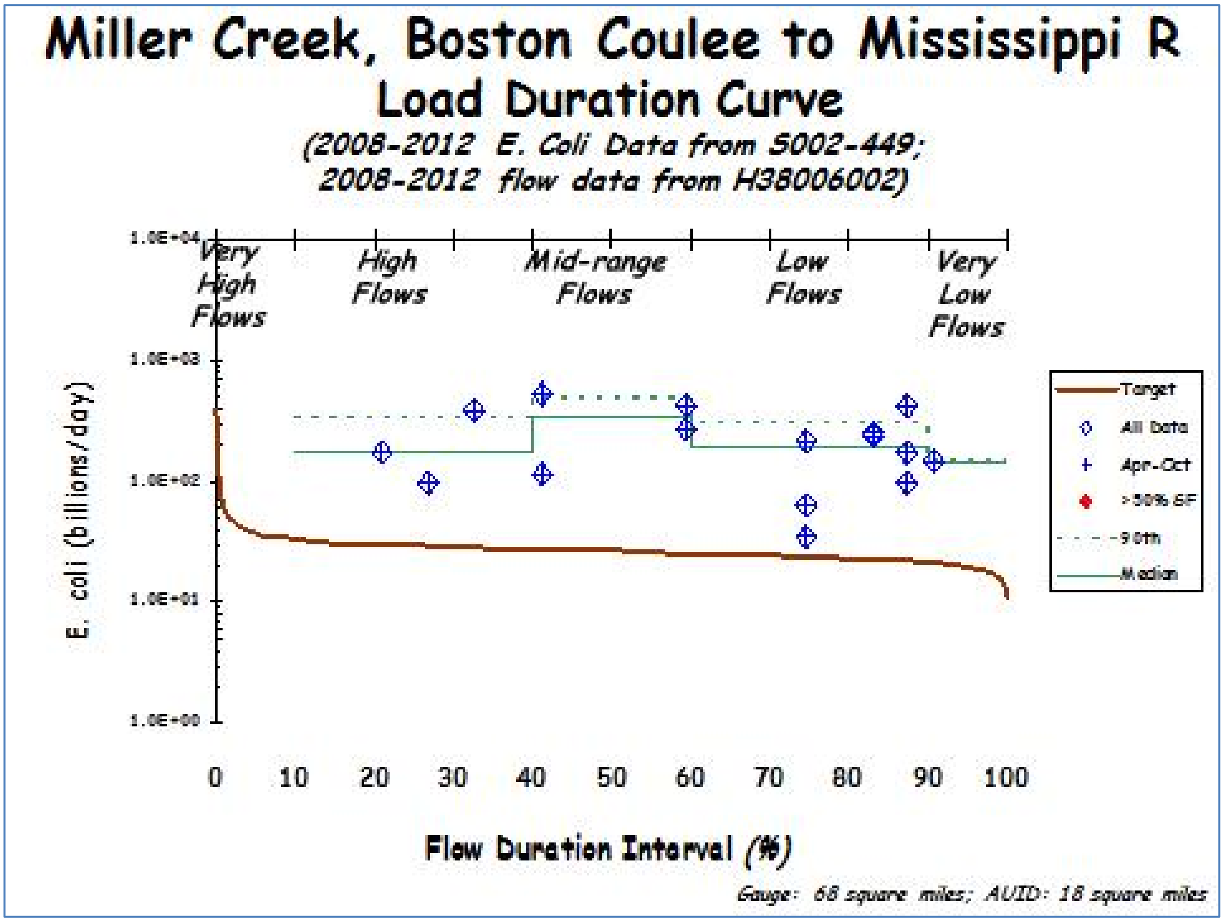
10.1.2 Bullard Creek.



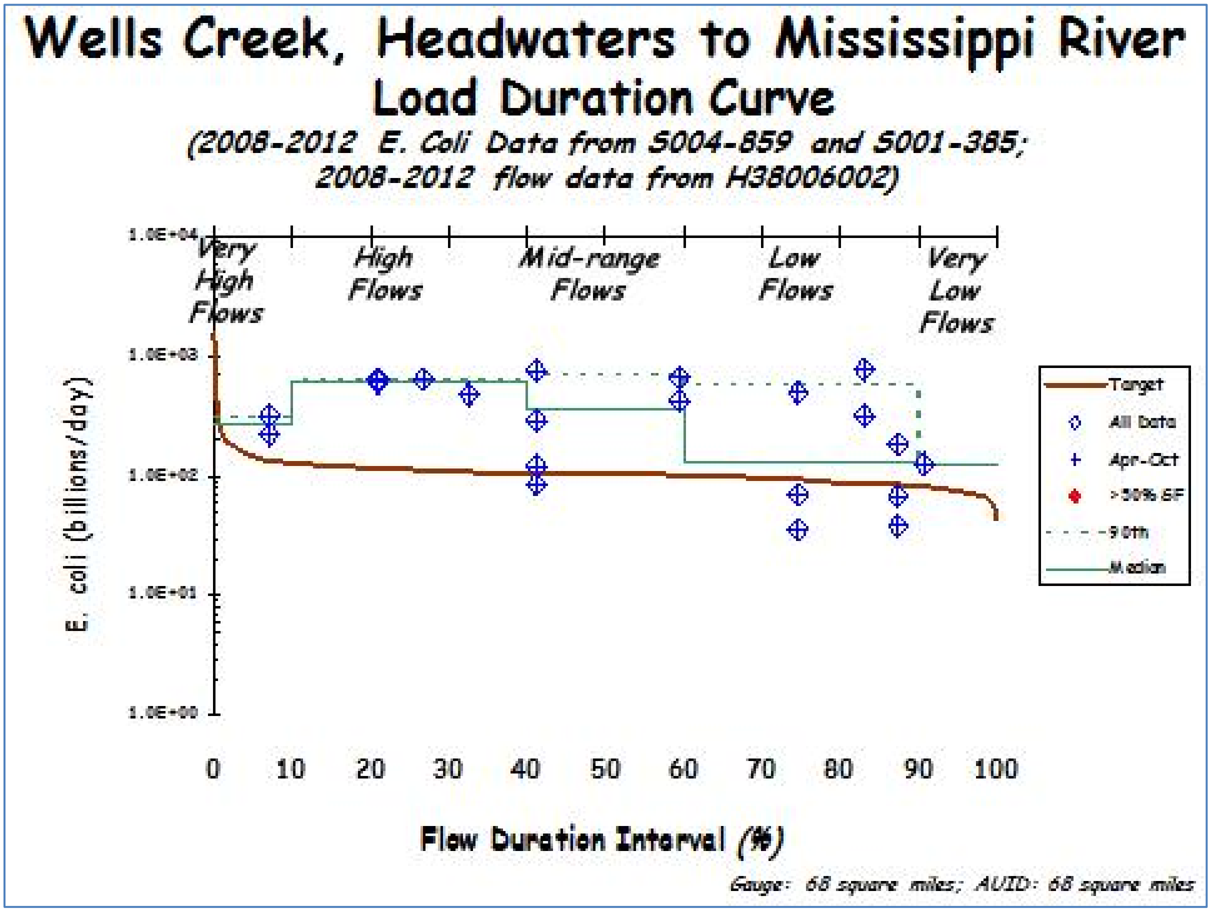
10.1.3 Gilbert Creek.



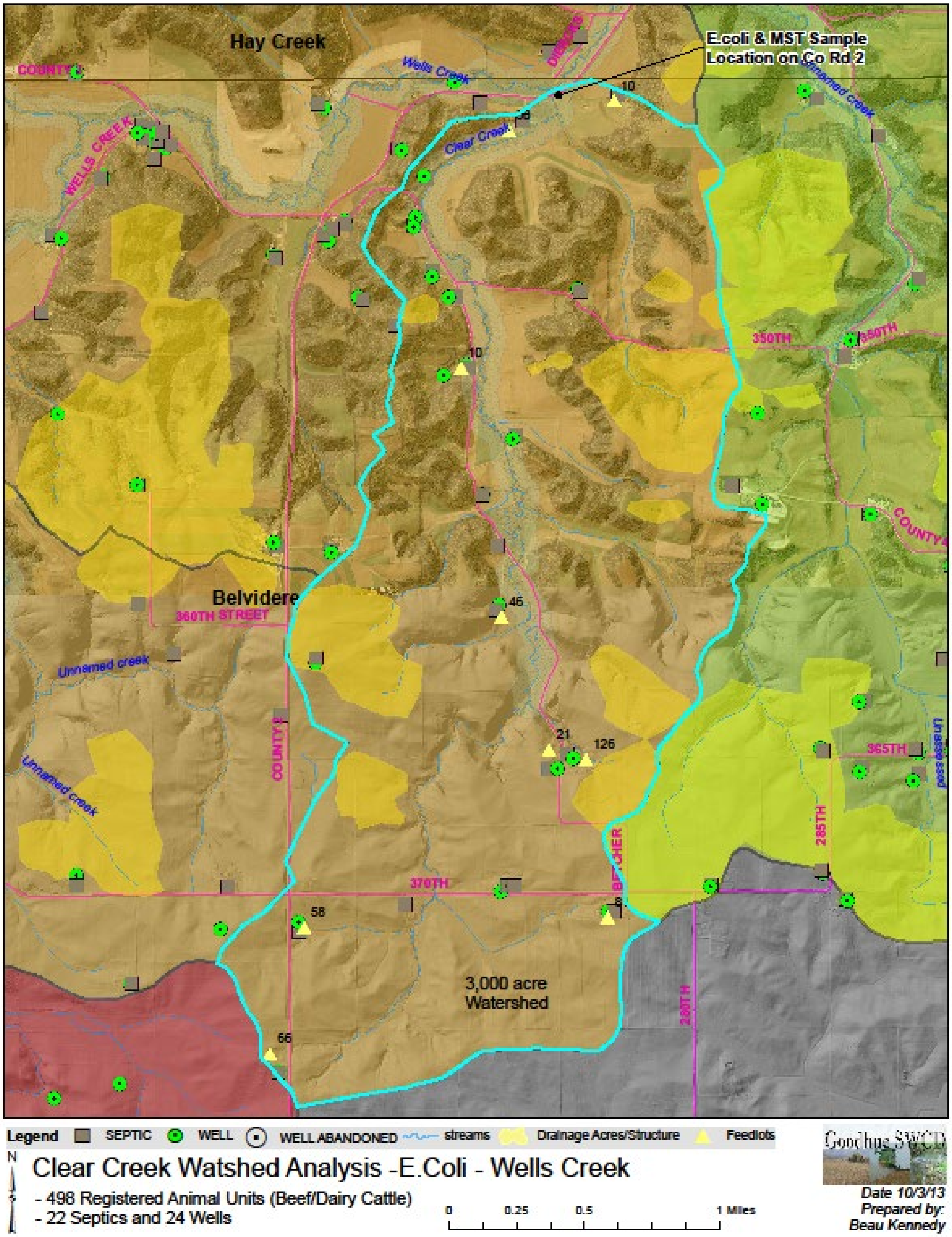
10.1.4 Miller Creek.

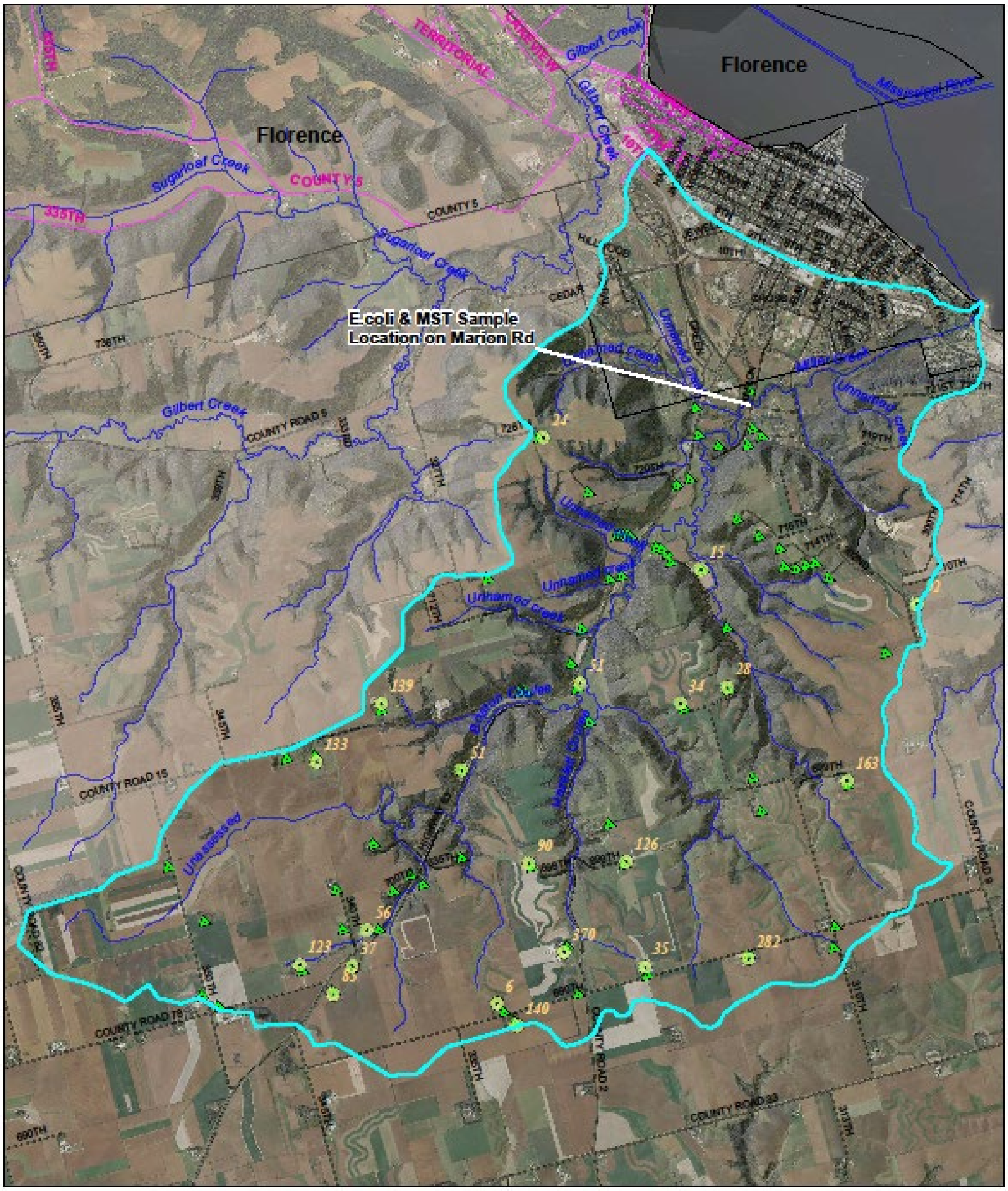


10.1.5 Wells Creek.



10.2 Appendix B: Pollutant Source Maps





Feedlot (au) Septic/Well Location streams

10,000 acre Watershed

Miller Creek Watershed Analysis -E.Coli - Wells Creek

- 2,080 Registered Animal Units (Beef/Dairy Cattle)
- 75 Septics and 75 Wells (assumed)

0 0.5 1 2 Miles

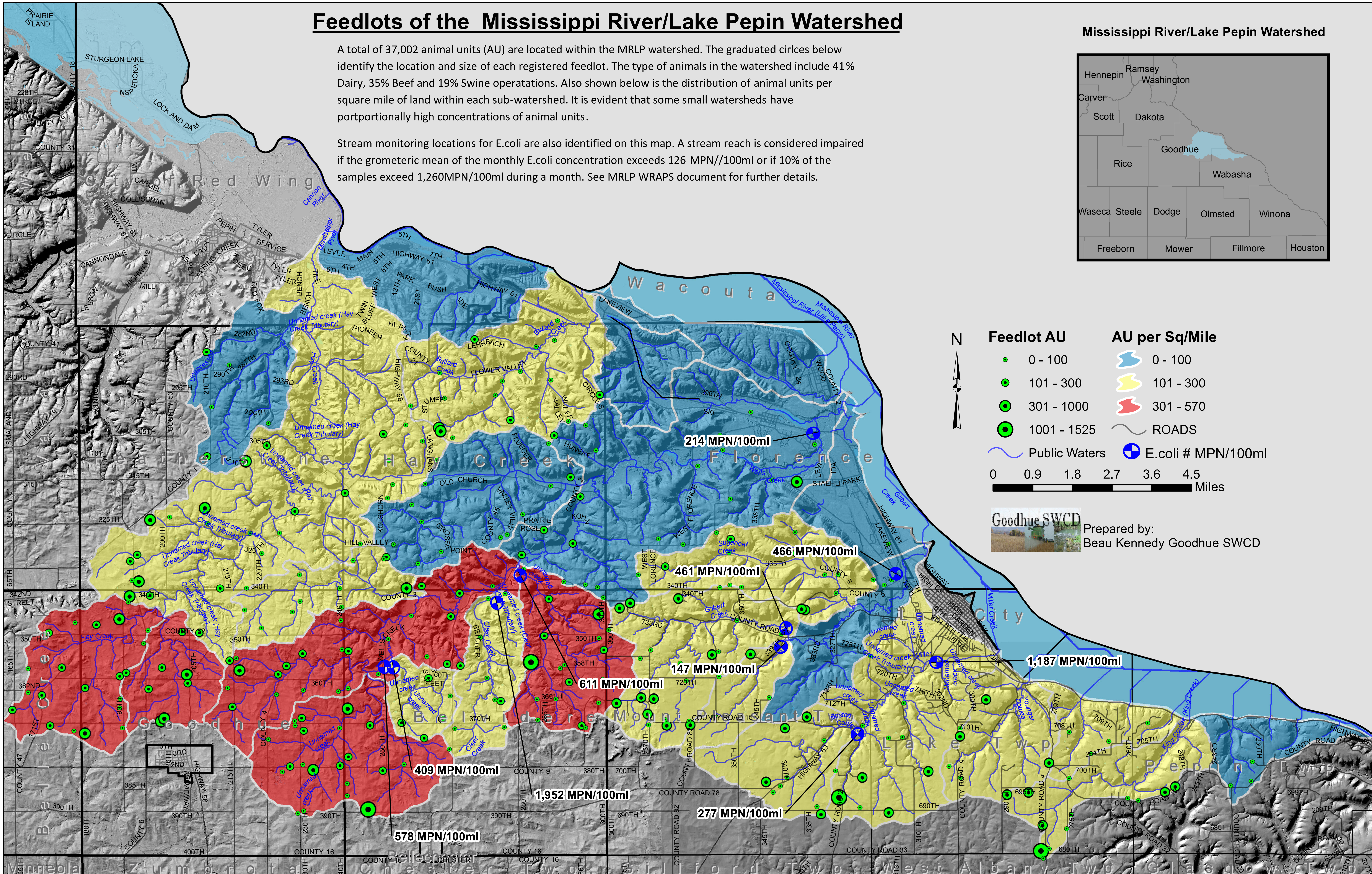
Goodhue SWCD

Date 10/16/13
Prepared by:
Beau Kennedy

Feedlots of the Mississippi River/Lake Pepin Watershed

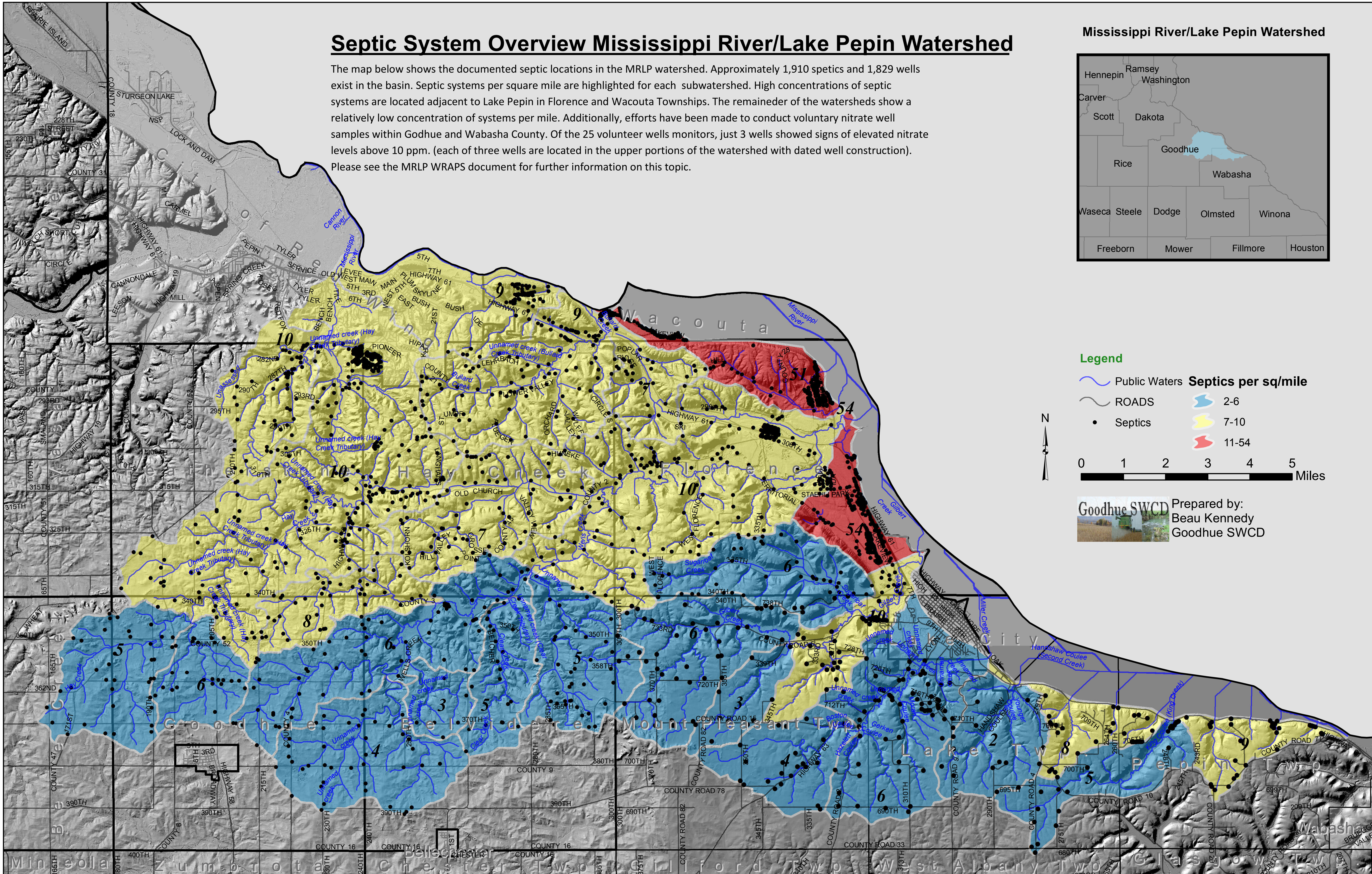
A total of 37,002 animal units (AU) are located within the MRLP watershed. The graduated cirlces below identify the location and size of each registered feedlot. The type of animals in the watershed include 41% Dairy, 35% Beef and 19% Swine operatations. Also shown below is the distribution of animal units per square mile of land within each sub-watershed. It is evident that some small watersheds have portportionally high concentrations of animal units.

Stream monitoring locations for E.coli are also identified on this map. A stream reach is considered impaired if the grometeric mean of the monthly E.coli concentration exceeds 126 MPN//100ml or if 10% of the samples exceed 1,260MPN/100ml during a month. See MRLP WRAPS document for further details.



Septic System Overview Mississippi River/Lake Pepin Watershed

The map below shows the documented septic locations in the MRLP watershed. Approximately 1,910 spetics and 1,829 wells exist in the basin. Septic systems per square mile are highlighted for each subwatershed. High concentrations of septic systems are located adjacent to Lake Pepin in Florence and Wacouta Townships. The remaineder of the watersheds show a relatively low concentration of systems per mile. Additionally, efforts have been made to conduct voluntary nitrate well samples within Godhue and Wabasha County. Of the 25 volunteer wells monitors, just 3 wells showed signs of elevated nitrate levels above 10 ppm. (each of three wells are located in the upper portions of the watershed with dated well construction). Please see the MRLP WRAPS document for further information on this topic.



10.3 Appendix C: Bacteria Source Tracking Data

Client Name	Client Reference	Analysis Requested	Present / Absent	Host Marker	General Marker	Date	SM Number	Sample Type
Goodhue SWCD	S002-449	Human Bacteroidetes ID	Absent	<LOD	NA	7/25/2013	SM-3G25002	Water
Goodhue SWCD	S002-449	Human Bacteroidetes ID 1	Absent	<LOD	NA	8/21/2013	SM-3H21002	Water
Goodhue SWCD	S002-449	Human Bacteroidetes ID 2	Absent	<LOD	NA	8/21/2013	SM-3H21004	Water
Goodhue SWCD	S002-449	Human Bacteroidetes ID 2	Absent	<LOD	NA	9/27/2013	SM-3I27009	Water
Goodhue SWCD	S002-449	Cow Bacteroidetes ID	Absent	<LOD	NA	7/25/2013	SM-3G25004	Water
Goodhue SWCD	S002-449	Cow Bacteroidetes ID	Absent	<LOD	NA	8/21/2013	SM-3H21006	Water
Goodhue SWCD	S002-449	Ruminant Fecal ID	Absent	<LOD	NA	8/21/2013	SM-3H21008	Water
Goodhue SWCD	S002-449	Ruminant Fecal ID	Absent	<LOD	NA	7/25/2013	SM-3H22004	Water
Goodhue SWCD	S007-121	Human Bacteroidetes ID	Absent	<LOD	NA	7/25/2013	SM-3G25001	Water
Goodhue SWCD	S007-121	Human Bacteroidetes ID 1	Absent	<LOD	NA	8/21/2013	SM-3H21001	Water
Goodhue SWCD	S007-121	Human Bacteroidetes ID 2	Absent	<LOD	NA	8/21/2013	SM-3H21003	Water
Goodhue SWCD	S007-121	Human Bacteroidetes ID 1	Absent	<LOD	NA	9/27/2013	SM-3I27008	Water
Goodhue SWCD	S007-121	Human Bacteroidetes ID 2	Absent	<LOD	NA	9/27/2013	SM-3I27010	Water
Goodhue SWCD	S007-121	Cow Bacteroidetes ID	Absent	<LOD	NA	7/25/2013	SM-3G25003	Water
Goodhue SWCD	S007-121	Cow Bacteroidetes ID	Absent	<LOD	NA	8/21/2013	SM-3H21005	Water
Goodhue SWCD	S007-121	Ruminant Fecal ID	Absent	<LOD	NA	8/21/2013	SM-3H21007	Water
Goodhue SWCD	S007-121	Ruminant Fecal ID	Absent	<LOD	NA	7/25/2013	SM-3H22003	Water
Goodhue SWCD	S002-449	Human Bacteroidetes ID 1	**Present**	1.15E+03	3.57E+05	9/27/2013	SM-3I27007	Water
Goodhue SWCD	S002-449	Ruminant Fecal ID	**Present**	3.76E+04	3.57E+05	9/27/2013	SM-3I27011	Water
Goodhue SWCD	S007-121	Ruminant Fecal ID	**Present**	6.79E+02	5.69E+03	9/27/2013	SM-3I27012	Water