Water Quality Improvement Plan
for the

Upper Chariton River Watershed

Clark, Lucas, Monroe, Decatur, Wayne,
and Appanoose Counties, Iowa

Total Maximum Daily Loads for:
Pathogen Indicators (*E. coli*)

Prepared by:
Andrew Frana and
James A. Hallmark, P.E.

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IOWA DNR WATERSHED IMPROVEMENT

Iowa Department of Natural Resources
Water Quality Monitoring and Assessment Section
2023

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List of Abbreviations

Units of measure:

ac	acre
cfs	cubic feet per second
cfu	colony-forming unit
cm	centimeter
cms	cubic meters per second
d	day
g	gram
ha	hectare
hm	hectometer
hr	hour
in	inch
kg	kilogram
km	kilometer
L	liter
lb	pound
m	meter
mg	milligram
Mg	megagram (= 1 mt)
mi	mile
ml	milliliter
mo	month
mt	metric ton (= 1 Mg)
orgs	E. *coli* organisms
ppm	parts per million
ppb	parts per billion
s	second
t	ton (English)
yd	yard
yr	year

Other abbreviations:

AFO	animal feeding operation
BMP	best management practice
Chl-a	chlorophyll *a*
E. coli	Escherichia coli
GM	geometric mean (pertains to WQS for *E. coli*, = 126 orgs/100 ml)
LDC	load duration curve
N	nitrogen
ortho-P	ortho-phosphate
P	phosphorus
SSM	single-sample max (pertains to WQS for *E. coli*, = 235 orgs/100 ml)
TN	total nitrogen
TP	total phosphorus
WQS	water quality standard

General Report Summary

What is the purpose of this report?
This report serves multiple purposes. First, it is a resource for increased understanding of watershed and water quality conditions in the Upper Chariton River watershed. Second, this report satisfies the Federal Clean Water Act requirement to develop a Total Maximum Daily Load (TMDL) report for all impaired 303(d) waterbodies. Third, it provides a foundation for locally-driven water quality improvements to the Upper Chariton River watershed in an effort to improve water quality. Finally, it may be useful for obtaining financial assistance to implement projects in the Upper Chariton River watershed that will eventually result in water quality improvements to justify removal from the federal 303(d) list of impaired waters.

What is wrong with the Upper Chariton River?
Five main stem stream segments in the Upper Chariton River and eleven of its tributaries are not supporting either secondary contact recreation or primary contact recreation "designated use" due to high levels of indicator bacteria called *Escherichia coli (E. coli*). Secondary contact recreation includes activities that involve indirect or accidental contact with the water such as fishing, boating, and shoreline activities. Primary contact recreation includes activities that involve direct contact with the water such as swimming and wading. High *E. coli* levels in the water can indicate the presence of potentially harmful bacteria and viruses (also called pathogens) that can cause humans to become ill if they come into contact with and/or ingest contaminated water.

What is causing the problem?
E. coli and harmful pathogens found in a waterbody can originate from point or nonpoint sources of pollution, or a combination of both. Point sources of pollution are easily identified sources that enter a waterbody at a distinct location, such as a wastewater treatment plant discharge. Nonpoint sources of pollution are discharged in a more indirect and diffuse manner, and are often more difficult to locate and identify. Nonpoint source pollution is usually carried with rainfall or snowmelt over the surface of the land and into the waterbody.

Both point and nonpoint sources of pollution can be responsible for high *E. coli* levels. Permitted sources include municipal wastewater treatment facilities (WWTF) and discharging onsite wastewater treatment and disposal systems. Onsite wastewater treatment systems are often called septic systems, even though not all systems include a septic tank. Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in the watershed. Specific examples of potential nonpoint sources of bacteria include cattle with direct access to streams, manure applied to row crops, non-permitted onsite wastewater systems, and natural sources such as wildlife.

What can be done to improve the Upper Chariton River?
To improve the water quality in the Upper Chariton River watershed so that secondary contact recreation and primary contact recreation are fully supported, the amount of *E. coli* entering the stream must be reduced. Accomplishing this will require a combination of land, animal, stormwater, and wastewater management practices. In the rural areas of the watershed, efforts should focus on eliminating livestock access to streams, strategic manure application that considers both timing and application methods, and improving failing onsite wastewater treatment systems to meet state standards.

Urban activities should include the adoption of stormwater BMPs geared specifically to *E. coli* reduction and / or runoff reduction. This approach includes elimination of sanitary sewer overflows (SSOs) and possible illicit sanitary sewer connections, strategic management of wastewater facility discharges (adjustment of discharge timing, disinfection, etc.). Additionally, public outreach and educational programs such as those encouraging pet owners to pick up pet waste may be helpful.

Who is responsible for a cleaner Upper Chariton River Watershed?
Everyone who lives, works, and plays in the Upper Chariton River watershed has a role to play in improving water quality. Because there are several point sources that discharge *E. coli* in the watershed, these facilities must meet wasteload allocations (WLAs) that will be incorporated into their National Pollutant Discharge Elimination System

(NPDES) permits. Voluntary management of land and animals by private citizens will also be needed to see positive results. The majority of land in the watershed is in agricultural production, and financial assistance is often available from government agencies to individual landowners willing to adopt best management practices (BMPs). Rural homeowners can have their septic systems inspected to ensure they function properly. Failing or malfunctioning systems should be repaired or replaced. Improving water quality in the Upper Chariton River watershed will require a collaborative effort of citizens and agencies with a genuine interest in protecting the streams and rivers now and in the future.

Does a TMDL guarantee water quality improvement?
The Iowa Department of Natural Resources (DNR) recognizes that technical guidance and support are critical to achieving the goals outlined in this Water Quality Improvement Plan (WQIP). The WQIP itself is only a document, and without implementation, will not improve water quality. Therefore, a basic implementation plan is included for use by local agencies, watershed managers, and citizens for decision-making support and planning purposes. This implementation plan should be used as a guide or foundation for detailed and comprehensive planning by local stakeholders.

Reducing pollutants from unregulated nonpoint sources requires voluntary implementation of best management practices. Many practices have benefits to sustained productivity of the land as well as water quality. Quantifying the value of sustainability and other ecosystem services is difficult and those benefits are not commonly recognized. Consequently, wide-spread adoption of voluntary conservation practices is often difficult to achieve. A coordinated watershed improvement effort for each individual stream could address some of these barriers by providing financial assistance, technical resources, and information outreach to landowners to encourage and facilitate adoption of conservation practices.

How should this document be used?
Because this document serves several purposes, not everyone will benefit from the entire document. While EPA will be interested in the technical segments that address the TMDL and loading calculations, for stakeholders in and around the Upper Chariton River watershed, the most pertinent information will be found in sections 6 and 7. These sections address what can be done to improve the water quality in the Upper Chariton River watershed.

Required Elements of the TMDL

This Water Quality Improvement Plan (WQIP) has been prepared in compliance with the current regulations for TMDL development that were promulgated in 1992 as 40 CFR Part 130.7 in compliance with the Clean Water Act. These regulations and consequent TMDL development are summarized below in Table 1.

Table 1. Technical Elements of the TMDL.

Name and geographic location of the impaired or threatened waterbody for which the TMDL is being established:	**South Fork Chariton River HUC 10** South Fork Chariton River IA 05-CHA-1327 IA 05-CHA-1328 South Fork Chariton Tributaries Jordan Creek, IA 05-CHA-1330 Jackson Creek, IA 05-CHA-1332 Ninemile Creek, IA 05-CHA-1335 Walker Branch, IA 05-CHA-1329 **Wolf Creek-Chariton River HUC 10** Chariton River IA 05-CHA-1310 IA 05-CHA-1311 IA 05-CHA-1312 Chariton River Tributaries Chariton Creek, IA 05-CHA-1313 Honey Creek, IA 05-CHA-1337 Wolf Creek, IA 05-CHA-1339 Fivemile Creek, IA 05-CHA-1341 Honey Creek, IA 05-CHA-2019 **Cooper Creek-Chariton River HUC 10** Chariton River, IA 05-CHA-1307 Chariton River, IA 05-CHA-1308
Surface water classification and designated uses:	**Class A1 Primary Contact Recreation** All segments listed above, except Honey Creek: IA 05-CHA-1337 **Class A2 Secondary Contact Recreation** Honey Creek: IA 05-CHA-1337 **Class B (WW-1) Aquatic Life** Chariton River: IA 05-CHA-1307, IA 05-CHA-1308, and IA 05-CHA-1312 Chariton Creek: IA 05-CHA-1313 Honey Creek: IA 05-CHA-2019

	Class B (WW-2) Aquatic Life Chariton River: IA 05-CHA-1310 and IA 05-CHA-1311 South Fork Chariton River: IA 05-CHA-1327 and IA 05-CHA-1328 Walker Branch: IA 05-CHA-1329 Jordan Creek: IA 05-CHA-1330 Jackson Creek: IA 05-CHA-1332 Ninemile Creek: IA 05-CHA-1335 Wolf Creek: IA 05-CHA-1339 Fivemile Creek: IA 05-CHA-1341 Honey Creek: IA 05-CHA-1337 **Class C (Drinking Water)** IA 05-CHA-1308 **Class HH (Human Health)** IA 05-CHA-1307 IA 05-CHA-1308
Impaired beneficial uses:	Class A1 Primary Contact Recreation Class A2 Secondary Contact Recreation (March 15 to November 15)
TMDL Priority Level	Tier III
Antidegradation Level	Tier 1
Identification of the pollutant and applicable water quality standards (WQS):	Pathogen Indicator, *E. coli*. Primary contact recreational (Class A1) and secondary contact recreational (Class A2) uses are not supported due to violations of the *E. coli* Water Quality Standard criteria. Class A1 use *E. coli* criteria is 126 organisms/100 ml for the geometric mean and 235 organisms/100 ml for the single sample maximum Class A2 use *E. coli* criteria is 630 organisms/100 ml for the geometric mean and 2,880 organisms/100 ml for the single sample maximum These standards only apply during the recreational season of March 15 - November 15.
Quantification of the pollutant load that may be present in the waterbody and still allow attainment and maintenance of water quality standards:	The target for the Upper Chariton River segments and its tributaries with a Class A1 designated use is an *E. coli* geometric mean (GM) of 126 organisms/100 ml and a single sample maximum (SSM) of 235 organisms/100 ml. For a Class A2 designated use the target is an *E. coli* GM of 630 organisms/100 ml and a SSM of 2,880 organisms/100 ml. See Sections 4.3, 5.3, and 6.3
Quantification of the amount or degree by which the current pollutant load in the waterbody, including the pollutant from upstream sources that is being accounted for as background loading, deviates from the pollutant load needed to attain and maintain water quality standards:	The *E. coli* load departure from capacity has been calculated for five flow recurrence intervals for each impaired segment in the watershed for the GM and the SSM. See Sections 4.3, 5.3, and 6.3

Identification of pollution source categories:	Point sources of bacteria include wastewater treatment facilities (WWTFs), onsite wastewater systems operating under NPDES permits, and sanitary sewer overflows (SSOs). Nonpoint sources of pollution include cattle with direct access to streams, manure application to row crops, failing onsite wastewater treatment systems, and wildlife.
Wasteload allocations (WLA) for pollutants from point sources:	Pathogen Indicator, *E. coli*. The wasteload allocations (WLA) for point sources for each segment are listed in Section 4.3, Section 5.3, and Section 6.3.
Load allocations for pollutants from nonpoint sources (NPS):	Pathogen Indicator, *E. coli*. The load allocations (LA) for point sources for each segment are listed in Section 4.3, Section 5.3, and Section 6.3.
Margin of safety (MOS):	Pathogen Indicator, *E. coli*. An explicit MOS of 10% is utilized in the TMDL for all impaired reaches.
Consideration of seasonal variation:	Pathogen Indicator, *E. coli*. These TMDLs were developed based on the Iowa WQS primary contact recreation season that runs from March 15 to November 15. Allocations are developed for a range of flow conditions, which help account for wet and dry periods within the recreation season.
Reasonable assurance that load and wasteload allocations will be met:	For nonpoint sources, reasonable assurance is provided by: (1) planned implementation activities that address the pollutant of concern, (2) local stakeholders working towards implementation of appropriate BMPs, (3) detailed requirements for watershed planning to ensure that 319 applications meet EPA requirements, and (4) available monetary support for nonpoint source pollution reduction. See Section 3.4 for more detailed discussion of reasonable assurance. For point sources, reasonable assurance is provided through NPDES permits.
Allowance for reasonably foreseeable increases in pollutant loads:	Because there are several unsewered communities in the watershed a reserve wasteload allocation was calculated in case they upgrade to a wastewater treatment system in the future.
Implementation plan:	A general implementation plan is outlined in Section 7 to guide local citizens, government, and water quality groups in the development of more detailed plans for individual streams within the Upper Chariton River watershed. *E. coli* reduction will be accomplished through a combination of land use, livestock / manure, stormwater, and wastewater management strategies.

1. Introduction

The Federal Clean Water Act requires states to assess their waterbodies every even numbered year and incorporate these assessments into the 305(b) Water Quality Assessment Report. Assessed lakes and streams that do not meet Iowa Water Quality Standards (WQS) criteria are placed on the 303(d) impaired waters list. Subsequently, a Total Maximum Daily Load (TMDL) for each pollutant must be calculated and a Water Quality Improvement Plan (WQIP) written for each impaired water body.

A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can tolerate without exceeding WQS and impairing the waterbody's designated uses. The TMDL calculation is represented by the following general equation:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where:	TMDL	= total maximum daily load
	LC	= loading capacity
	∑WLA	= sum of wasteload allocations (point sources)
	∑LA	= sum of load allocations (nonpoint sources)
	MOS	= margin of safety (to account for uncertainty)

Sixteen segments in the Upper Chariton River watershed, located in Clark, Lucas, Monroe, Decatur, Wayne, and Appanoose Counties in southern Iowa, are on the impaired waters list due to levels of indicator bacteria (*E. coli*) that violate state water quality criteria. The impaired segments include five main stem segments and eleven tributaries (Figure 1.1 and Table 1.1).

One purpose of this Water Quality Improvement Plan (WQIP) for the Upper Chariton River watershed is to provide a TMDL for indicator bacteria. The second purpose of the plan is to provide local stakeholders and watershed managers with a tool to promote awareness of water quality issues, develop a watershed management plan, and implement water quality improvement projects. This WQIP includes an assessment of the existing *E. coli* loads to each impaired segment, as well as a determination of how much *E. coli* each segment can tolerate and without exceeding standards.

The plan includes a description of potential actions that can reduce pollution to the streams. These actions are sometimes referred to as best management practices (BMPs) aimed to improve water quality in the Upper Chariton River watershed, with the ultimate goal of meeting water quality standards. These BMPs are outlined in Section 7 Implementation Plan.

The Iowa Department of Natural Resources (DNR) recommends a phased approach to watershed management. A phased approach is helpful when the origin, interaction, and quantification of pollutants contributing to water quality problems are complex and difficult to fully understand and predict. Iterative implementation of improvement practices and additional water quality assessment (i.e., monitoring) will help ensure progress towards water quality standards, maximize cost efficiency, and prevent unnecessary or ineffective implementation of costly BMPs. A water quality monitoring plan designed to help assess water quality improvement and BMP effectiveness is provided in Section 8.

This plan will be of little value unless additional watershed improvement activities and BMPs are implemented. This will require the active engagement of local stakeholders and the collaboration of several state and local agencies. Experience has shown that locally-led watershed plans have the highest potential for success. The Watershed Improvement Section of DNR has designed this plan for stakeholder use and may be able to provide technical support for the improvement of water quality in the Upper Chariton River watershed.

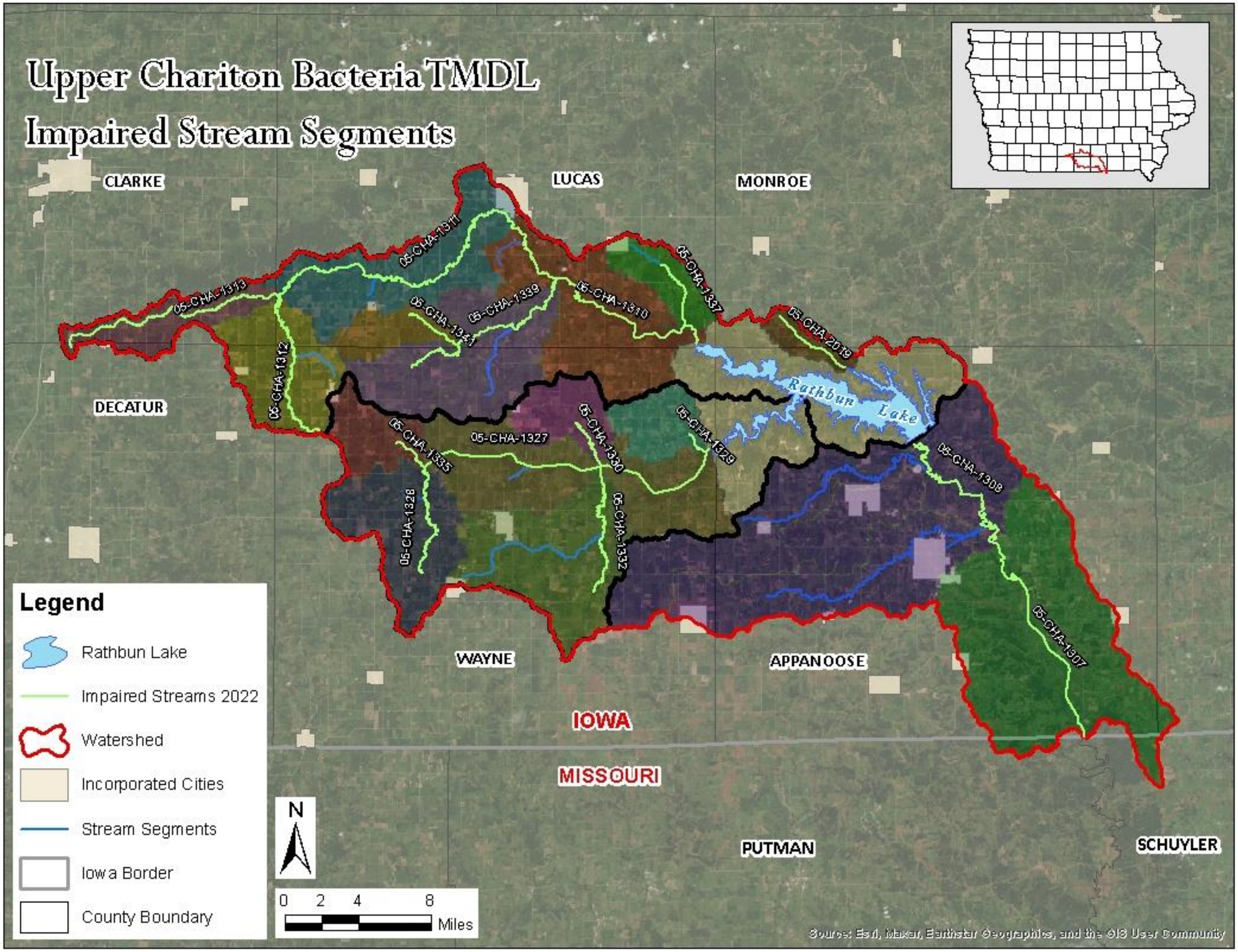

Figure 1.1. Impaired Segments of the Upper Chariton River Watershed

Table 1.1. Impaired Segments in the Upper Chariton River Watershed.

Segment name	Segment ID	HUC 10	Drainage Area (mi^2)	Impairment Category[(1)]
Chariton River	IA 05-CHA-1307	Cooper Creek –Chariton River	828.4	5a
Chariton River	IA 05-CHA-1308	Cooper Creek –Chariton River	719.8	5a
Chariton River	IA 05-CHA-1310	Wolf Creek – Chariton River	245.7	5p
Chariton River	IA 05-CHA-1311	Wolf Creek – Chariton River	106.1	5p
Chariton River	IA 05-CHA-1312	Wolf Creek – Chariton River	35.1	5p
Chariton Creek	IA 05-CHA-1313	Wolf Creek – Chariton River	20.05	5p
Honey Creek	IA 05-CHA-1337	Wolf Creek – Chariton River	15.4	5a
Wolf Creek	IA 05-CHA-1339	Wolf Creek – Chariton River	66.2	5p
Fivemile Creek	IA 05-CHA-1341	Wolf Creek – Chariton River	13.5	5p
Honey Creek	IA 05-CHA-2019	Wolf Creek – Chariton River	7.5	5p
South Fork Chariton River	IA 05-CHA-1327	South Fork Chariton River	208.3	5p
South Fork Chariton River	IA 05-CHA-1328	South Fork Chariton River	40.6	5p
Walker Branch	IA 05-CHA-1329	South Fork Chariton River	16.0	5p
Jordan Creek	IA 05-CHA-1330	South Fork Chariton River	17.9	5p
Jackson Creek	IA 05-CHA-1332	South Fork Chariton River	54.0	5p
Ninemile Creek	IA 05-CHA-1335	South Fork Chariton River	17.5	5p

(1) 5a pollutant caused impairment. TMDL needed; 5p Impairment occurs on a waterbody with presumptive A1 or B(WW1) use.

2. Description and History of the Upper Chariton River Watershed

2.1 History and Land Use

The impaired segments are located above the Rathbun Lake dam, with the exception of the two segments of the Chariton River, which are downstream of the dam. Rathbun Lake is the primary water source for the Rathbun Regional Water Association, which provides about eight million gallons of water per day (8 MGD) to almost 80,000 people for residential, agricultural, and industrial use. The dam was constructed in the late 1960s and is maintained by the US Army Corps of Engineers. The watershed covers 525,303 acres, with approximately 35 percent being used for row crops and another 34 percent is grassland. It is estimated that cropland has increased in the watershed by 38,700 acres in the last decade, mainly due to conversion of grassland and land once enrolled in the Conservation Reserve Program.

The Upper Chariton River watershed is located within the Loess Flats and Till Plains—Central Irregular Plains ecoregion (40a) (Prior 1991; Griffith et al., 1994). The landscape is characterized by rolling uplands, integrated drainage, and occasional broad alluvial plains. Most soils in the watershed formed in loess, glacial till, or alluvium. The majority of soils in the watershed have characteristics that limit their potential uses, such as high susceptibility to erosion, high water retention, and low fertility.

Land uses within the watershed are dominated by agriculture (Table 2.1 and Figure 2.1).

Table 2.1. Land Uses in the Rathbun Lake Watershed.

General Land Use	Land Use Description	Area	
		Acres	Percent
Grassland	Both pasture and ungrazed grassland	179,542.2	34.2
Row Crops	Corn, Soybeans, and others	183,144.2	34.9
Forest/Timber	All forested areas	107,064.0	20.4
Water/ Wetlands	Ponds, lakes, and wetlands	21,304.1	4.1
Urban/Developed	Includes all developed areas	23,750.9	4.5
Alfalfa/Hay	Alfalfa and Hay	10,083.8	1.9
Barren	Barren Land	414.1	<0.1
Total		525,303.3	100

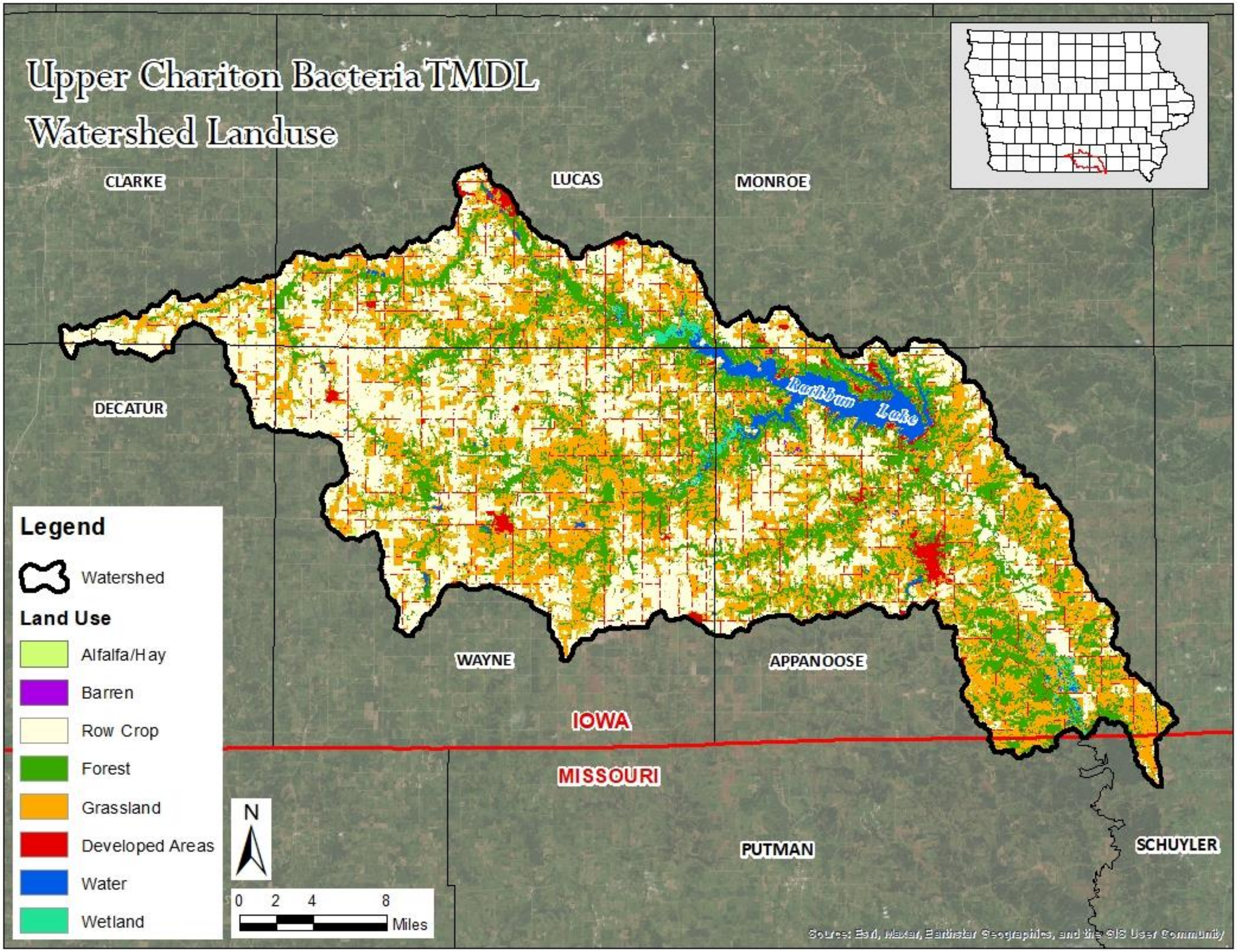

Figure 2.1. Upper Chariton River Watershed Landuse.

2.2 Hydrology, Soils, Climate, and Topography

Ten soils series make up approximately 64 percent of the Upper Chariton River watershed. These soils are largely glacial till underlying loess deposits on the surface. Soils with high clay content and low permeability dominate the landscape, making the watershed particularly susceptible to high runoff rates and soil erosion, especially on steep slopes. The topography consists of rolling hills interspersed with level, upland divides and alluvial lowlands. The drainage pattern is dendritic, with the upland plains and highly dissected stream valleys. As a result, there are many hillslopes, and over 50 percent of the watershed has a slope exceeding 5 percent. The flattest slopes are found in the alluvial floodplains and a few upland ridgelines between drainage divides.

There are six weather stations within eight miles of the Upper Chariton River watershed where temperature and precipitation are measured and recorded. These include National Weather Service (NWS) Cooperative Program (COOP) stations in Allerton, Chariton, and Osceola (IEM, 2015). Additionally, temperature and precipitation data were obtained from National Climatic Data Center (NCDC) stations at Leon, Promise City, and at the Rathbun Lake Dam (NOAA, 2015).

Based on the Rathbun Lake Dam weather station, average annual precipitation near Rathbun Lake was 40.2 inches from 1995-2014 (Figure 2.2). The climate of south-central Iowa is relatively humid, with precipitation exceeding evapotranspiration (ET) nearly year-round, with some exceptions in late summer months (Figure 2.3). However, in very dry years such as 2012, ET can exceed precipitation. Precipitation in the Rathbun Lake area varies not only from year-to-year, but also seasonally. Over 71 percent of the annual precipitation falls from April to September (i.e., during the growing season). The past eight years have been wetter than normal, with an average annual rainfall of 47.4 inches. Years 2007, 2008, and 2010 were extreme years with several flooding events and annual rainfall totals more than 25 percent above normal each year. Rainfall events resulting in runoff can carry bacteria off the landscape to streams, elevating bacteria levels above water quality standards.

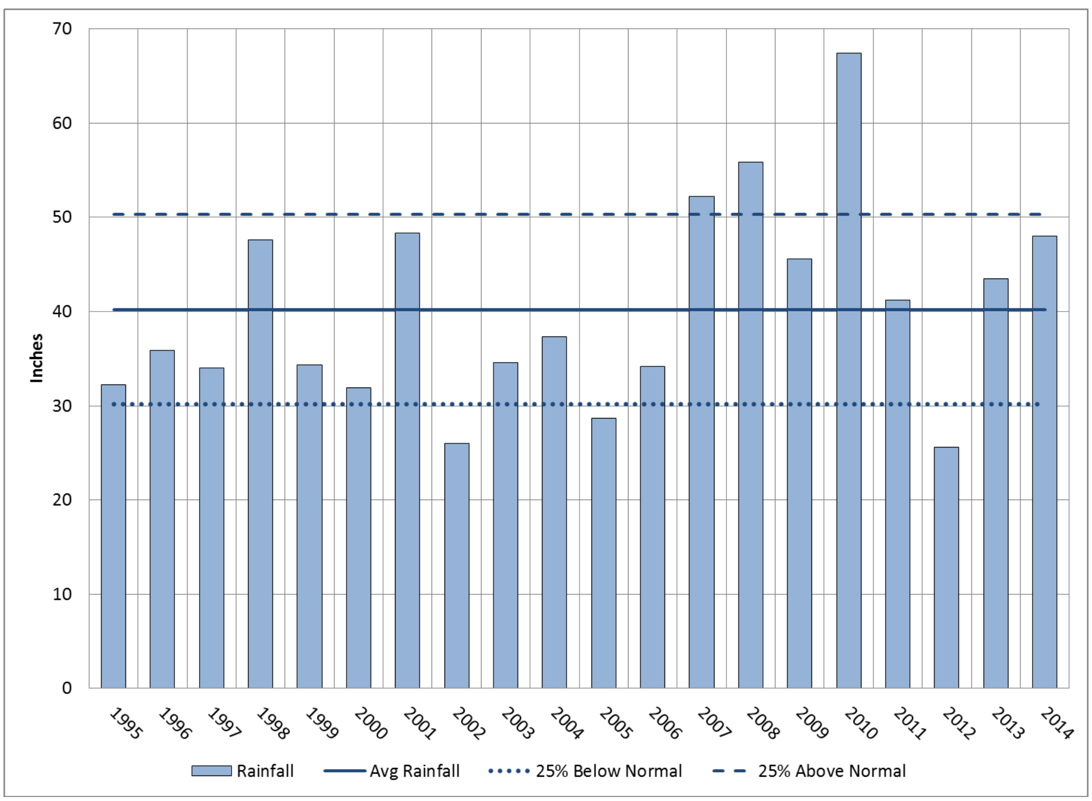

Figure 2.2. Annual Rainfall Totals at the Rathbun Lake Dam from 1995-2014

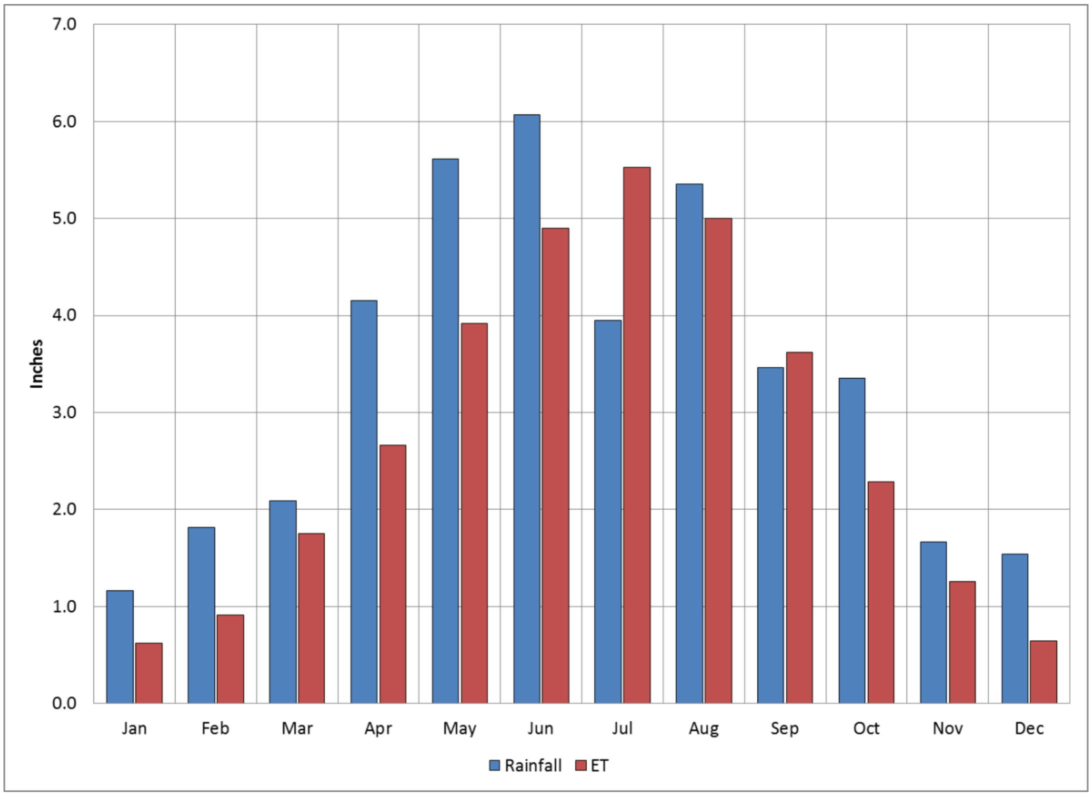

Figure 2.3. Monthly Precipitation and Estimated Evapotranspiration for the Upper Chariton River Watershed

3. General Stream and Environmental Information

3.1 Problem Identification

16 stream segments in the Upper Chariton River watershed (Figure 1.1) do not meet water quality standards (WQS) and are not supporting their designated uses due to the presence of high levels of an indicator bacteria called *Escherichia coli* (*E. coli*). High *E. coli* levels in a waterbody can indicate the presence of potentially harmful bacteria and viruses (also called pathogens). The applicable designated uses and water quality standards for pathogen indicators are found in the Iowa Administrative Code (567 Iowa Administrative Code, Chapter 61, (IAC)). Table 3.1 summarizes the water quality standards for pathogen indicators for Class A1 and Class A2 uses and the applicable season. A water body, with a Class A1 or Class A2 designated use, is impaired for *E. coli* if the geometric mean (GM) or the sample maximum (SSM) exceeds the values in Table 3.1. This standard is only applicable during the recreation season, defined as March 15 through November 15.

Table 3.1. *E. coli* Indicator Bacteria Criteria for Class A1 and Class A2 Uses (organisms/100 ml of water).

Use or Category	Geometric Mean	Sample Maximum
Class A1		
3/15 – 11/15	126	235
11/16 – 3/14	Does not apply	Does not apply
Class A2		
3/15 – 11/15	630	2,880
11/16 – 3/14	Does not apply	Does not apply

General Description of the Pollutants

Fecal material from warm-blooded animals contains many microorganisms. Some of these microorganisms can cause illness or disease if ingested by humans. The term pathogen refers to a disease-causing microorganism, and can include bacteria, viruses, and other microscopic organisms. Humans can become ill if they come into contact with and/or ingest water that contains pathogens.

It is not practical to test water for every possible pathogen that may be present - there are simply too many different kinds of pathogens. Instead, water quality assessments typically test for an organism such as total coliform, fecal coliform, or *E. coli* to indicate the presence of pathogens from fecal material. *E. coli* is a type of fecal coliform, and its presence theoretically correlates with illnesses that result from human exposure to water that is contaminated with fecal material (Mishra et al, 2008). It should be noted that not all types of *E. coli* cause human illness; however, the presence of *E. coli* indicates the likelihood that pathogens are present. For the purposes of this TMDL, *E. coli* is used as the indicator bacteria. The two primary reasons for using *E. coli* are: (1) the EPA currently considers *E. coli* to be the preferred bacterial indicator, and (2) Iowa's WQS are written for *E. coli*.

Problem Statement

Water quality assessments indicate that primary (Class A1) and secondary (Class A2) contact recreation uses are "not supported" in these segments due to high levels of indicator bacteria (*E. coli*) that violate the state's WQS. The significance of the impairments noted in the assessments is that desirable recreational activities, such as swimming and wading, are not supported by existing water quality in the impaired segments. As a result of these findings, the Federal Clean Water Act requires that TDMLs for *E. coli* be developed for all the impaired segments.

Stream Segment Designations and Descriptions

In February 2008, changes to Iowa's surface water classifications were approved by the EPA and all segments were presumed to be Class A1, primary contact recreation until a use attainability assessment could be completed and approved by the EPA. Stream designations are defined and classified for protection of beneficial uses in the Iowa Administrative Code (IAC) 567-61.3(1).

Beneficial uses as defined in the IAC 567-61.3(1) are cited below.

- 567-61.3(1)(b)(1) Primary contact recreational use (Class "A1"). Water in which recreational or other uses may result in prolonged and direct contact with the water, involving considerable risk of ingesting water in quantities sufficient to pose a health hazard. Such activities would include, but not be limited to, swimming, diving, water skiing, and water contact recreation canoeing.
- 567-61.3(1)(b)(2) Secondary contact recreational use (Class "A2"). Waters in which recreational or other uses may result in contact with the water that is either incidental or accidental. During the recreational use, the probability of ingesting appreciable quantities of water is minimal. Class A2 uses include fishing, commercial and recreational boating, any limited contact incidental to shoreline activities and activities in which users do not swim or float in the water body while on a boating activity.
- 567-61.3(1)(b)(6) Warm water-Type 1 (Class "B(WW-1)"). Waters in which temperature, flow and other habitat characteristics are suitable to maintain warm water game fish populations along with a resident aquatic community that includes a variety of native nongame fish and invertebrate species. These waters generally include border rivers, large interior rivers, and the lower segments of medium-size tributary streams.
- 567-61.3(1)(b)(7) Warm water-Type 1 (Class "B(WW-2)"). Waters in which flow or other habitat characteristics are capable of supporting a resident aquatic community that includes a variety of native nongame fish and invertebrate species. The flow and other physical characteristics limit the maintenance of warm water game fish populations. These waters generally consist of small perennially flowing streams.
- 567-61.3(1)(b)(10). Human health (Class "HH"). Waters in which fish are routinely harvested for human consumption or waters both designated as a drinking water supply and in which fish are routinely harvested for human consumption.

In 2010 the State of Iowa enacted an antidegradation policy. This policy was designed to maintain and protect high quality waters and existing water quality in other waters from unnecessary pollution. Protection levels (or tiers) as defined by the Iowa Administrative Code (IAC) 567-61.2 are cited below.

- 567-61.2(2)(a) Tier 1 protection. Existing surface water uses and the level of water quality necessary to protect the existing uses will be maintained and protected.

Stream segment designations and descriptions for individual impaired stream segments will be discussed in the respective sections of this report.

Data Sources and Monitoring Sites

The primary sources of water quality data used in the development of this WQIP are water quality data collected by the DNR and the USGS National Water-Quality Assessment (NAWQA) Program. These data consist primarily of grab samples collected by the agencies between 1997 and 2012. When available, additional water quality data through 2016 was utilized. Each section will outline specific sources used, but the following list summarizes sources of additional data used for this WQIP:

- Streamflow data collected by the USGS at multiple surface water gaging stations.
- Water quality data collected by the USACE, Kansas City District, as part of its reservoir monitoring program.
- Precipitation data from the National Weather Service Cooperative Observer Program (NWS COOP) (IEM, 2015)
- 10-m Digital Elevation Model (DEM) available from DNR GIS library.
- SSURGO soils data maintained by United States Department of Agriculture -Natural Resource Conservation Service (USDA-NRCS).
- U.S. Department of Agriculture National Agricultural Statistics Service Cropland Data Layer (USDA CDL) reflecting 2014 conditions.
- Aerial images (various years) collected and maintained by DNR.
- Water Quality data collected by the USDA's Agricultural Research Service National Laboratory for Agriculture and the Environment (NLAE).

3.2 TMDL Target

General Description of the Pollutant

Potential point sources of *E. coli* for the 16 impaired stream segments are undisinfected wastewater treatment facility discharges.

The nonpoint *E. coli* sources for the impaired segments are runoff from developed areas, grazing livestock, manure applied to fields., wildlife, and failed septic tank systems. These nonpoint sources can be divided into two categories. One is episodic and consists of livestock and wildlife fecal material periodically transported during precipitation events. The other is continuous discharges from leaking septic tank systems and manure from cattle in the and near streams. In addition, *E. coli* from nonpoint sources can be resuspended after disturbance of stream sediment.

Selection of Environmental Conditions

The critical period for the impairment occurs during the recreational season of March 15 to November 15.

Pollutant Loading Capacity (LC)

The TMDL (loading capacity) is the number of organisms that can be in a volume and meet the water quality standards. Load duration curves (LDC) were constructed using mean daily flows and the *E. coli* water quality standards criteria (see Table 3.1) to quantify the TMDL of each impaired segment, in terms of load (orgs/day), across a range of flow conditions. The TMDL for each impaired stream segment is calculated by multiplying the midpoint flow of each flow condition, in the load duration curve (LDC), by the *E. coli* criteria concentration.

Load Duration Curve

The *E. coli* TMDLs in this water quality improvement plan were developed using a LDC framework. The LDC is a graphical way of presenting the LC, existing loads, and the frequency and magnitude of WQS exceedances across a range of flow conditions. The LDC relates pollutant loads in a stream to the percent of time the stream flow has been met or exceeded and is developed by multiplying stream flow with the water quality target and a conversion factor. Figure 3.1**Error! Reference source not found.** represent a LDC for the Chariton River, segment IA 05-CHA-1312, and is presented here as an example of the format of the LDC used throughout this WQIP. It illustrates, data points, observed loading, and flow variable loading capacity, which is based on the WQS criterion of 235 orgs/100 ml for the SSM concentration.

The light blue dashed line represents the TMDL (or loading capacity, LC) for the SSM criterion. Points above this curve represent violation of the WQS, whereas points below the curves comply with WQS. *E. coli* loads were estimated by multiplying observed concentrations (orgs/100 ml) by the mean daily flow (cfs) on the day the sample was collected (including a unit's conversion). Using the load duration curve (LDC) approach, these measured loads are plotted against the flow duration interval, which allows loads to be grouped into the same flow conditions loading capacity.
Each diamond in Figure 3.1 represents an observed *E. coli* daily load. Green-shaded diamonds (◆) indicate samples that were collected in the spring (March to May), orange shading (◆) represents samples collected in the summer (June to September), and gray shading (◆) indicates samples that were collected in the fall (October to November).

LDCs for each stream segment show the observed loading, which is the 90th percentile (purple, dotted lines) within each flow condition and the TMDL (target loading or loading capacity, purple dashed line). The difference between these two is the departure from the loading capacity. The target loading is based on the mid-point flow in each flow condition multiplied by the SSM criterion of 235 orgs/100 ml (including a unit's conversion). The wasteload allocation (WLA) is represented by a solid dark blue line and is constant across all flow conditions, except on rare occasions where the WLA exceeds the target loading capacity. In these instances, the WLA is assigned the target loading capacity value minus 10 percent of the target loading capacity. This occurs when the effluent design flows from the treatment facility exceed the estimated average daily stream flow. In reality, this condition could not exist since the effluent from the treatment facility is part of the stream flow.

LDC's based on SSM and GM criteria will be presented for each stream since all streams are impaired based on the SSM and GM criteria.

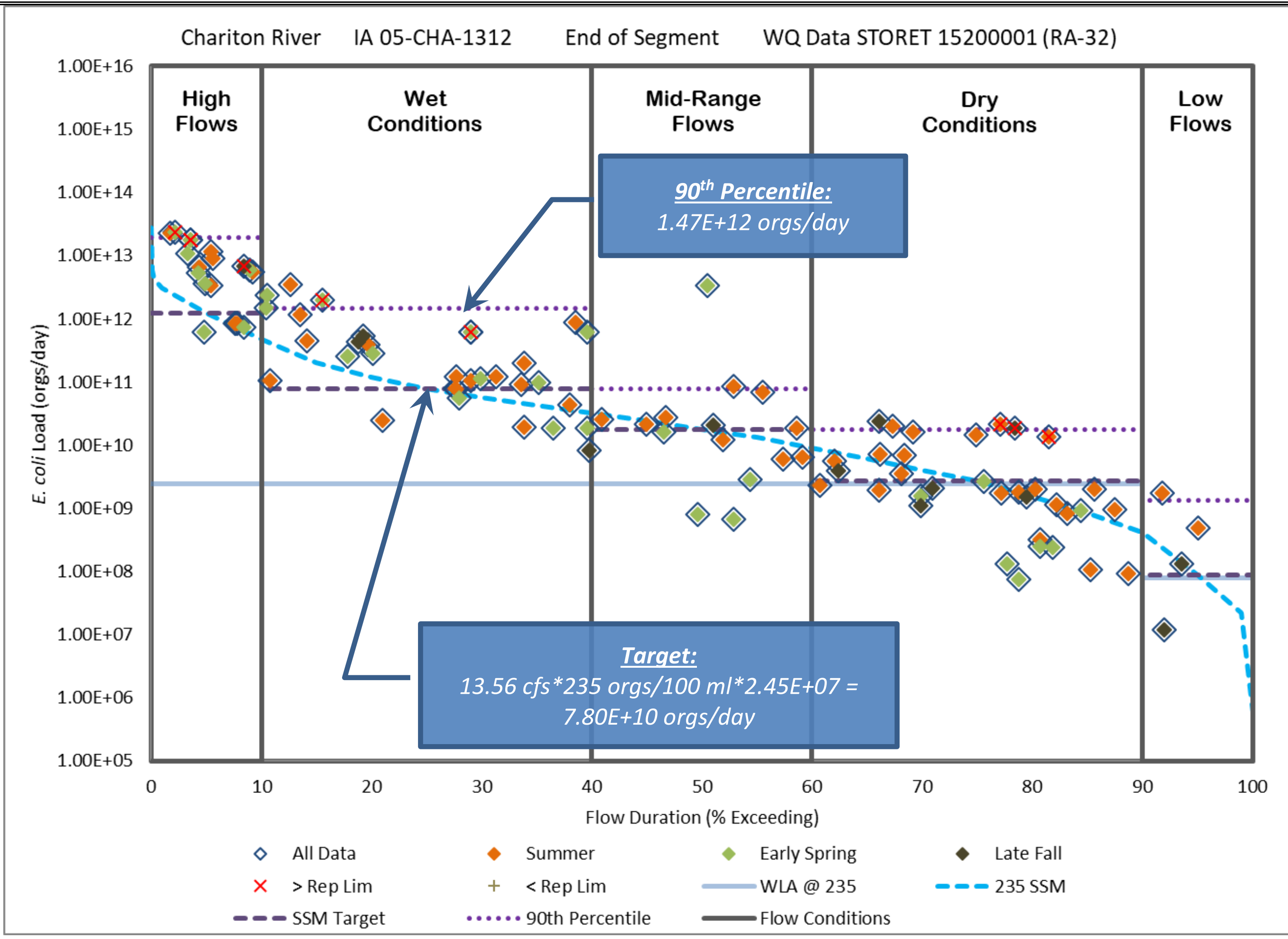

Figure 3.1. Example Load Duration Curve based on the SSM for Chariton River, Segment IA 05-CHA-1312.

Decision Criteria for WQS Attainment
Water quality, to fully support recreational uses, will be attained when the monitored *E. coli* concentration meets the geometric mean (GM) concentration of 126 orgs/100 ml and the single sample maximum (SSM) concentration of 235 orgs/100 ml for Class A1 designated use streams and a GM concentration of 630 orgs/100 ml and SSM concentration of 2,880 orgs/100 ml for Class A2 designated use streams, during the recreational season of March 15 - November 15 (See Table 3.1).

While the SSM and GM *E. coli* criteria are equally protective of human health since they are both derived from the same statistical data set, it should be noted that "…the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality. The geometric mean is generally more relevant because it is usually a more reliable measure of long term water quality, being less subject to random variation, and more directly linked to the underlying studies upon which the 1986 bacteria criteria were based." (EPA, 2006).

With two *E.coli* criteria (SSM and GM) it is necessary to establish a link to demonstrate consistency between the SSM and the GM. Development of ambient water quality criteria for *E. coli* defines the statistical relationship between the SSM and the GM, which can be used to show that attaining the SSM criteria will result in attainment of the GM criteria. The concepts to establish this link are described in the EPA publication *"Ambient Water Quality Criteria for Bacteria – 1986"*.

Linkage Analysis
In two cases, the target load is based on the SSM criterion of 235 orgs/100 ml. This occurs where the data is sufficient to determine the GM target but is insufficient to determine the percent load reduction required in *E. coli* to comply with the 126 orgs/100 ml criterion. This situation occurs in stream segments IA 05-CHA-1307 and IA 05-CHA-1308. For these

cases it will be necessary to establish a link to demonstrate that attaining compliance with the SSM will also achieve compliance with the GM criterion.

Iowa's *E coli* criteria are based on EA recommendations published in 1986. (USEPA, 1986), which included criteria for the GM and the SSM. The GM was established from epidemiological studies by comparing gastrointestinal illness at a rate of 8/1,000. The SSM was determined using the GM (126 orgs/100 ml) and the log standard deviation of 0.4. To account for different recreational use intensities EPA provided four SSM values corresponding to the 75th, 82nd, 90th and 95th percentiles of the expected water quality sampling distribution. Iowa adopted the most stringent SSM, the 75th percentile (235 orgs/100 ml), into the water quality standards. Based on the assessment methods used in this WQIP, the SSM existing load is taken as the 90th percentile.

Using the methods described in "An Approach for Using Load Duration Curves in the Development of TMDLs" (USEPA, 2007) a linkage analysis can be developed to demonstrate that attainment of the SSM criterion will result in attainment of the GM criterion. Figure 3.2 shows the original distribution around a GM of 126 orgs/100 and how the distribution adjusts changes around a SSM of 235 orgs/100 ml at a 90th percentile frequency interval. The GM associated with the adjusted distribution is 72 orgs/100 ml, which more stringent than the GM of the original distribution of 126 orgs/100 ml, showing that by attaining a SSM target will meet the GM criterion.

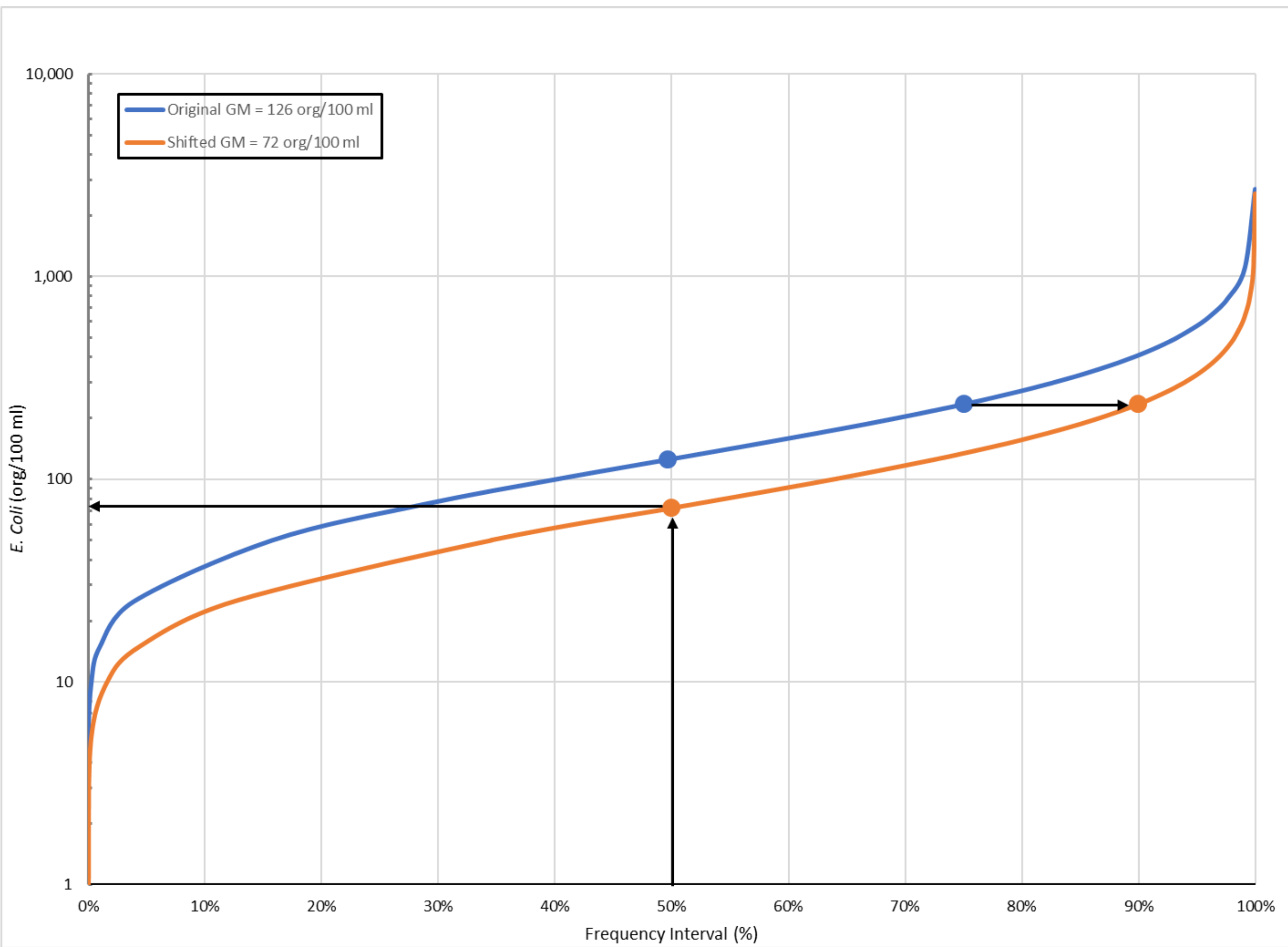

Figure 3.2. *E. Coli* Assessment Method on the Criteria's Original Log-Normal Frequency Distribution.

3.3 Pollution Source Assessment

Bacteria sources include wastewater treatment plants and urban storm sewer discharges, failed septic tanks, wildlife, grazing livestock, runoff from fields where manure has been applied, and feedlots. Nonpoint source bacteria problems often accompany heavy rainfall events. Point sources of bacteria, such as wastewater treatment plants, usually discharge continuously.

Existing Loads

The existing loads are derived from the data measured at the data collection sites shown in Table 4.3, Table 5.3, and Table 6.3. These data are the monitored points shown in the load duration curves in the following sections for the specific impaired waterbodies. The monitored *E. coli* concentrations are multiplied by the average daily flow to get the daily loads that are plotted with the load duration curves. The maximum allowable loads for a given flow equal the flow multiplied by the WQS limits for the geometric mean or single sample maximum. Monitored data that exceed the WQS criteria are above the WQS limit curves.

The maximum existing load occurs during events when maximum runoff and bacteria concentrations are highest often causing bacteria concentrations to exceed the criteria. The other condition leading to criteria violations occurs during dry low flow periods when continuous loads from livestock in the stream, local wildlife, septic tanks, and wastewater treatment plants cause bacteria problems.

The assessment methodology used to evaluate pathogen indicator criteria assume that if 10 percent or more of samples exceed the SSM *E. coli* criteria then the waterbody is not supporting recreational use. The 90th percentile of observed concentrations within each flow condition is multiplied by the median flow for each condition to estimate existing loads for the SSM criterion and the GM within each flow condition is multiplied by the median flow for each condition to estimate existing loads for the GM criterion.

Identification of Pollutant Sources

There are two categories of pollutant sources, point sources and non-point sources. Point sources include NPDES permitted facilities such as municipal and industrial wastewater treatment facilities. Nonpoint sources include all discharges that are not regulated and are discharged in an indirect and diffuse manner, such as runoff from agricultural areas.

Point Sources (Wasteload Allocation)

Point sources are permitted and discharge at specific locations such as pipes, outfalls, and conveyance channels. These sources are generally regulated by a federal NPDES permit. The point sources in the Upper Chariton River watershed include 14 NPDES permitted facilities, 10 CAFOs, and 10 private systems operating under General Permit #4 (GP#4). Wasteload allocations (WLA) based on the geometric mean criterion (126 orgs/100 ml) have been calculated for each of these facilities. Since This calculated WLA will be used in the TMDL calculations when considering for both A full list of the points sources in the watershed can be found in Appendix C.2.

Nonpoint Sources (Load Allocation)

Nonpoint sources are unpermitted sources and discharge in an indirect and diffuse manner, and often are difficult to located and quantify. Nonpoint sources of *E. coli* include contributors that do not have localized points of release into a stream. These loads may originate from various land use types in the watershed. In the watershed these sources can include:

- Grazing animals
- Cattle contributions directly deposited in a stream
- Land application of manure
- Urban and rural area runoff
- Wildlife
- Failing septic tank systems, including unsewered communities

Potential Sources

Figure 3.3 shows some potential *E. coli* contributing sources by flow condition. Each box represents a potential source and overlaps the flow conditions in which it is most likely to contribute to the impairment. The boxes are color coded with red shading indicating the condition in which the source has a greater impact to water quality and green shading indicates the condition in which the source has a lower impact to water quality.

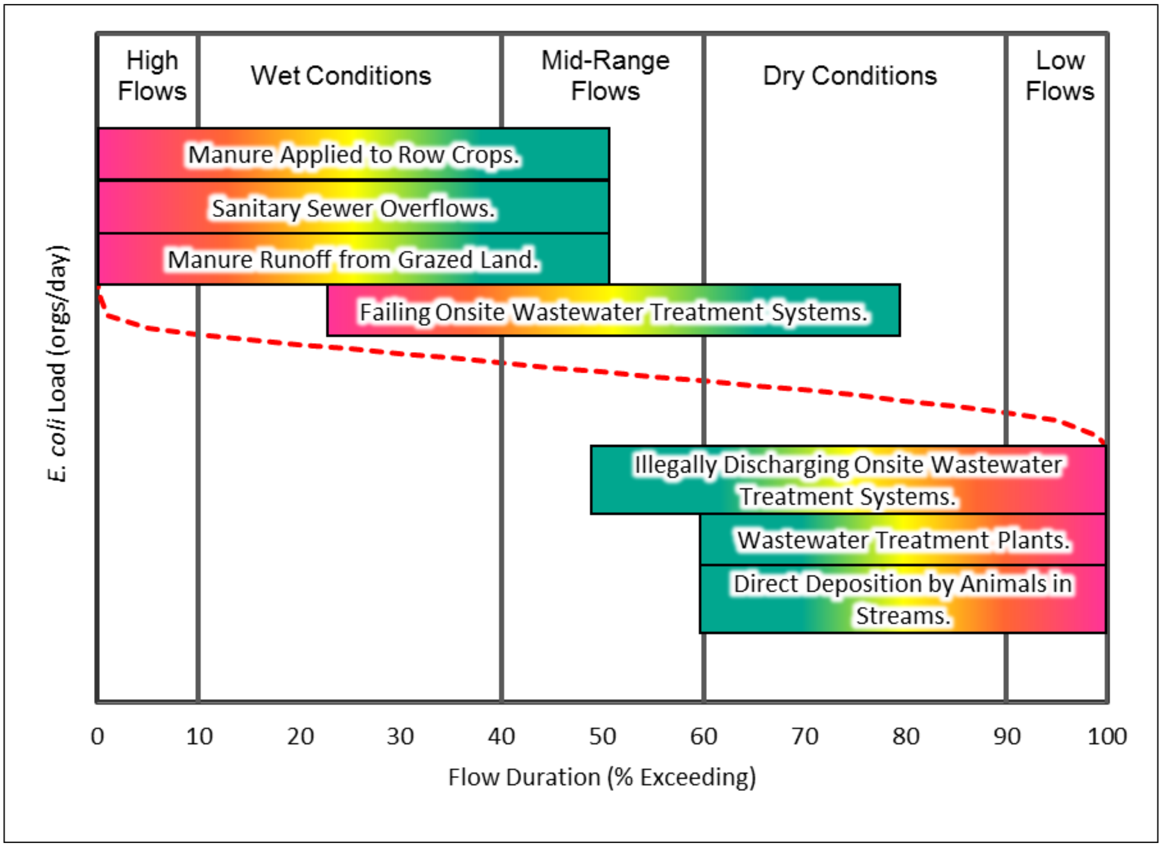

Figure 3.3. Potential *E. coli* Sources by Flow Condition.

3.4 Reasonable Assurance

Under current EPA guidance, TMDLs that allocate loads to both point sources (WLAs) and nonpoint sources (LAs) must demonstrate reasonable assurance that required load reductions will be implemented. For point sources, reasonable assurance is provided through NPDES permits. Permits include operation requirements and compliance schedules that are developed based on water quality protection. For nonpoint sources, allocations and proposed implementation activities must satisfy four criteria:

- They must apply to the pollutant of concern
- They will be implemented expeditiously
- They will be accomplished through effective programs
- They will be supported by adequate water quality funding

Nonpoint source measures developed in the Upper Chariton River watershed TMDL satisfy all four criteria. First, LAs and implementation activities described in Section 7 of the report apply directly to *E. coli*. Attainment of designated uses and existing water quality are measured using these indicator bacteria. Second, there are several active watershed groups already pursuing detailed watershed planning and implementation activities in the Upper Chariton River watershed. Third, DNR has set forth detailed requirements for watershed planning and implementation to ensure that watershed management plans and Section 319 applications meet EPA requirements and include: approximate timelines for implementation activities, ongoing monitoring to track progress towards water quality improvement, a phased and prioritized schedule of activities, and target the impairment appropriately. Finally, ongoing monetary support is available for implementation in a variety of forms, including Section 319 grants, as well as other federal, state, and local resources.

4. TMDLs for Wolf Creek-Chariton River for Indicator Bacteria (*E. coli*)

Total Maximum Daily Loads (TMDLs) are required for the eight impaired waterbody segments in the Wolf Creek-Chariton River HUC 10 (1028020102) by the Federal Clean Water Act. This section of the Water Quality Improvement Plan (WQIP) describes the pollutant, in this case Escherichia coli (*E. coli*), leading to the impairments and the maximum amount of *E. coli* the stream segments can assimilate and still support their designated uses.

4.1 Problem Identification

The primary contact recreation (Class A1) uses in Chariton Creek, three segments of the Chariton River, Fivemile Creek, Wolf Creek, and two segments of Honey Creek are not supported due to the presence of high levels of indicator bacteria (*E. coli*) (Figure 4.1). High *E. coli* levels in a waterbody can indicate the presence of potentially harmful bacteria and viruses (also called pathogens). Humans can become ill if they come into contact with and/or ingest water that contains pathogens. Under Iowa Administrative Code, streams are impaired for *E. coli* if they exceed a single sample maximum of 235 colony forming units (cfu) per 100 ml of water and the geometric mean of all samples exceeds 126 cfu/100 ml of water. This standard is only applicable during the recreation season, defined as March 15 through November 15.

Both point and nonpoint sources of pollution can be responsible for high *E. coli* levels. Permitted sources include municipal wastewater treatment facilities (WWTF) and discharging onsite wastewater treatment and disposal systems. Onsite wastewater treatment systems are often called septic systems, even though not all systems include a septic tank. Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include cattle with direct access to streams, manure applied to row crops, non-permitted onsite wastewater systems, and natural sources such as wildlife.

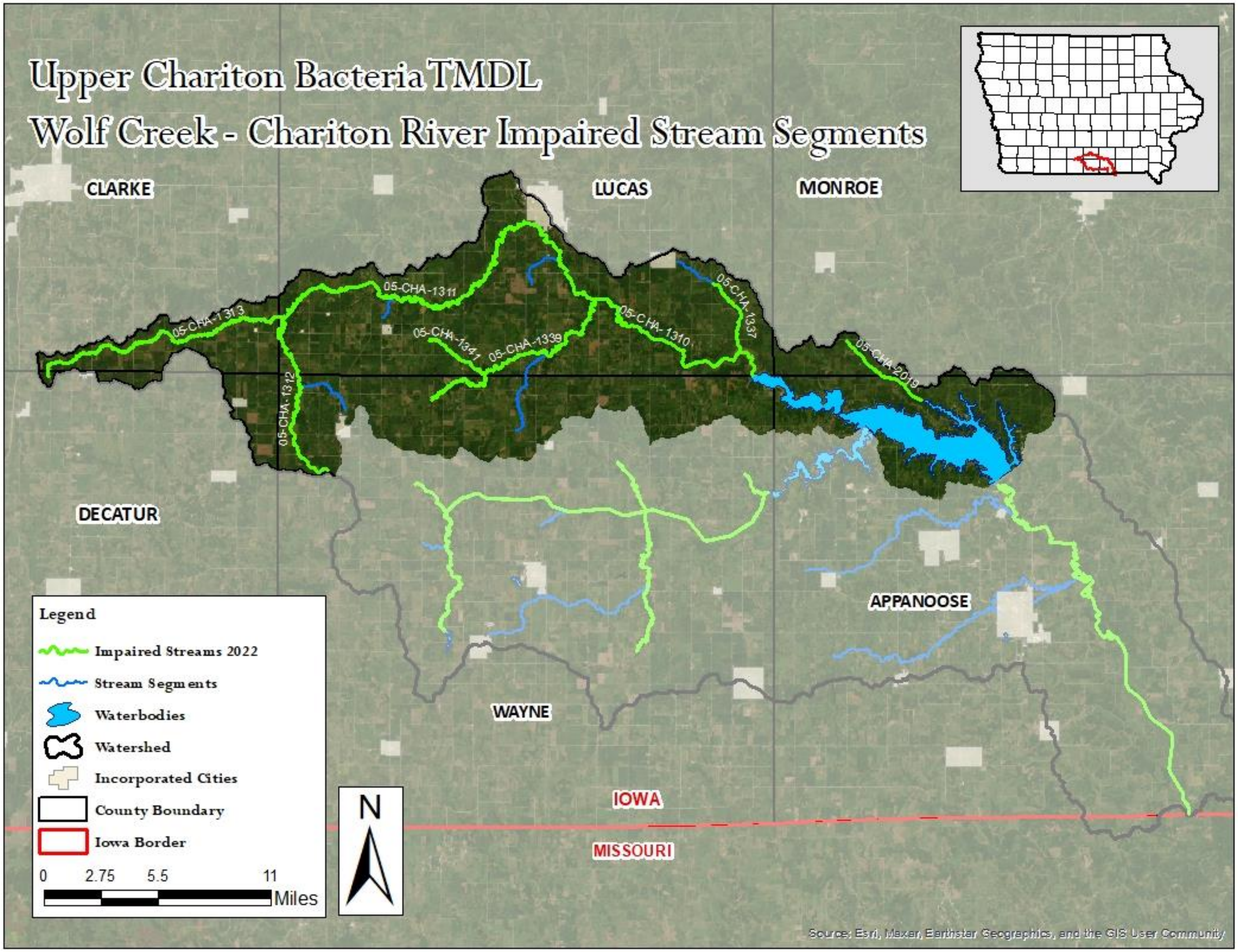

Figure 4.1. Map of the Wolf Creek - Chariton River HUC 10 with Impaired Stream Segments

Stream Segment Designations and Descriptions

Eight stream segments within the Wolf Creek-Chariton River HUC 10 do not meet water quality standards (WQS) and are not fully supporting class A1 (primary contact) designated uses due to presence of high levels of indicator bacteria called Escherichia coli (*E. coli*). Prior to 2008, none of the listed segments were designated for primary contact recreation (Class A1). In February 2008, changes to Iowa's surface water classifications were approved by the EPA and all segments were presumed to be Class A1, primary contact recreation. Table 4.1 is a summary of the impaired stream segments, segment identification, location description, segment length, designated uses, and impairment category.

Table 4.1. Impaired Stream Segments and Designated Uses.

Stream name	Segment ID	Location Description	Stream length (mi)	Designated Uses	Impairment Category(1)(2)
Chariton River	IA 05-CHA-1310	from upper end of Rathbun Lake to Hwy 14, Lucas Co.	18. 9	A1 B (WW2)	5p
Chariton River	IA 05-CHA-1311	from Hwy 14 (Lucas Co.) to confluence with Chariton Cr. in S19, T71N, R23W, Lucas Co.	28.89	A1 B (WW2)	5p
Chariton River	IA 05-CHA-1312	from confluence with Chariton Creek (S19, T71N, R23W, Lucas Co.) to headwaters	13.32	A1 B (WW1)	5p
Chariton Creek	IA 05-CHA-1313	mouth (S19, T71N, R23W, Lucas Co.) to headwaters	19.01	A1 B (WW1)	5p
Honey Creek(3)	IA 05-CHA-1337	mouth (S26, T71N, R20W, Lucas Co.) to confluence with unnamed tributary in S10,T71N, R20W, Lucas Co.	4.56	A2 B (WW2)	5a
Wolf Creek	IA 05-CHA-1339	mouth (S15, T71N, R21W, Lucas Co.) to confluence with unnamed tributary in E 1/2, NW 1/4, S8, T70N, R22W, Wayne Co.	16.94	A1 B (WW2)	5p
Fivemile Creek	IA 05-CHA-1341	mouth (S35, T71N, R22W, Lucas Co.) to confluence with unnamed tributary in S29, T71N, R22W, Lucas Co.	4.78	A1 B (WW2)	5p
Honey Creek	IA 05-CHA-2019	from upper end of Honey Creek arm of Rathbun Lake (NW 1/4, S8, T70N, R18W, Appanoose Co.) to headwaters in NW 1/4, S27, T71N, R19W, Monroe Co.	5.28	A1 B (WW1)	5p

(1) Impairment category: 5a (pollutant-caused impairment. TMDL needed)
(2) Impairment category: 5p (impairment occurs on a waterbody with a presumptive A1 or B(WW1) use.)
(3) This stream segment was approved as a Class A2 designated use stream on January 5, 2012. Prior to that date it was presumed to be a Class A1 designated use stream.

Problem Statement

Water quality assessments indicate that primary contact recreation is "not supported" in these segments due to high levels of indicator bacteria (*E. coli*) that routinely violate the state's water quality standards (Table 4.2). The significance of the impairments noted in the assessments is that desirable recreational activities, such as swimming and wading, are not adequately provided by existing water quality in the impaired segments. As a result of these findings, the Federal Clean Water Act requires that TDMLs be developed for all the impaired segments for *E. coli*.

Table 4.2. Impairment Criteria for each Impaired Segment.

Stream name	Segment ID	Geometric mean (impairment at 126 cfu/100 ml)			Single Sample Max. (235 cfu/100 ml) % samples exceeding
		2010	2011	2012	
Chariton River	IA 05-CHA-1310	757	208	1,425	79%
Chariton River	IA 05-CHA-1311	757	208	1,425	79%
Chariton River	IA 05-CHA-1312	587	371	370	75%
Chariton Creek	IA 05-CHA-1313	665	186	314	67%
Honey Creek(1)	IA 05-CHA-1337	533	607	1,692	9%
Wolf Creek	IA 05-CHA-1339	959	185	2,469	79%
Fivemile Creek	IA 05-CHA-1341	1,240	167	137	80%
Honey Creek	IA 05-CHA-2019	509	578	3,868	79%

(1) This stream segment was approved as a Class A2 designated use stream on January 5, 2012. Prior to that date it was presumed to be a Class A1 designated use stream. Geometric mean criterion is based on 630 orgs/100 ml and the single sample maximum criterion is based on 2,880 orgs/100 ml.

Data Sources

Sources of data used in the development of this TMDL include those used in the 2016 305(b) report, several sources of additional flow and water quality data, and non-water quality related data used for model development. Monitoring sites are listed in Table 4.3 and shown in Figure 4.2. Specific data includes:

- Stream data collected by DNR Watershed Improvement Section staff for the purpose of TMDL development
- Stream data collected by U.S. Army Corps of Engineers (USACE), Kansas City District, as part of its reservoir monitoring program
- Streamflow data collected by the U.S. Geological Survey (USGS) at multiple surface water gaging stations (USGS, 2015)
- Precipitation and temperature data from the National Weather Service Cooperative Observer Program (NWS COOP) (IEM, 2015)
- Precipitation and temperature data from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) (NOAA, 2015)
- 10-m Digital Elevation Model (DEM) available from DNR GIS library
- SSURGO soils data maintained by United States Department of Agriculture -Natural Resource Conservation Service (USDA-NRCS)
- U.S. Department of Agriculture National Agricultural Statistics Service Cropland Data Layer (CDL) reflecting 2006 conditions (USDA-NASS, 2013)
- Aerial images (various years) collected and maintained by DNR

Table 4.3. WQ Monitoring Sites of Wolf Creek - Chariton River HUC 10.

Site Name	ID	Longitude	Latitude
Brush Creek at 420th St (RA-32)	STORET 15200001	-93.5568	40.9274
Chariton River (RA-33)	STORET 15200002	-93.5614	40.9378
Chariton River at Hwy 14 (RA-15)	STORET 15590001	-93.3081	40.9922
Honey Creek at 430th Lane (RA-40)	STORET 15590002	-93.1282	40.9416
Wolf Creek at CR H50 (RA-41)	STORET 15590003	-93.2685	40.9413
Fivemile Creek at CR S23 (RA-42)	STORET 15590004	-93.3846	40.9082
Honey Creek at 550th (RA-43)	STORET 15680001	-93.0025	40.9020

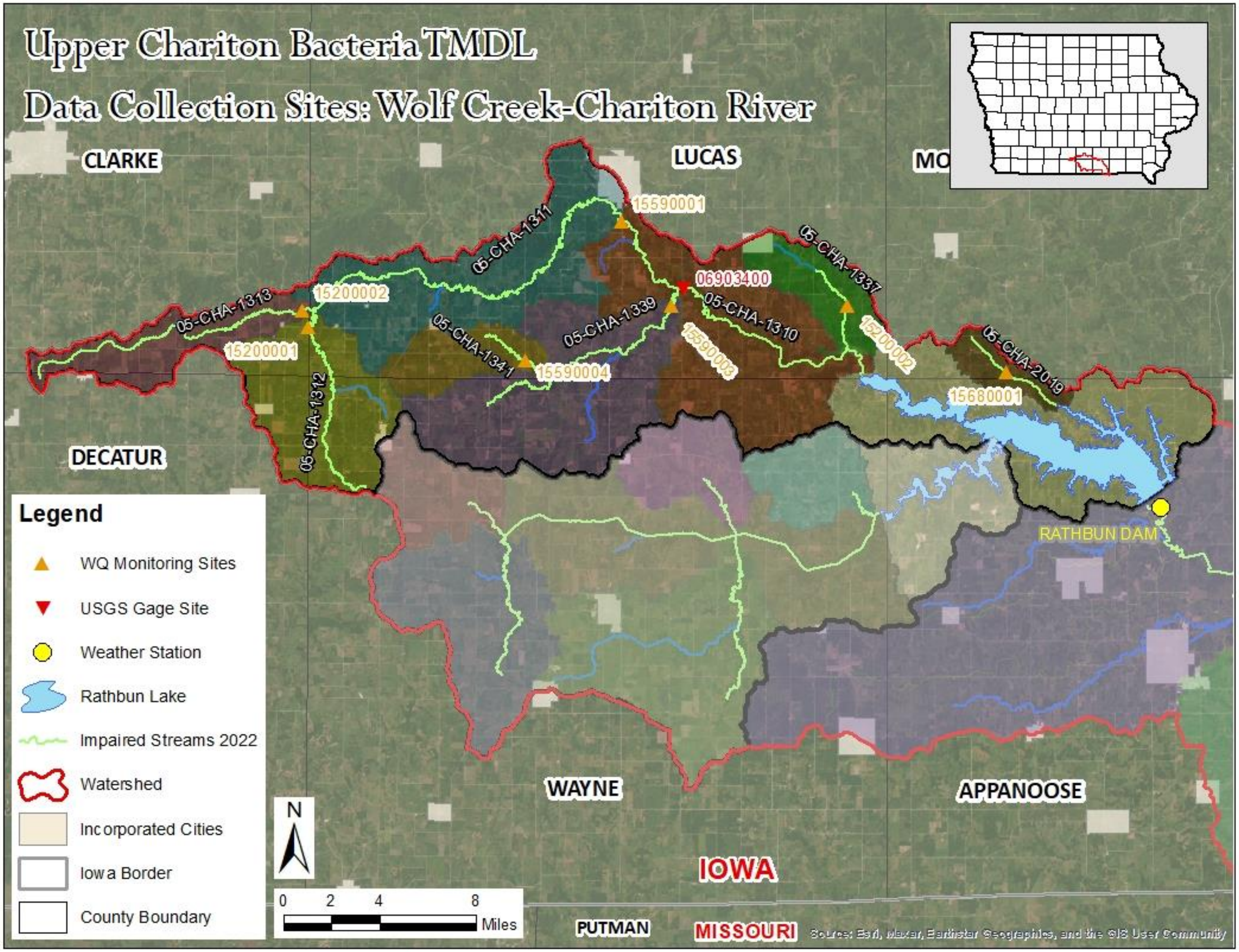

Figure 4.2. Data Sources Wolf Creek-Chariton River HUC-10.

Interpreting the Data
Analysis of the data show consistently high *E. coli* levels that exceed the criteria set in Iowa's WQS for primary and secondary contact recreation. Significant reductions in *E. coli* loading will be required to comply with the standards and fully support the designated recreational use in the impaired segments.

4.2 Pollution Source Assessment

Identification of Pollutant Sources
There are a variety of *E. coli* sources in the Wolf Creek - Chariton River watershed. These sources can be divided into two categories, point and non-point sources. Point sources may include municipal separate storm sewer systems (MS4s), municipal and industrial wastewater treatment facilities (WWTFs), sanitary sewer overflows (SSOs), onsite wastewater systems with permitted discharges, and animal feeding operations (AFOs) regulated as concentrated animal feeding operations (CAFOs). Nonpoint sources include wildlife, manure application to row crops, grazing livestock and small feeding operations, direct deposition by livestock in streams, and non-permitted (i.e., non-discharging) onsite wastewater systems.

Load duration curves (LDCs) were used in the development of *E. coli* TMDLs for impaired stream segments in the Wolf Creek - Chariton River Watershed (Section 4.2). The use of LDCs is helpful for understanding the importance that hydrology plays on pollutant loading. Information illustrated in LDCs provides a basic understanding of the importance of potential pollutant sources, although the approach does not offer explicit calculation of source-specific pollutant loads. However, when analyzed in conjunction with a detailed inventory of sources, LDCs can provide a quantitative means of comparing the relative importance of specific pollutant sources.

Point Sources
There are a total of three active NPDES permits for waste water treatment facilities (WWTF) in this watershed. In addition, there is one unsewered communities (Le Roy), nine General Permit #4 permits, and eight concentrated animal feeding operations (CAFOs) of over 1,000 animal units requiring an NPDES permit. Figure 4.3 shows the locations of all NPDES permitted wastewater facilities, concentrated animal feeding operations, unsewered communities, and private facilities that discharge under an NPDES General Permit #4. A full inventory of dischargers and their respective WLAs is provided in Appendix C.

Nonpoint Sources
The nonpoint sources of pathogen indicators include contributors that do not have localized points of release into a stream. In the watershed these sources are:

- Grazing animals
- Direct deposition of manure in streams
- Land application and subsequent runoff of manure
- Developed / urban area runoff
- Wildlife
- Faulty septic tank systems

Allowance for Increases in Pollutant Loads
There is one unsewered community in the Wolf Creek-Chariton River HUC 10. A reserve wasteload allocation was calculated for each community and applied to the WLA for the associated segment. Appendix C.2 lists all the unsewered communities in the Upper Chariton watershed. Any new or expanded dischargers will be expected to meet the same end-of-pipe criterion (GM of 126 orgs/100 ml) as dischargers for which WLAs were calculated and included in this TMDL. New or expanded facilities meeting the end-of-pipe criterion will not cause or contribute to the impairment.

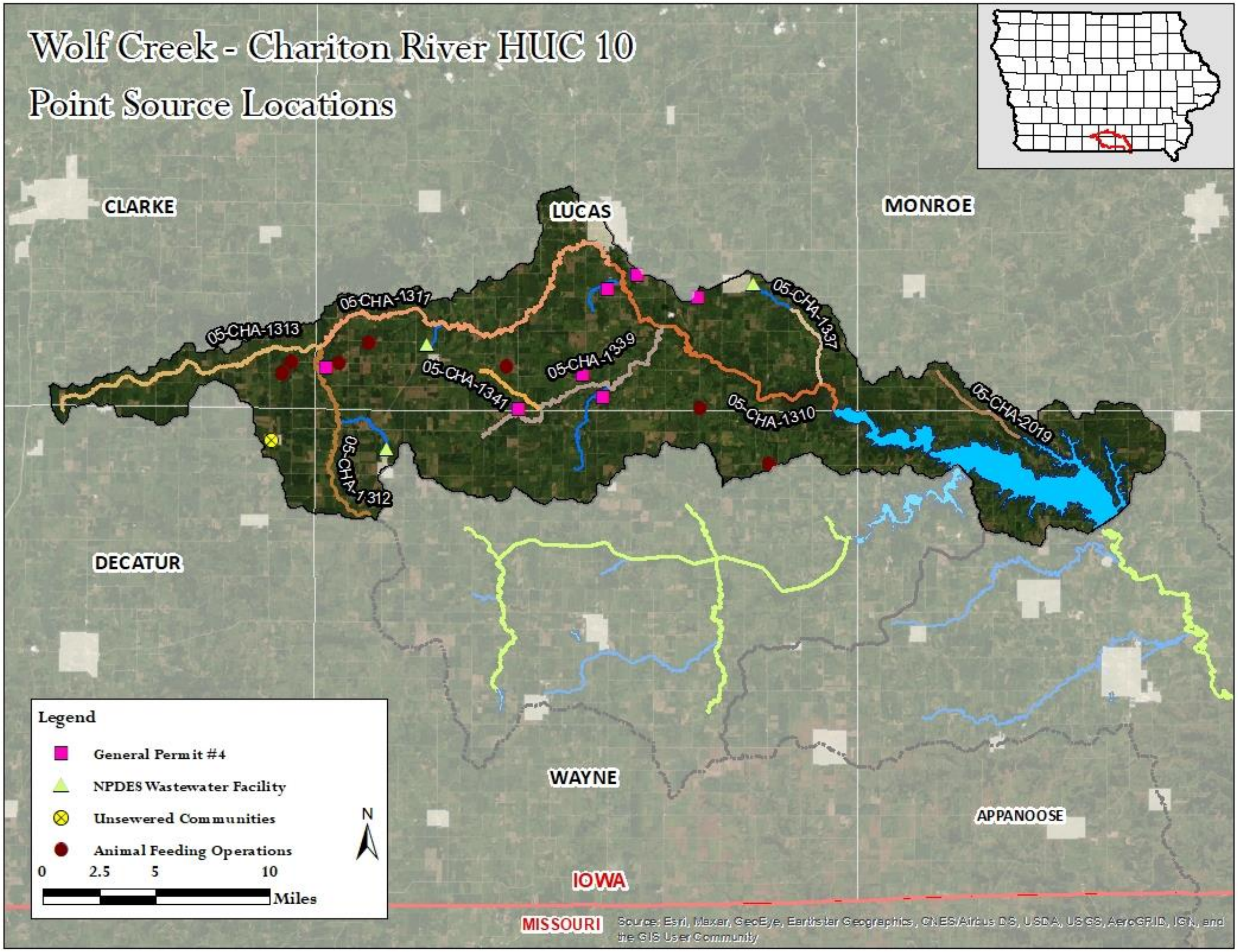

Figure 4.3. Map of the Wolf Creek - Chariton River Point Sources

4.3 Pollutant Allocation

Wasteload Allocation

A WLA was calculated for each wastewater treatment facility (WWTF) and an aggregate reserve WLA for unsewered communities in the watershed. Table 4.4 shows the aggregate WLA summary by facility type for the Wolf Creek - Upper Chariton River watershed. Individual WLAs for each discharger are included in Appendix C.

Table 4.4. Wasteload Allocations for Wolf Creek-Chariton River HUC-10.

Facility Type	Number of Facilities	Flow (MGD)(1)	GM Conc (orgs/100 ml)(2)	GM Load (orgs/day)	SSM Conc (orgs/100 ml)(2)	SSM Load (orgs/day)
WWTF(2)(3)	3	0.715	126	3.41E+09	235	6.36E+09
Unsewered	1	0.0014	126	6.68E+06	235	1.25E+07
CAFO(3)	8	0	126	0.00E+00	235	0.00E+00
GP #4(4)	9	0.00435	235	3.87E+07	235	3.87E+07
Totals	**21**	**0.7208**	**--**	**3.46E+09**	**--**	**6.41E+09**

(1) Flows used to calculate the wasteload allocation. See Appendix C.
(2) SSM WLA's were calculated for assessment purposes to determine an appropriate LA (nonpoint source). As per IAC 567 62.8(2) daily sample maximum criteria for *E coli* shall not be used as an end-of-pipe limitation.
(3) Stream segment IA 05-CHA-1337 is a Class A2 designated use stream and has limits of 630 orgs/100 ml and 2,880 orgs/100 ml for the GM and SSM, respectively. However, The City of Russell WWTF discharges to a short section of a Class A1 designated use stream, which is upstream of segment IA 05-CHA-1337 (Class A2). Consequently, the Russell WWTF effluent limits compatible with a Class A1 designated use stream. See Appendix C.
(4) Facilities with 1,000 or more AU requiring a NPDES permit
(5) General Permit #4, effluent discharge permitted for 235 orgs/100 ml.

Load Allocation

Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include animals directly depositing into streams, manure applied to row crops, manure runoff from grazed land, non-permitted onsite wastewater systems, and natural sources such as wildlife.

Margin of Safety

An explicit margin of safety (MOS) of 10 percent is applied to the calculation of loading capacities in this TMDL. The loading capacity for each segment is set equal to the appropriate water quality criteria (less 10 percent) with the goal of achieving the criteria at the sampling location. As a result, TMDLs do not consider dilution to meet WQS nor do they consider bacteria die-off and settling, which occur. Consequently, bacteria TMDLs are conservative.

Departure from Load Capacity & Critical Conditions

The LDCs, observed loads, and observed loads for each flow condition are plotted in Figure 4.4 through Figure 4.18. This methodology enables calculation of a TMDL target at the midpoint of each flow condition for each impaired segment, as provided in Table 4.5 through Table 4.19. For stream segments impaired for both the SSM and GM criteria figures and tables are provided. However, stream segment IA 05-CHA-1337 is only impaired for the GM criterion consequently, only the figure and table associated with the GM criterion is provided for this stream segment.

The critical condition for each TMDL is highlighted in yellow in each table. The critical condition is the flow requiring the largest percent reduction. However, the high flow or low flow conditions are not considered because these flow conditions are not representative of typical conditions (EPA, 2006). The exception to this is stream segment IA 05-CHA-1337 where the percent reduction for the wet to dry flow conditions are zero (0). Consequently, the critical condition is simply selected as the flow condition requiring the largest percent reduction.

Load Duration Curve

Figure 4.4 through Figure 4.18 show load durations for the impaired stream segments in this watershed. Table 4.5 through Table 4.19 are the existing load estimates and the TMDL summary for each impaired segment.

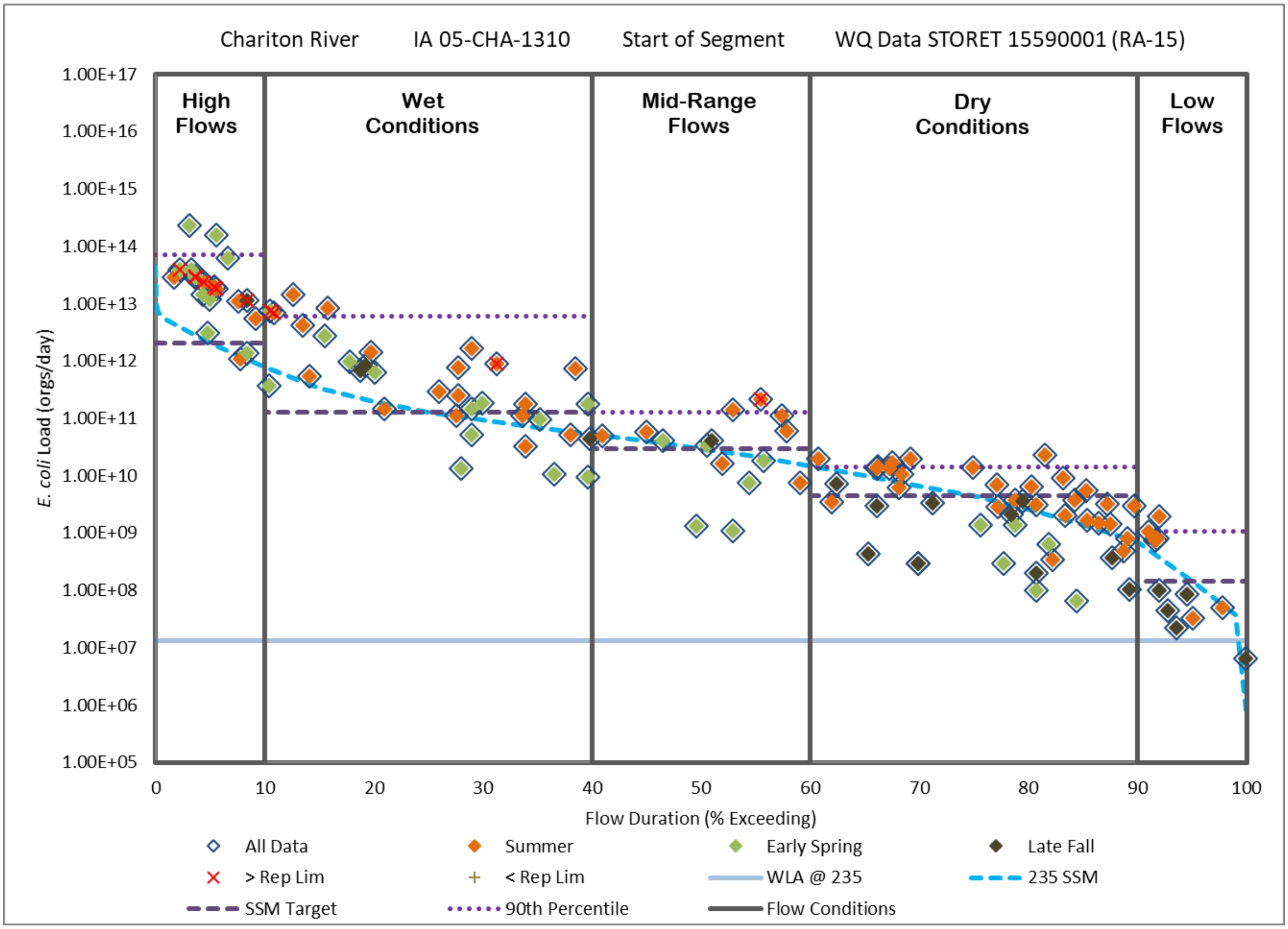

Figure 4.4. Load Duration Curve based on the SSM for IA 05-CHA-1310.

Table 4.5. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1310.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	7.22E+13	6.00E+12	1.29E+11	1.41E+10	1.05E+09
Capacity @ 235 orgs/100 ml (TMDL)	2.05E+12	1.29E+11	2.93E+10	4.40E+09	1.47E+08
SSM Departure (% Reduction)	7.02E+13 (97)	***5.87E+12 (98)***	9.95E+10 (77)	9.71E+09 (69)	9.05E+08 (86)
WLA	1.33E+07	1.33E+07	1.33E+07	1.33E+07	1.33E+07
LA	1.85E+12	1.16E+11	2.64E+10	3.94E+09	1.19E+08
MOS	2.05E+11	1.29E+10	2.93E+09	4.40E+08	1.47E+07
Midpoint Flow (cfs)	356.9	22.4	5.1	0.76	0.03

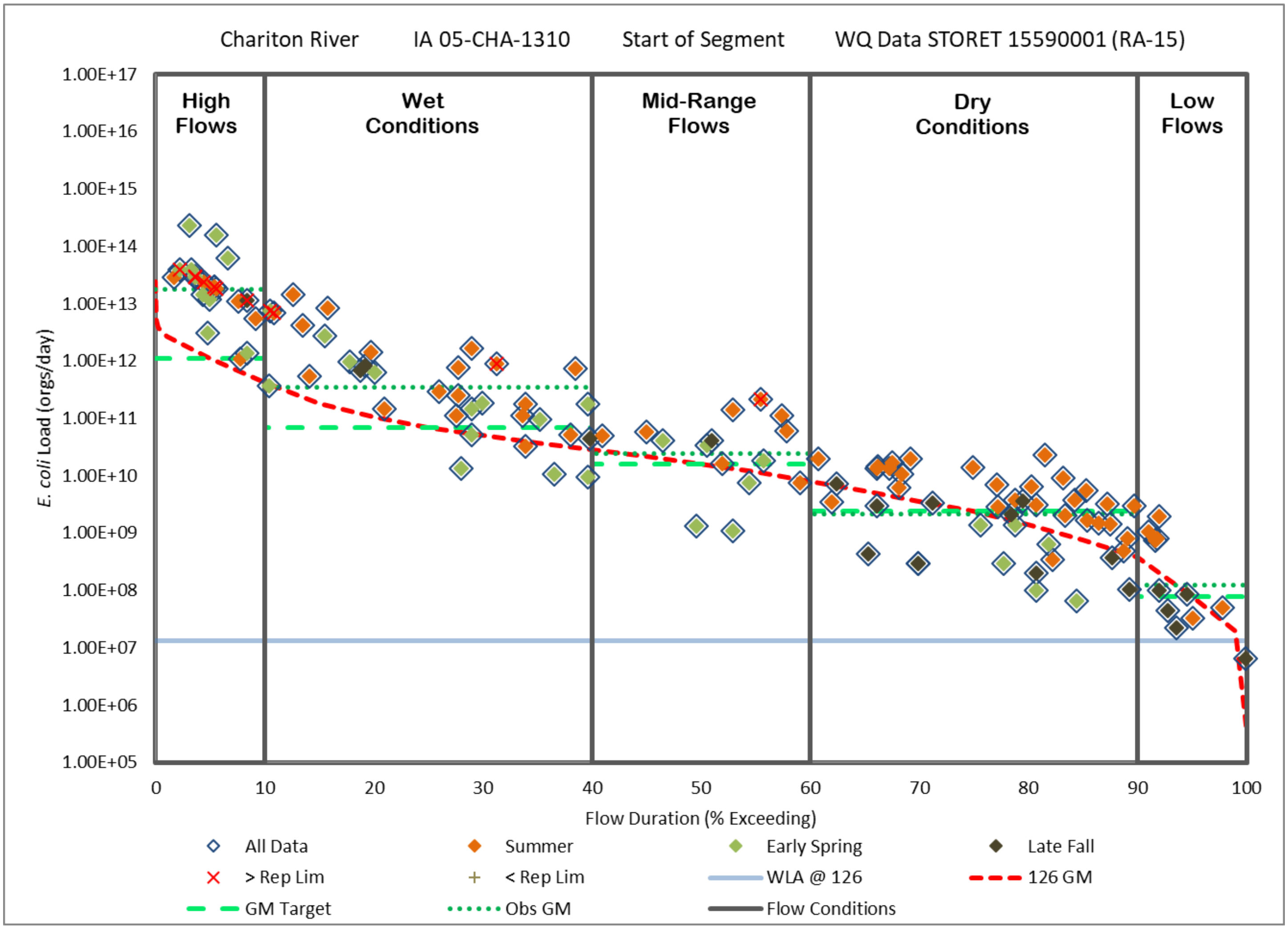

Figure 4.5. Load Duration Curve based on the GM for IA 05-CHA-1310.

Table 4.6. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1310.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.75E+13	3.50E+11	2.46E+10	2.15E+09	1.24E+08
Capacity @ 126 orgs/100 ml (TMDL)	1.10E+12	6.91E+10	1.57E+10	2.36E+09	7.86E+07
GM Departure (% Reduction)	1.64E+13 (94)	***2.81E+11 (80)***	8.90E+09 (36)	-2.06E+08 (0)	4.56E+07 (37)
WLA	1.33E+07	1.33E+07	1.33E+07	1.33E+07	1.33E+07
LA	9.90E+11	6.22E+10	1.41E+10	2.11E+09	5.74E+07
MOS	1.10E+11	6.91E+09	1.57E+09	2.36E+08	7.86E+06
Midpoint Flow (cfs)	356.9	22.4	5.1	0.8	0.03

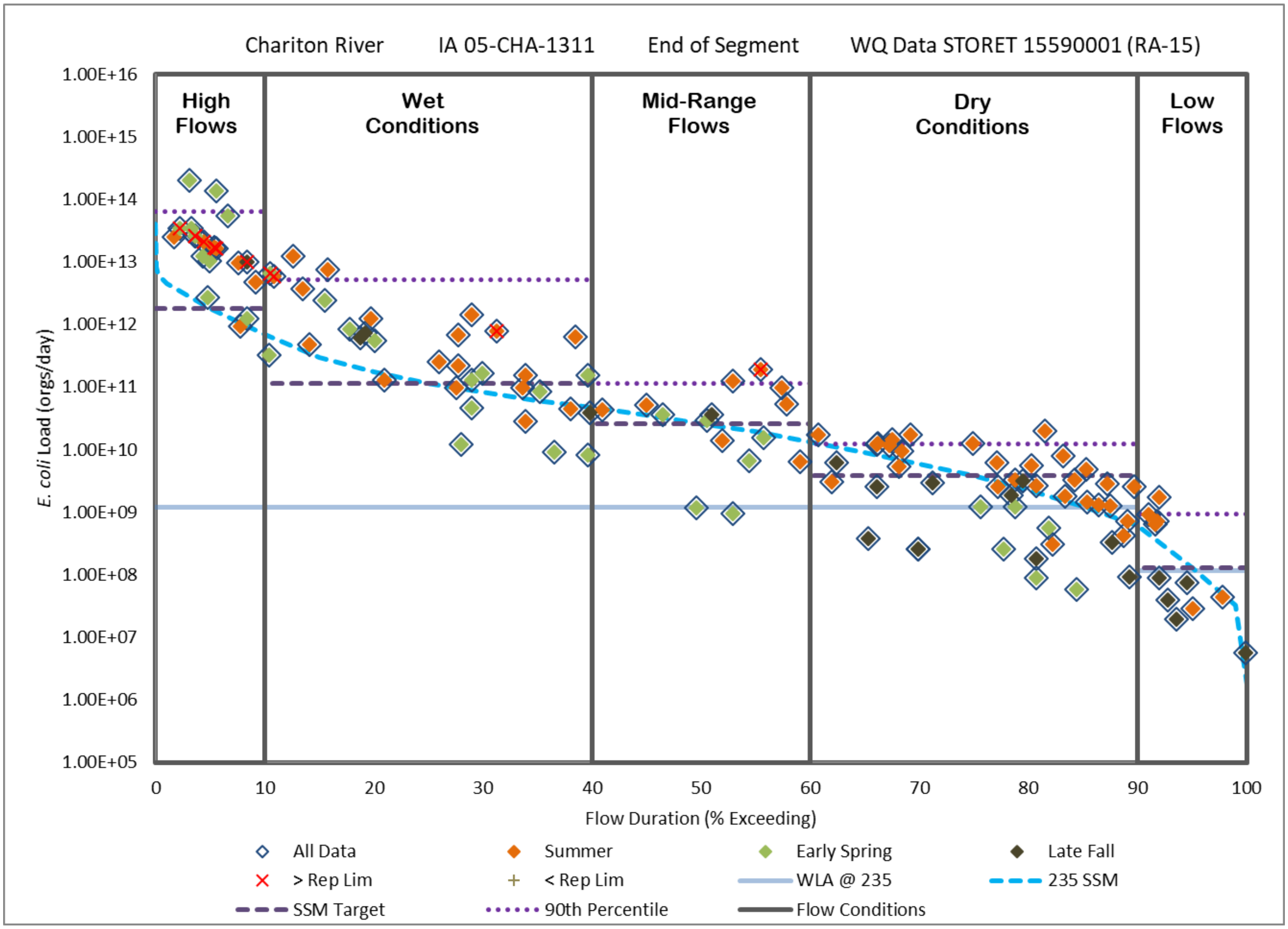

Figure 4.6. Load Duration Curve based on the SSM for IA 05-CHA-1311.

Table 4.7. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1311.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	6.34E+13	5.27E+12	1.13E+11	1.24E+10	9.24E+08
Capacity @ 235 orgs/100 ml (TMDL)	1.80E+12	1.13E+11	2.58E+10	3.86E+09	1.29E+08
SSM Departure (% Reduction)	6.16E+13 (97)	***5.16E+12 (98)***	8.74E+10 (77)	8.53E+09 (69)	7.95E+08 (86)
WLA[(1)]	1.21E+09	1.21E+09	1.21E+09	1.21E+09	1.16E+08[(1)]
LA	1.62E+12	1.01E+11	2.20E+10	2.27E+09	--
MOS	1.80E+11	1.13E+10	2.58E+09	3.86E+08	1.29E+07
Midpoint Flow (cfs)	313.5	19.7	4.5	0.67	0.022

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

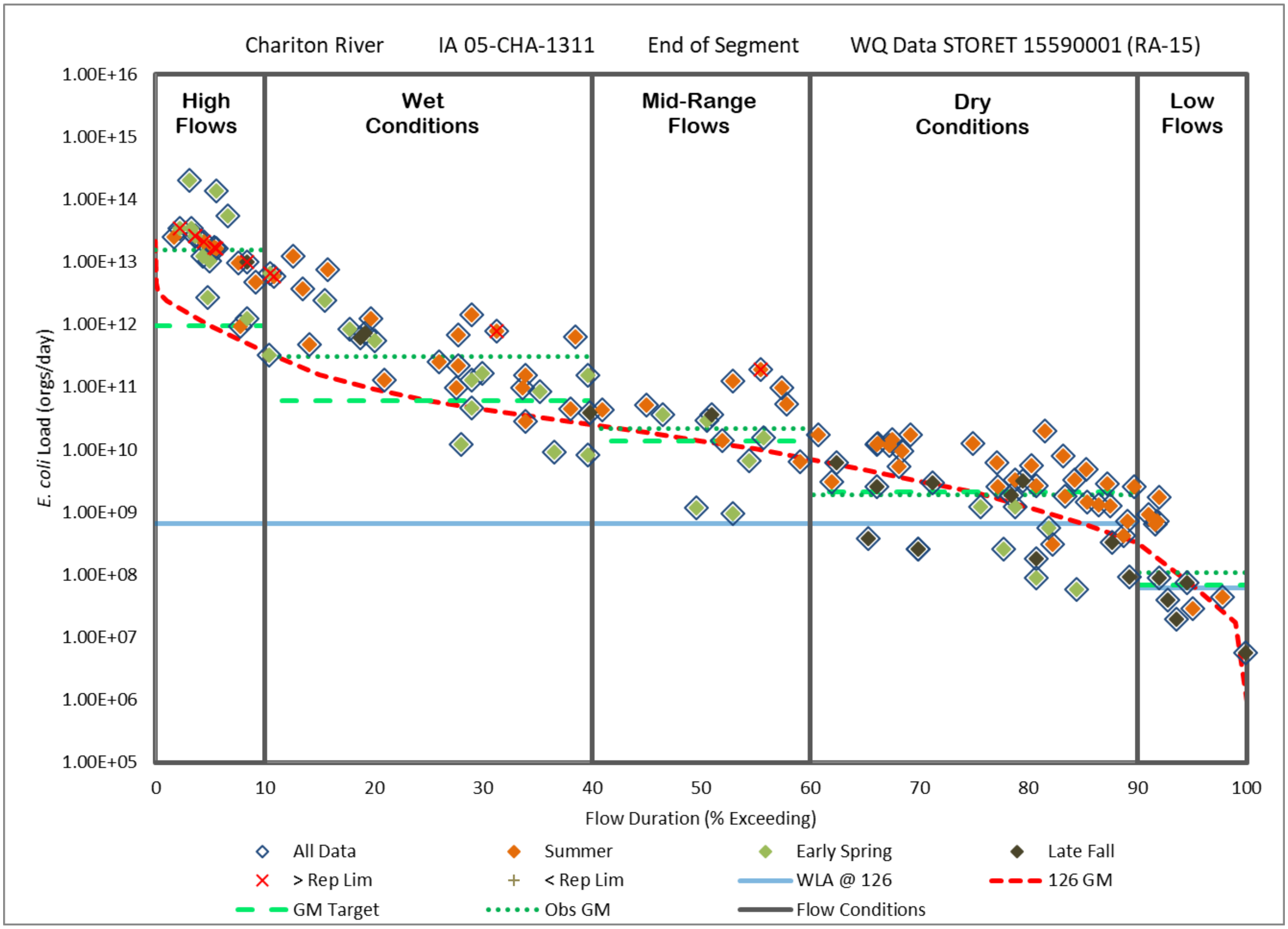

Figure 4.7. Load Duration Curve based on the GM for IA 05-CHA-1311.

Table 4.8. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1311.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.53E+13	3.07E+11	2.16E+10	1.89E+09	1.09E+08
Capacity @ 126 orgs/100 ml (TMDL)	9.67E+11	6.07E+10	1.38E+10	2.07E+09	6.90E+07
GM Departure (% Reduction)	1.44E+13 (94)	***2.46E+11 (80)***	7.82E+09 (36)	-1.81E+08 (0)	4.00E+07 (37)
WLA(1)	6.53E+08	6.53E+08	6.53E+08	6.53E+08	6.21E+07(1)
LA	8.69E+11	5.40E+10	1.18E+10	1.21E+09	--
MOS	9.67E+10	6.07E+09	1.38E+09	2.07E+08	6.90E+06
Midpoint Flow (cfs)	313.5	19.7	4.5	0.7	0.02

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

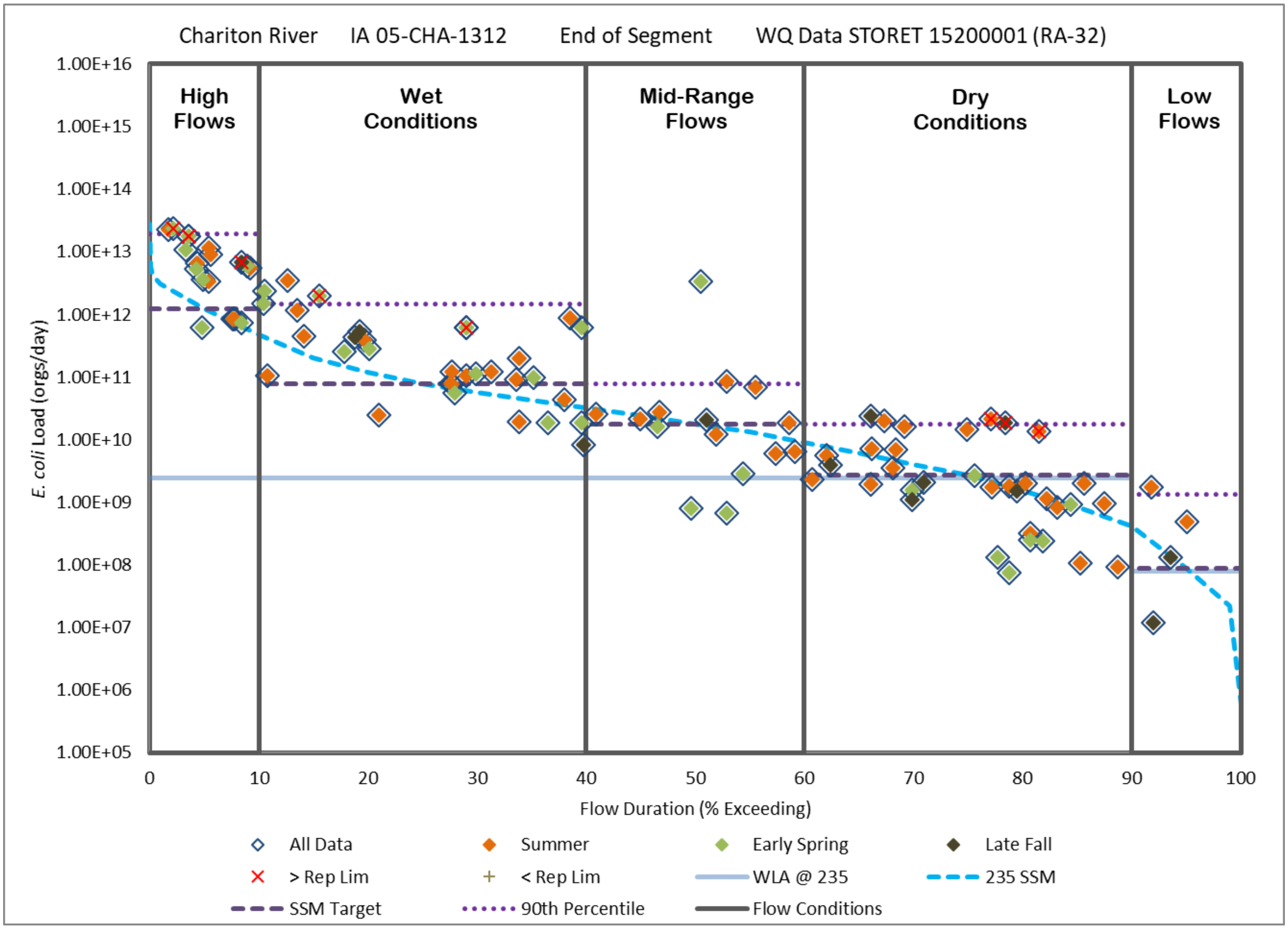

Figure 4.8. Load Duration Curve based on the SSM for IA 05-CHA-1312.

Table 4.9. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1312.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.92E+13	1.47E+12	7.92E+10	1.79E+10	1.35E+09
Capacity @ 235 orgs/100 ml (TMDL)	1.24E+12	7.80E+10	1.77E+10	2.66E+09	8.87E+07
SSM Departure (% Reduction)	1.80E+13 (94)	***1.40E+12 (95)***	6.15E+10 (78)	1.53E+10 (85)	1.26E+09 (93)
WLA(1)	2.42E+09	2.42E+09	2.42E+09	2.40E+09(1)	7.98E+07(1)
LA	1.12E+12	6.78E+10	1.35E+10	--	--
MOS	1.24E+11	7.80E+09	1.77E+09	2.66E+08	8.87E+06
Midpoint Flow (cfs)	216.0	13.6	3.1	0.46	0.015

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during the dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

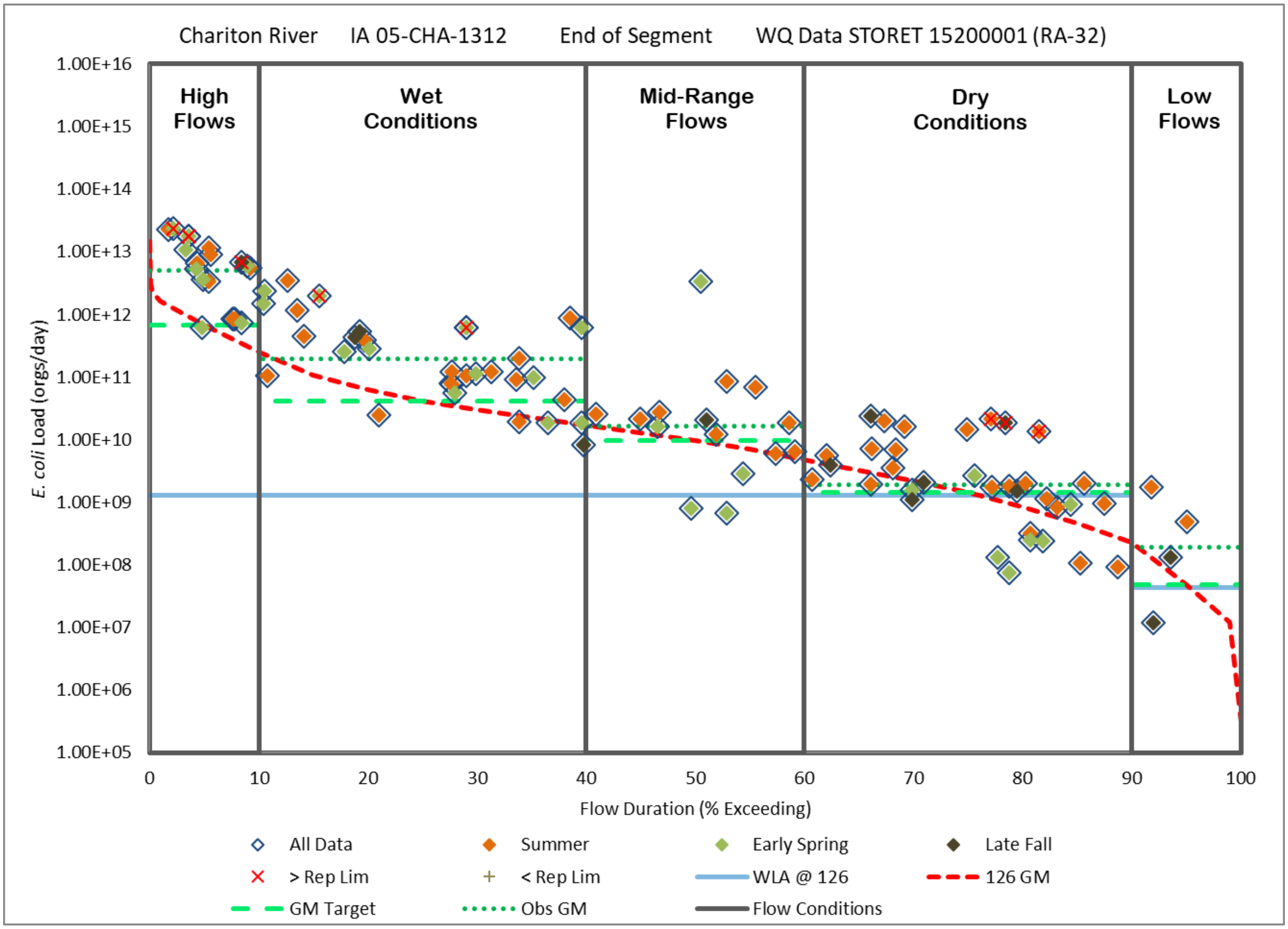

Figure 4.9. Load Duration Curve based on the GM for IA 05-CHA-1312.

Table 4.10. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1312.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	5.12E+12	1.92E+11	1.62E+10	1.90E+09	1.90E+08
Capacity @ 126 orgs/100 ml (TMDL)	6.66E+11	4.18E+10	9.51E+09	1.43E+09	4.76E+07
GM Departure (% Reduction)	4.45E+12 (87)	***1.50E+11 (78)***	6.72E+09 (41)	4.72E+08 (25)	1.43E+08 (75)
WLA(1)	1.30E+09	1.30E+09	1.30E+09	1.28E+09(1)	4.28E+07(1)
LA	5.98E+11	3.63E+10	7.26E+09	--	--
MOS	6.66E+10	4.18E+09	9.51E+08	1.43E+08	4.76E+06
Midpoint Flow (cfs)	216.0	13.6	3.1	0.5	0.02

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during the dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

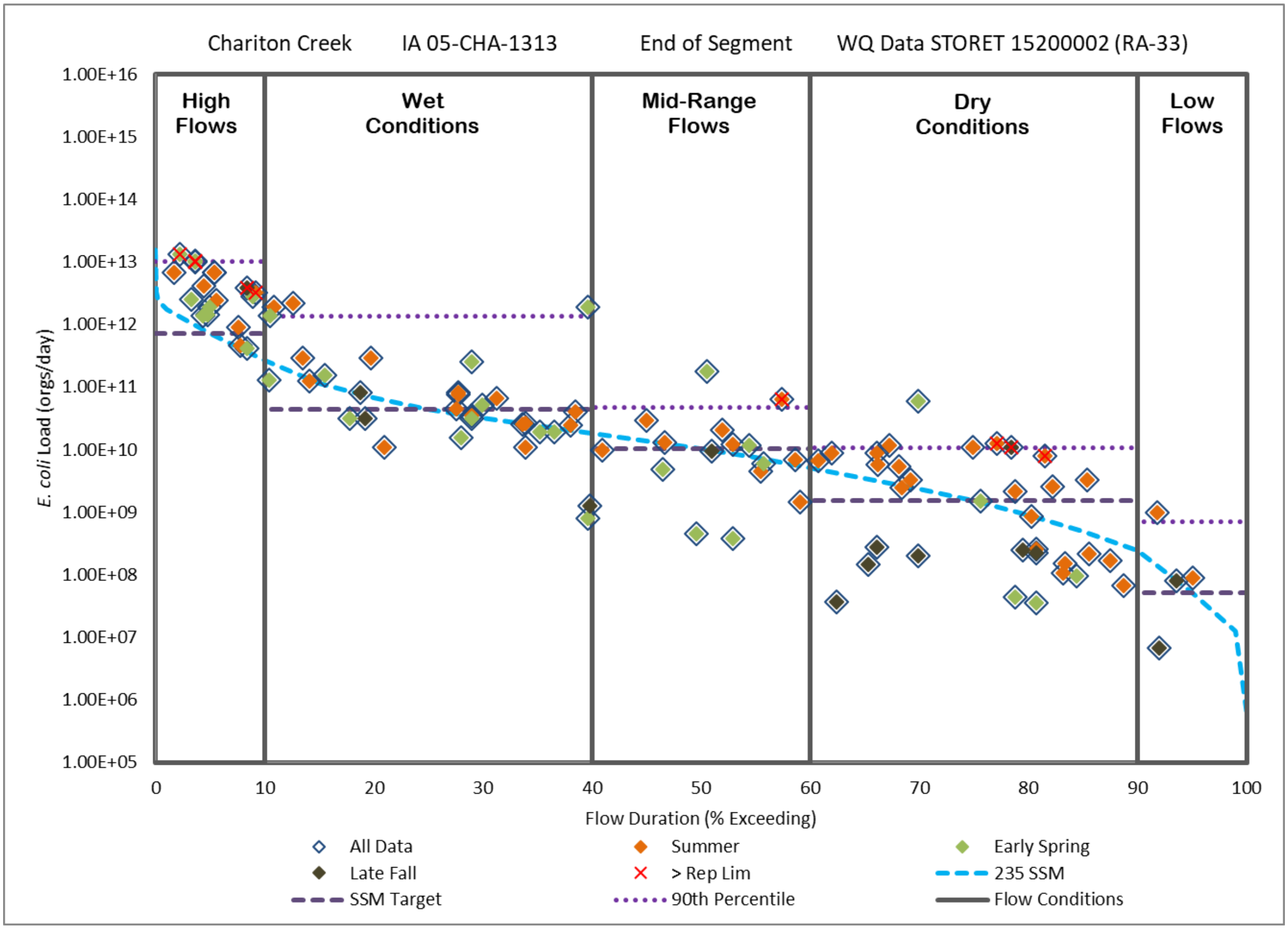

Figure 4.10. Load Duration Curve based on the SSM for IA 05-CHA-1313.

Table 4.11. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1313.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.01E+13	1.36E+12	4.68E+10	1.07E+10	7.13E+08
Capacity @ 235 orgs/100 ml (TMDL)	7.09E+11	4.45E+10	1.01E+10	1.52E+09	5.07E+07
SSM Departure (% Reduction)	9.42E+12 (93)	***1.32E+12 (97)***	3.67E+10 (78)	9.18E+09 (86)	6.63E+08 (93)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	6.38E+11	4.01E+10	9.12E+09	1.37E+09	4.56E+07
MOS	7.09E+10	4.45E+09	1.01E+09	1.52E+08	5.07E+06
Midpoint Flow (cfs)	123.4	7.7	1.8	0.26	0.01

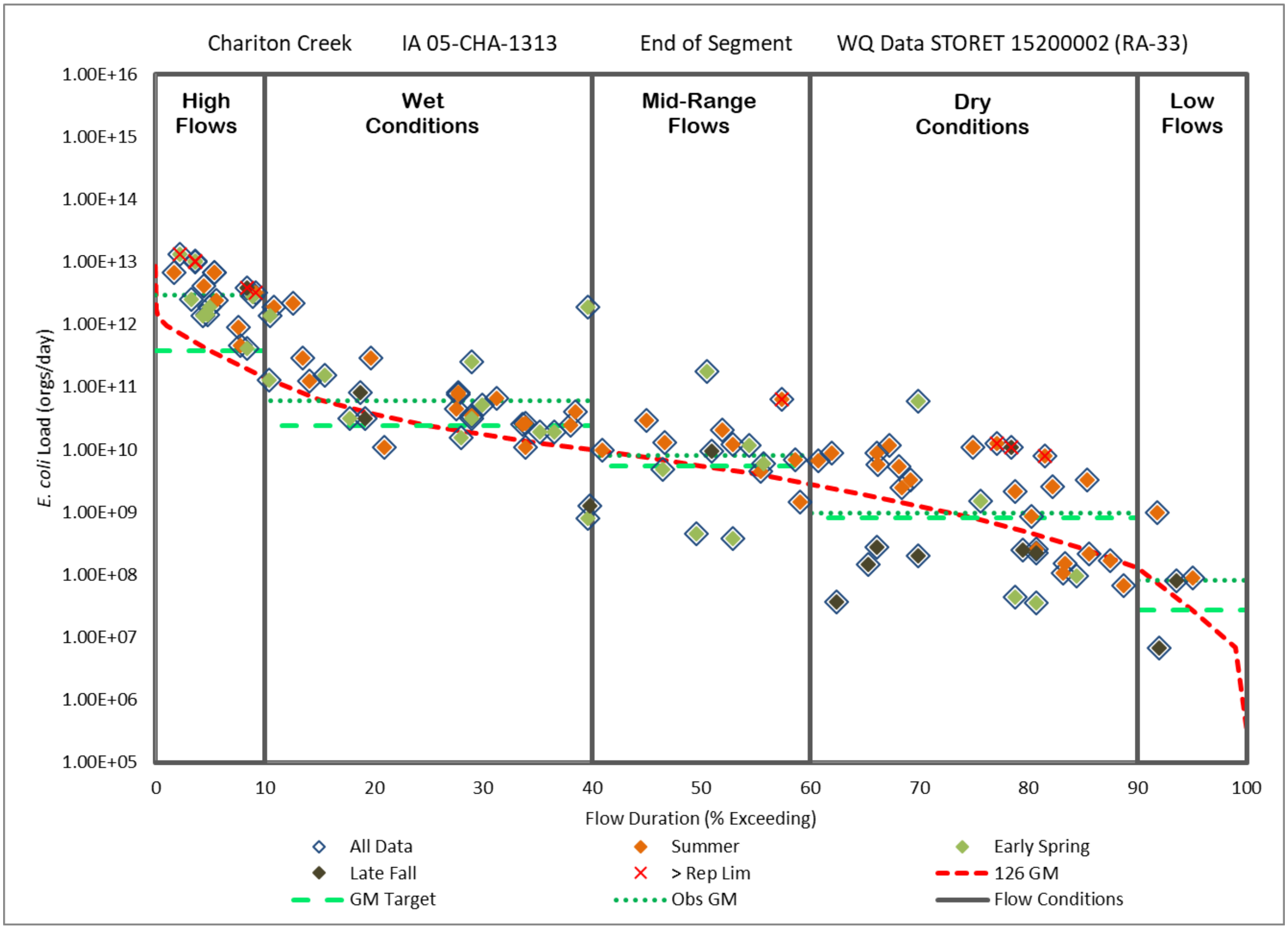

Figure 4.11. Load Duration Curve based on the GM for IA 05-CHA-1313.

Table 4.12. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1313.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	2.92E+12	6.10E+10	7.94E+09	9.78E+08	8.25E+07
Capacity @ 126 orgs/100 ml (TMDL)	3.80E+11	2.39E+10	5.43E+09	8.15E+08	2.72E+07
GM Departure (% Reduction)	2.54E+12 (87)	***3.71E+10 (61)***	2.51E+09 (32)	1.63E+08 (17)	5.53E+07 (67)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	3.42E+11	2.15E+10	4.89E+09	7.34E+08	2.45E+07
MOS	3.80E+10	2.39E+09	5.43E+08	8.15E+07	2.72E+06
Midpoint Flow (cfs)	123.4	7.7	1.8	0.26	0.01

Figure 4.12. Load Duration Curve based on the GM for IA 05-CHA-1337.

Table 4.13. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1337.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	2.01E+12	8.80E+10	7.92E+09	1.40E+09	1.49E+08
Capacity @ 126 orgs/100 ml (TMDL)	1.46E+12	9.17E+10	2.09E+10	3.13E+09	1.04E+08
GM Departure (% Reduction)	5.52E+11 (27)	-3.67E+09 (0)	-1.29E+10 (0)	-1.73E+09 (0)	***4.48E+07 (30)***
WLA[(1)(2)]	1.48E+09	1.48E+09	1.48E+09	1.48E+09	9.39E+07[(1)]
LA	1.31E+12	8.11E+10	1.73E+10	1.34E+09	--
MOS	1.46E+11	9.17E+09	2.09E+09	3.13E+08	1.04E+07
Midpoint Flow (cfs)	94.8	6.0	1.4	0.2	0.01

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.
(2) The City of Russell discharges to a Class A1 designated use stream.

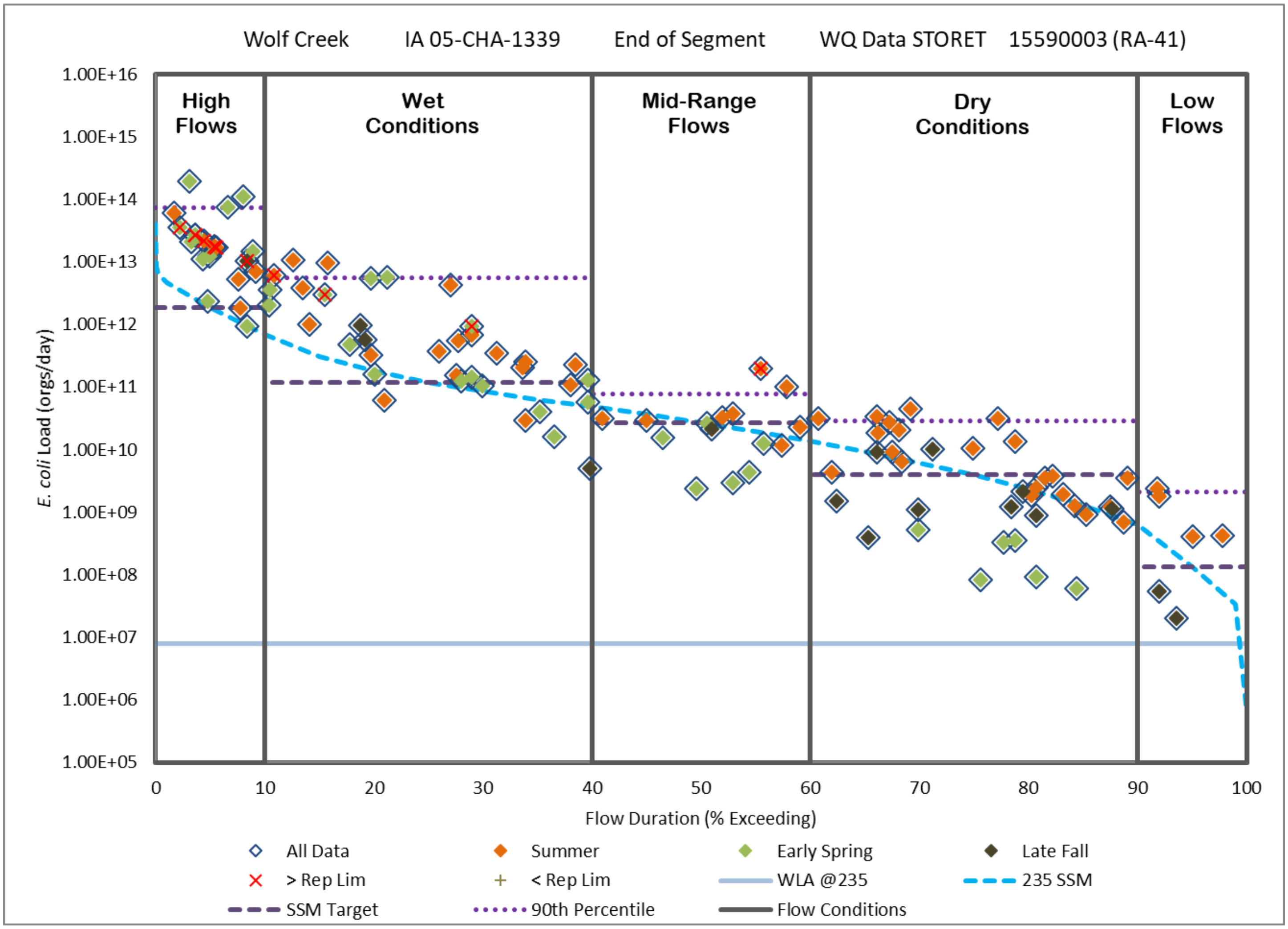

Figure 4.13. Load Duration Curve based on the SSM for IA 05-CHA-1339.

Table 4.14. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1339.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	7.43E+13	5.57E+12	7.60E+10	2.91E+10	2.09E+09
Capacity @ 235 orgs/100 ml (TMDL)	1.86E+12	1.17E+11	2.66E+10	4.00E+09	1.33E+08
SSM Departure (% Reduction)	7.25E+13 (97)	***5.45E+12 (98)***	4.94E+10 (65)	2.51E+10 (86)	1.96E+09 (94)
WLA	8.01E+06	8.01E+06	8.01E+06	8.01E+06	8.01E+06
LA	1.68E+12	1.05E+11	2.40E+10	3.59E+09	1.12E+08
MOS	1.86E+11	1.17E+10	2.66E+09	4.00E+08	1.33E+07
Midpoint Flow (cfs)	324.3	20.4	4.6	0.69	0.02

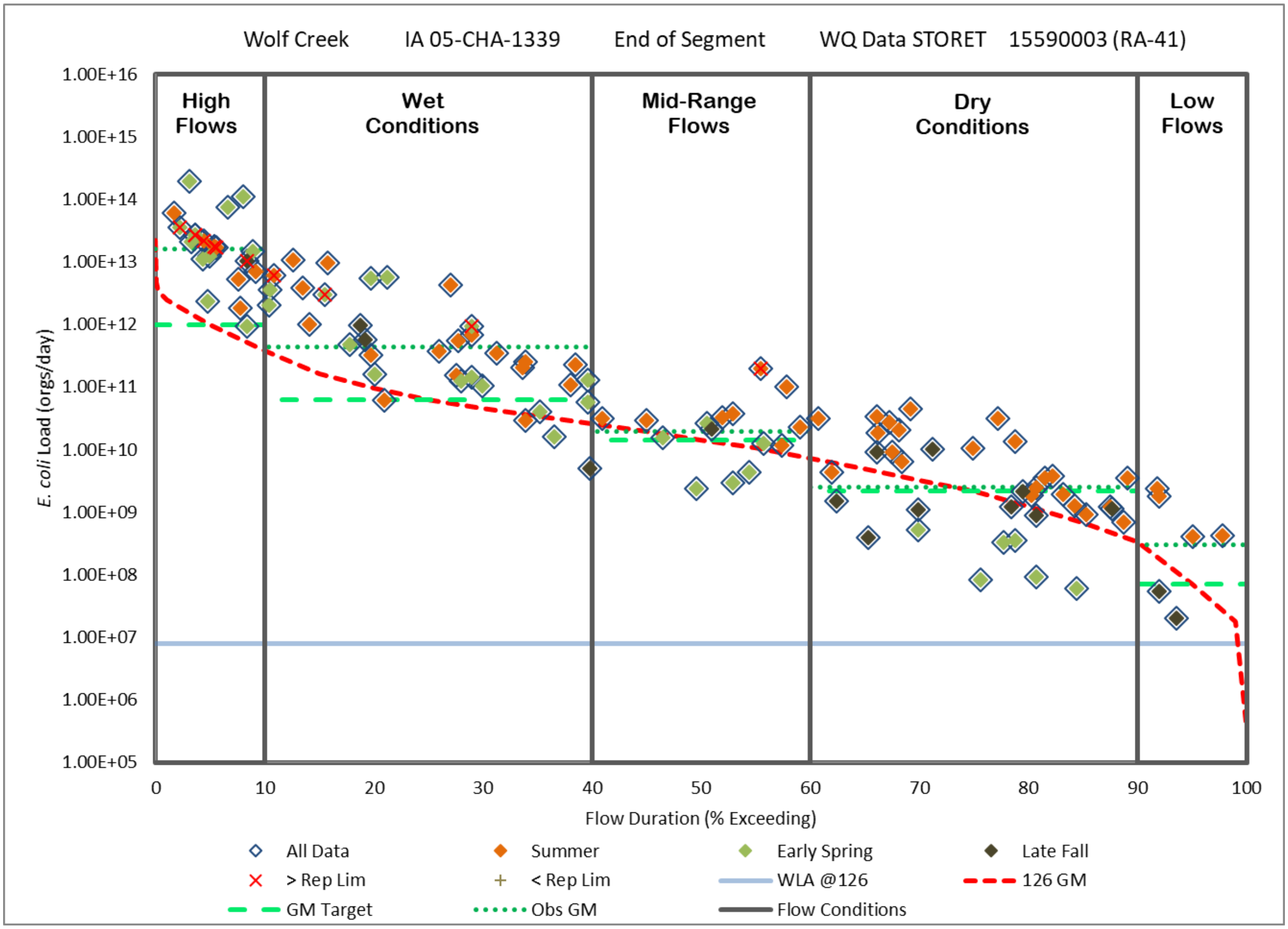

Figure 4.14. Load Duration Curve based on the GM for IA 05-CHA-1339.

Table 4.15. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1339.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.59E+13	4.30E+11	1.93E+10	2.54E+09	3.05E+08
Capacity @ 126 orgs/100 ml (TMDL)	1.00E+12	6.28E+10	1.43E+10	2.14E+09	7.14E+07
GM Departure (% Reduction)	1.49E+13 (94)	***3.67E+11*** ***(85)***	5.04E+09 (26)	3.95E+08 (16)	2.34E+08 (77)
WLA	8.01E+06	8.01E+06	8.01E+06	8.01E+06	8.01E+06
LA	9.00E+11	5.65E+10	1.28E+10	1.92E+09	5.63E+07
MOS	1.00E+11	6.28E+09	1.43E+09	2.14E+08	7.14E+06
Midpoint Flow (cfs)	324.3	20.4	4.6	0.7	0.02

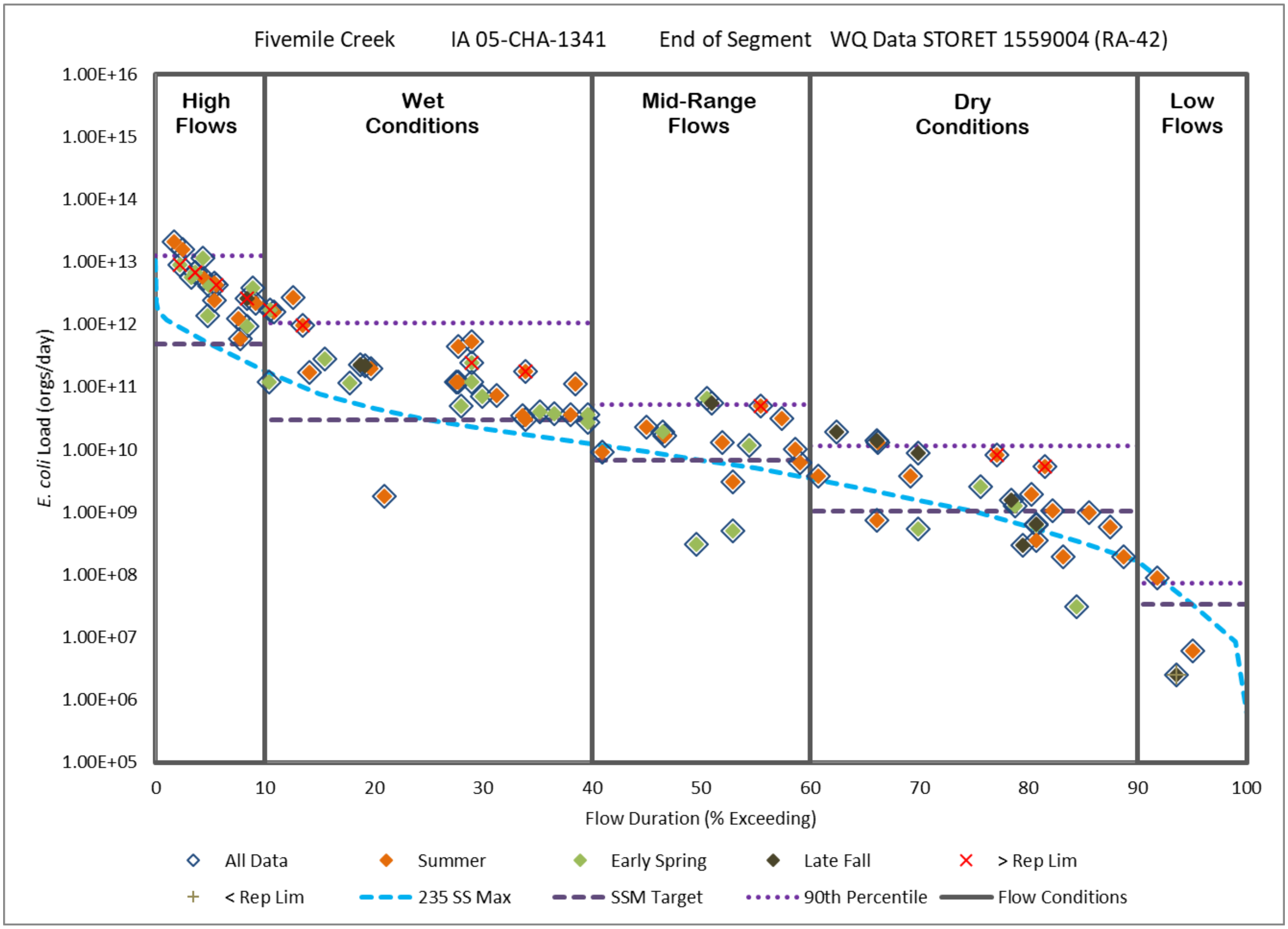

Figure 4.15. Load Duration Curve based on the SSM for IA 05-CHA-1341.

Table 4.16. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1341.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.24E+13	1.04E+12	5.29E+10	1.16E+10	7.29E+07
Capacity @ 235 orgs/100 ml (TMDL)	4.78E+11	3.00E+10	6.82E+09	1.02E+09	3.41E+07
SSM Departure (% Reduction)	1.19E+13 (96)	***1.01E+12 (97)***	4.61E+10 (87)	1.06E+10 (91)	3.88E+07 (53)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	4.30E+11	2.70E+10	6.14E+09	9.21E+08	3.07E+07
MOS	4.78E+10	3.00E+09	6.82E+08	1.02E+08	3.41E+06
Midpoint Flow (cfs)	83.1	5.2	1.2	0.18	0.01

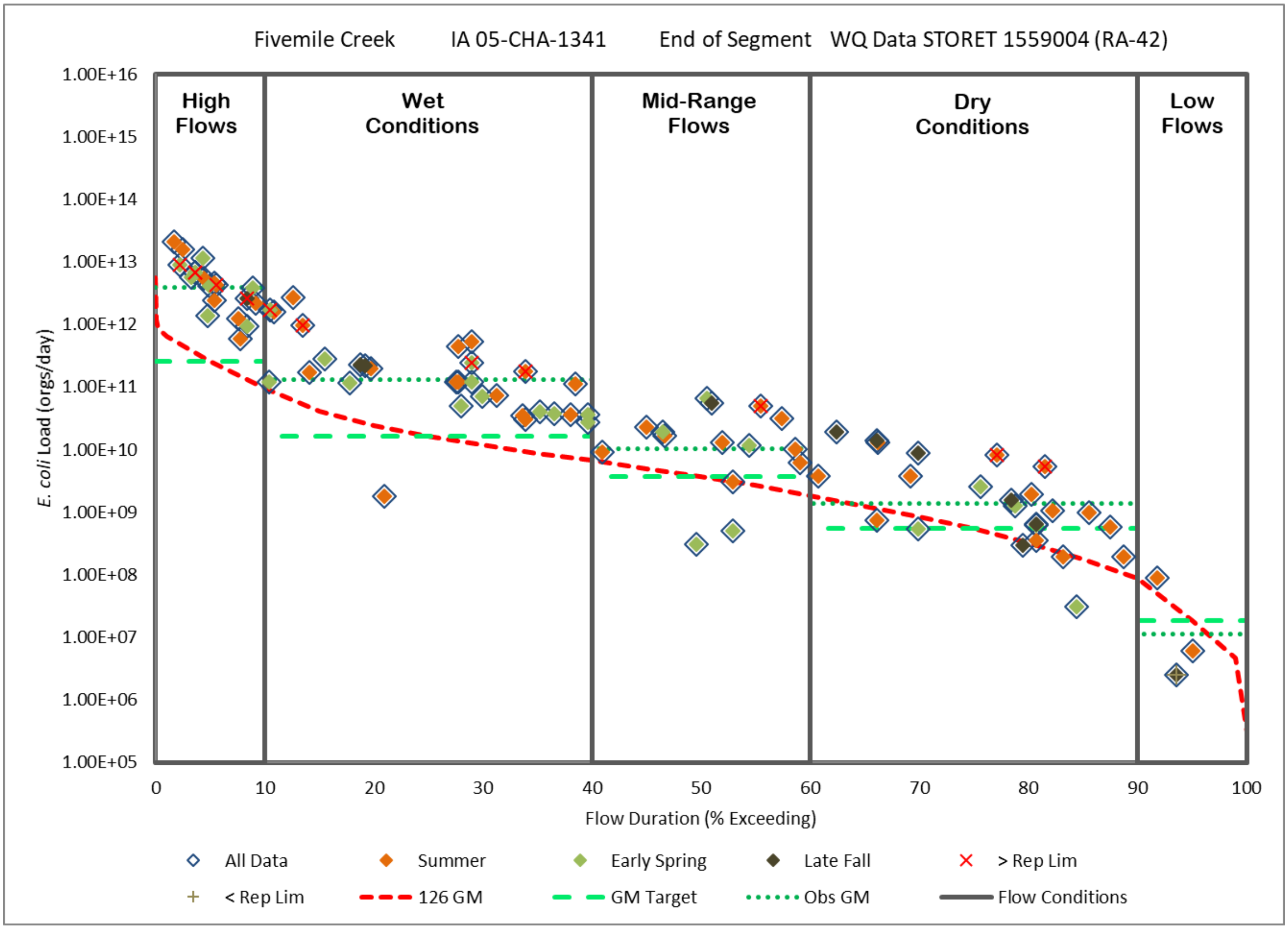

Figure 4.16. Load Duration Curve based on the GM for IA 05-CHA-1341.

Table 4.17. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1341.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	3.93E+12	1.30E+11	1.03E+10	1.37E+09	1.11E+07
Capacity @ 126 orgs/100 ml (TMDL)	2.56E+11	1.61E+10	3.66E+09	5.49E+08	1.83E+07
GM Departure (% Reduction)	3.67E+12 (93)	***1.14E+11 (88)***	6.69E+09 (65)	8.24E+08 (60)	-7.23E+06 (0)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	2.30E+11	1.45E+10	3.29E+09	4.94E+08	1.65E+07
MOS	2.56E+10	1.61E+09	3.66E+08	5.49E+07	1.83E+06
Midpoint Flow (cfs)	83.1	5.2	1.2	0.2	0.01

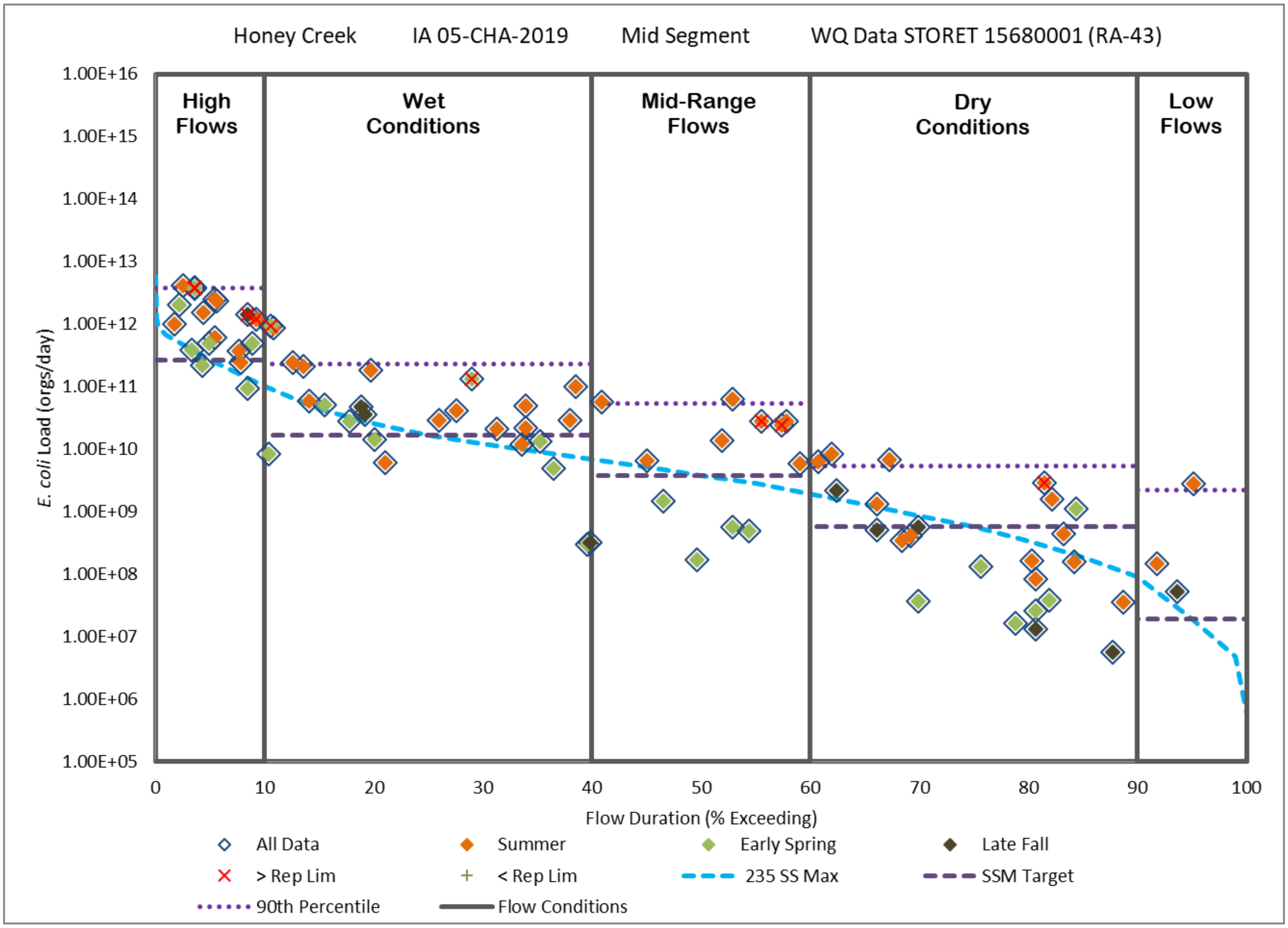

Figure 4.17. Load Duration Curve based on the SSM for IA 05-CHA-2019.

Table 4.18. Existing Loads Estimate, Departure and TMDLs Summary based on the SSM for IA 05-CHA-2019.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	3.79E+12	2.26E+11	5.29E+10	5.27E+09	2.22E+09
Capacity @ 235 orgs/100 ml (TMDL)	2.65E+11	1.67E+10	3.79E+09	5.69E+08	1.90E+07
SSM Departure (% Reduction)	3.52E+12 (93)	***2.09E+11 (93)***	***4.91E+10 (93)***	4.70E+09 (89)	2.20E+09 (99)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	2.39E+11	1.50E+10	3.40E+09	5.05E+08	9.91E+06
MOS	2.65E+10	1.67E+09	3.79E+08	5.69E+07	1.90E+06
Midpoint Flow (cfs)	46.2	2.9	0.7	0.10	0.003

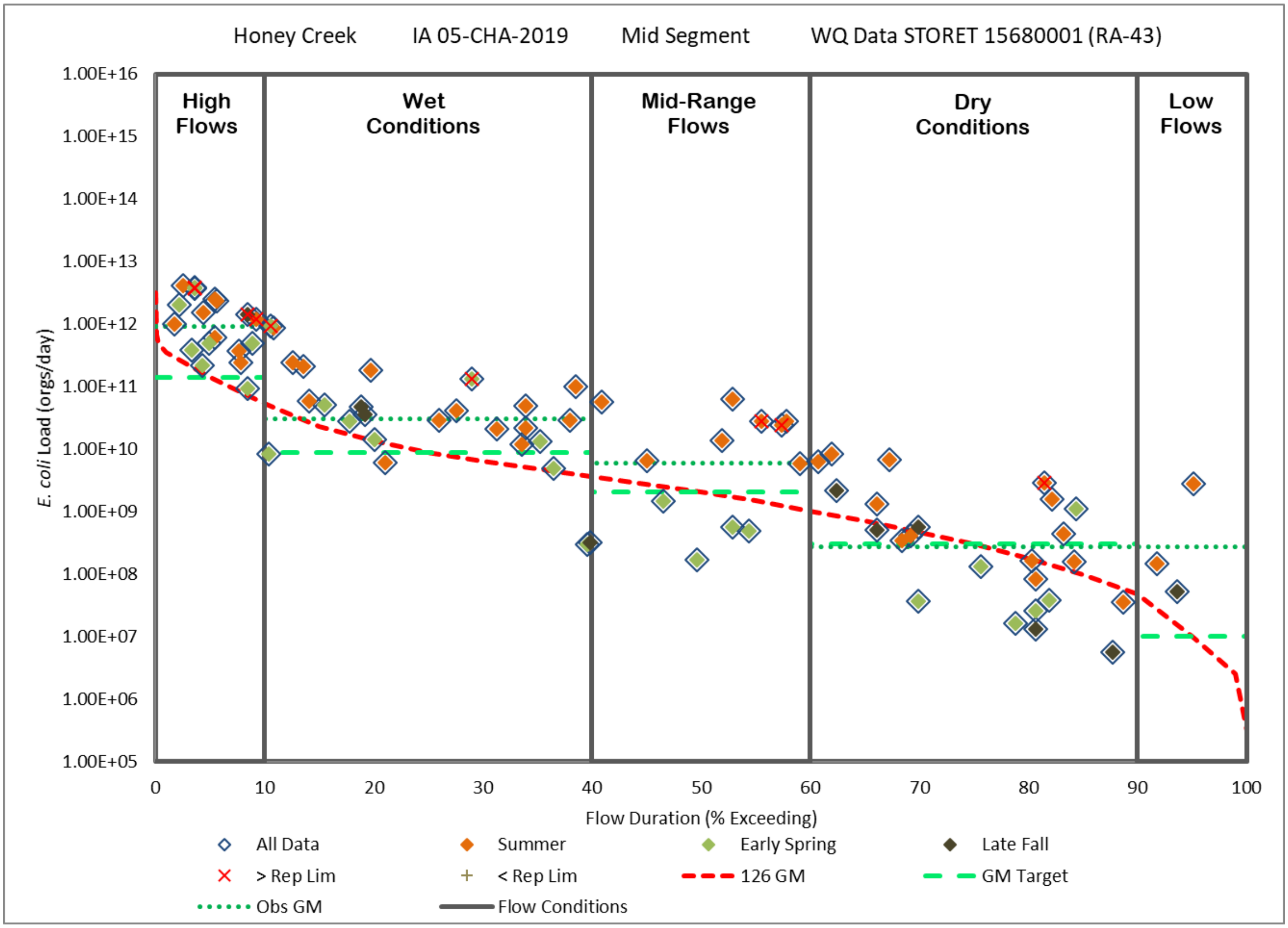

Figure 4.18. Load Duration Curve based on the GM for IA 05-CHA-2019.

Table 4.19. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-2019.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	9.15E+11	3.10E+10	6.03E+09	2.77E+08	2.74E+08
Capacity @ 126 orgs/100 ml (TMDL)	1.42E+11	8.93E+09	2.03E+09	3.05E+08	1.02E+07
GM Departure (% Reduction)	7.73E+11 (84)	***2.21E+10 (71)***	4.00E+09 (66)	-2.82E+07 (0)	2.64E+08 (96)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	1.28E+11	8.04E+09	1.83E+09	2.74E+08	9.15E+06
MOS	1.42E+10	8.93E+08	2.03E+08	3.05E+07	1.02E+06
Midpoint Flow (cfs)	46.2	2.9	0.7	0.1	0.003

4.4 TMDL Summary

The following equation represents the total maximum daily load (TMDL) and its components for the impaired segments of the Wolf Creek-Chariton River HUC 10:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where: TMDL = total maximum daily load
LC = loading capacity
∑WLA = sum of wasteload allocations (point sources)
∑LA = sum of load allocations (nonpoint sources)
MOS = margin of safety (to account for uncertainty)

Once the loading capacity, wasteload allocations, load allocations, and margin of safety have all been determined, the general equation above can be expressed for each segment and flow condition for *E. coli* as the allowable maximum daily load (Table 4.20) as required by EPA (see Appendix D).

Table 4.20. TMDL Summary by Impaired Segment for the Wolf Creek-Chariton River HUC 10.

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
Chariton River (IA 05-CHA-1310)					
SSM	High Flow	2.05E+12	1.33E+07	1.85E+12	2.05E+11
	Wet	1.29E+11	1.33E+07	1.16E+11	1.29E+10
	Average	2.93E+10	1.33E+07	2.64E+10	2.93E+09
	Dry	4.40E+09	1.33E+07	3.94E+09	4.40E+08
	Low Flow	1.47E+08	1.33E+07	1.19E+08	1.47E+07
GM	High Flow	1.10E+12	1.33E+07	9.90E+11	1.10E+11
	Wet	6.91E+10	1.33E+07	6.22E+10	6.91E+09
	Average	1.57E+10	1.33E+07	1.41E+10	1.57E+09
	Dry	2.36E+09	1.33E+07	2.11E+09	2.36E+08
	Low Flow	7.86E+07	1.33E+07	5.74E+07	7.86E+06
Chariton River (IA 05-CHA-1311)					
SSM	High Flow	1.80E+12	1.21E+09	1.62E+12	1.80E+11
	Wet	1.13E+11	1.21E+09	1.01E+11	1.13E+10
	Average	2.58E+10	1.21E+09	2.25E+10	2.58E+09
	Dry	3.86E+09	1.21E+09	2.82E+09	3.86E+08
	Low Flow(1)	1.29E+08	**1.16E+08**	0.00E+00	1.29E+07
GM	High Flow	9.67E+11	6.53E+08	8.69E+11	9.67E+10
	Wet	6.07E+10	6.53E+08	5.40E+10	6.07E+09
	Average	1.38E+10	6.53E+08	1.18E+10	1.38E+09
	Dry	2.07E+09	6.53E+08	1.21E+09	2.07E+08
	Low Flow(1)	6.90E+07	***6.21E+07***	0.00E+00	6.90E+06

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
Chariton River (IA 05-CHA-1312)					
SSM	High Flow	1.24E+12	2.42E+09	1.12E+12	1.24E+11
	Wet	7.80E+10	2.42E+09	6.78E+10	7.80E+09
	Average	1.77E+10	2.42E+09	1.35E+10	1.77E+09
	Dry(2)	2.66E+09	**2.40E+09**	0.00E+00	2.66E+08
	Low Flow(2)	8.87E+07	**7.98E+07**	0.00E+00	8.87E+06
GM	High Flow	6.66E+11	1.30E+09	5.98E+11	6.66E+10
	Wet	4.18E+10	1.30E+09	3.63E+10	4.18E+09
	Average	9.51E+09	1.30E+09	7.26E+09	9.51E+08
	Dry(2)	1.43E+09	***1.28E+09***	0.00E+00	1.43E+08
	Low Flow(2)	4.76E+07	***4.28E+07***	0.00E+00	4.76E+06
Chariton Creek (IA 05-CHA-1313)					
SSM	High Flow	7.09E+11	0.00E+00	6.38E+11	7.09E+10
	Wet	4.45E+10	0.00E+00	4.01E+10	4.45E+09
	Average	1.01E+10	0.00E+00	9.12E+09	1.01E+09
	Dry	1.52E+09	0.00E+00	1.37E+09	1.52E+08
	Low Flow	5.07E+07	0.00E+00	4.56E+07	5.07E+06
GM	High Flow	3.80E+11	0.00E+00	3.42E+11	3.80E+10
	Wet	2.39E+10	0.00E+00	2.15E+10	2.39E+09
	Average	5.43E+09	0.00E+00	4.89E+09	5.43E+08
	Dry	8.15E+08	0.00E+00	7.34E+08	8.15E+07
	Low Flow	2.72E+07	0.00E+00	2.45E+07	2.72E+06
Honey Creek (IA 05-CHA-1337)					
GM	High Flow	1.46E+12	1.48E+09	1.31E+12	1.46E+11
	Wet	9.17E+10	1.48E+09	8.11E+10	9.17E+09
	Average	2.09E+10	1.48E+09	1.73E+10	2.09E+09
	Dry	3.13E+09	1.48E+09	1.34E+09	3.13E+08
	Low Flow(1)	1.04E+08	***9.39E+07***	0.00E+00	1.04E+07
Wolf Creek (IA 05-CHA-1339)					
SSM	High Flow	1.86E+12	8.01E+06	1.68E+12	1.86E+11
	Wet	1.17E+11	8.01E+06	1.05E+11	1.17E+10
	Average	2.66E+10	8.01E+06	2.40E+10	2.66E+09
	Dry	4.00E+09	8.01E+06	3.59E+09	4.00E+08
	Low Flow	1.33E+08	8.01E+06	1.12E+08	1.33E+07
GM	High Flow	1.00E+12	8.01E+06	9.00E+11	1.00E+11
	Wet	6.28E+10	8.01E+06	5.65E+10	6.28E+09
	Average	1.43E+10	8.01E+06	1.28E+10	1.43E+09
	Dry	2.14E+09	8.01E+06	1.92E+09	2.14E+08
	Low Flow	7.14E+07	8.01E+06	5.63E+07	7.14E+06

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
Fivemile Creek (IA 05-CHA-1341)					
SSM	High Flow	4.78E+11	0.00E+00	4.30E+11	4.78E+10
	Wet	3.00E+10	0.00E+00	2.70E+10	3.00E+09
	Average	6.82E+09	0.00E+00	6.14E+09	6.82E+08
	Dry	1.02E+09	0.00E+00	9.21E+08	1.02E+08
	Low Flow	3.41E+07	0.00E+00	3.07E+07	3.41E+06
GM	High Flow	2.56E+11	0.00E+00	2.30E+11	2.56E+10
	Wet	1.61E+10	0.00E+00	1.45E+10	1.61E+09
	Average	3.66E+09	0.00E+00	3.29E+09	3.66E+08
	Dry	5.49E+08	0.00E+00	4.94E+08	5.49E+07
	Low Flow	1.83E+07	0.00E+00	1.65E+07	1.83E+06
Honey Creek (IA 05-CHA-2019)					
SSM	High Flow	2.65E+11	0.00E+00	2.39E+11	2.65E+10
	Wet	1.67E+10	0.00E+00	1.50E+10	1.67E+09
	Average	3.79E+09	0.00E+00	3.41E+09	3.79E+08
	Dry	5.69E+08	0.00E+00	5.12E+08	5.69E+07
	Low Flow	1.90E+07	0.00E+00	1.71E+07	1.90E+06
GM	High Flow	1.42E+11	0.00E+00	1.28E+11	1.42E+10
	Wet	8.93E+09	0.00E+00	8.04E+09	8.93E+08
	Average	2.03E+09	0.00E+00	1.83E+09	2.03E+08
	Dry	3.05E+08	0.00E+00	2.74E+08	3.05E+07
	Low Flow	1.02E+07	0.00E+00	9.15E+06	1.02E+06

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

(2) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

5. TMDLs for South Fork Chariton River for Indicator Bacteria (*E. coli*)

Total Maximum Daily Loads (TMDLs) are required for the six impaired waterbody segments in the South Fork Chariton River HUC 10 by the Federal Clean Water Act. This section of the Water Quality Improvement Plan (WQIP) describes the pollutant, in this case *Escherichia coli (E. coli)*, leading to the impairments and the maximum amount of *E. coli* the stream segments can assimilate and still support their designated uses.

5.1 Problem Identification

The primary contact recreation (Class A1) uses in Ninemile Creek, Jordan Creek, Jackson Creek, Walker Branch, and two segments of the South Fork Chariton River are not supported due to the presence of high levels of indicator bacteria (*E. coli*) (Figure 5.1). High *E. coli* levels in a waterbody can indicate the presence of potentially harmful bacteria and viruses (also called pathogens). Humans can become ill if they come into contact with and/or ingest water that contains pathogens. Under Iowa Administrative Code, streams are impaired for *E. coli* if they exceed a single sample maximum of 235 colony forming units (cfu) per 100 ml of water and the geometric mean of all samples exceeds 126 cfu/100 ml of water. This standard is only applicable during the recreation season, defined as March 15 through November 15.

Both point and nonpoint sources of pollution can be responsible for high *E. coli* levels. Permitted sources include municipal wastewater treatment facilities (WWTF) and discharging onsite wastewater treatment and disposal systems. Onsite wastewater treatment systems are often called septic systems, even though not all systems include a septic tank. Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include cattle with direct access to streams, manure applied to row crops, non-permitted onsite wastewater systems, and natural sources such as wildlife.

Stream Segment Designations and Descriptions

Six stream segments within the South Fork Chariton River HUC 10 do not meet water quality standards (WQS) and are not fully supporting class A1 (primary contact) designated uses due to presence of high levels of indicator bacteria called *Escherichia coli (E. coli)*. Prior to 2008, none of the listed segments were designated for primary contact recreation (Class A1). In February 2008, changes to Iowa's surface water classifications were approved by the EPA and all segments were now presumed to be Class A1, primary contact recreation. Table 5.1 is a summary of the impaired stream segments, segment identification, location description, segment length, and designated uses.

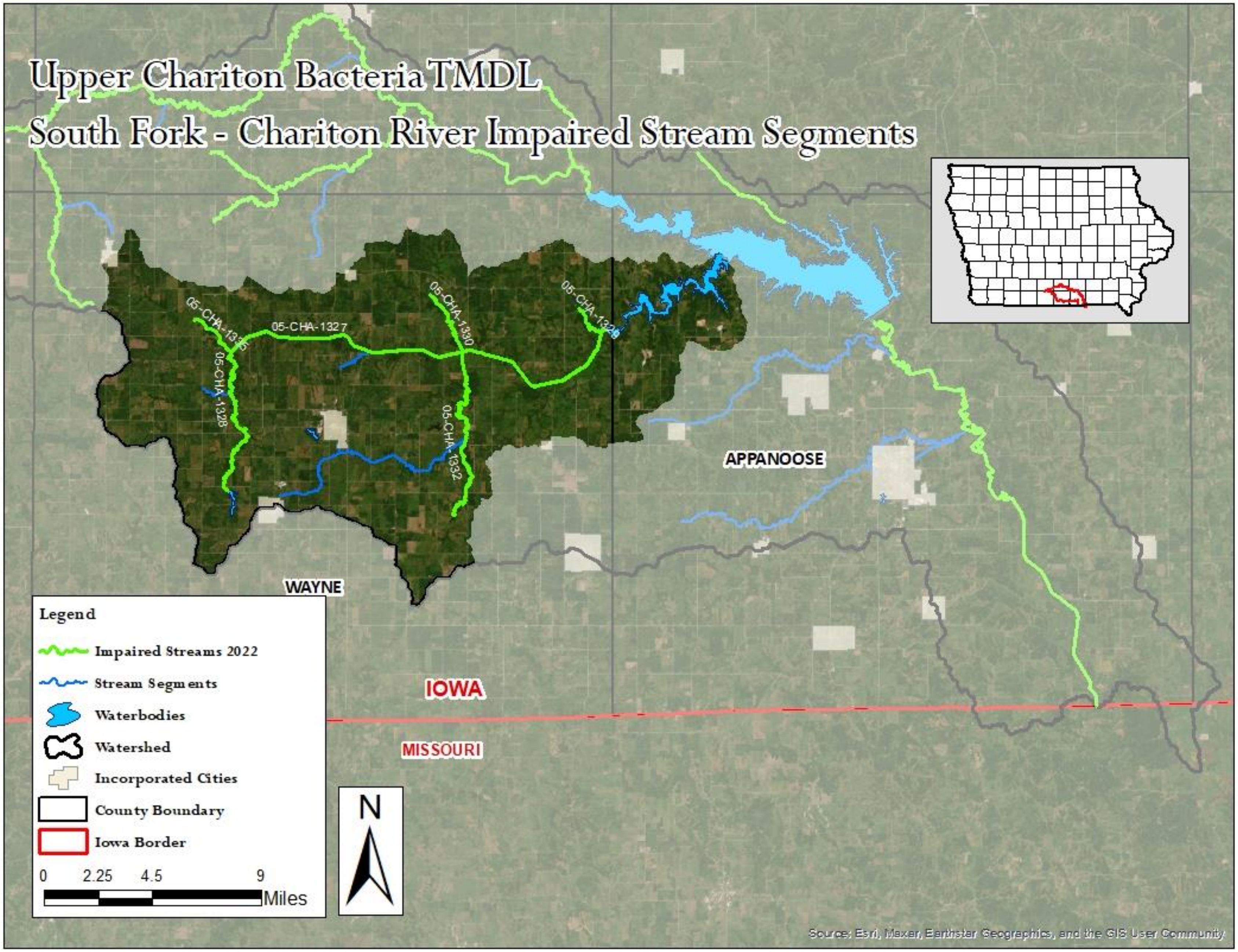

Figure 5.1. Map of the South Fork Chariton River HUC 10 with Impaired Stream Segments.

Table 5.1. Impaired Stream Segments and Designated Uses.

Stream name	Segment ID	Location Description	Stream length (mi)	Designated Uses	Impairment Category[(1)]
South Fork Chariton River	IA 05-CHA-1327	mouth (at Rathbun Lake) to confluence with Ninemile Cr. in S4, T69N, R22W, Wayne Co.	18.29	A1 B (WW2)	5p
South Fork Chariton River	IA 05-CHA-1328	from confluence with Ninemile Cr. (S4, T69N, R22W, Wayne Co.) to outfall of Bob White Lake in S4, T68N, R22W, Wayne Co.	10.88	A1 B (WW2)	5p
Walker Branch	IA 05-CHA-1329	mouth (S36, T70N, R20W, Wayne Co.) to confluence with S. Fork Walker Branch in SE 1/4, S26, T70N, R20W, Wayne Co.	2.1	A1 B (WW2)	5p
Jordan Creek	IA 05-CHA-1330	mouth (S1, T70N, R21W, Wayne Co.) to confluence with unnamed tributary in E 1/2, NW 1/4, S26, T70N, R21W, Wayne Co.	4.41	A1 B (WW2)	5p
Jackson Creek	IA 05-CHA-1332	mouth (S1, T70N, R21W, Wayne Co.) to confluence with unnamed tributary in S12, T68N, R21W, Wayne Co.	12.01	A1 B (WW2)	5p
Ninemile Creek	IA 05-CHA-1335	mouth (S4, T69N, R22W, Wayne Co.) to confluence with unnamed tributary in S31, T70N, R22W, Wayne Co.	2.62	A1 B (WW2)	5p

(1) Impairment category: 5p (impairment occurs on a waterbody with a presumptive A1 or B(WW1) use.)

Problem Statement
Water quality assessments indicate that primary contact recreation is "not supported" in these segments due to high levels of indicator bacteria (*E. coli*) that routinely violate the state's water quality standards (Table 5.2). The significance of the impairments noted in the assessments is that desirable recreational activities, such as swimming and wading, are not adequately provided by existing water quality in the impaired segments. As a result of these findings, the Federal Clean Water Act requires that TDMLs be developed for all the impaired segments for *E. coli*.

Table 5.2. Impairment Criteria for each Impaired Segment.

Stream name	Segment ID	Geometric mean (impairment at 126 cfu/100 ml)			Single Sample Max. (235 cfu/100 ml) % samples exceeding
		2010	2011	2012	
South Fork Chariton River	IA 05-CHA-1327	794	1,368	576	68%
South Fork Chariton River	IA 05-CHA-1328	679	489	208	67%
Walker Branch	IA 05-CHA-1329	679	26	45	36%
Jordan Creek	IA 05-CHA-1330	1,317	251	656	88%
Jackson Creek	IA 05-CHA-1332	836	248	934	72%
Ninemile Creek	IA 05-CHA-1335	569	181	196	62%

Data Sources

Sources of data used in the development of this TMDL include those used in the 2014 305(b) report, several sources of additional flow and water quality data, and non-water quality related data used for model development. Monitoring sites are listed in Table 5.3 and shown in Figure 5.2. Specific data includes:

- Stream data collected by DNR Watershed Improvement Section staff for the purpose of TMDL development
- Stream data collected by U.S. Army Corps of Engineers (USACE), Kansas City District, as part of its reservoir monitoring program
- Streamflow data collected by the U.S. Geological Survey (USGS) at multiple surface water gaging stations (USGS, 2015)
- Precipitation and temperature data from the National Weather Service Cooperative Observer Program (NWS COOP) (IEM, 2015)
- Precipitation and temperature data from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) (NOAA, 2015)
- 10-m Digital Elevation Model (DEM) available from DNR GIS library
- SSURGO soils data maintained by United States Department of Agriculture -Natural Resource Conservation Service (USDA-NRCS)
- U.S. Department of Agriculture National Agricultural Statistics Service Cropland Data Layer (CDL) reflecting 2006 conditions (USDA-NASS, 2013)
- Six-year crop rotation data for 2008-2013 developed by the USDA National Laboratory for Agriculture and the Environment (USDA-NLAE) (Tomer et al., 2013)
- Aerial images (various years) collected and maintained by DNR

Table 5.3. WQ Monitoring Sites of South Fork Chariton River HUC 10.

Site Name	ID	Longitude	Latitude
S. Fork Chariton River (RA-12)	STORET 15930001	-93.1928	40.8007
S. Fork Chariton River (RA-35)	STORET 15930002	-93.4005	40.7856
Ninemile Creek at Quail Run (RA-36)	STORET 15930003	-93.4089	40.8116
Jordan Creek at CR J32 (RA-37)	STORET 15930004	-93.2218	40.8119
Walker Branch at Raccoon (RA-38)	STORET 15930005	-93.1207	40.8266
Jackson Creek at Liberty (RA-39)	STORET 15930006	-93.2132	40.7544

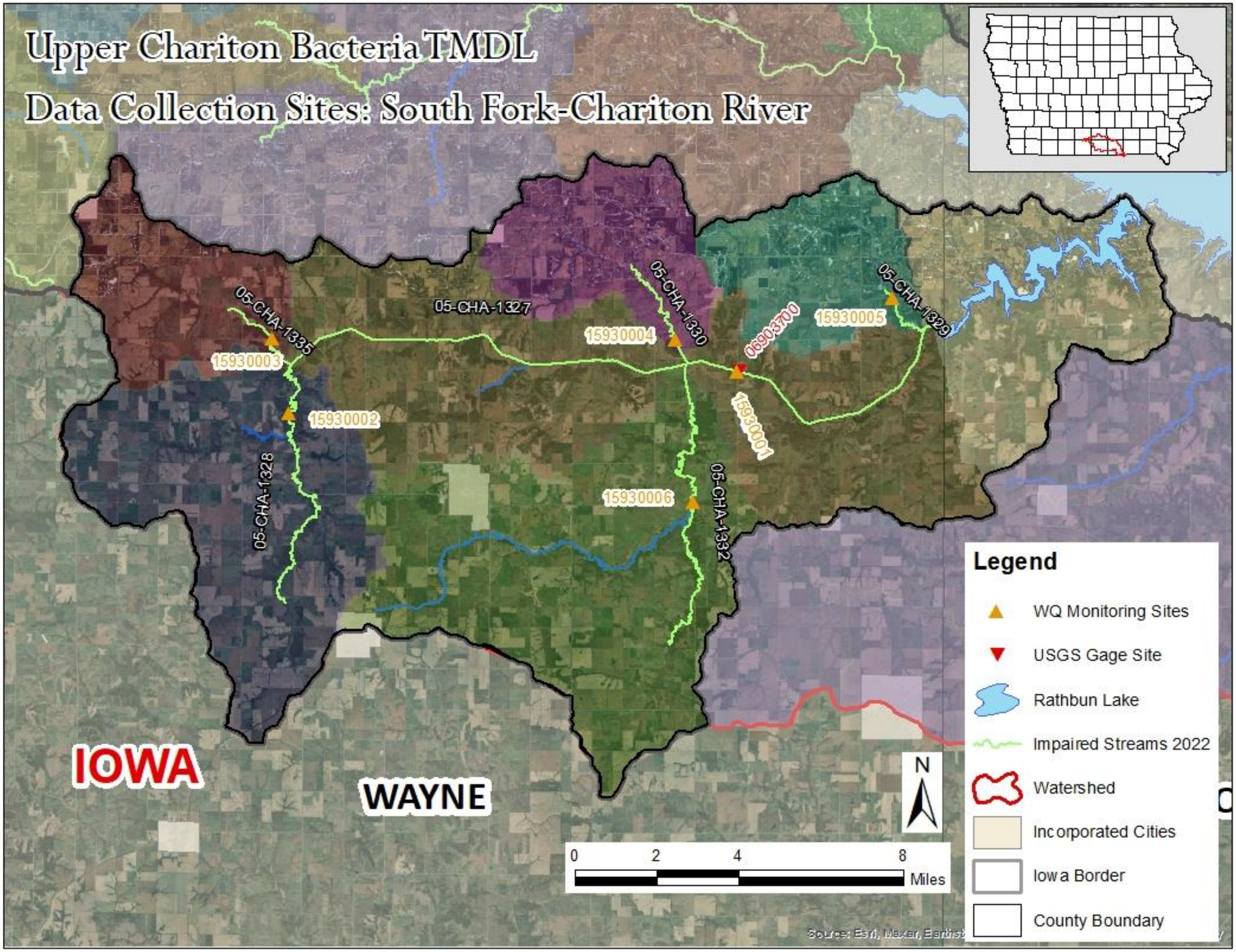

Figure 5.2. Data Sources South Fork-Chariton River HUC-10.

Interpreting the Data
Analysis of the data shows consistently high *E. coli* levels that significantly exceed both criteria set for in Iowa's water quality standards for primary contact recreation. Significant reductions in *E. coli* loading will be required to comply with the standards and fully support the designated recreational use in the impaired segments.

5.2 Pollution Source Assessment

Identification of Pollutant Sources
There are a variety of *E. coli* sources in the South Fork Chariton River watershed. These sources can be divided into two categories, point and non-point sources. Point sources include municipal separate storm sewer systems (MS4s), municipal and industrial wastewater treatment facilities (WWTFs), sanitary sewer overflows (SSOs), onsite wastewater systems with permitted discharges, and animal feeding operations (AFOs) regulated as concentrated animal feeding operations (CAFOs). Nonpoint sources include wildlife, manure application to row crops, grazing livestock and small feeding operations, direct deposition by livestock in streams, and non-permitted (i.e., non-discharging) onsite wastewater systems.

Load duration curves (LDCs) were used in the development of *E. coli* TMDLs for impaired stream segments in the South Fork Chariton River Watershed (Section 5.2). The use of LDCs is helpful for understanding the importance that hydrology plays on pollutant loading. Information illustrated in LDCs provides a basic understanding of the importance of potential pollutant sources, although the approach does not offer explicit calculation of source-specific pollutant loads. However, when analyzed in conjunction with a detailed inventory of sources, LDCs can provide a quantitative means of comparing the relative importance of specific pollutant sources.

Point Sources
There are a total of two active NPDES permits for waste water treatment facilities (WWTF) in this watershed. In addition, there are three unsewered communities (Confidence, Millerton, Cambria) and two concentrated animal feeding operations (CAFO). Figure 5.3 shows the locations of NPDES permitted wastewater facilities and the unsewered communities. A full inventory of dischargers and their respective WLAs is provided in Appendix C.

Nonpoint Sources
The nonpoint sources of pathogen indicators include contributors that do not have localized points of release into a stream. In the watershed these sources are:

- Grazing animals
- Direct deposition of manure in streams
- Land application and subsequent runoff of manure
- Developed / urban area runoff
- Wildlife
- Faulty septic tank systems

Allowance for Increases in Pollutant Loads
There are three unsewered communities in the South Fork Chariton River HUC 10. A reserve wasteload allocation was calculated for each community and applied to the WLA for the associated segment. Appendix C.2 lists all the unsewered communities in the Upper Chariton watershed. Any new or expanded dischargers will be expected to meet the same end-of-pipe criterion (GM of 126 orgs/100 ml) as dischargers for which WLAs were calculated and included in this TMDL. New or expanded facilities meeting the end-of-pipe criterion will not cause or contribute to the impairment.

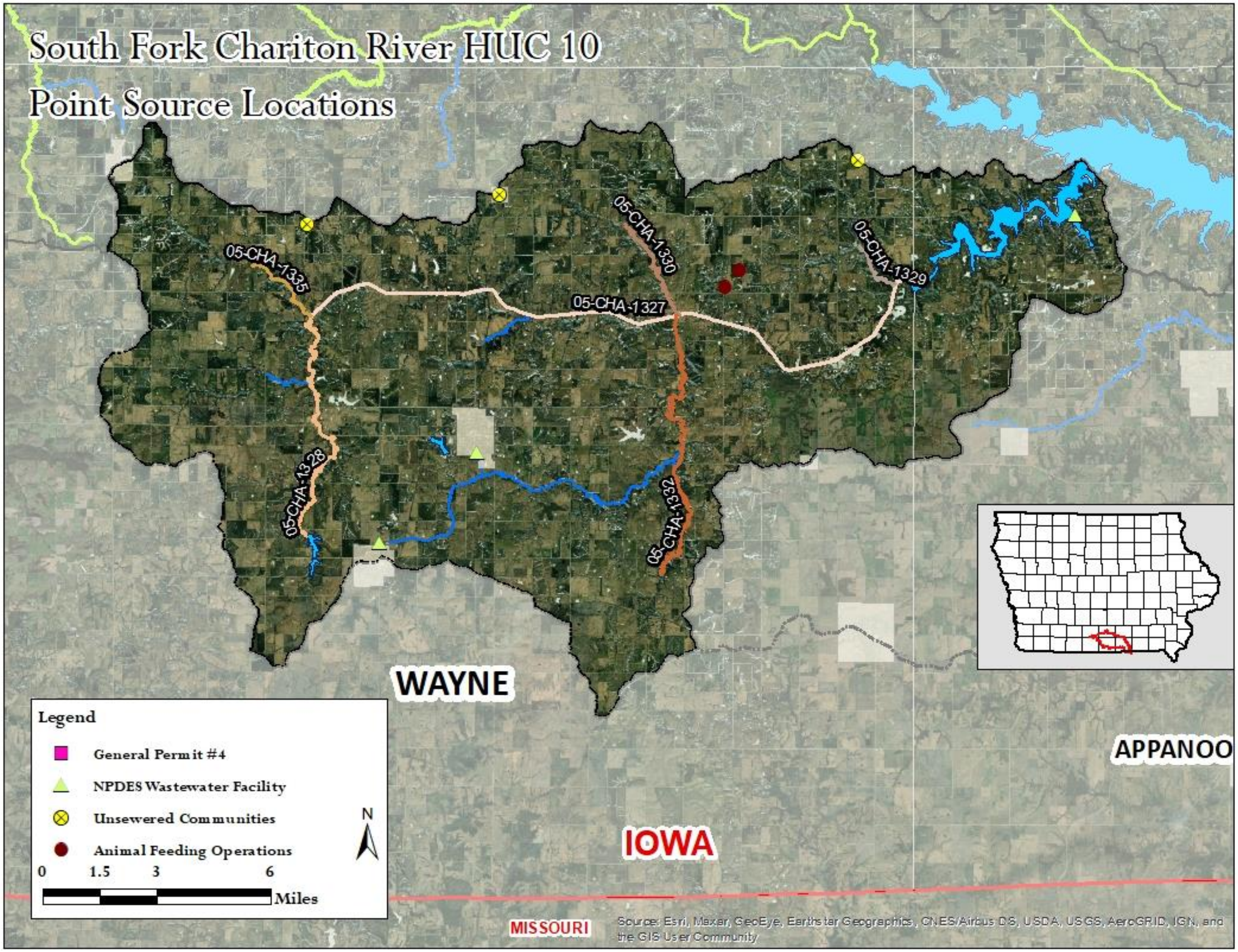

Figure 5.3. Map of the South Fork Chariton River Point Sources

5.3 Pollutant Allocation

Wasteload Allocation

As stated previously, the wasteload allocation was calculated for each WWTP in the watershed as well as a reserve WLA for the three unsewered communities.

Table 5.4. Wasteload Allocations for South Fork Chariton River HUC-10.

Facility Type	Number of Facilities(1)	Flow (MGD)(1)	GM Conc (orgs/100 ml)	GM Load (orgs/day)	SSM Conc (orgs/100 ml)	SSM Load (orgs/day)
WWTF(2)	2	1.14	126	5.42E+09	235	1.01E+10
Unsewered	3	0.0108	126	5.15E+07	235	9.61E+07
CAFO	2	0.00	126	0.00E+00	235	0.00E+00
Totals	**7**	**1.15**	**--**	**5.47E+09**	**--**	**1.02E+10**

(1) Flows used to calculate the wasteload allocation. See Appendix C.
(2) SSM WLA's were calculated for assessment purposes to determine an appropriate LA (nonpoint source). As per IAC 567 62.8(2) daily sample maximum criteria for *E coli* shall not be used as an end-of-pipe limitation.

Load Allocation

Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include animals directly depositing into streams, manure applied to row crops, manure runoff from grazed land, non-permitted onsite wastewater systems, and natural sources such as wildlife.

Margin of Safety

An explicit margin of safety (MOS) of 10 percent is applied to the calculation of loading capacities in this TMDL. The loading capacity for each segment is set equal to the appropriate water quality criteria (less 10 percent) with the goal of achieving the criteria at the sampling location. As a result, TMDLs do not consider dilution to meet WQS nor do they consider bacteria die-off and settling, which occur. Consequently, bacteria TMDLs are conservative.

Departure from Load Capacity and Critical Conditions

The LDCs, observed loads, and observed GM loads for each flow condition are plotted in Figure 5.4 through Figure 5.15. This methodology enables calculation of a TMDL target at the midpoint of each flow condition for each impaired segment, as provided in Table 5.5 through Table 5.16. Figures and Tables are provided for both the SSM and GM criteria.

The critical condition for each TMDL is highlighted in each table. The critical condition is the flow requiring the largest percent reduction. However, the high flow or low flow conditions are not considered because these flow conditions are not representative of typical conditions (EPA, 2006).

Load Duration Curve

Figure 5.4 through Figure 5.15 show load durations for the impaired stream segments in this watershed. Table 5.5 through Table 5.16 are the existing load estimates and the TMDL summary for each impaired segment.

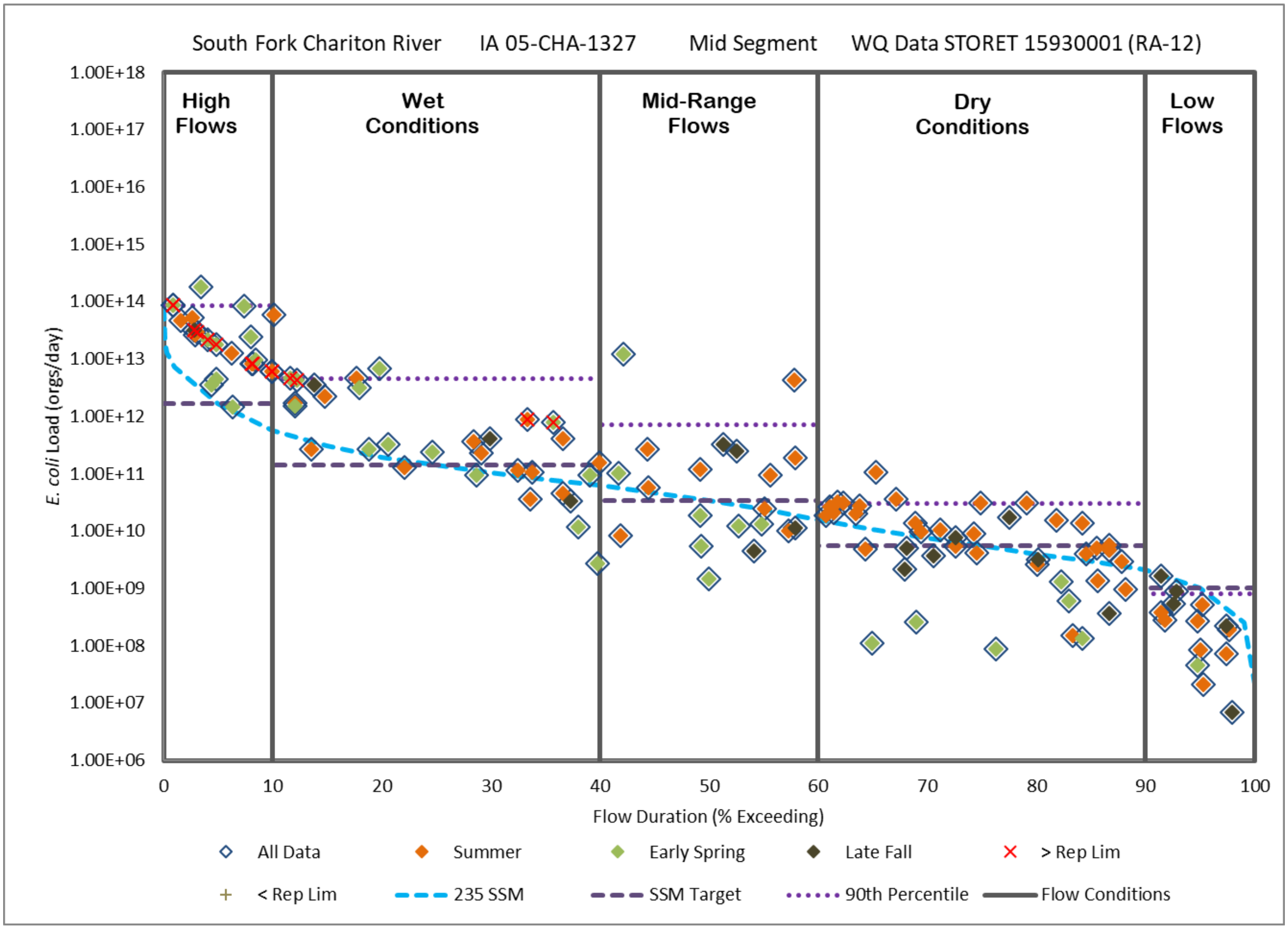

Figure 5.4. Load Duration Curve based on the SSM for IA 05-CHA-1327.

Table 5.5. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1327.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	8.58E+13	5.62E+12	3.12E+11	3.07E+10	7.90E+08
Capacity @ 235 orgs/100 ml (TMDL)	1.64E+12	1.39E+11	3.39E+10	5.47E+09	1.02E+09
SSM Departure (% Reduction)	8.42E+13 (98)	**4.45E+12 (97)**	6.79E+11 (95)	2.53E+10 (82)	-2.33E+08 (0)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	1.48E+12	1.25E+11	3.05E+10	4.93E+09	9.21E+08
MOS	1.64E+11	1.39E+10	3.39E+09	5.47E+08	1.02E+08
Midpoint Flow (cfs)	285.6	24.2	5.9	0.95	0.18

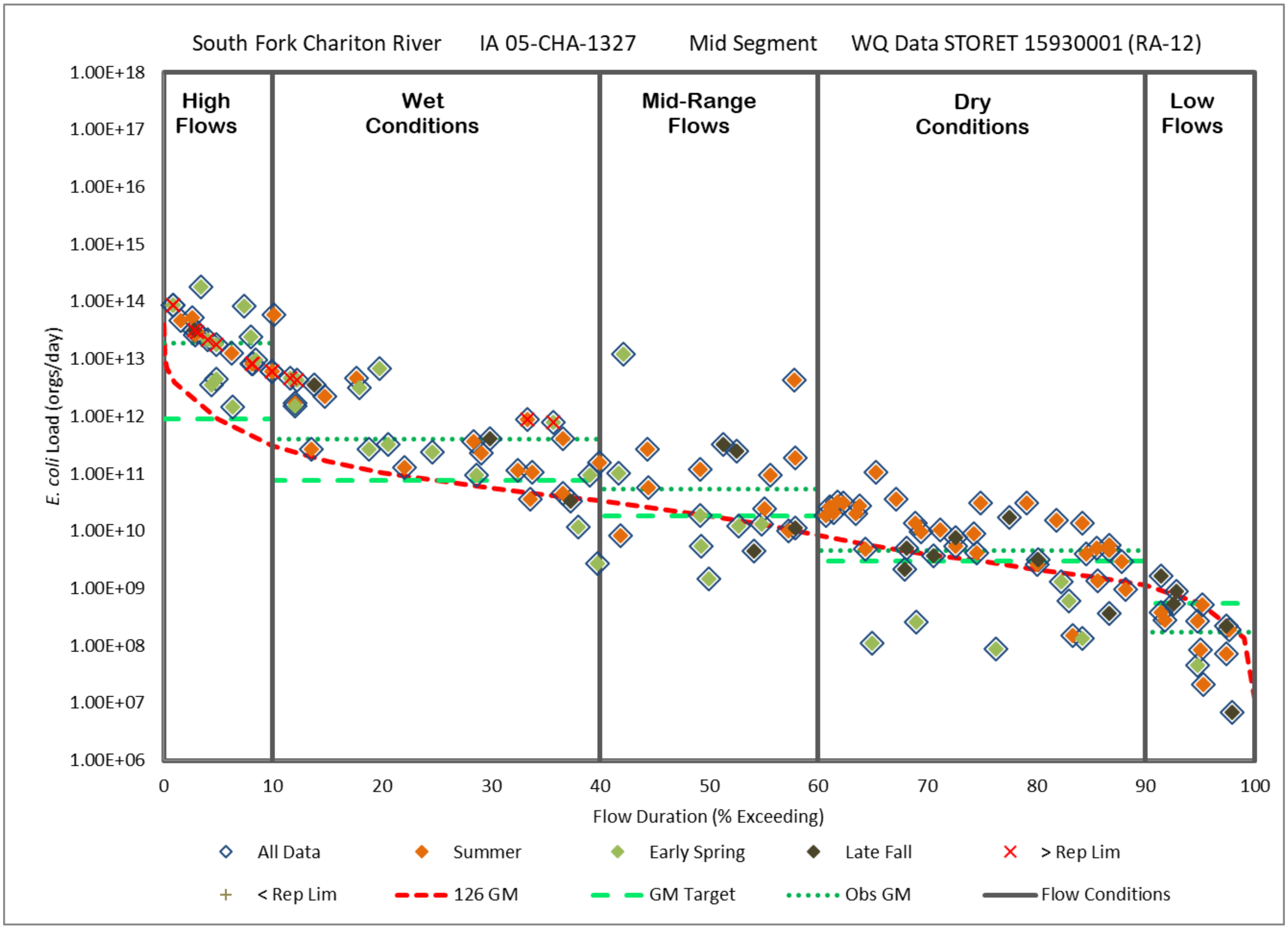

Figure 5.5. Load Duration Curve based on the GM for IA 05-CHA-1327.

Table 5.6. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1327.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.86E+13	3.99E+11	5.31E+10	4.59E+09	1.72E+08
Capacity @ 126 orgs/100 ml (TMDL)	8.80E+11	7.46E+10	1.82E+10	2.94E+09	5.49E+08
GM Departure (% Reduction)	1.77E+13 (95)	**3.25E+11 (81)**	3.49E+10 (66)	1.65E+09 (36)	-3.77E+08 (0)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	7.92E+11	6.72E+10	1.64E+10	2.64E+09	4.94E+08
MOS	8.80E+10	7.46E+09	1.82E+09	2.94E+08	5.49E+07
Midpoint Flow (cfs)	285.6	24.2	5.9	1.0	0.18

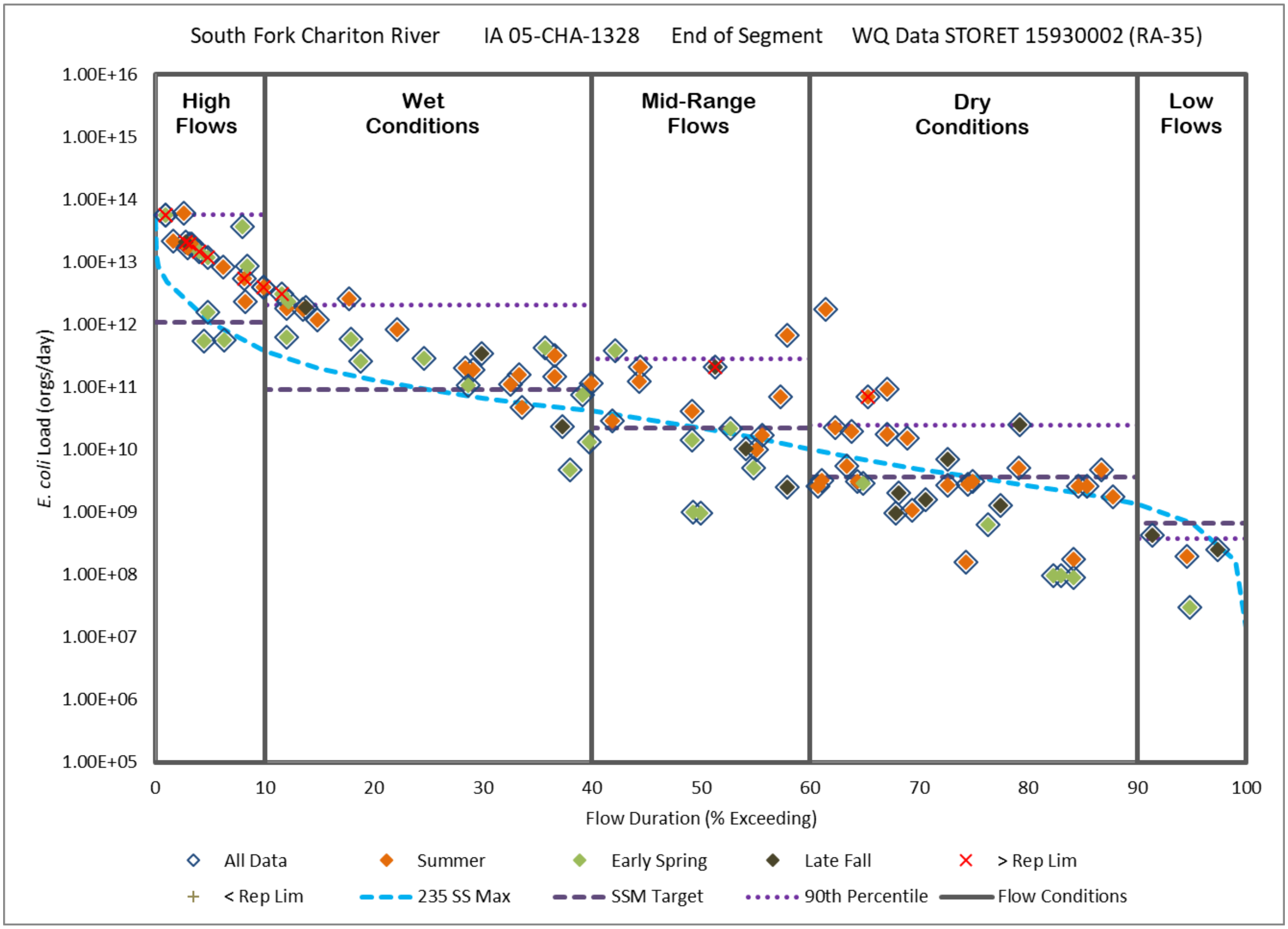

Figure 5.6. Load Duration Curve based on the SSM for IA 05-CHA-1328.

Table 5.7. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1328.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	5.59E+13	2.05E+12	2.80E+11	2.42E+10	3.74E+08
Capacity @ 235 orgs/100 ml (TMDL)	1.07E+12	9.07E+10	2.21E+10	3.57E+09	6.67E+08
SSM Departure (% Reduction)	5.49E+13 (98)	**1.96E+12 (96)**	2.58E+11 (92)	2.06E+10 (85)	-2.93E+08 (0)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	9.63E+11	8.17E+10	1.99E+10	3.21E+09	6.00E+08
MOS	1.07E+11	9.07E+09	2.21E+09	3.57E+08	6.67E+07
Midpoint Flow (cfs)	186.1	15.8	3.8	0.62	0.116

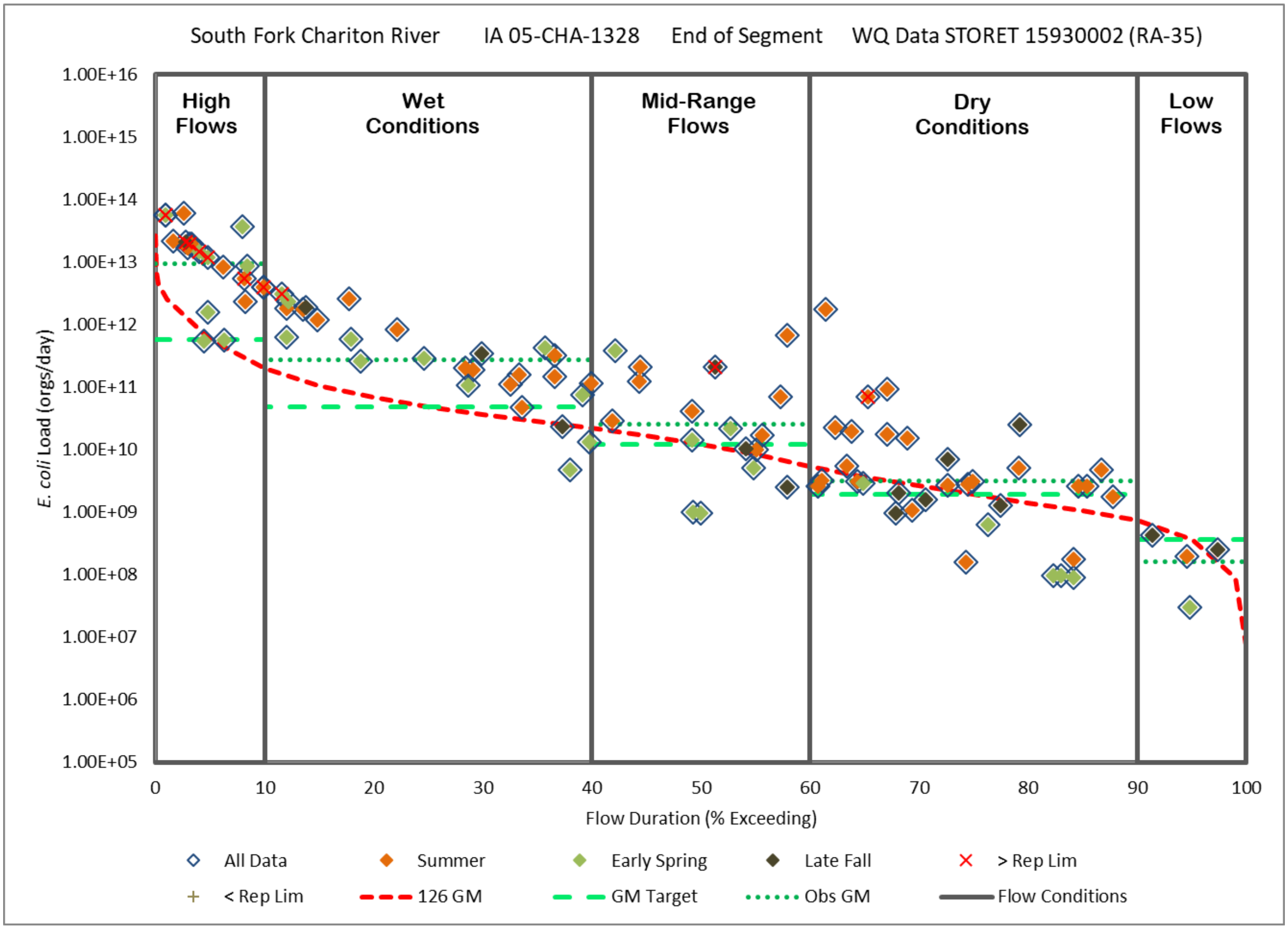

Figure 5.7. Load Duration Curve based on the GM for IA 05-CHA-1328.

Table 5.8. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1328.

Load Summary	Loads (orgs/day)				
	High	**Wet**	**Mid-Range**	**Dry**	**Low**
Geometric Mean	9.26E+12	2.74E+11	2.52E+10	3.17E+09	1.58E+08
Capacity @ 126 orgs/100 ml (TMDL)	5.74E+11	4.86E+10	1.18E+10	1.91E+09	3.58E+08
GM Departure (% Reduction)	8.68E+12 (94)	**2.26E+11 (82)**	1.34E+10 (53)	1.25E+09 (40)	-2.00E+08 (0)
WLA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA	5.16E+11	4.38E+10	1.07E+10	1.72E+09	3.22E+08
MOS	5.74E+10	4.86E+09	1.18E+09	1.91E+08	3.58E+07
Midpoint Flow (cfs)	186.1	15.8	3.8	0.6	0.12

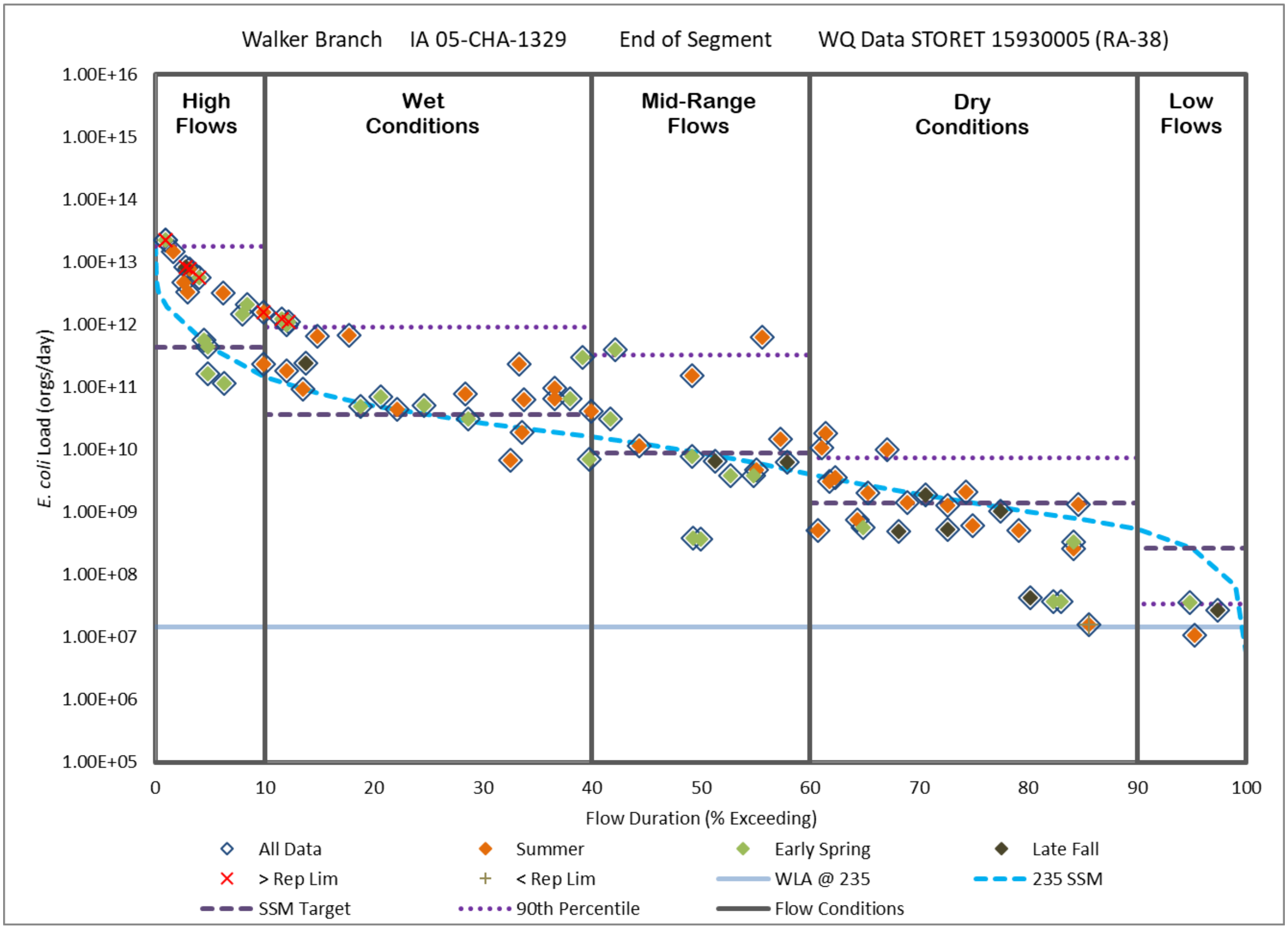

Figure 5.8. Load Duration Curve based on the SSM for IA 05-CHA-1329.

Table 5.9. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1329.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.75E+13	8.88E+11	3.18E+11	7.42E+09	3.42E+07
Capacity @ 235 orgs/100 ml (TMDL)	4.22E+11	3.58E+10	8.71E+09	1.41E+09	2.63E+08
SSM Departure (% Reduction)	1.71E+13 (98)	8.53E+11 (96)	***3.09E+11 (97)***	6.01E+09 (81)	-2.29E+08 (0)
WLA	1.42E+07	1.42E+07	1.42E+07	1.42E+07	1.42E+07
LA	3.80E+11	3.22E+10	7.82E+09	1.25E+09	2.22E+08
MOS	4.22E+10	3.58E+09	8.71E+08	1.41E+08	2.63E+07
Midpoint Flow (cfs)	73.3	6.2	1.5	0.24	0.046

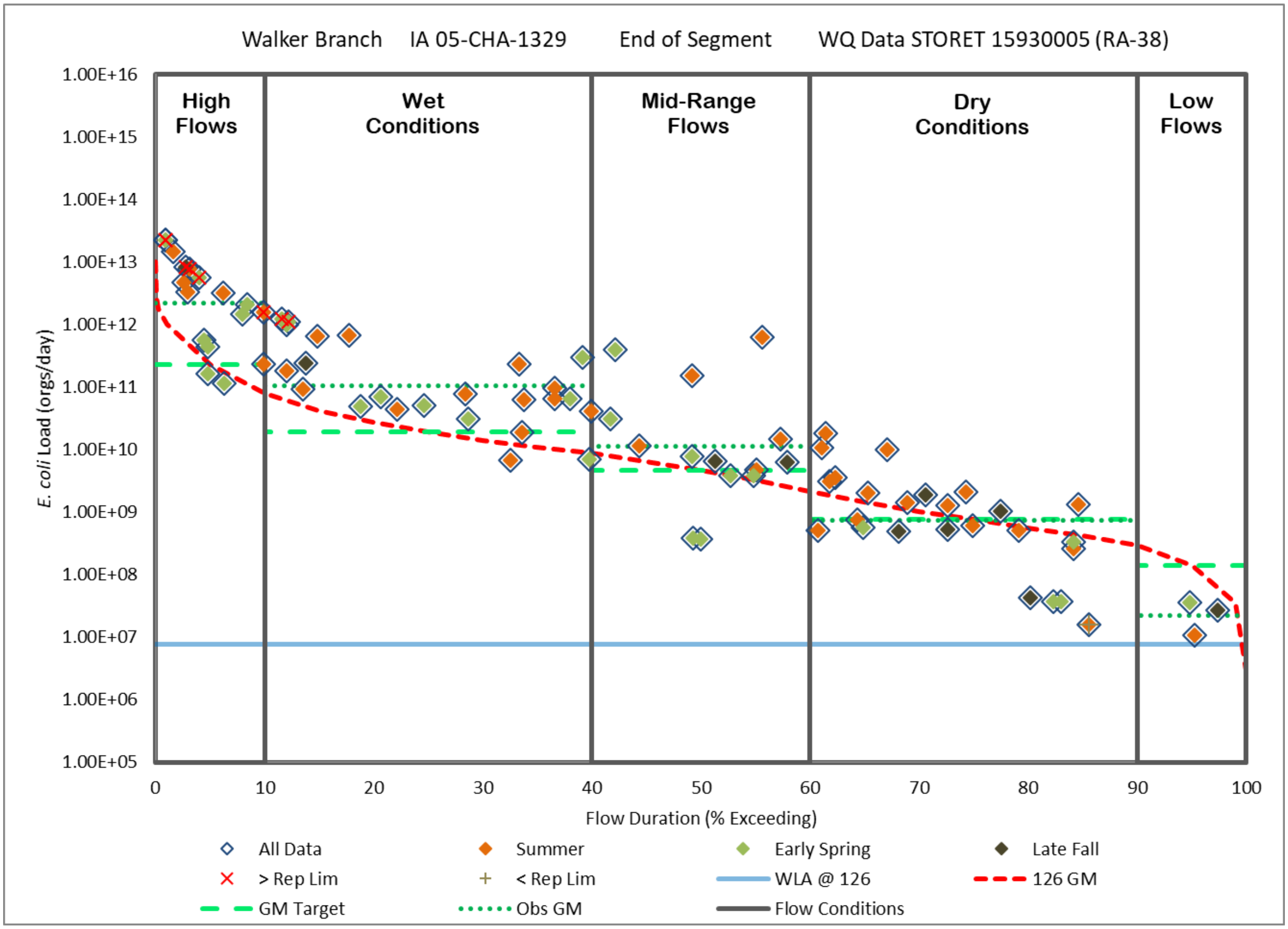

Figure 5.9. Load Duration Curve based on the GM for IA 05-CHA-1329.

Table 5.10. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1329.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	2.19E+12	1.04E+11	1.13E+10	7.40E+08	2.18E+07
Capacity @ 126 orgs/100 ml (TMDL)	2.26E+11	1.92E+10	4.67E+09	7.54E+08	1.41E+08
GM Departure (% Reduction)	1.97E+12 (90)	***8.47E+10 (82)***	6.67E+09 (59)	-1.39E+07 (0)	-1.19E+08 (0)
WLA	7.63E+06	7.63E+06	7.63E+06	7.63E+06	7.63E+06
LA	2.03E+11	1.72E+10	4.19E+09	6.71E+08	1.19E+08
MOS	2.26E+10	1.92E+09	4.67E+08	7.54E+07	1.41E+07
Midpoint Flow (cfs)	73.3	6.2	1.5	0.2	0.05

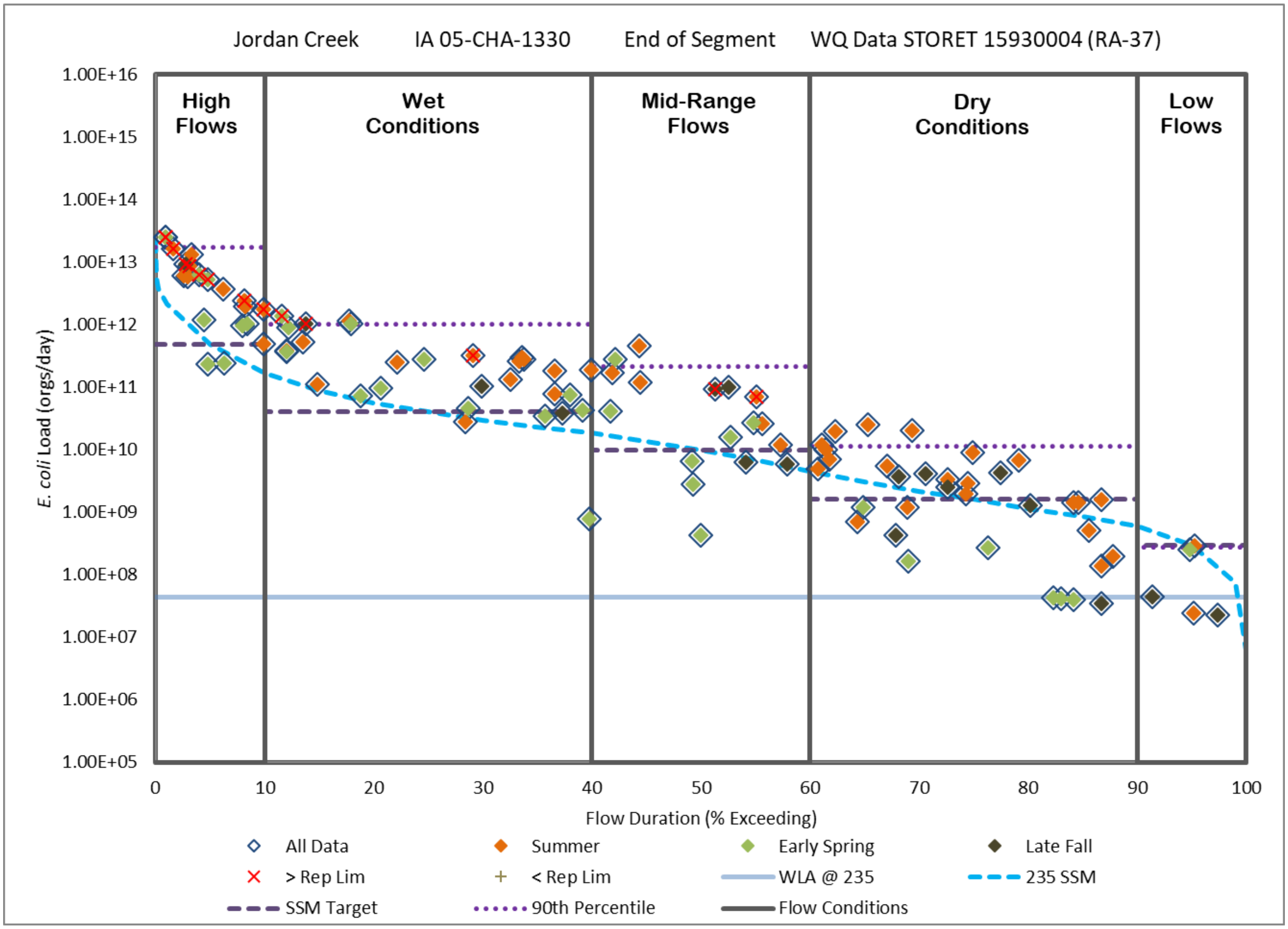

Figure 5.10. Load Duration Curve based on the SSM for IA 05-CHA-1330.

Table 5.11. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1330.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.71E+13	1.02E+12	2.09E+11	1.12E+10	2.72E+08
Capacity @ 235 orgs/100 ml (TMDL)	4.72E+11	4.00E+10	9.74E+09	1.57E+09	2.94E+08
SSM Departure (% Reduction)	1.66E+13 (97)	**9.77E+11 (96)**	1.99E+11 (95)	9.66E+09 (86)	-2.23E+07 (0)
WLA	4.27E+07	4.27E+07	4.27E+07	4.27E+07	4.27E+07
LA	4.25E+11	3.60E+10	8.72E+09	1.37E+09	2.22E+08
MOS	4.72E+10	4.00E+09	9.74E+08	1.57E+08	2.94E+07
Midpoint Flow (cfs)	82.1	7.0	1.7	0.3	0.05

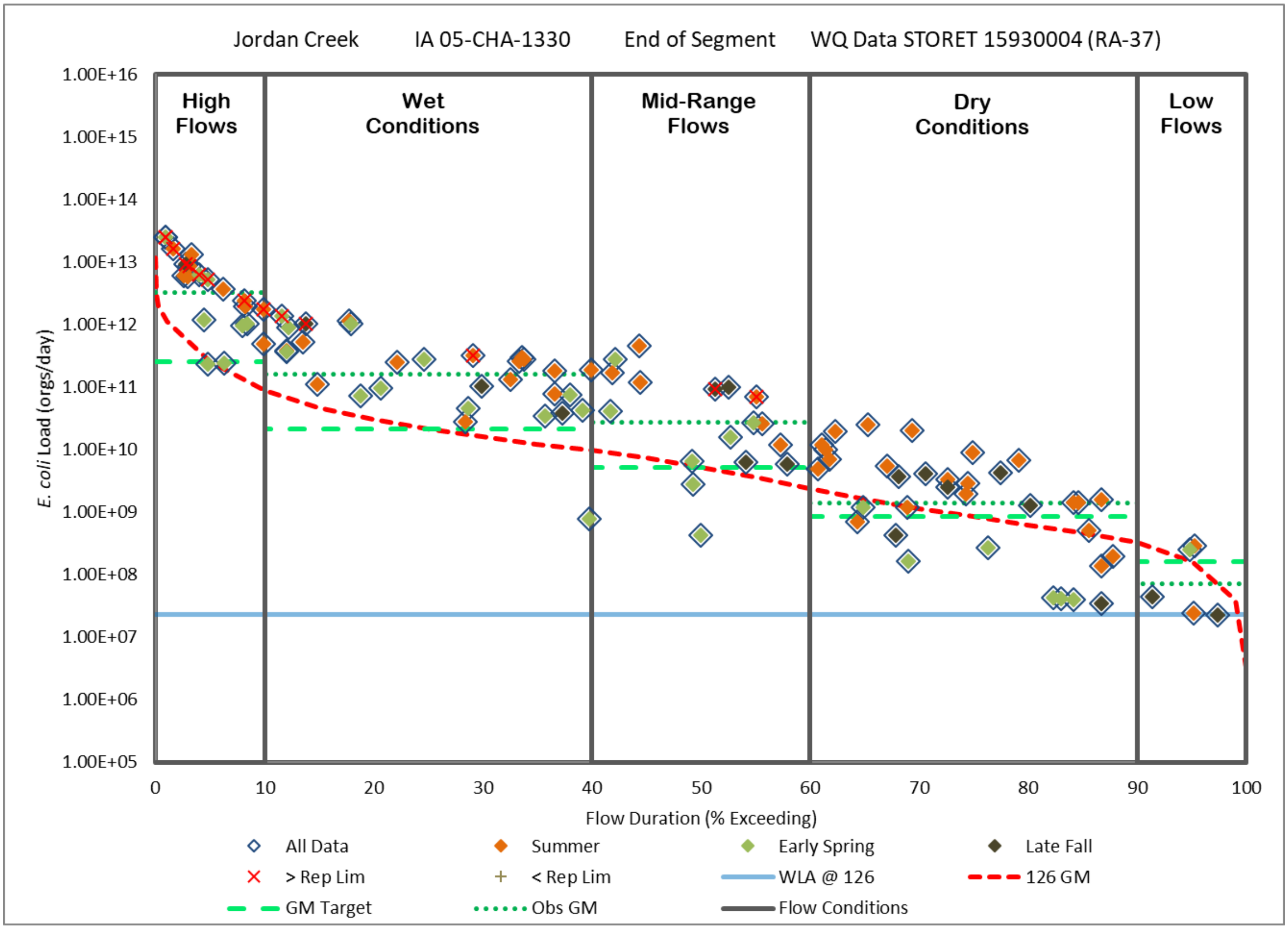

Figure 5.11. Load Duration Curve based on the GM for IA 05-CHA-1330.

Table 5.12. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1330.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	3.18E+12	1.57E+11	2.71E+10	1.40E+09	7.06E+07
Capacity @ 126 orgs/100 ml (TMDL)	2.53E+11	2.14E+10	5.22E+09	8.43E+08	1.58E+08
GM Departure (% Reduction)	2.92E+12 (92)	**1.36E+11 (86)**	2.18E+10 (81)	5.53E+08 (40)	-8.71E+07 (0)
WLA	2.29E+07	2.29E+07	2.29E+07	2.29E+07	2.29E+07
LA	2.28E+11	1.93E+10	4.68E+09	7.36E+08	1.19E+08
MOS	2.53E+10	2.14E+09	5.22E+08	8.43E+07	1.58E+07
Midpoint Flow (cfs)	82.1	7.0	1.7	0.3	0.05

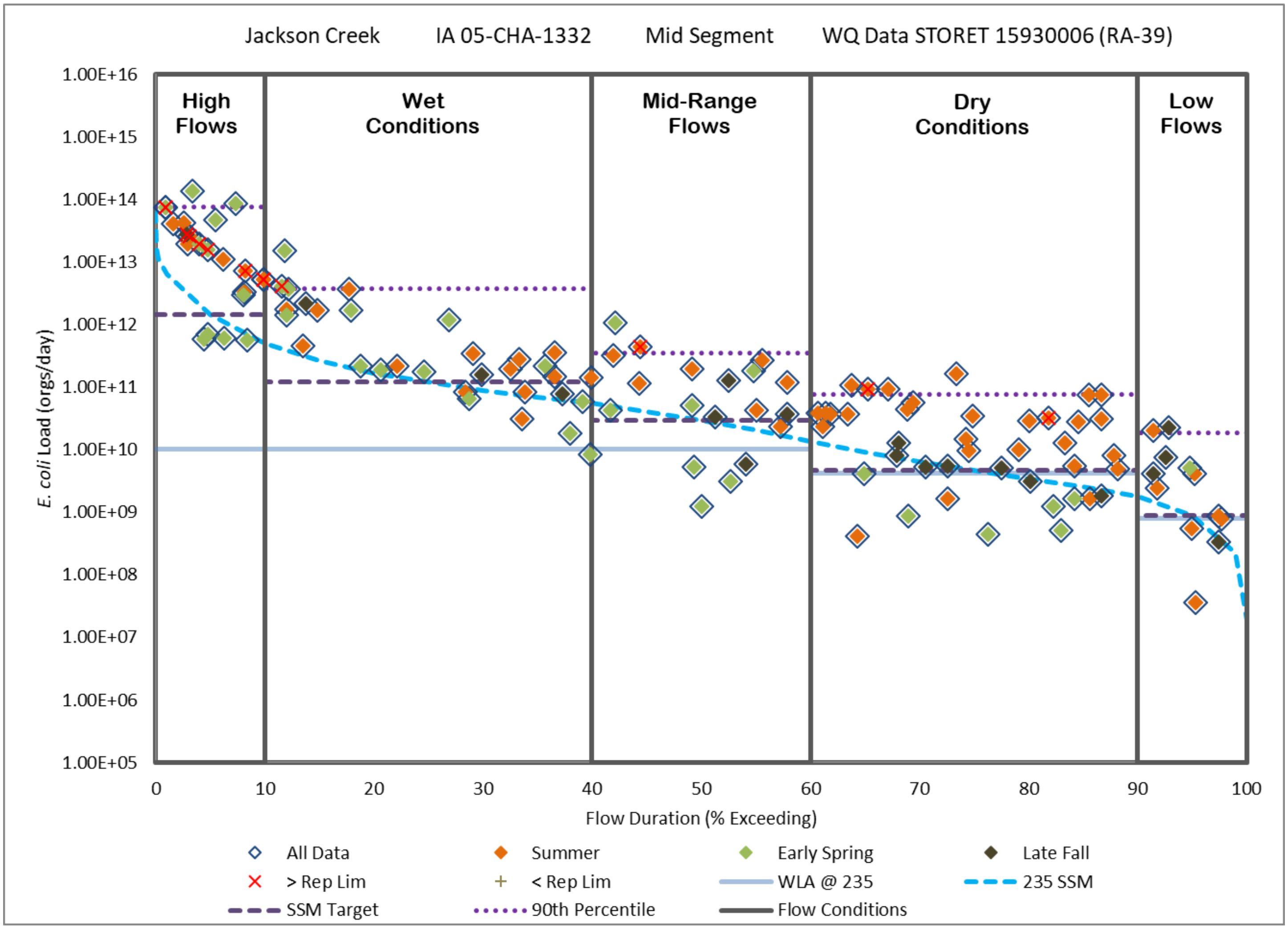

Figure 5.12. Load Duration Curve based on the SSM for IA 05-CHA-1332.

Table 5.13. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1332.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	7.44E+13	3.69E+12	3.45E+11	7.51E+10	1.88E+10
Capacity @ 235 orgs/100 ml (TMDL)	1.42E+12	1.21E+11	2.94E+10	4.74E+09	8.87E+08
SSM Departure (% Reduction)	7.30E+13 (98)	***3.57E+12 (97)***	3.15E+11 (91)	7.03E+10 (94)	1.79E+10 (95)
WLA(1)	1.01E+10	1.01E+10	1.01E+10	4.27E+09(1)	7.98E+08(1)
LA	1.27E+12	9.85E+10	1.63E+10	--	--
MOS	1.42E+11	1.21E+10	2.94E+09	4.74E+08	8.87E+07
Midpoint Flow (cfs)	247.5	21.0	5.1	0.83	0.154

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during the dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

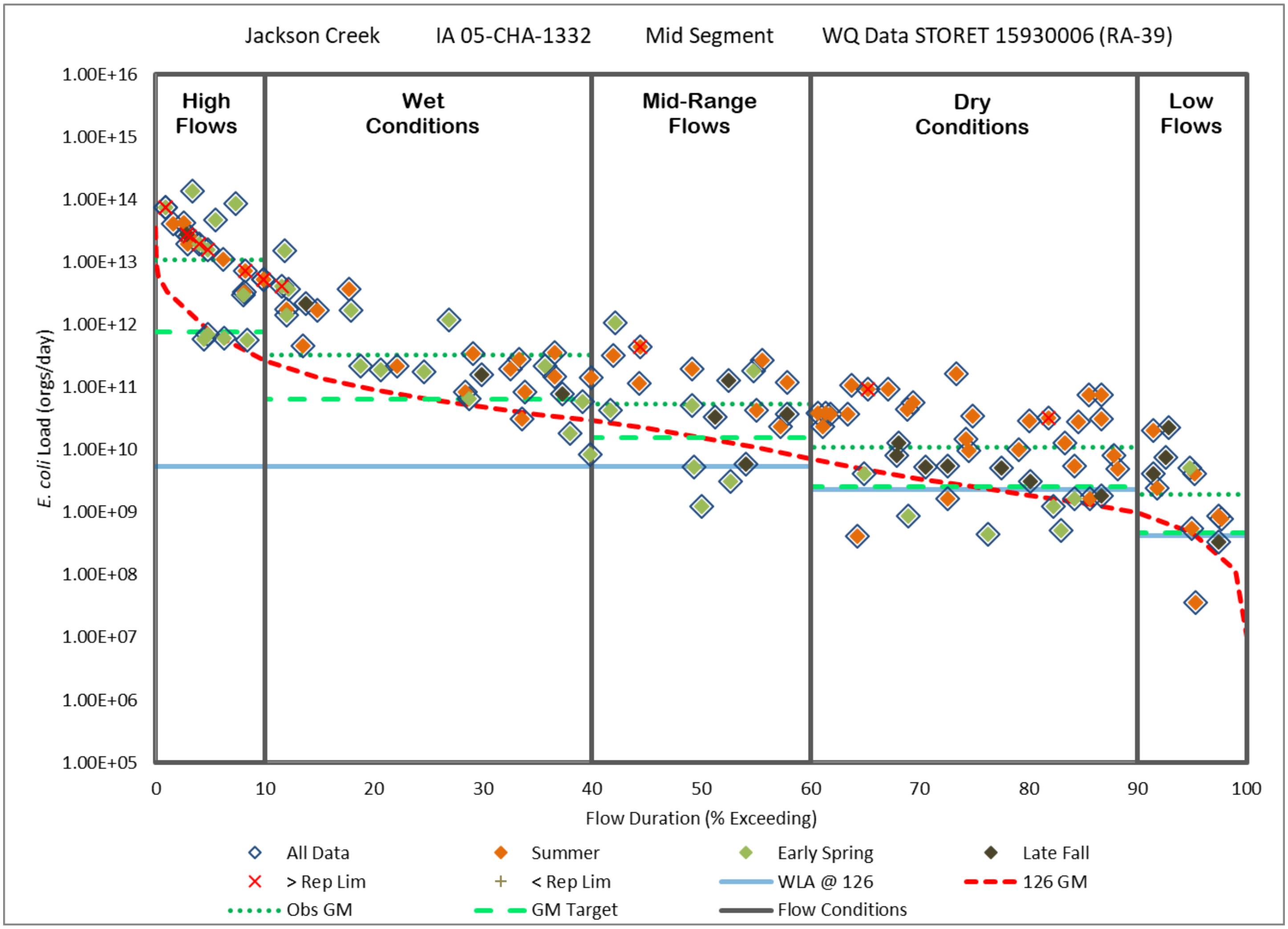

Figure 5.13. Load Duration Curve based on the GM for IA 05-CHA-1332.

Table 5.14. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1332.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.09E+13	3.22E+11	5.38E+10	1.07E+10	1.96E+09
Capacity @ 126 orgs/100 ml (TMDL)	7.63E+11	6.47E+10	1.58E+10	2.54E+09	4.76E+08
GM Departure (% Reduction)	1.01E+13 (93)	***2.57E+11 (80)***	3.81E+10 (71)	8.21E+09 (76)	1.48E+09 (76)
WLA(1)	5.42E+09	5.42E+09	5.42E+09	2.29E+09(1)	4.28E+08(1)
LA	6.81E+11	5.28E+10	8.76E+09	--	--
MOS	7.63E+10	6.47E+09	1.58E+09	2.54E+08	4.76E+07
Midpoint Flow (cfs)	247.5	21.0	5.1	0.83	0.154

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during the dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

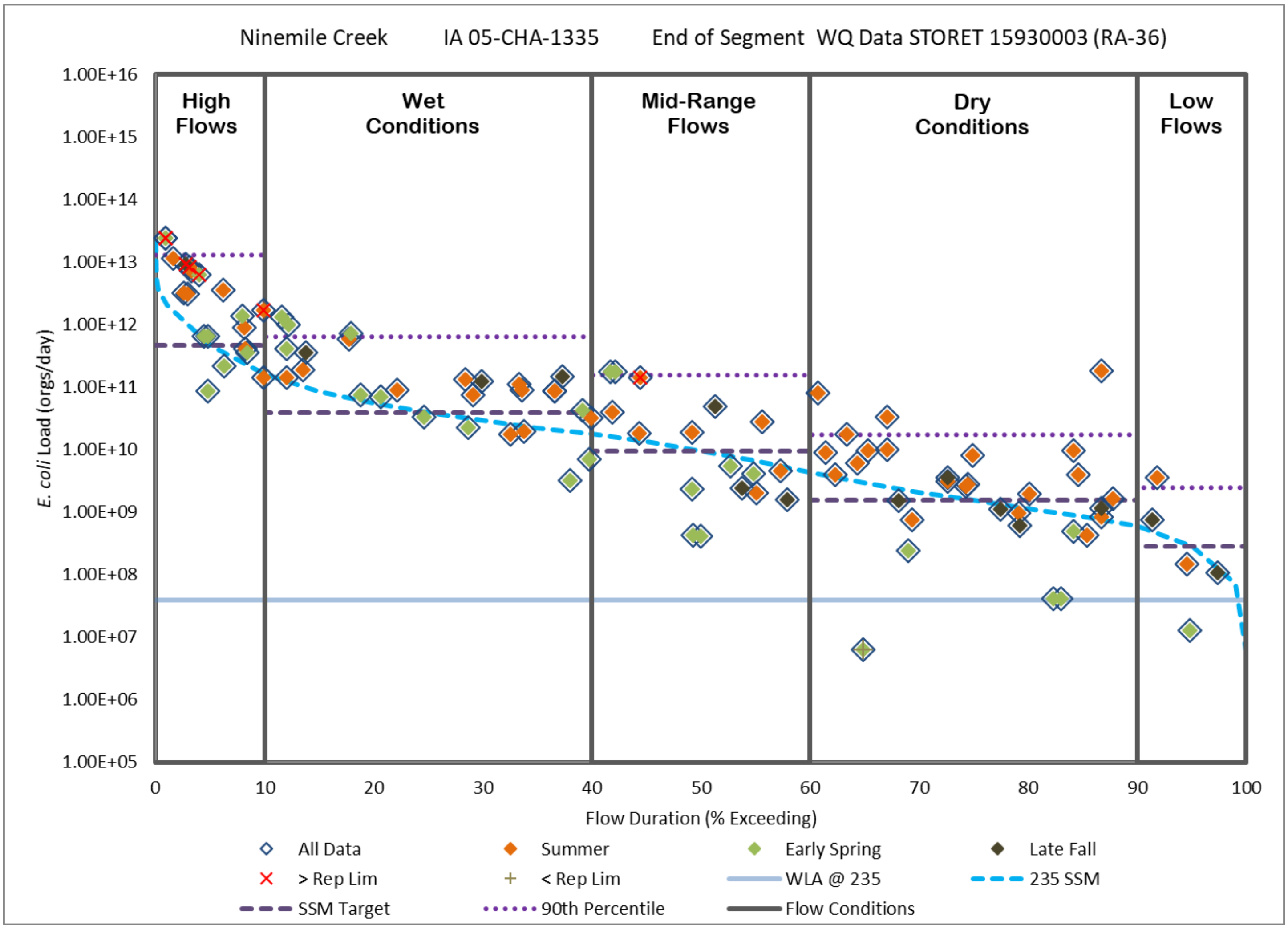

Figure 5.14. Load Duration Curve based on the SSM for IA 05-CHA-1335.

Table 5.15. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1335.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	1.27E+13	6.42E+11	1.53E+11	1.74E+10	2.45E+09
Capacity @ 235 orgs/100 ml (TMDL)	4.61E+11	3.91E+10	9.52E+09	1.54E+09	2.87E+08
SSM Departure (% Reduction)	1.22E+13 (96)	***6.03E+11 (94)***	***1.44E+11 (94)***	1.59E+10 (91)	2.16E+09 (88)
WLA	3.91E+07	3.91E+07	3.91E+07	3.91E+07	3.91E+07
LA	4.15E+11	3.52E+10	8.53E+09	1.34E+09	2.20E+08
MOS	4.61E+10	3.91E+09	9.52E+08	1.54E+08	2.87E+07
Midpoint Flow (cfs)	80.2	6.8	1.7	0.27	0.050

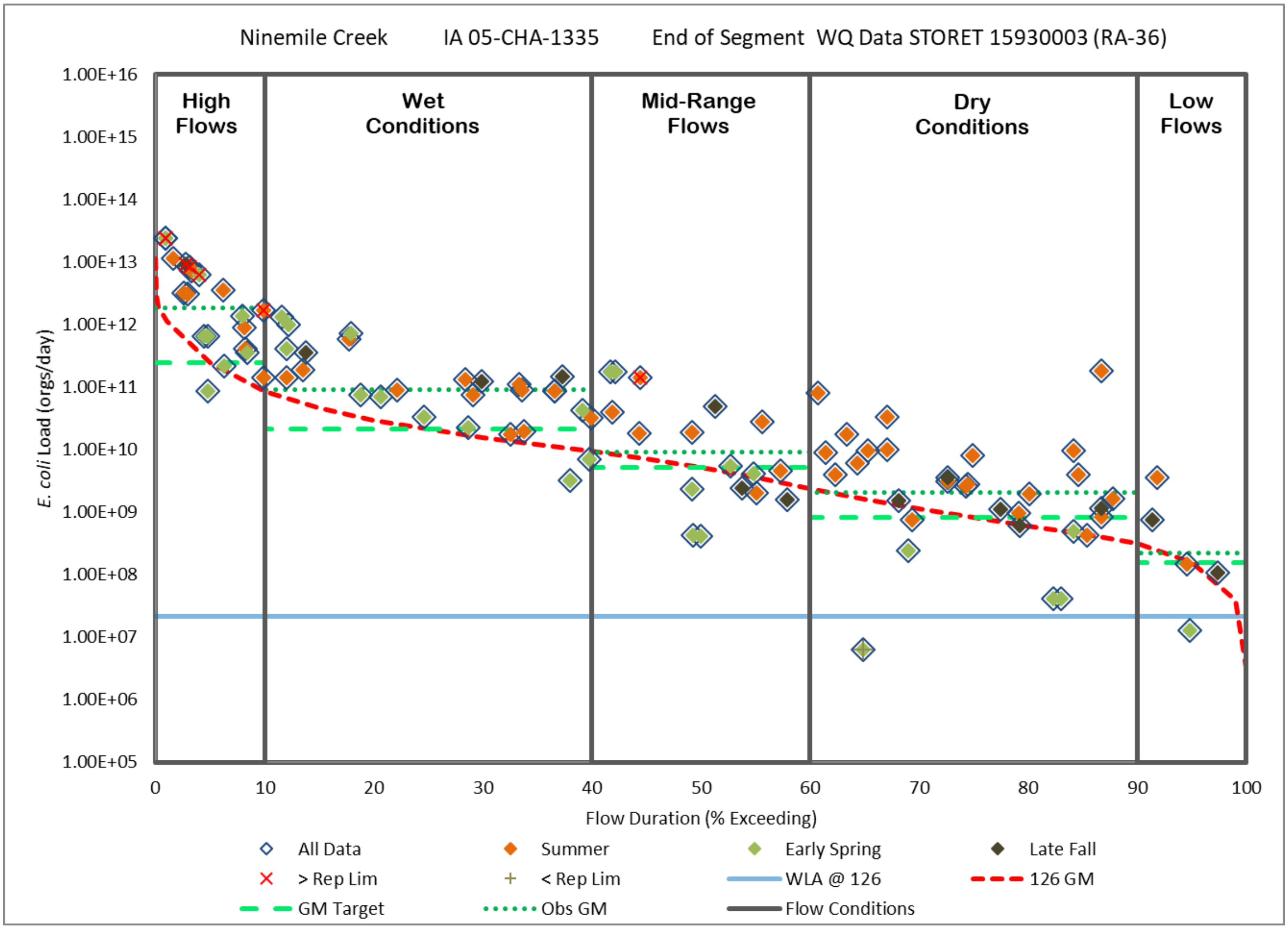

Figure 5.15. Load Duration Curve based on the GM for IA 05-CHA-1335.

Table 5.16. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1335.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	1.86E+12	9.14E+10	9.16E+09	2.05E+09	2.23E+08
Capacity @ 126 orgs/100 ml (TMDL)	2.47E+11	2.10E+10	5.11E+09	8.24E+08	1.54E+08
GM Departure (% Reduction)	1.62E+12 (87)	***7.04E+10 (77)***	4.05E+09 (44)	1.23E+09 (60)	6.87E+07 (31)
WLA	2.10E+07	2.10E+07	2.10E+07	2.10E+07	2.10E+07
LA	2.23E+11	1.89E+10	4.57E+09	7.21E+08	1.18E+08
MOS	2.47E+10	2.10E+09	5.11E+08	8.24E+07	1.54E+07
Midpoint Flow (cfs)	80.2	6.8	1.7	0.3	0.05

5.4 TMDL Summary

The following equation represents the total maximum daily load (TMDL) and its components for the impaired segments of the Wolf Creek-Chariton River HUC 10:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where: TMDL = total maximum daily load
LC = loading capacity
∑ WLA = sum of wasteload allocations (point sources)
∑ LA = sum of load allocations (nonpoint sources)
MOS = margin of safety (to account for uncertainty)

Once the loading capacity, wasteload allocations, load allocations, and margin of safety have all been determined, the general equation above can be expressed for each segment and flow condition for *E. coli* as the allowable maximum daily load (Table 5.17) as required by EPA (see Appendix D).

Table 5.17. TMDL Summary by Impaired Segment for the South Fork Chariton River HUC 10.

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
South Fork Chariton River (IA 05-CHA-1327)					
SSM	High Flow	1.64E+12	0.00E+00	1.48E+12	1.64E+11
	Wet	1.39E+11	0.00E+00	1.25E+11	1.39E+10
	Average	3.39E+10	0.00E+00	3.05E+10	3.39E+09
	Dry	5.47E+09	0.00E+00	4.93E+09	5.47E+08
	Low Flow	1.02E+09	0.00E+00	9.21E+08	1.02E+08
GM	High Flow	8.80E+11	0.00E+00	7.92E+11	8.80E+10
	Wet	7.46E+10	0.00E+00	6.72E+10	7.46E+09
	Average	1.82E+10	0.00E+00	1.64E+10	1.82E+09
	Dry	2.94E+09	0.00E+00	2.64E+09	2.94E+08
	Low Flow	5.49E+08	0.00E+00	4.94E+08	5.49E+07
South Fork Chariton Creek (IA 05-CHA-1328)					
SSM	High Flow	1.07E+12	0.00E+00	9.63E+11	1.07E+11
	Wet	9.07E+10	0.00E+00	8.17E+10	9.07E+09
	Average	2.21E+10	0.00E+00	1.99E+10	2.21E+09
	Dry	3.57E+09	0.00E+00	3.21E+09	3.57E+08
	Low Flow	6.67E+08	0.00E+00	6.00E+08	6.67E+07
GM	High Flow	5.74E+11	0.00E+00	5.16E+11	5.74E+10
	Wet	4.86E+10	0.00E+00	4.38E+10	4.86E+09
	Average	1.18E+10	0.00E+00	1.07E+10	1.18E+09
	Dry	1.91E+09	0.00E+00	1.72E+09	1.91E+08
	Low Flow	3.58E+08	0.00E+00	3.22E+08	3.58E+07

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
Walker Branch (IA 05-CHA-1329)					
SSM	High Flow	4.22E+11	1.42E+07	3.80E+11	4.22E+10
	Wet	3.58E+10	1.42E+07	3.22E+10	3.58E+09
	Average	8.71E+09	1.42E+07	7.82E+09	8.71E+08
	Dry	1.41E+09	1.42E+07	1.25E+09	1.41E+08
	Low Flow	2.63E+08	1.42E+07	2.22E+08	2.63E+07
GM	High Flow	2.26E+11	7.63E+06	2.03E+11	2.26E+10
	Wet	1.92E+10	7.63E+06	1.72E+10	1.92E+09
	Average	4.67E+09	7.63E+06	4.19E+09	4.67E+08
	Dry	7.54E+08	7.63E+06	6.71E+08	7.54E+07
	Low Flow	1.41E+08	7.63E+06	1.19E+08	1.41E+07
Jordan Creek (IA 05-CHA-1330)					
SSM	High Flow	4.72E+11	4.27E+07	4.25E+11	4.72E+10
	Wet	4.00E+10	4.27E+07	3.60E+10	4.00E+09
	Average	9.74E+09	4.27E+07	8.72E+09	9.74E+08
	Dry	1.57E+09	4.27E+07	1.37E+09	1.57E+08
	Low Flow	2.94E+08	4.27E+07	2.22E+08	2.94E+07
GM	High Flow	2.53E+11	2.29E+07	2.28E+11	2.53E+10
	Wet	2.14E+10	2.29E+07	1.93E+10	2.14E+09
	Average	5.22E+09	2.29E+07	4.68E+09	5.22E+08
	Dry	8.43E+08	2.29E+07	7.36E+08	8.43E+07
	Low Flow	1.58E+08	2.29E+07	1.19E+08	1.58E+07
Jackson Creek (IA 05-CHA-1332)					
SSM	High Flow	1.42E+12	1.01E+10	1.27E+12	1.42E+11
	Wet	1.21E+11	1.01E+10	9.85E+10	1.21E+10
	Average	2.94E+10	1.01E+10	1.63E+10	2.94E+09
	Dry(1)	4.74E+09	**4.27E+09**	0.00E+00	4.74E+08
	Low Flow(1)	8.87E+08	**7.98E+08**	0.00E+00	8.87E+07
GM	High Flow	7.63E+11	5.42E+09	6.81E+11	7.63E+10
	Wet	6.47E+10	5.42E+09	5.28E+10	6.47E+09
	Average	1.58E+10	5.42E+09	8.76E+09	1.58E+09
	Dry(1)	2.54E+09	**2.29E+09**	0.00E+00	2.54E+08
	Low Flow(1)	4.76E+08	**4.28E+08**	0.00E+00	4.76E+07

	Flow Condition	TMDL (orgs/day)	WLA (orgs/day)	LA (orgs/day)	MOS (orgs/day)
Ninemile Creek (IA 05-CHA-1335)					
SSM	High Flow	4.61E+11	3.91E+07	4.15E+11	4.61E+10
	Wet	3.91E+10	3.91E+07	3.52E+10	3.91E+09
	Average	9.52E+09	3.91E+07	8.53E+09	9.52E+08
	Dry	1.54E+09	3.91E+07	1.34E+09	1.54E+08
	Low Flow	2.87E+08	3.91E+07	2.20E+08	2.87E+07
GM	High Flow	2.47E+11	2.10E+07	2.23E+11	2.47E+10
	Wet	2.10E+10	2.10E+07	1.89E+10	2.10E+09
	Average	5.11E+09	2.10E+07	4.57E+09	5.11E+08
	Dry	8.24E+08	2.10E+07	7.21E+08	8.24E+07
	Low Flow	1.54E+08	2.10E+07	1.18E+08	1.54E+07

(1) The WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment during dry and low flow conditions. The WLA is assigned the TMDL target value less 10% of the TMDL target value.

6. TMDLs Cooper Creek - Chariton River for Indicator Bacteria (*E. coli*)

A Total Maximum Daily Load (TMDL) is required for the Cooper Creek - Chariton River segment (IA 05-CHA-1308) by the Federal Clean Water Act. This section of the Water Quality Improvement Plan (WQIP) describes the pollutant, in this case Escherichia coli (*E. coli*), leading to the impairments and the maximum amount of *E. coli* the stream segments can assimilate and still support their designated uses.

6.1 Problem Identification

The primary contact recreation (Class A1) uses in two segments of the Chariton River downstream of Rathbun Lake are not supported due to the presence of high levels of indicator bacteria (*E. coli*) (Figure 6.1). High *E. coli* levels in a waterbody can indicate the presence of potentially harmful bacteria and viruses (also called pathogens). Humans can become ill if they come into contact with and/or ingest water that contains pathogens. Under Iowa Administrative Code, streams are impaired for *E. coli* if they exceed a single sample maximum of 235 colony forming units (cfu) per 100 ml of water and the geometric mean of all samples exceeds 126 cfu/100 ml of water. This standard is only applicable during the recreation season, defined as March 15 through November 15.

Both point and nonpoint sources of pollution can be responsible for high *E. coli* levels. Permitted sources include municipal wastewater treatment facilities (WWTF) and discharging onsite wastewater treatment and disposal systems. Onsite wastewater treatment systems are often called septic systems, even though not all systems include a septic tank. Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include cattle with direct access to streams, manure applied to row crops, non-permitted onsite wastewater systems, and natural sources such as wildlife.

Stream Segment Designations and Descriptions

Two stream segments within the Cooper Creek - Chariton River HUC 10 do not meet water quality standards (WQS) and are not fully supporting class A1 (primary contact) designated uses due to presence of high levels of indicator bacteria called *Escherichia coli* (*E. coli*). Prior to 2008, none of the listed segments were designated for primary contact recreation (Class A1). In February 2008, changes to Iowa's surface water classifications were approved by the EPA and all segments were now presumed to be Class A1, primary contact recreation. Table 6.1 is a summary of the impaired stream segments, segment identification, location description, segment length, and designated uses.

Table 6.1. Impaired Stream Segment and Designated Uses.

Stream name	Segment ID	Location Description	Stream Length (MI)	Designated Uses	Impairment Category(1)
Chariton River	IA 05-CHA-1307	from the Iowa/Missouri State line to the Highway 2 crossing in S27, T69N, R17W, Appanoose Co.	13.51	A1 B (WW1) HH (Human Health)	5a
Chariton River	IA 05-CHA-1308	from the Highway 2 crossing (S27, T69N, R17W, Appanoose Co.) to Rathbun Dam in S35, T69N, R18W, Appanoose Co.	17.1	A1 B (WW1) C (Drinking Water) HH (Human Health)	5a

(1) Impairment category: 5a (pollutant-caused impairment. TMDL needed)

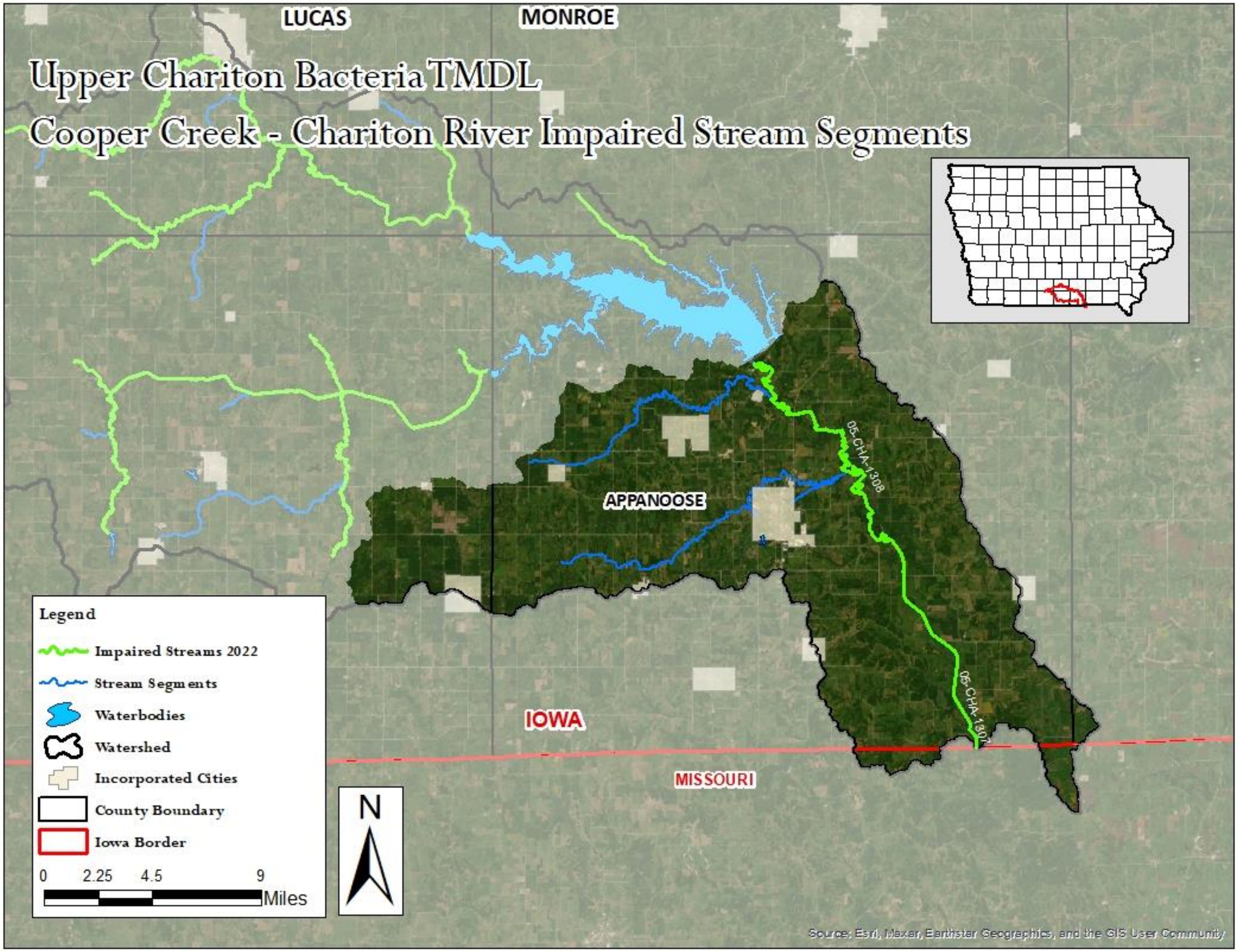

Figure 6.1. Map of the Cooper Creek - Chariton River HUC 10 with Impaired Stream Segments.

Problem Statement

Water quality assessments indicate that primary contact recreation is "not supported" in this segment due to high levels of indicator bacteria (*E. coli*) that routinely violate the state's water quality standards (Table 6.2). The significance of the impairments noted in the assessments is that desirable recreational activities, such as swimming and wading, are not adequately provided by existing water quality in the impaired segment. As a result of these findings, the Federal Clean Water Act requires that TDMLs be developed for all the impaired segments for *E. coli*.

Table 6.2. Impairment Criteria for the Impaired Segment.

Stream name	Segment ID	Geometric mean (impairment at 126 cfu/100 ml)			Single Sample Max. (235 cfu/100 ml)
		2010	2011	2012	% samples exceeding
Chariton River	IA 05-CHA-1307	31	83	235	21%
Chariton River	IA 05-CHA-1308	31	83	235	21%

Stream segment IA 05-CHA-1307 was originally included on the 303(d) list in 2016. This segment does not have any monitoring stations associated with it however, it is listed as impaired since the upstream segment (IA 05-CHA-1308) is impaired for *E. coli* and the adjacent downstream segment, which is located in Missouri, is impaired *E. coli* also. The explanation for assessing this as "not supported" states:

> "The Class A1 use was assessed as "not supported" due to identification of an impairment for indicator bacteria *(E. coli)* in the adjacent downstream segment by the Missouri Department of Natural Resources. This bacteria impairment covers the entire length of the Chariton River in Missouri. The bacterial impairment for the upper portion of the Chariton River in Missouri was based, in part, on data for *E. coli* from the DNR monitoring station downstream from Rathbun Dam (Station 10040001). Thus, identification of an IR Category 5a impairment for the Iowa segment of the river adjacent to Missouri is justified. A TMDL for the bacterial impairment on the Missouri portion of the Chariton River was approved by EPA in December 2010." (https://programs.iowadnr.gov/adbnet/Segments/1307/Assessment/2022).

Data Sources

Sources of data used in the development of this TMDL include those used in the 2012 305(b) report, several sources of additional flow and water quality data, and non-water quality related data used for model development. Monitoring sites are listed in Table 6.3 and shown in Figure 6.2. Specific data includes:

- Precipitation and temperature data from the National Weather Service Cooperative Observer Program (NWS COOP) (IEM, 2015)
- Precipitation and temperature data from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) (NOAA, 2015)
- 10-m Digital Elevation Model (DEM) available from DNR GIS library
- SSURGO soils data maintained by United States Department of Agriculture -Natural Resource Conservation Service (USDA-NRCS)
- U.S. Department of Agriculture National Agricultural Statistics Service Cropland Data Layer (CDL) reflecting 2006 conditions (USDA-NASS, 2013)
- Aerial images (various years) collected and maintained by DNR

Table 6.3 WQ Monitoring Sites of Cooper Creek – Chariton River HUC 10.

Site Name(1	Date Range	ID	Longitude	Latitude
Chariton River near Centerville)	1998-2013	STORET 10040001	-92.8580	40.7904
Chariton River at 561st St.	2014-present	STORET 10040002	-92.8823	40.8105

(1) Location changed to STORET 10040002 after 2013 sampling season due to safety concerns at 10040001.

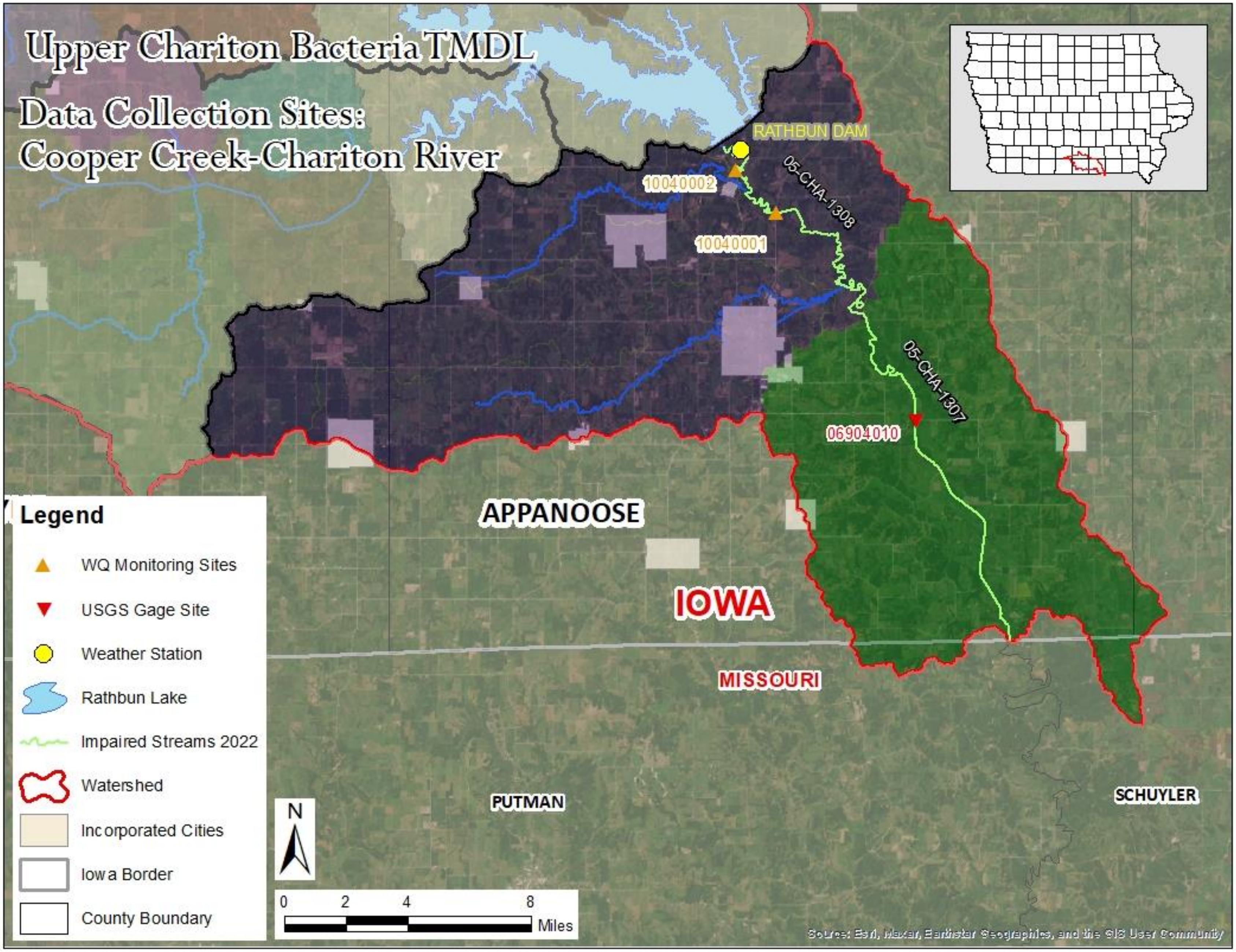

Figure 6.2. Data Sources Cooper Creek-Chariton River HUC-10.

Interpreting the Data
Analysis of the data shows consistently high *E. coli* levels that significantly exceed both criteria set for in Iowa's water quality standards for primary contact recreation. Significant reductions in *E. coli* loading will be required to comply with the standards and fully support the designated recreational use in the impaired segments.

6.2 Pollution Source Assessment

Identification of Pollutant Sources
There are a variety of *E. coli* sources in the Cooper Creek - Chariton River watershed. These sources can be divided into two categories, point and non-point sources. Point sources include municipal and industrial wastewater treatment facilities (WWTFs), sanitary sewer overflows (SSOs), onsite wastewater systems with permitted discharges, and animal feeding operations (AFOs) regulated as concentrated animal feeding operations (CAFOs). Nonpoint sources include wildlife, manure application to row crops, grazing livestock and small feeding operations, direct deposition by livestock in streams, and non-permitted (i.e., non-discharging) onsite wastewater systems.

Load duration curves (LDCs) were used in the development of *E. coli* TMDLs for impaired stream segments in the Cooper Creek - Chariton River Watershed (Section 6.3). The use of LDCs is helpful for understanding the importance that hydrology plays on pollutant loading. Information illustrated in LDCs provides a basic understanding of the importance of potential pollutant sources, although the approach does not offer explicit calculation of source-specific pollutant loads. However, when analyzed in conjunction with a detailed inventory of sources, LDCs can provide a quantitative means of comparing the relative importance of specific pollutant sources.

Point Sources
There are a total of eight active NPDES permits for waste water treatment facilities (WWTF) in the impaired segment of the Chariton River. In addition, there are four unsewered communities and one General Permit #4. There are no CAFOs reaching the threshold of 1,000 animal units, therefore there are no permitted confinement facilities in the impaired segment. Figure 6.3 shows the locations of NPDES permitted wastewater facilities, concentrated animal feeding operations, unsewered communities, and private facilities that discharge under an NPDES General Permit #4 within the HUC 10 area. A full inventory of dischargers and their respective WLAs is provided in Appendix C.

Nonpoint Sources
The nonpoint sources of pathogen indicators include contributors that do not have localized points of release into a stream. In the watershed these sources are:

- Grazing animals / wildlife
- Direct deposition of manure in streams
- Land application and subsequent runoff of manure
- Developed / urban area runoff
- Faulty septic tank systems

Allowance for Increases in Pollutant Loads
There are four unsewered communities in the Cooper Creek - Chariton River HUC 10. A reserve wasteload allocation was calculated for each community and applied to the WLA for the associated segment. Appendix C.2 lists all the unsewered communities in the Upper Chariton watershed. Any new or expanded dischargers will be expected to meet the same end-of-pipe criterion (GM of 126 orgs/100 ml) as dischargers for which WLAs were calculated and included in this TMDL. New or expanded facilities meeting the end-of-pipe criterion will not cause or contribute to the impairment.

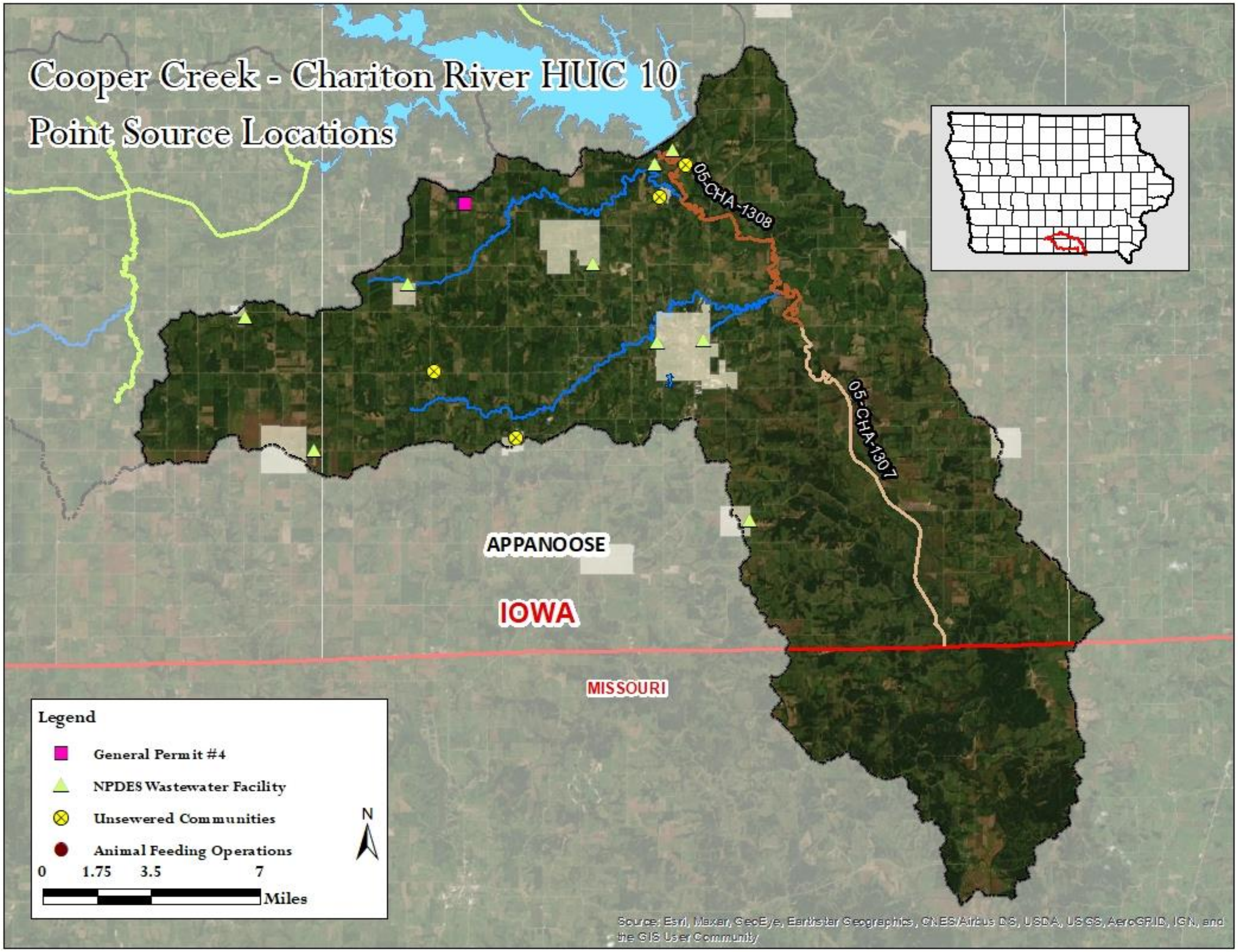

Figure 6.3. Map of the Cooper Creek - Chariton River Point Sources

6.3 Pollutant Allocation

Wasteload Allocation

A WLA was calculated for each wastewater treatment facility (WWTF) and an aggregate reserve WLA for unsewered communities in the watershed. Table 6.4 shows the aggregate WLA summary by facility type for the Cooper Creek – Chariton River watershed. Individual WLAs for each discharger are included in Appendix C.

Table 6.4. Wasteload Allocations for Cooper Creek - Chariton River HUC-10.

Facility Type	Number of Facilities	Flow (MGD)(1)	GM Conc (orgs/100 ml)	GM Load (orgs/day)	SSM Conc (orgs/100 ml)	SSM Load (orgs/day)
WWTF(2)	8	4.20	126	2.00E+10	235	3.73E+10
Unsewered	4	0.0261	126	1.24E+08	235	2.32E+08
GP #4(3)	1	0.00045	235	4.00E+06	235	4.00E+06
Totals	**13**	**4.22**	**--**	**2.01E+10**	**--**	**3.76E+10**

(1) Flows used to calculate the wasteload allocation. See Appendix C.
(2) SSM WLA's were calculated for assessment purposes to determine an appropriate LA (nonpoint source). As per IAC 567 62.8(2) daily sample maximum criteria for E coli shall not be used as an end-of-pipe limitation.
(3) General Permit #4, permitted for 235 orgs/100 ml in effluent discharge.

Load Allocation

Nonpoint sources result from livestock, pets, wildlife, and humans that live, work, and play in and around the stream. Specific examples of potential nonpoint sources of bacteria include animals directly depositing into streams, manure applied to row crops, manure runoff from grazed land, non-permitted onsite wastewater systems, and natural sources such as wildlife.

Margin of Safety

An explicit margin of safety (MOS) of 10 percent is applied to the calculation of loading capacities in this TMDL. The loading capacity for each segment is set equal to the appropriate water quality criteria (less 10 percent) with the goal of achieving the criteria at the sampling location. As a result, TMDLs do not consider dilution to meet WQS nor do they consider bacteria die-off and settling, which occur. Consequently, bacteria TMDLs are conservative.

Departure from Load Capacity and Critical Conditions

The LDC, observed load, and observed load for each flow condition are plotted in Figure 6.4 through Figure 6.7. This methodology enables calculation of a TMDL target at the midpoint of each flow condition for each impaired segment, as provided in Table 6.5 through Table 6.8. Figures and Tables are provided for both the SSM and GM criteria.

The critical condition for each TMDL in each table is highlighted in yellow with the departure and percent reduction also in bold font. The critical condition is the flow requiring the largest percent reduction. Typically, high and low flow conditions are not considered when selecting the critical condition because these flows are extreme and do not represent typical conditions (EPA, 2006). However, for both segments in this section, the percent reduction for the wet to dry conditions is zero (0) in the GM TMDL scenario. Consequently, the critical condition is simply selected as the flow condition requiring the largest percent reduction.

Load Duration Curve

Figure 6.4 and Figure 6.6 shows the load duration for the impaired stream segment in this watershed. Table 6.5 through Table 6.8 are the existing load estimates and the TMDL summary for each impaired segment.

Even though, both segments are impaired for GM and SSM it was not possible to calculate an existing GM load that exceeded the GM target within any of the flow regimes in the LDC, based on the data used in this WQIP. Consequently, the SSM target is used as the TMDL target for both criteria. This is possible because the SSM is protective of the GM as described in the subheading, *"Linkage Analysis"* in Section 3.2.

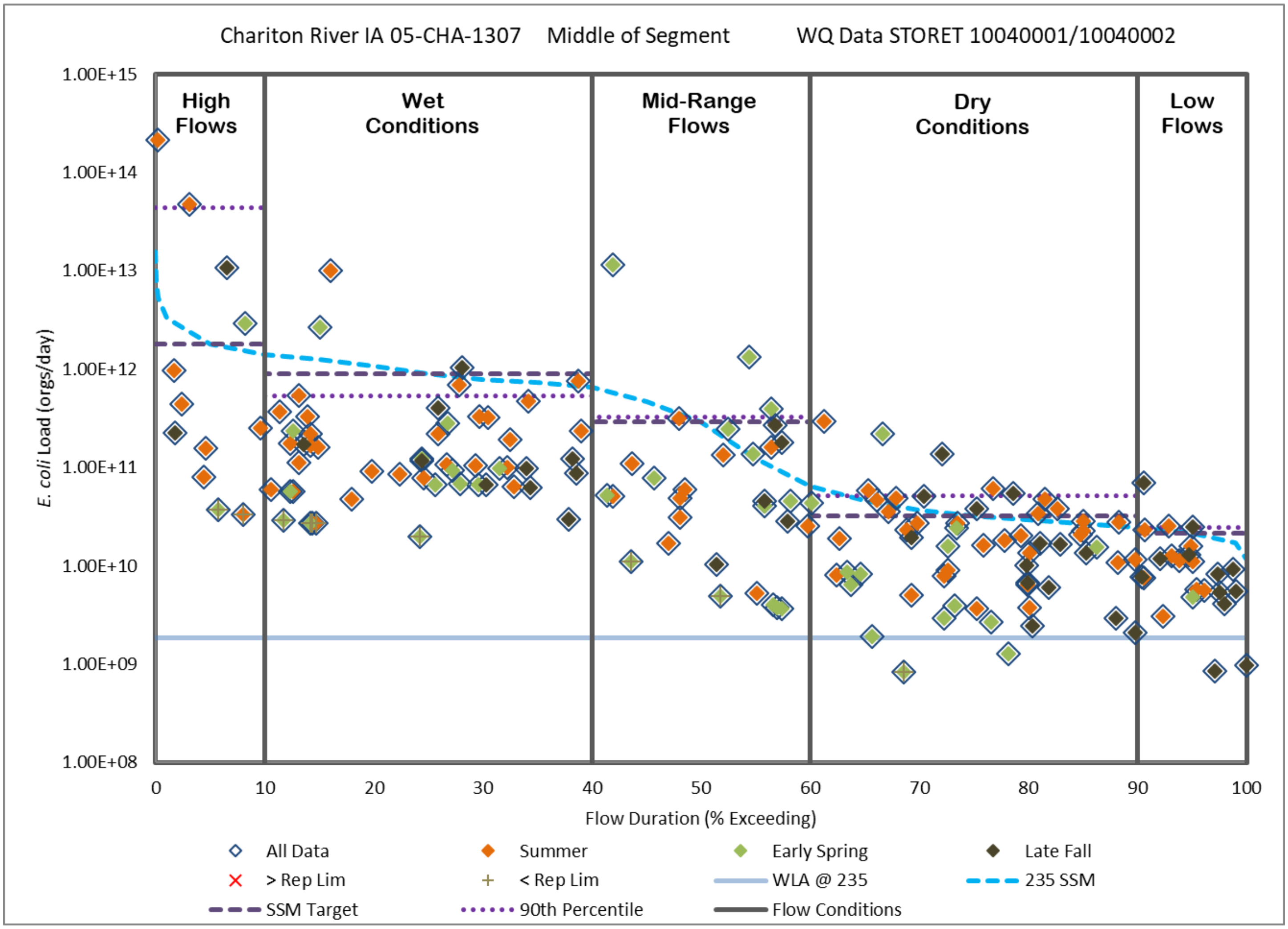

Figure 6.4. Load Duration Curve based on the SSM for IA 05-CHA-1307.

Table 6.5. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1307.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	4.38E+13	5.36E+11	3.22E+11	5.20E+10	2.45E+10
Capacity @ 235 orgs/100 ml (TMDL)	1.80E+12	8.86E+11	2.92E+11	3.21E+10	2.15E+10
SSM Departure (% Reduction)	4.20E+13 (96)	-3.50E+11 (0)	3.08E+10 (10)	**1.99E+10 (38)**	2.93E+09 (12)
WLA	1.83E+09	1.83E+09	1.83E+09	1.83E+09	1.83E+09
LA	1.62E+12	7.96E+11	2.61E+11	2.70E+10	1.75E+10
MOS	1.80E+11	8.86E+10	2.92E+10	3.21E+09	2.15E+09
Midpoint Flow (cfs)	312.6	154.1	50.7	5.58	3.74

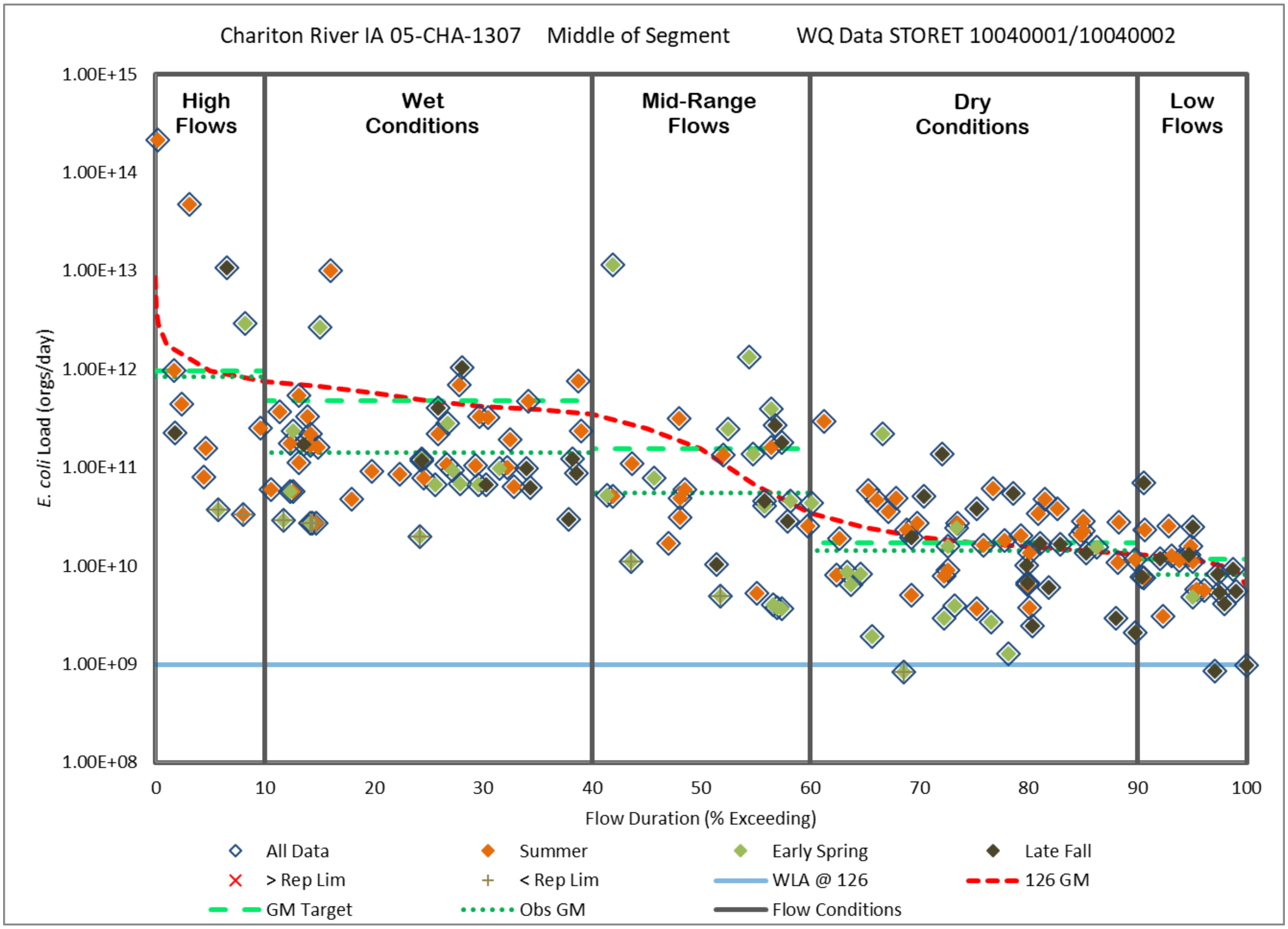

Figure 6.5. Load Duration Curve based on the GM for IA 05-CHA-1307.

Table 6.6. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1307.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	8.37E+11	1.41E+11	5.55E+10	1.44E+10	8.09E+09
Capacity @ 126 orgs/100 ml (TMDL)	9.64E+11	4.75E+11	1.56E+11	1.72E+10	1.15E+10
GM Departure (% Reduction)	-1.27E+11 (0)	-3.34E+11 (0)	-1.01E+11 (0)	-2.81E+09 (0)	-3.44E+09 (0)
WLA	9.83E+08	9.83E+08	9.83E+08	9.83E+08	9.83E+08
LA	8.66E+11	4.27E+11	1.40E+11	1.45E+10	9.40E+09
MOS	9.64E+10	4.75E+10	1.56E+10	1.72E+09	1.15E+09
Midpoint Flow (cfs)	312.6	154.1	50.7	5.6	3.74

Figure 6.6. Load Duration Curve based on the SSM for IA 05-CHA-1308.

Table 6.7. Existing Load Estimates, Departures, and TMDLs Summary based on the SSM for IA 05-CHA-1308.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
90th Percentile	2.90E+14	3.55E+12	2.14E+12	3.44E+11	1.62E+11
Capacity @ 235 orgs/100 ml (TMDL)	1.19E+13	5.87E+12	1.93E+12	2.13E+11	1.43E+11
SSM Departure (% Reduction)	2.79E+14 (96)	-2.32E+12 (0)	2.04E+11 (10)	**1.32E+11 (38)**	1.95E+10 (12)
WLA	3.57E+10	3.57E+10	3.57E+10	3.57E+10	3.57E+10
LA	1.07E+13	5.25E+12	1.70E+12	1.56E+11	9.26E+10
MOS	1.19E+12	5.87E+11	1.93E+11	2.13E+10	1.43E+10
Midpoint Flow (cfs)	2,071.9	1,021.3	336.1	36.96	24.80

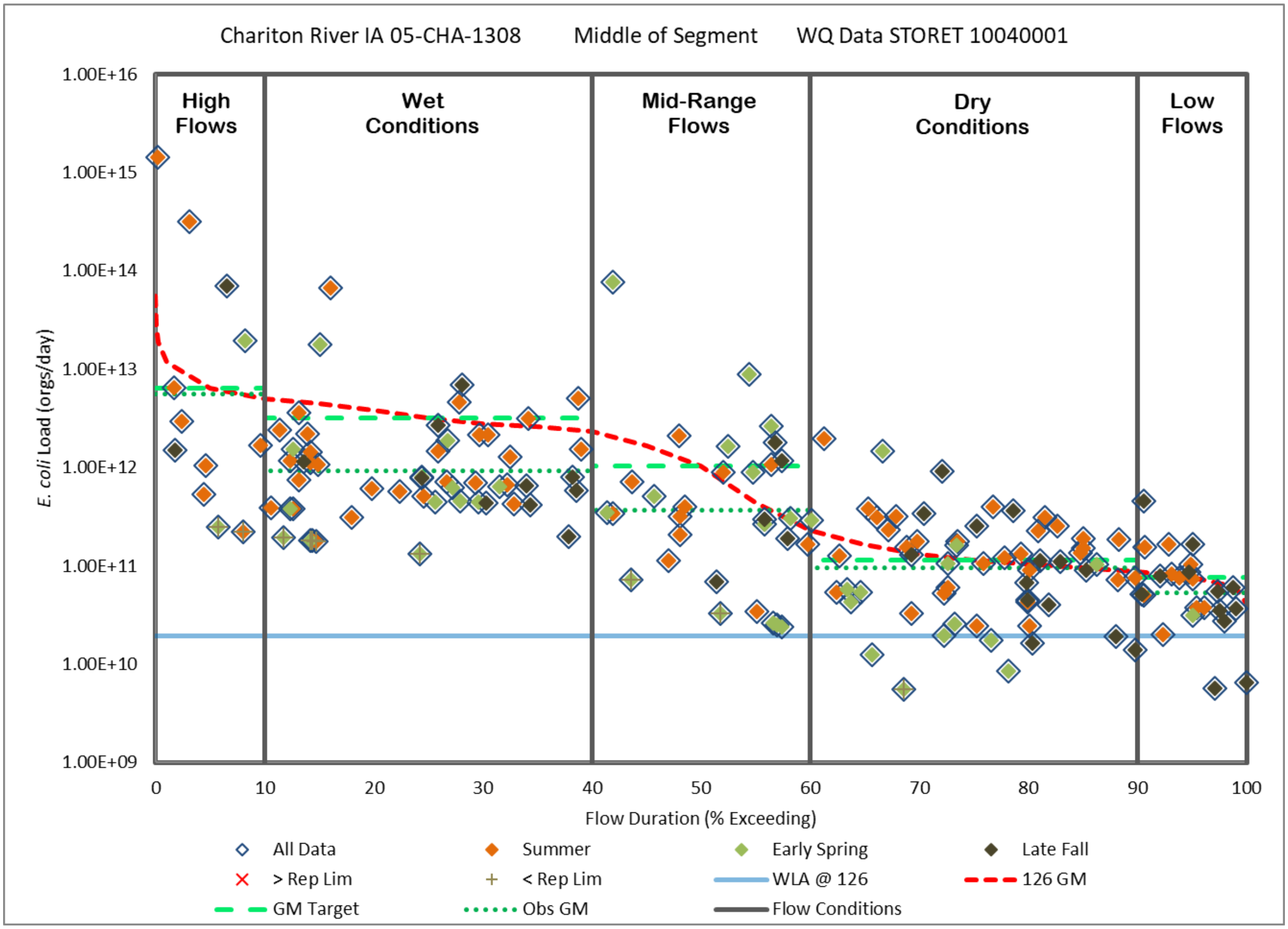

Figure 6.7. Load Duration Curve based on the GM for IA 05-CHA-1308.

Table 6.8. Existing Load Estimates, Departures, and TMDLs Summary based on the GM for IA 05-CHA-1308.

Load Summary	Loads (orgs/day)				
	High	Wet	Mid-Range	Dry	Low
Geometric Mean	5.55E+12	9.34E+11	3.68E+11	9.53E+10	5.36E+10
Capacity @ 126 orgs/100 ml (TMDL)	6.39E+12	3.15E+12	1.04E+12	1.14E+11	7.65E+10
GM Departure (% Reduction)	-8.40E+11 (0)	-2.21E+12 (0)	-6.68E+11 (0)	-1.86E+10 (0)	-2.28E+10 (0)
WLA	1.92E+10	1.92E+10	1.92E+10	1.92E+10	1.92E+10
LA	5.73E+12	2.81E+12	9.13E+11	8.34E+10	4.97E+10
MOS	6.39E+11	3.15E+11	1.04E+11	1.14E+10	7.65E+09
Midpoint Flow (cfs)	2,071.9	1,021.3	336.1	37.0	24.80

6.4 TMDL Summary

The following equation represents the total maximum daily load (TMDL) and its components for the impaired segment of the Chariton River:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

Where:

TMDL	= total maximum daily load
LC	= loading capacity
∑WLA	= sum of wasteload allocations (point sources)
∑LA	= sum of load allocations (nonpoint sources)
MOS	= margin of safety (to account for uncertainty)

Once the loading capacity, wasteload allocations, load allocations, and margin of safety have all been determined, the general equation above can be expressed for each segment and flow condition for *E. coli* as the allowable maximum daily load (Table 6.9) as required by EPA (see Appendix F).

Table 6.9. TMDL Summary by Flow Condition for the Chariton River.

	Flow Condition	TMDL (cfu/day)	WLA (cfu/day)	LA (cfu/day)	MOS (cfu/day)
Chariton River (IA 05-CHA-1307)					
SSM	High Flow	1.80E+12	1.83E+09	1.62E+12	1.80E+11
	Wet	8.86E+11	1.83E+09	7.96E+11	8.86E+10
	Average	2.92E+11	1.83E+09	2.61E+11	2.92E+10
	Dry	3.21E+10	1.83E+09	2.70E+10	3.21E+09
	Low Flow	2.15E+10	1.83E+09	1.75E+10	2.15E+09
GM	High Flow	9.64E+11	9.83E+08	8.66E+11	9.64E+10
	Wet	4.75E+11	9.83E+08	4.27E+11	4.75E+10
	Average	1.56E+11	9.83E+08	1.40E+11	1.56E+10
	Dry	1.72E+10	9.83E+08	1.45E+10	1.72E+09
	Low Flow	1.15E+10	9.83E+08	9.40E+09	1.15E+09
Chariton River (IA 05-CHA-1308)					
SSM	High Flow	1.19E+13	3.57E+10	1.07E+13	1.19E+12
	Wet	5.87E+12	3.57E+10	5.25E+12	5.87E+11
	Average	1.93E+12	3.57E+10	1.70E+12	1.93E+11
	Dry	2.13E+11	3.57E+10	1.56E+11	2.13E+10
	Low Flow	1.43E+11	3.57E+10	9.26E+10	1.43E+10
GM	High Flow	6.39E+12	1.92E+10	5.73E+12	6.39E+11
	Wet	3.15E+12	1.92E+10	2.81E+12	3.15E+11
	Average	1.04E+12	1.92E+10	9.13E+11	1.04E+11
	Dry	1.14E+11	1.92E+10	8.34E+10	1.14E+10
	Low Flow	7.65E+10	1.92E+10	4.97E+10	7.65E+09

7. Implementation Plan

An implementation plan is not a required component of a TMDL document but it is a useful and logical extension of TMDL development. It provides DNR staff, partners, and watershed stakeholders with a general idea of how a specific strategy and work plan can be developed. This strategy should guide stakeholders and the DNR in the development of a detailed and priority-based plan that implements best management practices, improves Upper Chariton River watershed water quality, and meets TMDL targets.

This water quality improvement plan sets targets for *E. coli* for the impaired segments of the Upper Chariton River watershed. Watershed stakeholders, including municipalities and agricultural interests, will need to participate in the implementation of bacteria controls and continuing evaluation to accomplish water quality improvement goals. It will take an ongoing effort to develop best management practices in the watershed through projects funded by a variety of water quality improvement programs.

As a start, it would be useful to create a local watershed advisory committee, where none exist, to help identify high priority areas where resources can be concentrated for the greatest effect. This would facilitate the organization and provide direction for monitoring specific stream sites to identify significant pollutant sources and to plan water quality improvement activities.

7.1 General Approach & Reasonable Timeline

Collaboration and action by watershed residents, landowners, producers, business owners, and local agencies will be required to improve water quality in the Upper Chariton River watershed to support designated uses. Locally-driven efforts have proven to be the most successful in obtaining real and significant water quality improvements. Each group has a stake in promoting awareness and educating others about the Upper Chariton River watershed, working together to adopt a comprehensive watershed improvement plan, and applying BMPs and land practice changes in the watershed. This large and diverse group of stakeholders provides the opportunity for an effective network of partnerships to be built.

General Approach

The existing loads, loading targets and allocations, and a general menu of potential BMPs needed to improve water quality are provided in this Water Quality Improvement Plan (WQIP). The TMDL must be followed by the development of a locally-led watershed management planning process. The watershed plan should include:

- A more comprehensive and detailed assessment of potential nonpoint pollutant sources that shows the source location, magnitude, and relative impact based on proximity to streams and runoff controls in place.
- Continued monitoring to better understand and document bacteria sources.
- Application of watershed and water quality models to provide information on which best management practices will have the most impact and where they can be most effectively deployed.
- Assessment of water quality trends.
- Assessment of water quality standards (WQS) attainment.

A phased approach to improving water quality is recommended for the Upper Chariton River watershed. Sources of bacteria, both large and small, must be reduced. However, the largest and most identifiable sources of bacteria should be given highest priority and addressed first. Less significant and/or less understood sources can be addressed later as funding allows and new monitoring data increases stakeholder understanding of their impacts to water quality.

Timeline

Development of a comprehensive watershed management plan may take one to two years from the completion of the WQIP. Implementation of BMPs could take five to ten years, depending on funding, willingness of stakeholder participation, and time needed for design and construction of structural BMPs. Realization and documentation of water quality benefits may take an additional five to ten years, depending on weather patterns, amount of water quality data collected, and the successful location, design, construction, and maintenance of BMPs. Utilization of the monitoring plan outlined in Section 8 should begin as soon as possible to help identify undocumented bacteria sources and establish a baseline. Monitoring should continue throughout implementation of BMPs and beyond to document water quality improvement.

7.2 Best Management Practices

This section provides a general summary of BMPs applicable to bacteria reduction. It is not an all-inclusive list, and further investigation (during development of the watershed management plan) may suggest that some alternatives should be implemented in favor of others. An important task in development of the watershed management plan will be to identify additional water quality improvement BMPs (both structural and non-structural), as well as prioritize, locate, and schedule implementation of BMPs.

There are two general strategies for reducing pollutant loads: source control and in-drainage reduction. Source control strategies are usually non-structural practices related to the management of runoff or production and application of pollutants (e.g., manure, fertilizer, industrial products). As the name implies, source control strategies focus on stopping or reducing the pollution at its source. Examples of source control strategies for bacteria reduction are listed in Table 7.1.

Table 7.1. Example Source Control Strategies (BMPs).

Strategy/BMP	Examples
Livestock manure management	Storage and/or treatment facilities, disposal
Manure management	Manure storage and strategic application (location, timing, and methods).
Pasture management	Elimination of stream access, grazing rotation
Septic system improvements	Inspection/repair/replacement
Wildlife management activities	Population control (particularly for geese)
Highway/roadway cleanup	Street sweeping, road kill pickup programs
Pet waste management	Educational programs, local ordinances
Low impact development (LID)(1)	LID ordinances/practices for new development
Runoff reduction(1)	Disconnection of impervious areas using rain barrels, porous pavement, rain gardens, etc.

(1) Some LID and runoff reduction strategies could be considered either source control or in-line drainage reduction.

In-drainage reduction strategies usually involve the use of structural BMPs to eliminate or reduce pollutants by intercepting and/or treating them within the drainage system using physical, chemical, or biological processes. Examples of in-drainage BMPs are provided in Table 7.2, along with their respective removal mechanisms.

Table 7.2. Example In-Drainage Strategies (BMPs).

Strategy/BMP	Removal Mechanism(s)(1)
Constructed wetlands	UV exposure, settling, predation
Wet detention ponds	UV exposure, settling, predation
Dry detention basin	UV exposure, settling, drying
Vegetated filter strips	Filtration, infiltration
Riparian buffers	Exclusion from stream, filtration, infiltration
Sand filters	Filtration
Infiltration trenches	Infiltration
Bioswales/bioretention	UV exposure, settling, infiltration, drying
Proprietary stormwater treatment systems(2)	Varies with device - usually settling and/or filtration

(1) Modified from North Carolina Cooperative Extension Service, 2008.
(2) Examples include hydrodynamic devices, gravity separators, and catch basin inserts.

Estimated bacteria removal efficiencies associated with the various source control BMPs are provided in Table 7.3.

Table 7.4 lists removal rates associated with in-drainage BMPs. Note that these rates are highly variable. Rates listed in Table 7.3 and Table 7.4 assume that the BMP is properly designed, implemented, and maintained. Additionally, these rates apply only to the specific source of bacteria they treat, not the overall reduction. These removal rates must be applied with caution on a case-by-case basis to avoid overestimating potential water quality improvements.

Because of the large reductions required for attainment of WQS in Upper Chariton River watershed and the highly variable nature of observed concentrations and removal, a combination of source control and in-drainage BMPs will be necessary. Additionally, many in-drainage BMPs function better when multiple systems are implemented in series. For example, grass bioswales may convey runoff to a vegetated filter strip before flows reach a constructed wetland. This type of treatment train approach offers the advantage of multiple removal mechanisms and built in redundancy to increase the reliability of bacteria reduction. The watershed management plan developed for the Upper Chariton River watershed should consider the use of treatment train approaches wherever possible.

Table 7.3. Source Control BMPs and Estimated Bacteria Removal Rates.

BMP	Removal (%)	Additional Comments
Manure injection	Up to 90(1)	Removal will vary with injection method, application rates, land slope, weather, and other variables. Injection can offer up to 90% reduction in bacteria transport when compared to surface application.
Manure export/disposal	Up to 100	Removing manure from the watershed would provide a 100% reduction from this source. However, if manure application is increased elsewhere, impacts to that watershed must be investigated.
Exclusion of livestock from streams	Up to 100	The removal associated with this practice is proportional to the percent of livestock that are excluded. If all livestock are excluded from streams at all times, then bacteria reduction from this source would be 100%.
Septic system improvements	Up to 100	Repair/replacement of all failing systems provides 100% reduction. Watershed wide removal rate would be proportional to the percent of failing systems fixed.
Wildlife management	Varies	If there are known areas of waterfowl populations (e.g., stormwater ponds), management of geese populations would provide some bacteria reductions. Removal rates would be proportional to population reduction.
Street sweeping	Up to 22(1)	Published literature contains conflicting information regarding potential bacteria reduction from street sweeping. This BMP should not be relied upon as a key part of the implementation strategy, but may help reduce bacteria loads in highly pervious urban areas.
Pet waste management	Up to 75(1)	Includes information and education programs regarding the importance of picking up after your pets. Could include the adoption of local ordinances.
LID and runoff reduction BMPs	Varies	Proportional to the amount of runoff reduction obtained. Some LID and runoff reduction measures are included as in-drainage BMPs in Table **7.4**.

(1) Source: VDEQ et al., 2009

Table 7.4. In-Drainage BMPs and Estimated Bacteria Removal Rates.

BMP	Removal (%)	Additional Comments
Constructed wetlands	78-99(2)(3)	Wetlands could act as a source if not properly designed or maintained, including management of potential waterfowl populations.
Wet detention ponds	44-99(2)(3)	Ponds could act as a source if not properly designed or maintained, including management of potential waterfowl populations.
Dry detention basins	Varies(2)(3)	Dry detention basins often act as a net source of bacteria and should not be considered reliable as stand-alone systems.
Vegetated filter strips	43-57(2)	Vegetated filter strips are flat or very gently sloped segments of land intended to "treat" inflows to the stream. Filter strips should be distinguished from riparian buffers, which offer less removal potential.
Riparian buffers	Up to 40(1)	The primary benefits of buffers are to "buffer" the stream from nearby land uses and activities, as the name suggests. Actual removal rates depend on the width of the buffer and the type and density of vegetation, as well as the portion of runoff that the buffer intercepts.
Sand filters	36-83(2)	Generally designed as part of the stormwater infrastructure to capture and treat the first flush of runoff from impervious surfaces.
Bioswales and bioretention	69-99(1)(2)(3)	Includes rain gardens. Should be used with caution or avoided in areas where possible groundwater contamination is a concern.
Pervious concrete; porous asphalt	30-65(4)	Requires careful design and construction and is only feasible in areas with adequate soil infiltration rates (at least 0.5 inches/hour).
Permeable pavers	65-100(4)	Similar to pervious concrete and porous asphalt. Utilizes pre-cast permeable blocks to infiltrate water. Adequate soil infiltration rates required.
Hydrodynamic devices	<30(4)	Type of proprietary stormwater treatment system.
Gravity separators	<30(4)	Type of proprietary stormwater treatment system.
Coagulation and/or flocculation	65-100(4)	Chemical treatment of stormwater. Usually implemented in conjunction with a stormwater pond. Offers high removal, but addition of coagulation/flocculation chemicals such as alum is required.

(1) Source: VDEQ et al., 2009
(2) Source: EPA, 2004
(3) Source: North Carolina Cooperative Extension Service, 2008
(4) Source: Iowa Stormwater Management Manual

8. Future Monitoring

Water quality monitoring is a critical element in assessing the current status of water resources and the historical trends. Furthermore, monitoring is necessary to track the effectiveness of water quality improvements made in the watershed and document the status of the waterbody in terms of achieving total maximum daily loads and water quality standards (WQS).

Future monitoring in the Upper Chariton River watershed can be agency-led, volunteer-based, or a combination of both. The Iowa Department of Natural Resources (DNR) Watershed Monitoring and Assessment Section administers a water quality monitoring program that provides training to interested volunteers. In January 2016, the DNR discontinued the IOWATER volunteer water monitoring program. However, volunteer water monitoring is still available. For those interested, more information can be found at the program website: http://www.iowadnr.gov/Environmental-Protection/Water-Quality/Water-Monitoring/Volunteer-Water-Monitoring.

It is important that volunteer-based monitoring efforts include an approved water quality monitoring plan, called a Quality Assurance Project Plan (QAPP), in accordance with Iowa Administrative Code (IAC) 567-61.10(455B) through 567-61.13(455B). The IAC can be viewed here: https://www.legis.iowa.gov/docs/iac/chapter/11-23-2016.567.61.pdf. Failure to prepare an approved QAPP will prevent data from being used to assess a waterbody's status on the state's 303(d) list - the list that assesses waterbodies and their designated uses as impaired.

Some of the monitoring projects that provided the data used to create this report are expected to be ongoing. Monitoring of Upper Chariton River watershed bacteria are expected to continue at the ISU/ACOE sites identified in this report. Data collected at all of these sites will continue to be used by the DNR for its biannual water quality assessments (305(b) report) of the Upper Chariton River watershed.

8.1 Monitoring Plan to Track TMDL Effectiveness

Given current resources and funding, future water quality data collection in the Upper Chariton River watershed to assess water quality trends and compliance with WQS will be limited. Unless there is local interest in collecting additional water quality data, it will be difficult to implement a watershed management plan and document TMDL effectiveness and water quality improvement with respect to bacteria.

As noted in the implementation plan, follow-up to this report requires stakeholder driven solutions and more effective management practices. Continued monitoring plays an important role in determining what practices result in load reductions and the attainment of WQS. Continued monitoring will:

- Assess the future beneficial use status;
- Determine if water quality is improving, getting worse, or staying the same;
- Evaluate the effectiveness of implemented best management practices.

Table 8.1 is an example monitoring plan.

Table 8.1. Example Monitoring Plan for Individual Segments.

Parameter(s)	Sampling Interval	Sampling Duration	Purpose
E. coli and flow	Weekly snapshot	Throughout recreation season (ongoing)	Evaluate ambient conditions
Microbial source tracking (MST)	Snapshot	At least two sampling events within recreation season. Consider one during high flow and one during low flow.	Determine the source(s) of *E. coli*
E. coli and flow (event sampling)	15-60 minutes	Throughout rising and falling limbs of hydrograph during at least two runoff events within recreation season.	Evaluate the importance of high flow conditions
E. coli and flow (dry weather sampling)	Snapshot	At least twice during low flow conditions within recreation season.	Evaluate the importance of low flow conditions

8.2 Idealized Plan for Future Watershed Projects

Future watershed improvement projects should be developed and implemented to help restore and protect water quality. If the watershed project is funded with incremental Clean Water Act Section 319 funds, the EPA requires that nine elements be addressed in the watershed plan and recommends that these nine elements be included in all other watershed plans funded through other sources (EPA, 2008). A summary of the nine elements follows. For a more detailed discussion of these elements see EPA, 2008.

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan.
2. An estimate of the load reductions expected from management measures.
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in item 2, and a description of the critical areas in which those measures will be needed to implement this plan.
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above.

Other elements that could be included in a watershed plan include, but not limited to the following:

- Complete a Use Attainability Assessment (UAA) on streams that have not been assessed. The UAA is used to determine what uses each stream can support and will help in prioritizing the streams to focus on.
- Evaluate and determine gaps in data and collecting additional data where necessary. This could include determining the location of sampling points; frequency of sampling; determining groups or individuals responsible for sampling, this could be private groups, federal, state, or local governmental agencies.
- Community education and involvement. While this was mentioned as one of the nine minimum elements it cannot be overstressed the importance to obtain local involvement.
- Review of funding availability and funding sources.
- Determination of the size or scope of the watershed plan. This report reviewed the impaired streams based on HUC-8 watershed. However, this is too large for local and community involvement. Planning should be based on a HUC-12 watershed or smaller.
- Determine the source of the impairment, point or nonpoint.
- Determine potential BMP’s for reducing and eliminating the impairment and modeling the BMP’s to identify the most efficient placement.

9. Public Participation

Public involvement is important in the TMDL process since it is the land owners, tenants, and citizens who directly manage land and live in the watershed that determine the water quality in the Upper Chariton River watershed. During the development of this TMDL, efforts were made to ensure that local stakeholders were involved in the decision-making process regarding goals and required actions for improving water quality in the Upper Chariton River watershed.

9.1 Public Meetings

Public Presentations

A virtual presentation was posted on the DNR's YouTube channel for public viewing on July 20, 2023. A link to the presentation can be located on the DNR's website at https://www.iowadnr.gov/environmental-protection/water-quality/watershed-improvement/water-improvement-plans. The presentation will be available for viewing through the public comment period.

9.2 Written Comments

A press release was issued in tandem with the posting of the presentation to the DNR's YouTube channel on July 20, 2023 to begin the 30-day public comment period which ends on August 21, 2023. All comments received by the DNR during the 30-day public comment period will be included in Appendix F.

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Appendix A - Glossary of Terms, Abbreviations, and Acronyms

303(d) list: Refers to section 303(d) of the Federal Clean Water Act, which requires a listing of all public surface waterbodies (creeks, rivers, wetlands, and lakes) that do not support their general and/or designated uses, also called the state's "Impaired Waters List."

305(b) assessment: Refers to section 305(b) of the Federal Clean Water Act, it is a comprehensive assessment of the state's public waterbodies' ability to support their general and designated uses. Those bodies of water which are found to be not supporting their uses are placed on the 303(d) list.

319: Refers to Section 319 of the Federal Clean Water Act, the Nonpoint Source Management Program. Under this amendment, States receive grant money from EPA to provide technical & financial assistance, education, & monitoring to implement local nonpoint source water quality projects.

AFO: Animal Feeding Operation. A lot, yard, corral, building, or other area in which animals are confined and fed and maintained for 45 days or more in any 12-month period, and all structures used for the storage of manure from animals in the operation. Open feedlots and confinement feeding operations are considered to be separate animal feeding operations.

AU: Animal Unit. A unit of measure used to compare manure production between animal types or varying sizes of the same animal. For example, one 1,000 pound steer constitutes one AU, while one mature hog weighing 200 pounds constitutes 0.2 AU.

Benthic: Associated with or located at the bottom (in this context, "bottom" refers to the bottom of streams, lakes, or wetlands). Usually refers to algae or other aquatic organisms that reside at the bottom of a wetland, lake, or stream (see periphyton).

Benthic macroinvertebrates: Animals larger than 0.5 mm that do not have backbones. These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. They include crayfish, mussels, snails, aquatic worms, and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

Base flow: Sustained flow of a stream in the absence of direct runoff. It can include natural and human-induced stream flows. Natural base flow is sustained largely by groundwater discharges.

Biological impairment: A stream segment is classified as biologically impaired if one or more of the following occurs, the FIBI and or BMIBI scores fall below biological reference conditions, a fish kill has occurred on the segment, or the segment has seen a > 50% reduction in mussel species.

Biological reference condition: Biological reference sites represent the least disturbed (i.e. most natural) streams in the ecoregion. The biological data from these sites are used to derive least impacted BMIBI and FIBI scores for each ecoregion. These scores are used to develop Biological Impairment Criteria (BIC) scores for each ecoregion. The BIC is used to determine the impairment status for other stream segments within an ecoregion.

BMIBI: Benthic Macroinvertebrate Index of Biotic Integrity. An index-based scoring method for assessing the biological health of streams and rivers (scale of 0-100) based on characteristics of bottom-dwelling invertebrates.

BMP: Best Management Practice. A general term for any structural or upland soil or water conservation practice. For example terraces, grass waterways, sediment retention ponds, reduced tillage systems, etc.

CAFO: Concentrated Animal Feeding Operation. A federal term defined as any animal feeding operation (AFO) with more than 1000 animal units confined on site, or an AFO of any size that discharges pollutants (e.g. manure, wastewater) into any ditch, stream, or other water conveyance system, whether man-made or natural.

CBOD5: 5-day Carbonaceous Biochemical Oxygen Demand. Measures the amount of oxygen used by microorganisms to oxidize hydrocarbons in a sample of water at a temperature of 20°C and over an elapsed period of five days in the dark.

CFU: A Colony Forming Unit is a cell or cluster of cells capable of multiplying to form a colony of cells. Used as a unit of bacteria concentration when a traditional membrane filter method of analysis is used. Though not necessarily equivalent to most probably number (MPN), the two terms are often used interchangeably.

Confinement feeding operation: An animal feeding operation (AFO) in which animals are confined to areas which are totally roofed.

Credible data law: Refers to 455B.193 of the Iowa Administrative Code, which ensures that water quality data used for all purposes of the Federal Clean Water Act are sufficiently up-to-date and accurate. To be considered "credible," data must be collected and analyzed using methods and protocols outlined in an approved Quality Assurance Project Plan (QAPP).

Cyanobacteria (blue-green algae): Members of the phytoplankton community that are not true algae but are capable of photosynthesis. Some species produce toxic substances that can be harmful to humans and pets.

Designated use(s): Refer to the type of economic, social, or ecological activities that a specific waterbody is intended to support. See Appendix B for a description of all general and designated uses.

DNR (or Iowa DNR): Iowa Department of Natural Resources.

Ecoregion: Areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources based on geology, vegetation, climate, soils, land use, wildlife, and hydrology.

EPA (or USEPA): United States Environmental Protection Agency.

Ephemeral gully erosion: Ephemeral gullies occur where runoff from adjacent slopes forms concentrated flow in drainage ways. Ephemerals are void of vegetation and occur in the same location every year. They are crossable with farm equipment and are often partially filled in by tillage.

FIBI: Fish Index of Biotic Integrity. An index-based scoring method for assessing the biological health of streams and rivers (scale of 0-100) based on characteristics of fish species.

FSA: Farm Service Agency (United States Department of Agriculture). Federal agency responsible for implementing farm policy, commodity, and conservation programs.

General use(s): Refer to narrative water quality criteria that all public waterbodies must meet to satisfy public needs and expectations. See Appendix B for a description of all general and designated uses.

Geometric Mean (GM): A statistic that is a type of mean or average (different from arithmetic mean or average) that measures central tendency of data. It is often used to summarize highly skewed data or data with extreme values such as wastewater discharges and bacteria concentrations in surface waters. In Iowa's water quality standards and assessment procedures, the geometric mean criterion for *E. coli* is measured using at least five samples collected over a 30-day period.

GIS: Geographic Information System(s). A collection of map-based data and tools for creating, managing, and analyzing spatial information.

Groundwater: Subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

Gully erosion: Soil movement (loss) that occurs in defined upland channels and ravines that are typically too wide and deep to fill in with traditional tillage methods.

HEL: Highly Erodible Land. Defined by the USDA Natural Resources Conservation Service (NRCS), it is land, which has the potential for long-term annual soil losses to exceed the tolerable amount by eight times for a given agricultural field.

IDALS: Iowa Department of Agriculture and Land Stewardship

Integrated report: Refers to a comprehensive document that combines the 305(b) assessment with the 303(d) list, as well as narratives and discussion of overall water quality trends in the state's public waterbodies. The Iowa Department of Natural Resources submits an integrated report to the EPA biennially in even numbered years.

LA: Load Allocation. The portion of the loading capacity attributed to (1) the existing or future nonpoint sources of pollution and (2) natural background sources. Wherever possible, nonpoint source loads and natural loads should be distinguished. (The total pollutant load is the sum of the wasteload and load allocations.)

LiDAR: Light Detection and Ranging. Remote sensing technology that uses laser scanning to collect height or elevation data for the earth's surface.

Load: The total amount of pollutants entering a waterbody from one or multiple sources, measured as a rate, as in weight per unit time or per unit area.

Macrophyte: An aquatic plant that is large enough to be seen with the naked eye and grows either in or near water. It can be floating, completely submerged (underwater), or partially submerged.

MOS: Margin of Safety. A required component of the TMDL that accounts for the uncertainty in the response of the water quality of a waterbody to pollutant loads.

MPN: Most Probable Number. Used as a unit of bacteria concentration when a more rapid method of analysis (such as Colisure or Colilert) is utilized. Though not necessarily equivalent to colony forming units (CFU), the two terms are often used interchangeably.

MS4: Municipal Separate Storm Sewer System. A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned and operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to state law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under state law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act (CWA) that discharges to waters of the United States.

Nonpoint source pollution: Pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related either to land or water use including failing septic tanks, improper animal-keeping practices, forestry practices, and urban and rural runoff.

NPDES: National Pollution Discharge Elimination System. The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Section 307, 402, 318, and 405 of the Clean Water Act. Facilities subjected to NPDES permitting regulations include operations such as municipal wastewater treatment plants and industrial waste treatment facilities, as well as some MS4s.

NRCS: Natural Resources Conservation Service (United States Department of Agriculture). Federal agency that provides technical assistance for the conservation and enhancement of natural resources.

Open feedlot: An unroofed or partially roofed animal feeding operation (AFO) in which no crop, vegetation, or forage growth or residue cover is maintained during the period that animals are confined in the operation.

Periphyton: Algae that are attached to substrates (rocks, sediment, wood, and other living organisms). Are often located at the bottom of a wetland, lake, or stream.

Phytoplankton: Collective term for all photosynthetic organisms suspended in the water column. Includes many types of algae and cyanobacteria.

Point source pollution: Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources are generally regulated by a federal NPDES permit.

Pollutant: As defined in Clean Water Act section 502(6), a pollutant means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water.

Pollution: The man-made or man-induced alteration of the chemical, physical, biological, and/or radiological integrity of water.

PPB: Parts per Billion. A measure of concentration that is the same as micrograms per liter (µg/L).

PPM: Parts per Million. A measure of concentration that is the same as milligrams per liter (mg/L).

RASCAL: Rapid Assessment of Stream Conditions Along Length. RASCAL is a global positioning system (GPS) based assessment procedure designed to provide continuous stream and riparian condition data at a watershed scale.

Riparian: Refers to areas near the banks of natural courses of water. Features of riparian areas include specific physical, chemical, and biological characteristics that differ from upland (dry) sites. Usually refers to the area near a bank of a stream or river.

RUSLE: Revised Universal Soil Loss Equation. An empirical model for estimating long term, average annual soil losses due to sheet and rill erosion.

Scientific notation: See explanation on page 107.

Secchi disk: A device used to measure transparency in waterbodies. The greater the Secchi depth (typically measured in meters), the more transparent the water.

Sediment delivery ratio: A value, expressed as a percent, which is used to describe the fraction of gross soil erosion that is delivered to the waterbody of concern.

Seston: All particulate matter (organic and inorganic) suspended in the water column.

SHL: State Hygienic Laboratory (University of Iowa). Provides physical, biological, and chemical sampling for water quality purposes in support of beach monitoring, ambient monitoring, biological reference monitoring, and impaired water assessments.

Sheet & rill erosion: Sheet and rill erosion is the detachment and removal of soil from the land surface by raindrop impact, and/or overland runoff. It occurs on slopes with overland flow and where runoff is not concentrated.

Single-Sample Maximum (SSM): A water quality standard criterion used to quantify *E. coli* levels. The single-sample maximum is the maximum allowable concentration measured at a specific point in time in a waterbody.

SI: Stressor Identification. A process by which the specific cause(s) of a biological impairment to a waterbody can be determined from cause-and-effect relationships.

Storm flow (or stormwater): The discharge (flow) from surface runoff generated by a precipitation event. *Stormwater* generally refers to runoff that is routed through some artificial channel or structure, often in urban areas.

STP: Sewage Treatment Plant. General term for a facility that treats municipal sewage prior to discharge to a waterbody according to the conditions of an NPDES permit.

SWCD: Soil and Water Conservation District. Agency that provides local assistance for soil conservation and water quality project implementation, with support from the Iowa Department of Agriculture and Land Stewardship.

TDS: Total Dissolved Solids: The quantitative measure of matter (organic and inorganic material) dissolved, rather than suspended, in the water column. TDS is analyzed in a laboratory and quantifies the material passing through a filter and dried at 180 degrees Celsius.

TMDL: Total Maximum Daily Load. As required by the Federal Clean Water Act, a comprehensive analysis and quantification of the maximum amount of a particular pollutant that a waterbody can tolerate while still meeting its general and designated uses. A TMDL is mathematically defined as the sum of all individual wasteload allocations (WLAs), load allocations (LAs), and a margin of safety (MOS).

Trophic state: The level of ecosystem productivity, typically measured in terms of algal biomass.

TSI (or Carlson's TSI): Trophic State Index. A standardized scoring system developed by Carlson (1977) that places trophic state on an exponential scale of Secchi depth, chlorophyll, and total phosphorus. TSI ranges between 0 and 100, with 10 scale units representing a doubling of algal biomass.

TSS: Total Suspended Solids. The quantitative measure of matter (organic and inorganic material) suspended, rather than dissolved, in the water column. TSS is analyzed in a laboratory and quantifies the material retained by a filter and dried at 103 to 105 degrees Celsius.

Turbidity: A term used to indicate water transparency (or lack thereof). Turbidity is the degree to which light is scattered or absorbed by a fluid. In practical terms, highly turbid waters have a high degree of cloudiness or murkiness caused by suspended particles.

UAA: Use Attainability Analysis. A protocol used to determine which (if any) designated uses apply to a particular waterbody. (See Appendix B for a description of all general and designated uses.)

USDA: United States Department of Agriculture

USGS: United States Geologic Survey (United States Department of the Interior). Federal agency responsible for implementation and maintenance of discharge (flow) gauging stations on the nation's waterbodies.

Watershed: The land area that drains water (usually surface water) to a particular waterbody or outlet.

WLA: Wasteload Allocation. The portion of a receiving waterbody's loading capacity that is allocated to one of its existing or future point sources of pollution (e.g., permitted waste treatment facilities).

WQS: Water Quality Standards. Defined in Chapter 61 of Environmental Protection Commission [567] of the Iowa Administrative Code, they are the specific criteria by which water quality is gauged in Iowa.

WWTF: Wastewater Treatment Facility. General term for a facility that treats municipal, industrial, or agricultural wastewater for discharge to public waters according to the conditions of the facility's NPDES permit. Used interchangeably with wastewater treatment plant (WWTP).

Zooplankton: Collective term for all animal plankton suspended in the water column which serve as secondary producers in the aquatic food chain and the primary food source for larger aquatic organisms.

Scientific Notation

Scientific notation is the way that scientists easily handle very large numbers or very small numbers. For example, instead of writing 45,000,000,000 we write 4.5E+10. So, how does this work?

We can think of 4.5E+10 as the product of two numbers: 4.5 (the digit term) and E+10 (the exponential term). Here are some examples of scientific notation.

10,000 = 1E+4	24,327 = 2.4327E+4
1,000 = 1E+3	7,354 = 7.354E+3
100 = 1E+2	482 = 4.82E+2
1/100 = 0.01 = 1E-2	0.053 = 5.3E-2
1/1,000 = 0.001 = 1E-3	0.0078 = 7.8E-3
1/10,000 = 0.0001 = 1E-4	0.00044 = 4.4E-4

As you can see, the exponent is the number of places the decimal point must be shifted to give the number in long form. A **positive** exponent shows that the decimal point is shifted that number of places to the right. A **negative** exponent shows that the decimal point is shifted that number of places to the left.

Appendix B - General and Designated Uses of Iowa's Waters

Introduction

Iowa's water quality standards (WQS) (Environmental Protection Commission [567], Chapter 61 of the Iowa Administrative Code) provide the narrative and numerical criteria by which water bodies are judged when determining the health and quality of our aquatic ecosystems. These standards vary depending on the type of water body (lakes vs. rivers) and the assigned uses (general use vs. designated uses) of the water body that is being dealt with. This appendix is intended to provide information about how Iowa's water bodies are classified and what the use designations mean, hopefully providing a better general understanding for the reader.

All public surface waters in the state are protected for certain beneficial uses, such as livestock and wildlife watering, aquatic life, non-contact recreation, crop irrigation, and other incidental uses (e.g. withdrawal for industry and agriculture). However, certain rivers and lakes warrant a greater degree of protection because they provide enhanced recreational, economical, or ecological opportunities. Thus, all public bodies of surface water in Iowa are divided into two main categories: general use segments and designated use segments. This is an important classification because it means that not all of the criteria in the state's water quality standards apply to all water ways; rather, the criteria which apply depend on the use designation & classification of the water body.

General Use Segments

A general use segment water body is one which does not maintain perennial (year-round) flow of water or pools of water in most years (i.e. ephemeral or intermittent waterways). In other words, stream channels or basins which consistently dry up year after year would be classified as general use segments. Exceptions are made for years of extreme drought or floods. For the full definition of a general use water body, consult section 61.3(1) in the state's published water quality standards.

General use waters are protected for the beneficial uses listed above, which are: livestock and wildlife watering, aquatic life, non-contact recreation, crop irrigation, and industrial, agricultural, domestic and other incidental water withdrawal uses. The criteria used to ensure protection of these uses are described in section 61.3(2) in the state's published water quality standards.

Designated Use Segments

Designated use segments are water bodies which maintain flow throughout the year, or at least hold pools of water which are sufficient to support a viable aquatic community (i.e. perennial waterways). In addition to being protected for the same beneficial uses as the general use segments, these perennial waters are protected for more specific activities such as primary contact recreation, drinking water sources, or cold-water fisheries. There are a total of thirteen different designated use classes (Table B.1) which may apply, and a water body may have more than one designated use. For definitions of the use classes and more detailed descriptions, consult section 61.3(1) in the state's published water quality standards.

Table B.1. Designated Use Classes for Iowa Water Bodies.

Class prefix	Class	Designated use	Brief comments
A	A1	Primary contact recreation	Supports swimming, water skiing, etc.
	A2	Secondary contact recreation	Limited/incidental contact occurs, such as boating
	A3	Children's contact recreation	Urban/residential waters that are attractive to children
B	B(CW1)	Cold water aquatic life - Type 2	Able to support coldwater fish (e.g. trout) populations
	B(CW2)	Cold water aquatic life - Type 2	Typically unable to support consistent trout populations
	B(WW-1)	Warm water aquatic life - Type 1	Suitable for game and nongame fish populations
	B(WW-2)	Warm water aquatic life - Type 2	Smaller streams where game fish populations are limited by physical conditions & flow
	B(WW-3)	Warm water aquatic life - Type 3	Streams that only hold small perennial pools which extremely limit aquatic life
	B(LW)	Warm water aquatic life - Lakes and Wetlands	Artificial and natural impoundments with "lake-like" conditions
C	C	Drinking water supply	Used for raw potable water
Other	HQ	High quality water	Waters with exceptional water quality
	HQR	High quality resource	Waters with unique or outstanding features
	HH	Human health	Fish are routinely harvested for human consumption

Appendix C - Waste Load Allocation Calculations

Appendix C.1. Wasteload Allocation by Stream Segment for the Upper Chariton Watershed

This appendix provides description of the type of wasteload allocations (WLA) for facilities in all three HUC-10 watersheds in the study area. Included are tables of waste load allocations by segment and by facility type.

- AL - Aerated Lagoon
- AS - Activated Sludge
- AS/SBR- Activated Sludge/Sequencing Batch Reactor
- CAFO - Concentrated Animal Feeding Operation.
- GP #4 - Private Facility operating under an NPDES General Permit #4
- ST/SF - Septic Tank Sand Filter
- SW - Stormwater
- TF - Trickling Filter
- UNSWD - Unsewered Community
- WSL - Waste Stabilization Lagoon (Controlled Discharge Lagoon, CDL)

Wastewater Treatment Facility (WWTF)

WWTF can be grouped two types of discharging facilities, continuous and intermittent. All of the WWTF listed in this WQIP are continuous discharging facilities with the exception of Waste Stabilization Lagoons, which are intermittent discharging facilities.

The design flow for WWTF is the NPDES permitted average wet weather (AWW) flow. For a continuous discharging facility this is the 30-day AWW flow and the 180-day AWW flow for intermittent discharging facilities.

The WLA for continuous discharging facilities is the product of the WQS concentration of 126 orgs/100 ml and the design flow.

Intermittent discharging facilities operate as a hold and discharge facility with a minimum holding time of 180-days. These facilities typically discharge twice per year for short periods of time in the spring and in the fall when stream flows are at the highest. These facilities are permitted to discharge at a rate that is ten times the 180-day AWW flow. WLA for intermittent discharging facilities is the WQS concentration multiplied by ten times the 180-day AWW flow.

Unsewered (UNSWD)

WLA for unsewered communities is the product of the population and a per capita rate of 100 gallons per capita-day. Populations for unsewered communities were obtained or estimated from the 2010 US Census (U.S. Census Bureau, 2010). The per capita flow rate of 100 gallons per capita-day is required for facility planning of new WWTF by the Iowa Wastewater Facilities Design Standards. Unsewered communities with estimated populations of zero were omitted from WLA calculations.

Concentrated Animal Feeding Operations (CAFOs)

Regulatory CAFOs are not allowed to discharge, therefore their WLA is zero.

General Permit No. 4 (GP#4)

Facilities operating under a GP #4 are private systems that only treat domestic waste from commercial and residential properties and serve an equivalent population of less than 16 people. These sources are required to sample at least twice per year at six-month intervals. The effluent water quality *E. coli* criterion for these facilities is 235 orgs/100 ml. Therefore, the WLA for these systems is based on the 235 orgs/100 ml criterion. Design flows for these facilities is based on 150 gpd/bedroom. The number of bedrooms per residence was determined based on available county data.

GP#4's are typically private residential properties consequently, they are not listed by owner in this water quality improvement plan.

Stormwater (SW)

NPDES permits for MS4 communities do not include numeric limits for *E. coli*. However, they do include storm water pollution prevention and management provisions that include the implementation of Best Management Practices (BMP) to reduce pollutants in the discharge.

The WLA for MS4 communities in this WQIP are based on the ratio of the area of the MS4 community to the drainage area attributed to the impaired segment that the community discharges to multiply by the TMDL attributed to the drainage area of that impaired segment. There are no MS4 communities in the Upper Chariton River watershed.

The various point sources in each impaired segment of the Upper Chariton River watershed will be organized by HUC 10.

Point Sources in Wolf Creek – Chariton River HUC 10 impaired segments

Table C.1. WLA for IA 05-CHA-1310

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, *E. coli*, orgs/100 ml	SSM Load, *E. coli*, orgs/day
Alexander David & Ewing Family Farms Lc	CAFO	58437	0.00	126	0.00E+00	235	0.00E+00
Wayne Finisher Farm	CAFO	69152	0.00	126	0.00E+00	235	0.00E+00
3 Permitted Facilities	GP #4	--	0.0015	235	1.33E+07	235	1.33E+07
Totals	**--**	**--**	**0.0015**	**--**	**1.33E+07**	**--**	**1.33E+07**

Table C.2. WLA for IA 05-CHA-1311

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
DERBY CITY OF STP	WSL	5909001	0.0135	126	6.44E+08	235	1.20E+09
Derby Sow Farm S034	CAFO	69194	0.00	126	0.00E+00	235	0.00E+00
2 Permitted Facilities	GP #4	--	0.00105	235	9.34E+06	235	9.34E+06
Totals	**--**	**--**	**0.01455**	**--**	**6.53E+08**	**--**	**1.21E+09**

Table C.3. WLA for IA 05-CHA-1312

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
HUMESTON CITY OF STP	AL	9348001	0.27	126	1.29E+09	235	2.40E+09
Last Chance Sow Farm	CAFO	60069	0.00	126	0.00E+00	235	0.00E+00
Smyrna Sow Farm	CAFO	69833	0.00	126	0.00E+00	235	0.00E+00
Hooper Sow Farm	CAFO	71345	0.00	126	0.00E+00	235	0.00E+00
Le Roy	UNSWD	--	0.0014	126	6.68E+06	235	1.25E+07
1 Permitted Facility	GP #4	--	0.0006	235	5.34E+06	235	5.34E+06
Totals	**--**	**--**	**0.272**	**--**	**1.30E+09**	**--**	**2.42E+09**

Table C.4. WLA for IA 05-CHA-1313

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Iowa Quality Farms LC	CAFO	59925	0.00	126	0.00E+00	235	0.00E+00
Totals	**--**	**--**	**0.00**	**--**	**0.00E+00**	**--**	**0.00E+00**

Table C.5. WLA for IA 05-CHA-1337

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day
RUSSELL CITY OF STP	AL	5939001	0.31	126	1.48E+09
1 Permitted Facility	GP #4	--	0.0003	235	2.67E+06
Totals	--	--	0.3103	--	1.48E+09

Stream segment IA 05-CHA-1337 is impaired for GM criterion only. Therefore, no SSM calculations are provided.

Table C.6. WLA for IA 05-CHA-1339

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
2 Permitted Facilities	GP #4	--	0.0009	235	8.01E+06	235	8.01E+06
Totals	**--**	**--**	**0.0009**	**--**	**8.01E+06**	**--**	**8.01E+06**

Table C.7. WLA for IA 05-CHA-1341

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Lucas Gilt Developer Unit	CAFO	60671	0.00	126	0.00E+00	126	0.00E+00
Totals	**--**	**--**	**0.00**	**126**	**0.00E+00**	**126**	**0.00E+00**

Point Sources in South Fork Chariton River HUC 10 impaired segments

Table C.8. WLA for IA 05-CHA-1329

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Confidence	UNSWD	--	0.0016	126	7.63E+06	235	1.42E+07
Paul Alexander Farms	CAFO	62619	0.00	126	0.00E+00	235	0.00E+00
Double A Pork Inc	CAFO	63942	0.00	126	0.00E+00	235	0.00E+00
Totals	**--**	**--**	**0.0016**	**--**	**7.63E+06**	**--**	**1.42E+07**

Table C.9. WLA for IA 05-CHA-1330

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Millerton	UNSWD	--	0.0048	126	2.29E+07	235	4.27E+07
Totals	**--**	**--**	**0.0048**	**--**	**2.29E+07**	**--**	**4.27E+07**

Table C.10. WLA for IA 05-CHA-1332

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
ALLERTON CITY OF STP (North)	WSL	9303003	0.02	126	9.54E+08	235	1.78E+09
CORYDON CITY OF STP	AL	9334004	0.936	126	4.46E+09	235	8.33E+09
Totals	**--**	**--**	**0.956**	**--**	**5.42E+09**	**--**	**1.01E+10**

Table C.11. WLA for IA 05-CHA-1335

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Cambria	UNSWD	--	0.0044	126	2.10E+07	235	3.91E+07
Totals	**--**	**--**	**0.0044**	**--**	**2.10E+07**	**--**	**3.91E+07**

Point Sources in Cooper Creek – Chariton River HUC 10 impaired segments

Table C.12. WLA for IA 05-CHA-1307

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Exline, city of STP	WSL	426001	0.0206	126	9.82E+08	235	1.83E+09
Totals	**--**	**--**	**0.0206**	**--**	**9.82E+08**	**--**	**1.83E+09**

Table C.13. WLA for IA 05-CHA-1308

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day	SSM, E. coli, orgs/100 ml	SSM Load, E. coli, orgs/day
Iowa DNR Rathbun Fish Hatchery	WSL	400913	0.008	126	3.82E+08	235	7.12E+08
Rathbun Regional Water Association (1)	OTHER	400918	--	--	--	--	--
Centerville City of STP (east)	AS	407003	1.5	126	7.15E+09	235	1.33E+10
Centerville City of STP (west)	AS	407004	0.41	126	1.96E+09	235	3.65E+09
Mystic City of STP	WSL	477001	0.071	126	3.39E+09	235	5.34E+08
Plano, Iowa	WSL	484001	0.006	126	2.86E+08	235	6.32E+09
Promise City, City of STP	WSL	9360001	0.013	126	6.20E+08	235	1.16E+09
Seymour City of STP	WSL	9368001	0.11	126	5.25E+09	235	9.79E+09
Darbyville	UNSWD	--	0.003	126	1.43E+07	235	2.67E+07
Rathbun	UNSWD	--	0.0088	126	4.20E+07	235	7.83E+07
Jerome	UNSWD	--	0.0034	126	1.62E+07	235	3.02E+07
Numa	UNSWD	--	0.003	126	5.20E+07	235	9.70E+07
1 Permitted Facilities	GP#4	--	0.00045	235	4.00E+06	235	4.00E+06
Totals	**--**	**--**	**2.145**	**--**	**1.92E+10**		**3.57E+10**

(1) The RRWA is a water treatment facility and is not permitted to discharge *E. coli* in its effluent. Consequently, this facility was not considered as a contributing source but is listed here as having an NPDES permit.

Appendix C.2. WLA by Treatment Type

This appendix provides the WLA for each facility based on the Treatment Type. Treatment types include: Municipal and Semi-public (WWTF); CAFO; General Permit #4; Unsewered; and Stormwater.

Wastewater Treatment Facility (WWTF) includes the following facility types:

- AL - Aerated Lagoon
- AS - Activated Sludge
- AS/SBR- Activated Sludge/Sequencing Batch Reactor
- ST/SF - Septic Tank Sand Filter
- TF - Trickling Filter
- WSL - Waste Stabilization Lagoon

Table C.14. WLA for WWTFs in Upper Chariton River Watershed

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day[1]	SSM, *E. coli*, orgs/100 ml	SSM Load, E. coli, orgs/day
Exline, City of STP	WSL	0426001	0.0206	126	9.82E+08	235	1.83E+09
ALLERTON CITY OF STP (North)	WSL	9303003	0.02	126	9.54E+07	235	1.78E+09
CORYDON CITY OF STP	AL	9334004	0.936	126	4.46E+09	235	8.33E+09
HUMESTON CITY OF STP	AL	9348001	0.270	126	1.28E+09	235	2.40E+09
RUSSELL CITY OF STP	AL	5939001	0.31	126	1.48E+09	235	2.76E+09
Centerville City of STP (east)	AS	0407003	1.50	126	7.15E+09	235	1.33E+10
Centerville City of STP (west)	AS	0407004	0.41	126	1.96E+09	235	3.65E+09
Promise City, City of Stp[2]	WSL	9360001	0.0126	126	6.20E+07	235	1.12E+09
Seymour City of Stp[(2)]	WSL	9368001	0.11	126	5.25E+08	235	9.79E+09
Iowa DNR Rathbun Fish Hatchery[(2)]	WSL	0400913	8.00E+03	126	3.82E+08	235	7.12E+08
Plano, Iowa[(2)]	WSL	0484001	6.00E+03	126	2.86E+07	235	5.34E+08
Mystic City of Stp[(2)]	WSL	0477001	7.10E+04	126	3.39E+08	235	6.32E+09
DERBY CITY OF STP[(2)]	WSL	5909001	1.35E+04	126	6.44E+07	235	1.20E+09
Rathbun Regional Water Association[(3)]	OTHER	0400918	3.80E+04	--	--	--	--
DNR Honey Creek State Park – IA OP Permit[(3)(4)]	Land Application	0400914	0.011	--	--	--	--
Parkside Knolls HOA[(4)]	WSL	0400302		--	--	--	--
Indian Ridge Homeowners Association[(4)]	AL	9300601	0.0074	--	--	--	--
DNR Honey Creek Resort State Park[(4)(5)]	WSL	0400922	0.044	--	--	--	--
Totals	**--**	**--**	**--**	**126**	**3.47E+10**		**8.48E+10**

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (mgd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day(1)	SSM, *E. coli*, orgs/100 ml	SSM Load, E. coli, orgs/day

(1) The WLA for continuous discharging facilities is the product of the WQS concentration of 126 orgs/100 ml and the design flow.
(2) The WLA for intermittent discharging facilities is the WQS concentration multiplied by ten times the 180-day AWW flow.
(3) Operation permits are permitted to land apply treated wastewater and do not discharge to surface water. Water treatment plants are not permitted to discharge *E. coli* in its effluent. Consequently, this facility was not considered as a contributing source but are listed here as having an NPDES permit
(4) These facilities are being listed as NPDES permitted facilities in the watershed. However, they were not considered in this TMDL because they discharged to Rathbun Lake and it is assumed that bacteria concentrations at the outflow are below detection limits therefore, they would not contribute to any downstream impairments.
(5) This facility has 2 outfalls in its NPDES permit 1) from a three cell WSL and 2) occasional draining of the aquatic center. The outfall for the WSL discharges outside of the watershed. The outfall for the aquatic center discharges to Rathbun Lake and has no *e-coli* limits in its NPDES permit. Consequently, this outfall was not considered as a contributing source but is listed as having an NPDES permit.

Table C.15. WLA for CAFOs in Upper Chariton River Watershed

Facility Name	Facility Type	Iowa NPDES ID or AFO ID	Design Flow (gpd)	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day(1)
Alexander David & Ewing Family Farms Lc	CAFO	58437	0.0	126	0.00E+00
Iowa Quality Farms Lc	CAFO	59925	0.0	126	0.00E+00
Last Chance Sow Farm	CAFO	60069	0.0	126	0.00E+00
Lucas Gilt Developer Unit	CAFO	60671	0.0	126	0.00E+00
Paul Alexander Farms	CAFO	62619	0.0	126	0.00E+00
Double A Pork Inc	CAFO	63942	0.0	126	0.00E+00
Wayne Finisher Farm	CAFO	69152	0.0	126	0.00E+00
Derby Sow Farm S034	CAFO	69194	0.0	126	0.00E+00
Smyrna Sow Farm	CAFO	69833	0.0	126	0.00E+00
Hooper Sow Farm	CAFO	71345	0.0	126	0.00E+00
Totals	--	--	0.0	126	0.00E+00

(1) Regulatory CAFOs are not allowed to discharge therefore their WLA is zero.

Table C.16. Estimated Wasteloads for GP #4 in Upper Chariton River Watershed

Facility Name	Facility Type	Design Flow (gpd)	Stream Segment	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day
3 Permitted Facilities	GP #4	1,500	IA 05-CHA-1310	235	1.33E+07
2 Permitted Facilities	GP #4	1,050	IA 05-CHA-1311	235	9.34E+06
1 Permitted Facility	GP #4	600	IA 05-CHA-1312	235	5.34E+06
1 Permitted Facilities	GP #4	300	IA 05-CHA-1337	235	2.67E+06
2 Permitted Facilities	GP #4	900	IA 05-CHA-1339	235	8.01E+06
1 Permitted Facilities	GP #4	450	IA 05-CHA-1308	235	4.00E+06
Totals		**4,800**		**235**	**4.27E+07**

(1) In some cases, these sources are small and do not significantly contribute to the impairment. However, in other cases they are the only permitted source in the watershed. Therefore, a WLA for all these systems is included in this WQIP.
(2) GP#4's are typically private residential properties consequently, they are not listed individually in this water quality improvement plan.
(3) Permit limits for GP #4 is 235 orgs/100 ml. Therefore, WLA for GM and SSM are the same.

Table C.17. Unsewered communities in Upper Chariton River Watershed

Facility Name	Facility Type	Population[1]	Design Flow (gpd)	Receiving Stream Segment	GM, *E. coli*, orgs/100 ml	WLA, *E. coli*, orgs/day[1]	SSM, *E. coli*, orgs/100 ml	SSM, WLA, E. coli, orgs/day1
Le Roy	UNSWD	14	1,400	IA 05-CHA-1312	126	6.68E+06	235	1.25E+07
Confidence	UNSWD	16	1,600	IA 05-CHA-1329	126	7.63E+06	235	1.42E+07
Millerton	UNSWD	48	4,800	IA 05-CHA-1330	126	2.29E+07	235	4.27E+07
Cambria	UNSWD	44	4,400	IA 05-CHA-1335	126	2.10E+07	235	3.91E+07
Darbyville	UNSWD	30	3,000	IA 05-CHA-1308	126	1.43E+07	235	2.67E+07
Rathbun	UNSWD	88	8,800	IA 05-CHA-1308	126	4.20E+07	235	7.83E+07
Jerome	UNSWD	34	3,400	IA 05-CHA-1308	126	1.62E+07	235	3.02E+07
Numa	UNSWD	109	10,900	IA 05-CHA-1308	126	5.20E+07	235	9.70E+07
Totals		**383**	**38,300**		**--**	**1.83E+08**	**--**	**3.41E+08**

(1) WLA for unsewered communities is the product of the population and a per capita rate of 100 gallons per capita-day times the WQS concentration.

Appendix C.3. Water Quality Data

Water Quality Data in Wolf Creek – Chariton River HUC 10 impaired segments

Table C.18. Water Quality Data for IA 05-CHA-1310 and STORET Site #15590001 (RA-15).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	372.857	340.0	4/15/2003	1.179	10.0
4/13/1999	16.571	460.0	5/14/2003	6.374	260.0
5/11/1999	18.484	30.0	6/17/2003	1.625	340.0
6/11/1999	331.429	2,400.0	7/15/2003	0.351	40.0
6/15/1999	35.692	1,600.0	7/29/2003	0.083	400.0
7/13/1999	7.011	340.0	8/12/2003	0.013	160.0
8/18/1999	1.275	630.0	9/16/2003	1.609	360.0
9/13/1999	0.414	300.0	10/16/2003	0.140	30.0
10/13/1999	0.478	310.0	3/31/2004	34.099	750.0
11/15/1999	0.080	52.0	4/21/2004	9.560	760.0
3/28/2000	0.271	10.0	5/19/2004	5.099	270.0
4/18/2000	0.414	10.0	6/22/2004	10.516	200.0
5/16/2000	0.510	110.0	7/13/2004	83.176	7,000.0
6/13/2000	31.868	190.0	7/20/2004	1.498	360.0
6/27/2000	216.703	2,100.0	8/17/2004	1.402	180.0
7/19/2000	4.462	1,300.0	9/21/2004	1.370	320.0
8/15/2000	2.231	63.0	10/19/2004	1.737	10.0
9/12/2000	0.239	930.0	3/16/2005	4.462	10.0
10/17/2000	0.178	86.0	4/13/2005	519.451	3,100.0
11/14/2000	0.414	20.0	5/10/2005	3.888	80.0
3/20/2001	183.242	310.0	6/15/2005	18.930	1,652.0
4/17/2001	43.659	910.0	6/29/2005	17.400	3,840.0
5/15/2001	411.099	1,400.0	7/20/2005	0.236	288.0
6/1/2001	726.593	1,600.0	7/28/2005	0.787	727.0
6/12/2001	13.066	100.0	8/25/2005	0.207	290.9
7/11/2001	2.741	110.0	3/16/2006	0.564	21.1
8/14/2001	0.153	130.0	4/12/2006	0.727	77.1
9/27/2001	0.306	1,200.0	4/27/2006	0.357	72.4
10/16/2001	1.625	74.0	5/25/2006	17.400	344.8
11/13/2001	1.179	10.0	6/7/2006	0.593	196.8
3/26/2002	5.418	10.0	6/21/2006	0.080	1,011.2
4/16/2002	9.560	40.0	7/27/2006	0.131	913.9
5/14/2002	366.484	1,300.0	8/28/2006	0.602	478.6
6/11/2002	10.198	2,900.0	9/13/2006	0.303	275.5
7/23/2002	0.510	300.0	10/12/2006	0.003	82.0
8/13/2002	0.143	230.0	4/25/2007	497.143	2,419.6(1)
9/17/2002	0.086	350.0	5/23/2007	3.537	206.4
10/24/2002	0.032	110.0	6/5/2007	18.834	547.5
11/12/2002	0.061	30.0	6/21/2007	1.469	461.1

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/17/2007	0.191	686.7	4/19/2010	11.345	37.7
7/26/2007	0.099	435.2	4/24/2010	493.956	2,419.6(1)
8/8/2007	0.382	2,419.6	5/11/2010	650.110	2,419.6(1)
8/21/2007	3.601	2,419.6(1)	5/26/2010	56.088	1,986.3
9/11/2007	0.421	613.1	6/22/2010	398.352	2,419.6(1)
9/27/2007	0.185	313.0	7/13/2010	19.153	235.9
10/4/2007	0.523	166.4	8/11/2010	114.407	2,419.6(1)
10/18/2007	188.659	2,419.6(1)	9/21/2010	331.429	2,419.6(1)
11/13/2007	2.138	135.4	10/9/2010	4.876	344.8
5/29/2008	12.110	325.5	4/16/2011	257.176	10,000.0
6/3/2008	157.110	1,413.6	8/16/2011	3.047	800.0
6/16/2008	211.923	206.4	9/19/2011	0.274	560.0
7/1/2008	13.193	344.8	10/17/2011	0.045	20.0
7/15/2008	4.685	139.6	4/16/2012	318.681	20,000.0
8/12/2008	8.859	228.2	5/3/2012	544.945	17,000.0
9/8/2008	3.158	1,413.6	6/18/2012	53.220	6,500.0
10/27/2008	37.286	920.8	6/26/2012	21.065	560.0
11/4/2008	9.274	193.5	7/11/2012	0.025	52.0
5/14/2009	17.496	122.3	10/22/2012	1.042	130.0
5/28/2009	123.967	2,419.6(1)			
6/18/2009	15.074	2,419.6(1)			
6/25/2009	65.330	344.8	Min =	0.003	10
7/16/2009	13.034	547.5	1st Quartile =	0.42	130
8/11/2009	71.066	2,419.6	Median =	4.5	340
8/17/2009	310.714	2,419.6(1)	3rd Quartile =	35.7	1,300
9/23/2009	2.428	325.5	Max =	726.6	20,000
10/27/2009	38.560	727.0	Mean(2) =	70.4	348
3/22/2010	124.604	122.3	Std Dev =	148.0	2,624

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.19. Water Quality Data for IA 05-CHA-1311 and STORET Site #15590001 (RA-15).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	327.536	340.0	6/17/2003	1.428	340.0
4/13/1999	14.557	460.0	7/15/2003	0.308	40.0
5/11/1999	16.237	30.0	7/29/2003	0.073	400.0
6/11/1999	291.143	2,400.0	8/12/2003	0.011	160.0
6/15/1999	31.354	1,600.0	9/16/2003	1.414	360.0
7/13/1999	6.159	340.0	10/16/2003	0.123	30.0
8/18/1999	1.120	630.0	3/31/2004	29.954	750.0
9/13/1999	0.364	300.0	4/21/2004	8.398	760.0
10/13/1999	0.420	310.0	5/19/2004	4.479	270.0
11/15/1999	0.070	52.0	6/22/2004	9.238	200.0
3/28/2000	0.238	10.0	7/13/2004	73.066	7,000.0
4/18/2000	0.364	10.0	7/20/2004	1.316	360.0
5/16/2000	0.448	110.0	8/17/2004	1.232	180.0
6/13/2000	27.995	190.0	9/21/2004	1.204	320.0
6/27/2000	190.363	2,100.0	10/19/2004	1.526	10.0
7/19/2000	3.919	1,300.0	3/16/2005	3.919	10.0
8/15/2000	1.960	63.0	4/13/2005	456.310	3,100.0
9/12/2000	0.210	930.0	5/10/2005	3.415	80.0
10/17/2000	0.157	86.0	6/15/2005	16.629	1,652.0
11/14/2000	0.364	20.0	6/29/2005	15.285	3,840.0
3/20/2001	160.968	310.0	7/20/2005	0.207	288.0
4/17/2001	38.352	910.0	7/28/2005	0.691	727.0
5/15/2001	361.129	1,400.0	8/25/2005	0.182	290.9
6/1/2001	638.275	1,600.0	3/16/2006	0.496	21.1
6/12/2001	11.478	100.0	4/12/2006	0.638	77.1
7/11/2001	2.408	110.0	4/27/2006	0.314	72.4
8/14/2001	0.134	130.0	5/25/2006	15.285	344.8
9/27/2001	0.269	1,200.0	6/7/2006	0.521	196.8
10/16/2001	1.428	74.0	6/21/2006	0.070	1,011.2
11/13/2001	1.036	10.0	7/27/2006	0.115	913.9
3/26/2002	4.759	10.0	8/28/2006	0.529	478.6
4/16/2002	8.398	40.0	9/13/2006	0.266	275.5
5/14/2002	321.937	1,300.0	10/12/2006	0.003	82.0
6/11/2002	8.958	2,900.0	4/25/2007	436.714	2,419.6(1)
7/23/2002	0.448	300.0	5/23/2007	3.107	206.4
8/13/2002	0.126	230.0	6/5/2007	16.545	547.5
9/17/2002	0.076	350.0	6/21/2007	1.291	461.1
10/24/2002	0.028	110.0	7/17/2007	0.168	686.7
11/12/2002	0.053	30.0	7/26/2007	0.087	435.2
4/15/2003	1.036	10.0	8/8/2007	0.336	2,419.6
5/14/2003	5.599	260.0	8/21/2007	3.163	2,419.6(1)

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
9/11/2007	0.370	613.1	5/11/2010	571.088	2,419.6(1)
9/27/2007	0.162	313.0	5/26/2010	49.270	1,986.3
10/4/2007	0.459	166.4	6/22/2010	349.931	2,419.6(1)
10/18/2007	165.727	2,419.6(1)	7/13/2010	16.825	235.9
11/13/2007	1.878	135.4	8/11/2010	100.500	2,419.6(1)
5/29/2008	10.638	325.5	9/21/2010	291.143	2,419.6(1)
6/3/2008	138.013	1,413.6	10/9/2010	4.283	344.8
6/16/2008	186.163	206.4	4/16/2011	225.916	10,000.0
7/1/2008	11.590	344.8	8/16/2011	2.676	800.0
7/15/2008	4.115	139.6	9/19/2011	0.241	560.0
8/12/2008	7.782	228.2	10/17/2011	0.039	20.0
9/8/2008	2.774	1,413.6	4/16/2012	279.945	20,000.0
10/27/2008	32.754	920.8	5/3/2012	478.706	17,000.0
11/4/2008	8.146	193.5	6/18/2012	46.751	6,500.0
5/14/2009	15.369	122.3	6/26/2012	18.504	560.0
5/28/2009	108.899	2,419.6(1)	7/11/2012	0.022	52.0
6/18/2009	13.241	2,419.6(1)	10/22/2012	0.915	130.0
6/25/2009	57.389	344.8			
7/16/2009	11.450	547.5			
8/11/2009	62.428	2,419.6	Min =	0.003	10
8/17/2009	272.946	2,419.6(1)	1st Quartile =	0.37	130
9/23/2009	2.133	325.5	Median =	3.9	340
10/27/2009	33.873	727.0	3rd Quartile =	31.4	1,300
3/22/2010	109.459	122.3	Max =	638.3	20,000
4/19/2010	9.966	37.7	Mean(2) =	61.8	348
4/24/2010	433.915	2,419.6(1)	Std Dev =	130.0	2,624

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.20. Water Quality Data for IA 05-CHA-1312 and STORET Site #15200001 (RA-32).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	225.6	110	5/19/2004	3.1	44,000
4/13/1999	10.0	460	5/26/2004	100.9	2,400
5/11/1999	11.2	200	6/22/2004	6.4	280
6/11/1999	200.6	2,400	7/13/2004	50.3	2,800
6/15/1999	21.6	740	7/20/2004	0.9	910
7/13/1999	4.2	210	8/17/2004	0.8	170
8/18/1999	0.8	850	9/21/2004	0.8	340
9/13/1999	0.3	51	3/16/2005	2.7	10
10/13/1999	0.3	210	4/13/2005	314.4	1,400
11/15/1999	0.0	10	5/10/2005	2.4	50
3/28/2000	0.2	230	6/15/2005	11.5	271
4/18/2000	0.3	41	6/29/2005	10.5	406
5/16/2000	0.3	10	7/28/2005	0.5	1,249.8
6/13/2000	19.3	52	3/16/2006	0.3	16
6/27/2000	131.1	260	4/12/2006	0.4	248.1
7/19/2000	2.7	1,300	4/27/2006	0.2	45.2
8/15/2000	1.4	170	5/25/2006	10.5	2419.6
9/12/2000	0.1	30	6/7/2006	0.4	201.4
3/20/2001	110.9	270	8/28/2006	0.4	> 2,419.6(1)
4/17/2001	26.4	390	4/25/2007	300.9	> 2,419.6(1)
5/15/2001	248.8	880	6/5/2007	11.4	435.2
6/1/2001	439.7	2,100	8/8/2007	0.2	> 2,419.6(1)
6/12/2001	7.9	100	8/21/2007	2.2	1,299.7
7/11/2001	1.7	160	9/11/2007	0.3	325.5
8/14/2001	0.1	41	9/27/2007	0.1	344.8
9/27/2001	0.2	180	10/4/2007	0.3	> 2,419.6(1)
10/16/2001	1.0	990	10/18/2007	114.2	> 2,419.6(1)
11/13/2001	0.7	63	11/13/2007	1.3	122.3
3/26/2002	3.3	10	5/29/2008	7.3	547.5
4/16/2002	5.8	130	6/3/2008	95.1	2,419.6
5/14/2002	221.8	660	6/16/2008	128.3	272.3
6/11/2002	6.2	5,900	7/1/2008	8.0	461.1
7/23/2002	0.3	240	7/15/2008	2.8	178.5
4/15/2003	0.7	90	8/12/2008	5.4	193.5
5/14/2003	3.9	170	9/8/2008	1.9	130.1
6/17/2003	1.0	80	10/27/2008	22.6	980.4
7/15/2003	0.2	220	11/4/2008	5.6	60.5
7/29/2003	0.1	1,400	5/14/2009	10.6	> 2,419.6(1)
9/16/2003	1.0	300	5/28/2009	75.0	1,299.7
3/31/2004	20.6	570	6/18/2009	9.1	547.5
4/21/2004	5.8	4400	6/25/2009	39.5	461.1

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/16/2009	7.9	1,046.2	8/15/2011	1.7	440
8/11/2009	43.0	1,119.9	9/20/2011	0.1	580
8/17/2009	188.0	1,986.3	10/18/2011	0.0	200
9/23/2009	1.5	65	6/27/2012	3.8	300
10/27/2009	23.3	770.1	7/12/2012	0.0	1,300
3/22/2010	75.4	816.4	10/23/2012	0.7	130
4/19/2010	6.9	110.6			
4/24/2010	298.9	> 2,419.6(1)			
5/11/2010	393.4	> ,2419.6(1)	Min =	0.015	10
5/26/2010	33.9	> 2,419.6(1)	1st Quartile =	0.69	165
6/22/2010	241.1	1,119.9	Median =	4.2	340
7/13/2010	11.6	275.5	3rd Quartile =	24.9	1,185
8/11/2010	69.2	61.8	Max =	439.7	44,000
9/21/2010	200.6	686.7	Mean(2) =	45.6	368
10/9/2010	3.0	290.9	Std Dev =	91.1	4,354

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.

(2) For *E. coli* this is a geomean.

Table C.21. Water Quality Data for IA-CHA-1313 and STORET Site #15200002 (RA-33).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	128.89	450	5/26/2004	57.62	2,000
4/13/1999	5.73	370	6/22/2004	3.64	280
5/11/1999	6.39	100	7/13/2004	28.75	3,100
6/11/1999	114.57	2,400	7/20/2004	0.52	910
6/15/1999	12.34	970	8/17/2004	0.48	450
7/13/1999	2.42	490	9/21/2004	0.47	210
8/18/1999	0.44	300	10/19/2004	0.60	10
9/13/1999	0.14	74	3/16/2005	1.54	10
10/13/1999	0.17	62	4/13/2005	179.57	580
11/15/1999	0.03	10	5/10/2005	1.34	360
3/28/2000	0.09	41	6/15/2005	6.54	478
4/18/2000	0.14	10	6/29/2005	6.02	238
5/16/2000	0.18	10	7/20/2005	0.08	1,640
6/13/2000	11.02	41	7/28/2005	0.27	1,607
6/27/2000	74.91	500	4/12/2006	0.25	248
7/19/2000	1.54	320	5/25/2006	6.02	1,733
8/15/2000	0.77	460	8/28/2006	0.21	> 2419.6(1)
11/14/2000	0.14	63	9/13/2006	0.10	58
3/20/2001	63.34	270	4/25/2007	171.86	> 2419.6(1)
4/17/2001	15.09	86	5/23/2007	1.22	201
5/15/2001	142.11	390	6/5/2007	6.51	517
6/1/2001	251.18	1,100	8/8/2007	0.13	> 2419.6(1)
6/12/2001	4.52	100	8/21/2007	1.24	146
7/11/2001	0.95	63	9/11/2007	0.15	236
8/14/2001	0.05	52	9/27/2007	0.06	108
9/27/2001	0.11	41	10/4/2007	0.18	> 2419.6(1)
10/16/2001	0.56	20	10/18/2007	65.22	> 2419.6(1)
11/13/2001	0.41	20	11/13/2007	0.74	2
3/26/2002	1.87	10	5/29/2008	4.19	187
4/16/2002	3.30	10	6/3/2008	54.31	> 2419.6(1)
5/14/2002	126.69	600	6/16/2008	73.26	261
6/11/2002	3.53	460	7/1/2008	4.56	225
7/23/2002	0.18	500	7/15/2008	1.62	517
4/15/2003	0.41	6,000	8/12/2008	3.06	129
5/14/2003	2.20	90	9/8/2008	1.09	> 2419.6(1)
6/17/2003	0.56	640	10/27/2008	12.89	99
7/15/2003	0.12	860	11/4/2008	3.21	16
7/29/2003	0.03	1,400	5/14/2009	6.05	210
9/16/2003	0.56	420	5/28/2009	42.85	1,300
4/21/2004	3.30	23,000	6/18/2009	5.21	517
5/19/2004	1.76	4,100	6/25/2009	22.58	225

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/16/2009	4.51	236	8/15/2011	0.99	280
8/11/2009	24.57	488	9/20/2011	0.08	110
8/17/2009	107.41	921	10/18/2011	0.02	210
9/23/2009	0.84	322	6/27/2012	2.17	240
10/27/2009	13.33	249	7/12/2012	0.01	410
3/22/2010	43.07	121			
4/19/2010	3.92	201			
4/24/2010	170.76	> 2419.6(1)			
5/11/2010	224.74	> 2419.6(1)	Min =	0.009	2
5/26/2010	19.39	326	1st Quartile =	0.42	108
6/22/2010	137.71	1,203	Median =	2.3	310
7/13/2010	6.62	276	3rd Quartile =	14.7	918
8/11/2010	39.55	1,986	Max =	251.2	23,000
9/21/2010	114.57	2,420	Mean(2) =	26.2	288
10/9/2010	1.69	228	Std Dev =	52.3	2,414

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.

(2) For *E. coli* this is a geomean.

Table C.22. Water Quality Data for IA 05-CHA-1337 and STORET Site #15590002 (RA-40).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	99.00	91	7/13/2004	22.08	12,000
4/13/1999	4.40	27	7/20/2004	0.40	800
5/11/1999	4.91	410	8/17/2004	0.37	490
6/11/1999	88.00	2,400	9/21/2004	0.36	330
6/15/1999	9.48	1,600	10/19/2004	0.46	330
7/13/1999	1.86	930	3/16/2005	1.18	20
8/18/1999	0.34	1,500	4/13/2005	137.92	360
9/13/1999	0.11	510	5/10/2005	1.03	90
10/13/1999	0.13	1,200	6/15/2005	5.03	344
11/15/1999	0.02	170	6/29/2005	4.62	738
3/28/2000	0.07	20	7/28/2005	0.21	2,142
4/18/2000	0.11	10	4/12/2006	0.19	29
6/13/2000	8.46	1,200	4/27/2006	0.09	26
6/27/2000	57.54	790	5/25/2006	4.62	517
7/19/2000	1.18	200	6/7/2006	0.16	921
8/15/2000	0.59	180	4/25/2007	132.00	> 2419.6[(1)]
10/17/2000	0.05	610	5/23/2007	0.94	866
11/14/2000	0.11	1,800	6/5/2007	5.00	1,414
3/20/2001	48.65	140	6/21/2007	0.39	> 2419.6[(1)]
4/17/2001	11.59	190	8/21/2007	0.96	> 2419.6[(1)]
5/15/2001	109.15	270	9/11/2007	0.11	579
6/1/2001	192.92	1,400	10/18/2007	50.09	> 2419.6[(1)]
6/12/2001	3.47	100	5/29/2008	3.22	1,414
8/14/2001	0.04	160	6/3/2008	41.72	1,553
9/27/2001	0.08	140	6/16/2008	56.27	1,733
10/16/2001	0.43	210	7/1/2008	3.50	980
11/13/2001	0.31	31	7/15/2008	1.24	488
3/26/2002	1.44	10	8/12/2008	2.35	30
4/16/2002	2.54	27	5/14/2009	4.65	> 2419.6[(1)]
5/14/2002	97.31	200	5/28/2009	32.92	> 2419.6[(1)]
6/11/2002	2.71	910	6/18/2009	4.00	687
4/15/2003	0.31	10	6/25/2009	17.35	980
5/14/2003	1.69	72	7/16/2009	3.46	> 2419.6[(1)]
6/17/2003	0.43	600	8/11/2009	18.87	841
7/15/2003	0.09	2,000	8/17/2009	82.50	> 2419.6[(1)]
7/29/2003	0.02	1,100	9/23/2009	0.64	> 2419.6[(1)]
3/31/2004	9.05	40	10/27/2009	10.24	727
4/21/2004	2.54	690	3/22/2010	33.08	135
5/19/2004	1.35	950	4/19/2010	3.01	118
5/26/2004	44.25	3,400	4/24/2010	131.15	> 2419.6[(1)]
6/22/2004	2.79	590	5/11/2010	172.62	> 2419.6[(1)]

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
5/26/2010	14.89	461	Min =	0.007	10
8/16/2011	0.81	10,000	1st Quartile =	0.34	170
9/19/2011	0.07	260	Median =	2.5	687
10/17/2011	0.01	86	3rd Quartile =	11.6	1,553
6/26/2012	5.59	2,600	Max =	192.9	12,000
7/11/2012	0.01	2,300	Mean(2) =	20.5	452
10/22/2012	0.28	810	Std Dev =	40.8	1,736

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.23. Water Quality Data for IA 05-CHA-1339 and STORET Site #15590003 (RA-41).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	338.79	280	8/12/2003	0.01	1,500
4/13/1999	15.06	280	9/16/2003	1.46	510
5/11/1999	16.79	300	3/31/2004	30.98	210
6/11/1999	301.14	2,400	4/21/2004	8.69	600
6/15/1999	32.43	410	5/19/2004	4.63	230
7/13/1999	6.37	190	5/26/2004	151.44	4,000
8/18/1999	1.16	1,600	6/22/2004	9.56	460
9/13/1999	0.38	270	7/13/2004	75.58	5,700
10/13/1999	0.43	200	7/20/2004	1.36	830
11/15/1999	0.07	31	8/17/2004	1.27	650
3/28/2000	0.25	10	9/21/2004	1.25	210
4/18/2000	0.38	10	10/19/2004	1.58	10
5/16/2000	0.46	31	3/16/2005	4.05	30
6/13/2000	28.96	86	4/13/2005	471.98	1,800
6/27/2000	196.90	1,100	5/10/2005	3.53	50
7/19/2000	4.05	380	6/15/2005	17.20	1,298
8/15/2000	2.03	86	6/29/2005	15.81	1,780
9/12/2000	0.22	170	7/28/2005	0.72	602
10/17/2000	0.16	290	3/16/2006	0.51	26
11/14/2000	0.38	97	4/12/2006	0.66	5
3/20/2001	166.50	230	5/25/2006	15.81	> 2419.6[(1)]
4/17/2001	39.67	500	6/7/2006	0.54	2,420
5/15/2001	373.53	1,200	6/21/2006	0.07	1,011
6/1/2001	660.20	3,800	4/25/2007	451.71	> 2419.6[(1)]
6/12/2001	11.87	100	5/23/2007	3.21	157
7/11/2001	2.49	380	6/21/2007	1.33	276
8/14/2001	0.14	200	8/8/2007	0.35	411
9/27/2001	0.28	280	8/21/2007	3.27	> 2419.6[(1)]
10/16/2001	1.48	250	9/11/2007	0.38	201
11/13/2001	1.07	41	9/27/2007	0.17	291
3/26/2002	4.92	20	10/4/2007	0.47	104
4/16/2002	8.69	270	10/18/2007	171.42	> 2419.6[(1)]
5/14/2002	332.99	1,500	11/13/2007	1.94	31
6/11/2002	9.27	1,000	5/29/2008	11.00	150
7/23/2002	0.46	1,200	6/3/2008	142.75	1,986
8/13/2002	0.13	1,100	6/16/2008	192.56	387
4/15/2003	1.07	20	7/1/2008	11.99	687
5/14/2003	5.79	110	7/15/2008	4.26	313
6/17/2003	1.48	940	8/12/2008	8.05	158
7/15/2003	0.32	490	9/8/2008	2.87	167
7/29/2003	0.08	1,300	10/27/2008	33.88	687

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
11/4/2008	8.43	24	5/12/2011	28.23	8,200
5/14/2009	15.90	365	5/21/2011	187.06	24,000
5/28/2009	112.64	1,300	8/6/2011	18.01	9,800
6/18/2009	13.70	1,046	8/16/2011	2.77	1,500
6/25/2009	59.36	687	9/19/2011	0.25	210
7/16/2009	11.84	866	10/17/2011	0.04	20
8/11/2009	64.57	2,420	4/14/2012	32.43	6,900
8/17/2009	282.32	> 2419.6(1)	5/3/2012	495.15	16,000
9/23/2009	2.21	579	6/18/2012	48.36	8,200
10/27/2009	35.04	1,120	6/26/2012	19.14	790
3/22/2010	113.22	727	7/12/2012	0.02	720
4/19/2010	10.31	64	10/22/2012	0.95	440
4/24/2010	448.82	> 2419.6(1)			
5/11/2010	590.70	> 2419.6(1)			
5/26/2010	50.96	> 2419.6(1)	Min =	0.012	5
6/22/2010	361.95	> 2419.6(1)	1st Quartile =	1.01	197
7/13/2010	17.40	365	Median =	8.0	490
8/11/2010	103.95	> 2419.6(1)	3rd Quartile =	44.0	1,500
9/21/2010	301.14	> 2419.6(1)	Max =	660.2	24,000
10/9/2010	4.43	193	Mean(2) =	70.5	458
4/16/2011	233.68	13,000	Std Dev =	137.6	3,216

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.24. Water Quality Data for IA 05-CHA-1341 and STORET Site #15590004 (RA-42).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	86.79	650	7/13/2004	19.36	5,600
4/13/1999	3.86	760	3/16/2005	1.04	20
5/11/1999	4.30	470	4/13/2005	120.91	1,900
6/11/1999	77.14	2,400	5/10/2005	0.90	530
6/15/1999	8.31	980	6/15/2005	4.41	4,060
7/13/1999	1.63	570	6/29/2005	4.05	5,310
8/18/1999	0.30	520	4/12/2006	0.17	613
9/13/1999	0.10	150	5/25/2006	4.05	> 2419.6(1)
10/13/1999	0.11	110	8/28/2006	0.14	> 2419.6(1)
3/28/2000	0.06	20	4/25/2007	115.71	> 2419.6(1)
4/18/2000	0.10	260	6/5/2007	4.38	1,120
5/16/2000	0.12	430	8/8/2007	0.09	> 2419.6(1)
6/13/2000	7.42	10	8/21/2007	0.84	> 2419.6(1)
6/27/2000	50.44	1,000	9/11/2007	0.10	816
7/19/2000	1.04	120	9/27/2007	0.04	548
11/14/2000	0.10	270	10/4/2007	0.12	517
3/20/2001	42.65	880	10/18/2007	43.91	> 2419.6(1)
4/17/2001	10.16	470	11/13/2007	0.50	1,553
5/15/2001	95.69	4,900	5/29/2008	2.82	579
6/1/2001	169.12	5,000	6/3/2008	36.57	2,420
6/12/2001	3.04	410	6/16/2008	49.33	488
7/11/2001	0.64	400	7/1/2008	3.07	461
8/14/2001	0.04	220	7/15/2008	1.09	488
9/27/2001	0.07	110	8/12/2008	2.06	178
10/16/2001	0.38	1,500	9/8/2008	0.74	1,733
11/13/2001	0.27	1,300	10/27/2008	8.68	1,046
3/26/2002	1.26	10	5/14/2009	4.07	1,203
4/16/2002	2.23	500	5/28/2009	28.85	> 2419.6(1)
5/14/2002	85.30	2,000	6/18/2009	3.51	866
6/11/2002	2.37	1,900	6/25/2009	15.21	461
4/15/2003	0.27	81	7/16/2009	3.03	> 2419.6(1)
5/14/2003	1.48	520	8/11/2009	16.54	> 2419.6(1)
6/17/2003	0.38	80	8/17/2009	72.32	> 2419.6(1)
7/15/2003	0.08	530	9/23/2009	0.57	276
7/29/2003	0.02	190	10/27/2009	8.98	1,046
9/16/2003	0.37	1,400	3/22/2010	29.00	172
4/21/2004	2.23	670	4/19/2010	2.64	579
5/19/2004	1.19	2,300	4/24/2010	114.97	> 2419.6(1)
5/26/2004	38.79	4,100	5/11/2010	151.32	> 2419.6(1)
6/15/2004	144.64	4,500	5/26/2010	13.05	866
6/22/2004	2.45	600	6/22/2010	92.72	2,420

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/13/2010	4.46	1,120			
8/11/2010	26.63	2,420			
9/21/2010	77.14	1,300	Min =	0.006	10
10/9/2010	1.13	1,986	1st Quartile =	0.38	461
8/15/2011	0.67	620	Median =	2.4	760
9/20/2011	0.05	750	3rd Quartile =	18.0	2,350
10/18/2011	0.01	<10(1)	Max =	169.1	5,600
6/27/2012	1.46	460	Mean(2) =	21.3	679
7/12/2012	0.01	41	Std Dev =	38.9	1,298

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.25. Water Quality Data for IA 05-CHA-2019 and STORET Site #15680001 (RA-43).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
6/11/1999	42.86	2,400	4/13/2005	67.17	230
6/15/1999	4.62	1,600	5/10/2005	0.50	40
7/13/1999	0.91	290	4/12/2006	0.09	58
8/18/1999	0.16	100	4/27/2006	0.05	34
9/13/1999	0.05	63	4/25/2007	64.29	> 2419.6(1)
3/28/2000	0.04	1,300	8/8/2007	0.05	> 2419.6(1)
4/18/2000	0.05	20	8/21/2007	0.47	> 2419.6(1)
5/16/2000	0.07	10	9/11/2007	0.05	121
6/13/2000	4.12	61	10/18/2007	24.40	> 2419.6(1)
6/27/2000	28.02	550	11/13/2007	0.28	326
7/19/2000	0.58	4,400	5/29/2008	1.57	345
8/15/2000	0.29	1,200	6/3/2008	20.32	> 2419.6(1)
10/17/2000	0.02	10	6/16/2008	27.40	365
11/14/2000	0.05	10	7/1/2008	1.71	285
3/20/2001	23.70	160	7/15/2008	0.61	921
4/17/2001	5.65	200	8/12/2008	1.15	1,986
5/15/2001	53.16	170	9/8/2008	0.41	> 2419.6(1)
6/1/2001	93.96	440	10/27/2008	4.82	299
6/12/2001	1.69	520	11/4/2008	1.20	11
7/11/2001	0.35	680	5/14/2009	2.26	> 2419.6(1)
8/14/2001	0.02	74	5/28/2009	16.03	> 2419.6(1)
9/27/2001	0.04	460	6/18/2009	1.95	436
10/16/2001	0.21	98	6/25/2009	8.45	285
11/13/2001	0.15	150	7/16/2009	1.69	1,203
3/26/2002	0.70	10	8/11/2009	9.19	921
4/16/2002	1.24	10	8/17/2009	40.18	2,420
5/14/2002	47.39	420	9/23/2009	0.31	816
6/11/2002	1.32	3,100	10/27/2009	4.99	387
4/15/2003	0.15	10	3/22/2010	16.11	21
5/14/2003	0.82	72	4/19/2010	1.47	135
6/17/2003	0.21	260	4/24/2010	63.87	> 2419.6(1)
7/15/2003	0.05	1,400	5/11/2010	84.07	980
7/29/2003	0.01	550	5/26/2010	7.25	291
3/31/2004	4.41	130	6/22/2010	51.51	1,203
5/26/2004	21.55	950	7/13/2010	2.48	687
6/15/2004	80.36	2,100	8/11/2010	14.79	2,420
6/22/2004	1.36	880	9/21/2010	42.86	579
7/13/2004	10.76	930	8/16/2011	0.39	2,900
7/20/2004	0.19	1,400	9/19/2011	0.04	180
9/21/2004	0.18	80	10/17/2011	0.01	370
3/16/2005	0.58	40	6/26/2012	2.72	440

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/11/2012	0.003	34,000	Min =	0.003	10
			1st Quartile =	0.19	126
			Median =	1.3	436
			3rd Quartile =	12.8	1,350
			Max =	94.0	34,000
			Mean(2) =	12.3	353
			Std Dev =	22.0	3,743

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Water Quality Data in South Fork Chariton River HUC 10 impaired segments

Table C.26. Water Quality Data for IA 05-CHA-1327 and STORET Site #15930001 (RA-12).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	340.05	420	6/17/2003	1.11	200
4/13/1999	19.28	200	7/15/2003	0.53	310
5/11/1999	11.50	330	7/29/2003	1.59	920
6/11/1999	213.23	2,400	8/12/2003	0.17	120
6/15/1999	19.65	740	9/16/2003	2.04	550
7/13/1999	1.97	100	10/16/2003	1.49	60
8/18/1999	0.96	1,300	3/31/2004	32.67	410
9/13/1999	0.48	470	4/21/2004	10.01	420
10/13/1999	0.32	210	5/19/2004	9.68	51,000
11/15/1999	0.48	31	5/26/2004	40.42	3,200
3/28/2000	0.59	41	6/22/2004	14.65	300
4/18/2000	0.56	10	7/13/2004	40.79	4,600
5/16/2000	0.19	10	7/20/2004	2.43	350
6/13/2000	1.00	360	8/17/2004	2.47	430
6/27/2000	74.54	930	9/21/2004	1.34	300
7/19/2000	4.08	930	10/19/2004	1.25	120
8/15/2000	1.41	390	3/16/2005	6.16	36
9/12/2000	0.09	85	4/13/2005	133.87	2,900
10/17/2000	0.10	86	5/10/2005	4.97	100
11/14/2000	0.82	850	6/15/2005	6.27	782
3/20/2001	301.49	610	6/29/2005	54.14	1,652
4/17/2001	37.08	290	7/20/2005	1.19	364
5/15/2001	143.14	6,900	7/28/2005	3.19	2,400
6/1/2001	574.79	3,800	8/25/2005	0.52	393
6/12/2001	14.83	100	9/13/2005	0.19	59
7/11/2001	2.56	300	3/16/2006	1.40	28
8/14/2001	0.56	990	4/12/2006	1.85	62
9/27/2001	0.74	1,700	4/27/2006	0.89	64
10/16/2001	1.11	280	5/25/2006	13.42	> 2419.6[1]
11/13/2001	1.48	140	6/7/2006	0.30	238
3/26/2002	5.93	10	6/21/2006	0.18	119
4/16/2002	11.13	10	7/27/2006	0.10	330
5/14/2002	74.54	840	8/28/2006	0.63	1,986
6/11/2002	8.53	1,300	9/13/2006	0.57	411
7/23/2002	0.45	270	10/12/2006	0.09	93
8/13/2002	0.48	390	4/25/2007	1,449.96	> 2419.6[1]
9/17/2002	0.32	50	5/23/2007	4.34	126
10/24/2002	0.26	140	6/5/2007	11.09	579
11/12/2002	0.27	80	6/21/2007	2.10	387
4/15/2003	0.60	90	7/17/2007	0.68	157
5/14/2003	6.23	120	7/26/2007	0.42	91

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
8/8/2007	101.608	> 2419.6(1)	4/24/2010	370.833	> 2419.6(1)
8/21/2007	1.787	2,420	5/11/2010	1,449.958	> 2419.6(1)
9/11/2007	3.393	122	5/26/2010	305.196	> 2419.6(1)
9/27/2007	2.295	548	6/22/2010	138.321	> 2419.6(1)
10/4/2007	5.451	2,420	7/13/2010	18.838	488
10/18/2007	545.125	> 2419.6(1)	8/11/2010	141.288	> 2419.6(1)
11/13/2007	3.197	144	9/21/2010	534.000	1,986
5/29/2008	24.957	387	10/9/2010	12.423	109
6/3/2008	956.750	1,986	4/16/2011	452.417	16,000
6/16/2008	102.350	> 2419.6(1)	5/12/2011	34.450	8,200
7/1/2008	29.741	173	6/21/2011	97.529	25,000
7/15/2008	15.723	291	7/25/2011	3.200	54,000
8/12/2008	9.790	35	8/15/2011	0.979	170
9/8/2008	8.455	272	9/19/2011	0.508	110
10/27/2008	17.948	921	10/17/2011	0.675	190
11/4/2008	4.487	41	5/3/2012	167.246	20,000
5/14/2009	79.358	> 2419.6(1)	6/26/2012	2.377	550
5/28/2009	71.942	> 2419.6(1)	7/11/2012	0.171	5
6/18/2009	12.794	147	10/22/2012	5.043	2,000
6/25/2009	61.929	173			
7/16/2009	15.019	> 2419.6(1)	Min =	0.085	10
8/11/2009	12.794	1,300	1st Quartile =	0.89	122
8/17/2009	500.625	> 2419.6(1)	Median =	5.0	387
9/23/2009	4.116	238	3rd Quartile =	37.1	1,986
10/27/2009	59.704	2,420	Max =	1,450.0	54,000
3/22/2010	210.633	285	Mean(2) =	82.7	436
4/19/2010	12.015	40	Std Dev =	225.2	7,205

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.27. Water Quality Data for IA 05-CHA-1328 and STORET Site #15930002 (RA-35).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	221.61	100	5/26/2004	26.34	910
4/13/1999	12.57	350	6/15/2004	306.92	2,600
5/11/1999	7.49	400	7/13/2004	26.58	4,000
6/11/1999	138.96	2,400	7/20/2004	1.58	45,000
6/15/1999	12.81	630	8/17/2004	1.61	81
7/13/1999	1.28	100	9/21/2004	0.87	50
8/18/1999	0.63	200	10/19/2004	0.81	80
9/13/1999	0.31	620	3/16/2005	4.01	10
10/13/1999	0.21	85	4/13/2005	87.24	4,000
3/28/2000	0.39	10	5/10/2005	3.24	270
4/18/2000	0.36	10	6/15/2005	4.08	406
5/16/2000	0.12	10	6/29/2005	35.28	1,370
6/13/2000	0.65	10	7/28/2005	2.08	12,997
6/27/2000	48.58	1,500	4/12/2006	1.21	96
7/19/2000	2.66	260	4/27/2006	0.58	45
8/15/2000	0.92	680	5/25/2006	8.75	1,986
10/17/2000	0.07	150	4/25/2007	944.92	> 2419.6[(1)]
11/14/2000	0.53	98	5/23/2007	2.83	74
3/20/2001	196.48	320	6/5/2007	7.23	649
4/17/2001	24.17	430	6/21/2007	1.37	161
5/15/2001	93.28	16,000	8/8/2007	66.22	> 2419.6[(1)]
6/1/2001	374.58	6,600	8/21/2007	1.16	> 2419.6[(1)]
6/12/2001	9.67	200	9/11/2007	2.21	1,300
7/11/2001	1.67	63	9/27/2007	1.50	613
8/14/2001	0.36	20	10/4/2007	3.55	> 2419.6[(1)]
9/27/2001	0.48	430	10/18/2007	355.25	> 2419.6[(1)]
10/16/2001	0.73	390	11/13/2007	2.08	49
11/13/2001	0.97	85	5/29/2008	16.26	727
3/26/2002	3.87	10	6/3/2008	623.50	1,414
4/16/2002	7.25	73	6/16/2008	66.70	2,420
5/14/2002	48.58	520	7/1/2008	19.38	1,733
6/11/2002	5.56	900	7/15/2008	10.25	435
7/23/2002	0.29	250	8/12/2008	6.38	184
4/15/2003	0.39	10	9/8/2008	5.51	1,553
5/14/2003	4.06	140	10/27/2008	11.70	1,203
6/17/2003	0.73	150	11/4/2008	2.92	145
7/15/2003	0.34	310	5/14/2009	51.72	> 2419.6[(1)]
7/29/2003	1.03	3,600	5/28/2009	46.88	1,986
9/16/2003	1.33	590	6/18/2009	8.34	727
10/16/2003	0.97	40	6/25/2009	40.36	1,733
5/19/2004	6.31	2,500	7/16/2009	9.79	649

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
8/11/2009	8.338	1,553	8/15/2011	0.638	180
8/17/2009	326.250	> 2419.6(1)	9/20/2011	0.338	310
9/23/2009	2.683	152	10/18/2011	0.479	2,100
10/27/2009	38.908	1,986	6/27/2012	1.032	690
3/22/2010	137.267	166	7/12/2012	0.128	63
4/19/2010	7.830	24			
4/24/2010	241.667	> 2419.6(1)			
5/11/2010	944.917	> 2419.6(1)	Min =	0.068	10
5/26/2010	198.892	> 2419.6(1)	1st Quartile =	0.97	118
6/22/2010	90.142	1,046	Median =	5.5	520
7/13/2010	12.277	613	3rd Quartile =	38.9	1,986
8/11/2010	92.075	> 2419.6(1)	Max =	944.9	45,000
9/21/2010	348.000	1,986	Mean(2) =	64.5	418
10/9/2010	8.096	118	Std Dev =	161.3	4,864

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.28. Water Quality Data for IA 05-CHA-1329 and STORET Site #15930005 (RA-38).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	87.33	260	8/17/2004	0.63	680
4/13/1999	4.95	250	10/19/2004	0.32	240
5/11/1999	2.95	4,100	3/16/2005	1.58	10
6/11/1999	54.76	2,400	4/13/2005	34.38	2,500
6/15/1999	5.05	630	5/10/2005	1.28	120
7/13/1999	0.50	60	6/15/2005	1.61	3,840
8/18/1999	0.25	100	6/29/2005	13.90	1,920
3/28/2000	0.15	10	4/12/2006	0.48	49
4/18/2000	0.14	95	4/25/2007	372.38	> 2419.6(1)
5/16/2000	0.05	31	5/23/2007	1.11	142
6/13/2000	0.26	330	6/5/2007	2.85	579
6/27/2000	19.14	380	8/8/2007	26.10	> 2419.6(1)
7/19/2000	1.05	24,000	9/11/2007	0.87	687
8/15/2000	0.36	160	9/27/2007	0.59	249
10/17/2000	0.03	41	10/4/2007	1.40	192
11/14/2000	0.21	200	10/18/2007	140.00	> 2419.6(1)
3/20/2001	77.43	86	11/13/2007	0.82	313
4/17/2001	9.52	210	5/29/2008	6.41	326
5/15/2001	36.76	1,600	6/3/2008	245.71	2,420
6/1/2001	147.62	1,300	6/16/2008	26.29	365
6/12/2001	3.81	200	7/1/2008	7.64	238
7/11/2001	0.66	31	7/15/2008	4.04	67
8/14/2001	0.14	74	5/14/2009	20.38	> 2419.6(1)
9/27/2001	0.19	110	5/28/2009	18.48	> 2419.6(1)
10/16/2001	0.29	74	6/18/2009	3.29	1,203
11/13/2001	0.38	52	6/25/2009	15.90	238
3/26/2002	1.52	10	7/16/2009	3.86	2,420
4/16/2002	2.86	100	8/11/2009	3.29	816
5/14/2002	19.14	2,100	8/17/2009	128.57	> 2419.6(1)
6/11/2002	2.19	210	9/23/2009	1.06	185
4/15/2003	0.15	10	10/27/2009	15.33	649
5/14/2003	1.60	200	3/22/2010	54.10	87
6/17/2003	0.29	180	4/19/2010	3.09	866
7/15/2003	0.14	400	4/24/2010	95.24	> 2419.6(1)
7/29/2003	0.41	1,000	5/11/2010	372.38	> 2419.6(1)
3/31/2004	8.39	340	5/26/2010	78.38	228
4/21/2004	2.57	480	9/21/2010	137.14	980
5/19/2004	2.49	6,400	8/16/2011	0.46	180
6/22/2004	3.76	670	9/19/2011	0.13	<10(1)
7/13/2004	10.48	2,600	10/17/2011	0.17	10
7/20/2004	0.62	1,200	6/26/2012	0.61	206

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/11/2012	0.044	10	Min =	0.027	10
			1st Quartile =	0.47	105
			Median =	2.6	260
			3rd Quartile =	17.2	1,252
			Max =	372.4	24,000
			Mean(2) =	28.3	320
			Std Dev =	68.5	2,777

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.29. Water Quality Data for IA 05-CHA-1330 and STORET Site #15930004 (RA-37).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	97.70	490	10/16/2003	0.43	40
4/13/1999	5.54	330	3/31/2004	9.39	420
5/11/1999	3.30	520	4/21/2004	2.88	580
6/11/1999	61.26	2,400	5/19/2004	2.78	4,000
6/15/1999	5.65	200	5/26/2004	11.61	3,600
7/13/1999	0.56	50	6/15/2004	135.32	4,000
8/18/1999	0.28	1,300	6/22/2004	4.21	2,700
9/13/1999	0.14	41	7/13/2004	11.72	3,900
10/13/1999	0.09	20	7/20/2004	0.70	580
11/15/1999	0.14	10	8/17/2004	0.71	680
3/28/2000	0.17	10	9/21/2004	0.39	2,100
4/18/2000	0.16	10	10/19/2004	0.36	460
5/16/2000	0.05	190	3/16/2005	1.77	63
6/13/2000	0.29	280	4/13/2005	38.46	1,100
6/27/2000	21.42	730	5/10/2005	1.43	450
7/19/2000	1.17	910	6/29/2005	15.56	288
8/15/2000	0.40	120	3/16/2006	0.40	17
10/17/2000	0.03	31	4/12/2006	0.53	91
11/14/2000	0.23	750	4/27/2006	0.25	42
3/20/2001	86.62	110	5/25/2006	3.86	365
4/17/2001	10.65	280	4/25/2007	416.60	> 2419.6[(1)]
5/15/2001	41.13	930	5/23/2007	1.25	866
6/1/2001	165.15	1,500	6/5/2007	3.19	2,420
6/12/2001	4.26	2,800	8/8/2007	29.19	> 2419.6[(1)]
7/11/2001	0.74	270	8/21/2007	0.51	1,986
8/14/2001	0.16	360	9/11/2007	0.97	488
9/27/2001	0.21	1,300	9/27/2007	0.66	1,203
10/16/2001	0.32	320	10/4/2007	1.57	> 2419.6[(1)]
11/13/2001	0.43	350	10/18/2007	156.63	> 2419.6[(1)]
3/26/2002	1.70	10	11/13/2007	0.92	261
4/16/2002	3.20	10	5/29/2008	7.17	1,553
5/14/2002	21.42	700	6/3/2008	274.89	> 2419.6[(1)]
6/11/2002	2.45	7,500	6/16/2008	29.41	687
7/23/2002	0.13	63	7/1/2008	8.55	1,203
8/13/2002	0.14	460	7/15/2008	4.52	1,203
4/15/2003	0.17	10	8/12/2008	2.81	2,420
5/14/2003	1.79	150	9/8/2008	2.43	1,986
6/17/2003	0.32	430	10/27/2008	5.16	816
7/15/2003	0.15	380	11/4/2008	1.29	201
7/29/2003	0.46	490	5/14/2009	22.80	> 2419.6[(1)]
8/12/2003	0.05	20	5/28/2009	20.67	1,733

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
6/18/2009	3.676	869	10/9/2010	3.569	435
6/25/2009	17.793	1,203	8/15/2011	0.281	420
7/16/2009	4.315	2,420	9/19/2011	0.146	140
8/11/2009	3.676	1,986	10/17/2011	0.194	270
8/17/2009	143.839	> 2419.6(1)	6/26/2012	0.683	420
9/23/2009	1.183	> 2419.6(1)	7/11/2012	0.049	240
10/27/2009	17.154	> 2419.6(1)	10/22/2012	1.449	2,800
3/22/2010	60.519	163			
4/19/2010	3.452	866			
4/24/2010	106.548	> 2419.6(1)	Min =	0.030	10
5/11/2010	416.601	> 2419.6(1)	1st Quartile =	0.40	261
5/26/2010	87.689	> 2419.6(1)	Median =	2.5	680
6/22/2010	39.742	1,986	3rd Quartile =	15.6	2,100
7/13/2010	5.413	> 2419.6(1)	Max =	416.6	7,500
8/11/2010	40.595	> 2419.6(1)	Mean(2) =	27.5	495
9/21/2010	153.429	1,553	Std Dev =	69.9	1,226

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.

(2) For *E. coli* this is a geomean.

Table C.30. Water Quality Data for IA 05-CHA-1332 and STORET Site #15930006 (RA-39).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	294.75	82	6/17/2003	0.96	70
4/13/1999	16.71	160	7/15/2003	0.46	2,500
5/11/1999	9.96	240	7/29/2003	1.38	2,800
6/11/1999	184.82	2,400	8/12/2003	0.15	1,100
6/15/1999	17.04	200	9/16/2003	1.76	2,500
7/13/1999	1.70	10	10/16/2003	1.29	260
8/18/1999	0.84	1,700	3/31/2004	28.32	270
9/13/1999	0.42	7,300	4/21/2004	8.68	200
10/13/1999	0.27	610	5/19/2004	8.39	5,100
11/15/1999	0.42	180	5/26/2004	35.04	2,000
3/28/2000	0.51	41	6/22/2004	12.70	270
4/18/2000	0.48	140	7/13/2004	35.36	4,300
5/16/2000	0.16	1,300	7/20/2004	2.11	740
6/13/2000	0.87	700	8/17/2004	2.14	450
6/27/2000	64.61	1,100	9/21/2004	1.16	2,000
7/19/2000	3.54	3,100	10/19/2004	1.08	200
8/15/2000	1.22	1,500	3/16/2005	5.34	40
9/12/2000	0.08	400	4/13/2005	116.04	200
10/17/2000	0.09	150	5/10/2005	4.31	30
11/14/2000	0.71	300	6/15/2005	5.43	1,445
3/20/2001	261.32	110	6/29/2005	46.93	1,445
4/17/2001	32.14	280	7/28/2005	2.76	1,733
5/15/2001	124.07	990	8/25/2005	0.45	6,867
6/1/2001	498.21	3,400	3/16/2006	1.21	30
6/12/2001	12.86	100	4/12/2006	1.60	105
7/11/2001	2.22	710	4/27/2006	0.77	24
8/14/2001	0.48	470	5/25/2006	11.64	770
9/27/2001	0.64	630	6/7/2006	0.26	387
10/16/2001	0.96	230	6/21/2006	0.16	143
11/13/2001	1.29	400	7/27/2006	0.09	416
3/26/2002	5.14	10	8/28/2006	0.55	> 2419.6(1)
4/16/2002	9.64	36	9/13/2006	0.50	1,046
5/14/2002	64.61	910	4/25/2007	1,256.79	> 2419.6(1)
6/11/2002	7.39	640	5/23/2007	3.76	1,986
7/23/2002	0.39	870	6/5/2007	9.61	613
8/13/2002	0.42	3,000	6/21/2007	1.82	816
9/17/2002	0.27	3,000	7/17/2007	0.59	1,986
10/24/2002	0.23	4,000	7/26/2007	0.37	548
11/12/2002	0.23	1,300	8/8/2007	88.07	> 2419.6(1)
4/15/2003	0.52	99	8/21/2007	1.55	> 2419.6(1)
5/14/2003	5.40	380	9/11/2007	2.94	326

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
10/4/2007	4.725	291	6/22/2010	119.893	> 2419.6(1)
10/18/2007	472.500	> 2419.6(1)	7/13/2010	16.329	866
11/13/2007	2.771	548	8/11/2010	122.464	1,120
5/29/2008	21.632	326	9/21/2010	462.857	1,733
6/3/2008	829.286	1,986	10/9/2010	10.768	299
6/16/2008	88.714	> 2419.6(1)	4/16/2011	392.143	14,000
7/1/2008	25.779	344	5/13/2011	18.771	2,600
7/15/2008	13.629	579	5/21/2011	145.929	24,000
8/12/2008	8.486	1,553	8/15/2011	0.849	460
9/8/2008	7.329	> 2419.6(1)	9/19/2011	0.440	150
10/27/2008	15.557	416	10/17/2011	0.585	220
11/4/2008	3.889	62	4/14/2012	66.536	9,200
5/14/2009	68.786	> 2419.6(1)	5/7/2012	221.143	8,700
5/28/2009	62.357	2,420	6/26/2012	2.060	740
6/18/2009	11.089	548	7/11/2012	0.148	10
6/25/2009	53.679	344	8/27/2012	0.919	7,300
7/16/2009	13.018	866	10/22/2012	4.371	1,200
8/11/2009	11.089	1,300			
8/17/2009	433.929	> 2419.6(1)			
9/23/2009	3.568	488	Min =	0.080	10
10/27/2009	51.750	1,733	1st Quartile =	0.84	260
3/22/2010	182.571	133	Median =	4.7	740
4/19/2010	10.414	72	3rd Quartile =	35.0	2,420
4/24/2010	321.429	> 2419.6(1)	Max =	1,256.8	24,000
5/11/2010	1,256.786	> 2419.6(1)	Mean(2) =	73.3	640
5/26/2010	264.536	> 2419.6(1)	Std Dev =	195.6	2,861

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.

Table C.31. Water Quality Data for IA 05-CHA-1335 and STORET Site #15930003 (RA-36).

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
3/17/1999	95.52	280	5/19/2004	2.72	2,600
4/13/1999	5.42	170	5/26/2004	11.35	2,600
5/11/1999	3.23	540	6/15/2004	132.29	2,200
6/11/1999	59.90	2,400	6/22/2004	4.11	190
6/15/1999	5.52	970	7/13/2004	11.46	2,100
7/13/1999	0.55	450	7/20/2004	0.68	530
8/18/1999	0.27	1,200	9/21/2004	0.38	80
9/13/1999	0.14	250	3/16/2005	1.73	10
10/13/1999	0.09	350	4/13/2005	37.60	390
11/15/1999	0.14	350	5/10/2005	1.40	160
3/28/2000	0.17	10	6/15/2005	1.76	429
4/18/2000	0.16	130	3/16/2006	0.39	25
5/16/2000	0.05	10	4/12/2006	0.52	< 1.0[3]
6/13/2000	0.28	370	6/7/2006	0.08	1,733
6/27/2000	20.94	270	4/25/2007	407.29	> 2419.6[1]
7/19/2000	1.15	1,000	5/23/2007	1.22	139
10/17/2000	0.03	150	6/5/2007	3.11	411
11/14/2000	0.23	200	6/21/2007	0.59	1,203
3/20/2001	84.69	41	7/17/2007	0.19	411
4/17/2001	10.42	290	8/8/2007	28.54	> 2419.6[1]
5/15/2001	40.21	1,400	8/21/2007	0.50	770
6/1/2001	161.46	790	9/11/2007	0.95	192
6/12/2001	4.17	860	9/27/2007	0.64	248
7/11/2001	0.72	4,600	10/4/2007	1.53	1,300
8/14/2001	0.16	2,500	10/18/2007	153.13	> 2419.6[1]
9/27/2001	0.21	190	11/13/2007	0.90	71
10/16/2001	0.31	470	5/29/2008	7.01	194
11/13/2001	0.42	150	6/3/2008	268.75	1,733
3/26/2002	1.67	10	6/16/2008	28.75	204
4/16/2002	3.13	91	7/1/2008	8.35	435
5/14/2002	20.94	800	7/15/2008	4.42	162
6/11/2002	2.40	310	8/12/2008	2.75	579
7/23/2002	0.13	540	9/8/2008	2.38	> 2419.6[1]
8/13/2002	0.14	54,000	10/27/2008	5.04	980
4/15/2003	0.17	10	5/14/2009	22.29	2,420
5/14/2003	1.75	54	5/28/2009	20.21	1,986
6/17/2003	0.31	410	6/18/2009	3.59	980
7/15/2003	0.15	1,100	6/25/2009	17.40	435
7/29/2003	0.45	3,000	7/16/2009	4.22	1,046
3/31/2004	9.18	310	8/11/2009	3.59	980
4/21/2004	2.81	2,500	8/17/2009	140.63	> 2419.6[1]

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
9/23/2009	1.156	70	9/20/2011	0.146	120
10/27/2009	16.771	866	10/18/2011	0.206	120
3/22/2010	59.167	151	6/27/2012	0.445	910
4/19/2010	3.375	39	7/12/2012	0.055	110
4/24/2010	104.167	> 2419.6(1)	10/23/2012	1.302	75
5/11/2010	407.292	> 2419.6(1)			
5/26/2010	85.729	308	Min =	0.029	1
6/22/2010	38.854	435	1st Quartile =	0.39	168
7/13/2010	5.292	579	Median =	2.6	435
8/11/2010	39.688	914	3rd Quartile =	16.9	1,201
9/21/2010	150.000	841	Max =	407.3	54,000
10/9/2010	3.490	1,733	Mean(1) =	28.0	403
8/15/2011	0.275	410	Std Dev =	69.8	5,367

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.
(3) *E. coli* was not detectable. The minimum detection limit is 1 orgs/100/ml. Consequently, 0.5 orgs/100 ml was used in calculations.

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Table C.32. Water Quality Data for IA 05-CHA-1307 and STORET Site #10040002.

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
10/25/1999	4.40	27	4/4/2005	7.75	10
4/3/2000	5.87	27	5/2/2005	136.48	20
5/2/2000	4.55	140	6/1/2005	11.43	90
6/20/2000	5.58	530	7/6/2005	61.05	40
7/24/2000	6.46	170	8/1/2005	5.28	140
8/28/2000	4.84	320	9/6/2005	5.05	30
9/12/2000	4.99	280	10/3/2005	5.17	430
10/5/2000	6.02	940	11/1/2005	3.38	50
11/9/2000	6.31	330	4/4/2006	13.22	140
4/3/2001	236.28	Not Detected(3)	5/2/2006	26.12	2,100
5/1/2001	151.16	18	6/1/2006	4.65	180
6/6/2001	396.24	4,900	7/3/2006	4.64	250
7/3/2001	228.94	20	8/1/2006	4.39	100
8/1/2001	145.58	30	9/6/2006	4.64	200
9/4/2001	6.75	140	10/2/2006	4.89	50
10/2/2001	5.58	280	11/1/2006	4.26	20
11/5/2001	6.60	120	4/2/2007	18.34	90
4/1/2002	14.82	10	5/1/2007	142.94	27
5/1/2002	23.19	240	6/4/2007	88.64	50
6/3/2002	231.88	10	7/5/2007	186.38	20
7/1/2002	39.33	140	8/1/2007	9.16	36
8/5/2002	5.14	160	9/5/2007	149.69	60
9/4/2002	4.26	110	10/1/2007	134.87	20
10/1/2002	4.98	140	11/5/2007	118.87	30
11/5/2002	5.06	54	4/1/2008	265.63	450
4/1/2003	5.24	10	5/5/2008	132.37	30
5/5/2003	104.34	4,500	6/2/2008	130.61	60
6/4/2003	5.96	54	7/9/2008	1,306.14	6,700
7/2/2003	7.85	300	8/6/2008	223.07	40
8/4/2003	5.44	120	9/4/2008	224.54	60
9/1/2003	7.22	200	4/1/2009	233.34	10
10/1/2003	5.08	81	5/4/2009	144.56	80
11/3/2003	14.82	490	6/1/2009	134.28	98
4/5/2004	39.92	Not Detected(3)	7/1/2009	128.27	150
5/3/2004	5.88	110	8/3/2009	176.11	20
6/1/2004	206.93	2,000	9/1/2009	136.19	98
7/1/2004	117.26	81	10/5/2009	128.56	31
8/2/2004	10.10	1,200	11/2/2009	149.69	110
9/1/2004	118.43	260	4/5/2010	223.07	Not Detected(3)
10/4/2004	18.49	100	5/3/2010	231.88	41
11/1/2004	15.85	700	6/1/2010	218.67	30

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/1/2010	233.343	31	10/1/2015	120.781	41
8/2/2010	441.738	41	11/9/2015	121.515	10
9/1/2010	466.686	85	4/11/2016	8.629	41
10/4/2010	459.349	20	5/2/2016	37.129	270
11/1/2010	159.965	30	6/1/2016	64.279	200
4/4/2011	8.512	31	7/11/2016	5.048	110
5/3/2011	77.341	41	8/1/2016	4.931	390
6/1/2011	141.327	200	9/1/2016	5.885	63
7/5/2011	249.486	41	10/3/2016	4.593	120
8/1/2011	237.746	63	11/2/2016	3.742	270
9/1/2011	7.602	250	4/3/2017	16.290	10
10/3/2011	5.004	20	5/8/2017	159.965	31
11/2/2011	4.168	680	6/1/2017	21.280	10
4/2/2012	7.455	1,200	7/3/2017	4.153	230
5/1/2012	16.730	960	8/1/2017	4.168	74
6/11/2012	4.373	260	9/6/2017	3.640	63
7/3/2012	3.948	130	10/5/2017	3.463	63
8/1/2012	3.742	120	11/6/2017	3.507	10
9/4/2012	3.860	120	4/3/2018	5.430	20
10/1/2012	3.786	140	5/1/2018	3.742	52
11/5/2012	4.021	120	6/4/2018	3.962	260
4/1/2013	15.409	10	7/5/2018	3.757	170
5/1/2013	140.740	20	8/1/2018	3.992	31
6/3/2013	325.800	10	9/5/2018	7.030	280
7/1/2013	242.149	10	10/1/2018	4.828	140
8/5/2013	192.251	10	11/5/2018	226.005	31
9/3/2013	69.563	10	4/2/2019	303.786	Not Detected(3)
10/2/2013	3.478	97	5/1/2019	217.200	500
11/4/2013	4.183	75	6/3/2019	228.941	97
4/1/2014	6.780	Not Detected(3)	7/1/2019	321.397	20
5/1/2014	107.279	20	8/5/2019	6.560	31
6/2/2014	130.026	20	9/4/2019	8.996	86
7/1/2014	103.610	20	10/1/2019	290.578	1,500
8/5/2014	5.782	190	11/5/2019	42.266	10
9/3/2014	158.497	20	4/1/2020	89.668	Not Detected(3)
10/2/2014	140.593	300	5/7/2020	8.130	41
11/5/2014	128.119	20	6/8/2020	223.070	31
4/2/2015	5.988	20	7/8/2020	5.063	52
5/4/2015	5.826	170	8/4/2020	3.698	63
6/1/2015	131.347	31	9/9/2020	5.386	460
7/6/2015	221.603	Not Detected(3)	10/1/2020	3.023	75
8/3/2015	270.032	Not Detected(3)	11/2/2020	1.981	20
9/2/2015	137.364	31	4/5/2021	161.432	Not Detected(3)

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
5/3/2021	11.065	160	Min =	1.981	5
6/1/2021	63.546	31	1st Quartile =	5.07	20
7/6/2021	63.399	20	Median =	15.8	63
8/4/2021	220.135	Not Detected(3)	3rd Quartile =	142.1	170
9/1/2021	16.877	390	Max =	1,306.1	6,700
10/5/2021	3.111	120	Mean(2) =	90.5	68
11/9/2021	13.634	85	Std Dev =	139.2	749

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.
(3) *E. coli* was not detectable. The minimum detection limit is 10 orgs/100/ml. Consequently, 5.0 orgs/100 ml was used in calculations.

Table C.33. Water Quality Data for IA 05-CHA-1308 and STORET Site #10040002.

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
10/25/1999	29.18	27	4/4/2005	51.36	10
4/3/2000	38.91	27	5/2/2005	904.61	20
5/2/2000	30.15	140	6/1/2005	75.77	90
6/20/2000	36.96	530	7/6/2005	404.64	40
7/24/2000	42.80	170	8/1/2005	35.02	140
8/28/2000	32.10	320	9/6/2005	33.46	30
9/12/2000	33.07	280	10/3/2005	34.24	430
10/5/2000	39.88	940	11/1/2005	22.37	50
11/9/2000	41.83	330	4/4/2006	87.64	140
4/3/2001	1,566.05	Not Detected(3)	5/2/2006	173.14	2,100
5/1/2001	1,001.88	18	6/1/2006	30.83	180
6/6/2001	2,626.30	4,900	7/3/2006	30.74	250
7/3/2001	1,517.42	20	8/1/2006	29.08	100
8/1/2001	964.92	30	9/6/2006	30.74	200
9/4/2001	44.74	140	10/2/2006	32.39	50
10/2/2001	36.96	280	11/1/2006	28.21	20
11/5/2001	43.77	120	4/2/2007	121.59	90
4/1/2002	98.24	10	5/1/2007	947.41	27
5/1/2002	153.69	240	6/4/2007	587.51	50
6/3/2002	1,536.87	10	7/5/2007	1,235.33	20
7/1/2002	260.68	140	8/1/2007	60.70	36
8/5/2002	34.04	160	9/5/2007	992.16	60
9/4/2002	28.21	110	10/1/2007	893.91	20
10/1/2002	32.97	140	11/5/2007	787.89	30
11/5/2002	33.56	54	4/1/2008	1,760.59	450
4/1/2003	34.73	10	5/5/2008	877.38	30
5/5/2003	691.59	4,500	6/2/2008	865.71	60
6/4/2003	39.49	54	7/9/2008	8,657.05	6,700
7/2/2003	52.04	300	8/6/2008	1,478.51	40
8/4/2003	36.09	120	9/4/2008	1,488.24	60
9/1/2003	47.86	200	4/1/2009	1,546.60	10
10/1/2003	33.66	81	5/4/2009	958.11	80
11/3/2003	98.24	490	6/1/2009	890.02	98
4/5/2004	264.58	Not Detected(3)	7/1/2009	850.14	150
5/3/2004	39.01	110	8/3/2009	1,167.24	20
6/1/2004	1,371.51	2,000	9/1/2009	902.67	98
7/1/2004	777.19	81	10/5/2009	852.09	31
8/2/2004	66.92	1,200	11/2/2009	992.16	110
9/1/2004	784.97	260	4/5/2010	1,478.51	Not Detected(3)
10/4/2004	122.56	100	5/3/2010	1,536.87	41
11/1/2004	105.05	700	6/1/2010	1,449.33	30

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
7/1/2010	1,546.60	31	10/1/2015	800.53	41
8/2/2010	2,927.84	41	11/9/2015	805.40	10
9/1/2010	3,093.19	85	4/11/2016	57.19	41
10/4/2010	3,044.56	20	5/2/2016	246.09	270
11/1/2010	1,060.25	30	6/1/2016	426.04	200
4/4/2011	56.42	31	7/11/2016	33.46	110
5/3/2011	512.61	41	8/1/2016	32.68	390
6/1/2011	936.71	200	9/1/2016	39.01	63
7/5/2011	1,653.59	41	10/3/2016	30.45	120
8/1/2011	1,575.78	63	11/2/2016	24.80	270
9/1/2011	50.39	250	4/3/2017	107.97	10
10/3/2011	33.17	20	5/8/2017	1,060.25	31
11/2/2011	27.62	680	6/1/2017	141.04	10
4/2/2012	49.41	1,200	7/3/2017	27.53	230
5/1/2012	110.89	960	8/1/2017	27.62	74
6/11/2012	28.99	260	9/6/2017	24.12	63
7/3/2012	26.17	130	10/5/2017	22.96	63
8/1/2012	24.80	120	11/6/2017	23.25	10
9/4/2012	25.58	120	4/3/2018	35.99	20
10/1/2012	25.10	140	5/1/2018	24.80	52
11/5/2012	26.65	120	6/4/2018	26.26	260
4/1/2013	102.13	10	7/5/2018	24.90	170
5/1/2013	932.82	20	8/1/2018	26.46	31
6/3/2013	2,159.40	10	9/5/2018	46.59	280
7/1/2013	1,604.96	10	10/1/2018	32.00	140
8/5/2013	1,274.24	10	11/5/2018	1,497.96	31
9/3/2013	461.06	10	4/2/2019	2,013.49	Not Detected(3)
10/2/2013	23.05	97	5/1/2019	1,439.60	500
11/4/2013	27.72	75	6/3/2019	1,517.42	97
4/1/2014	44.94	Not Detected(3)	7/1/2019	2,130.22	20
5/1/2014	711.05	20	8/5/2019	43.48	31
6/2/2014	861.81	20	9/4/2019	59.63	86
7/1/2014	686.73	20	10/1/2019	1,925.95	1,500
8/5/2014	38.32	190	11/5/2019	280.14	10
9/3/2014	1,050.52	20	4/1/2020	594.32	Not Detected(3)
10/2/2014	931.85	300	5/7/2020	53.89	41
11/5/2014	849.17	20	6/8/2020	1,478.51	31
4/2/2015	39.69	20	7/8/2020	33.56	52
5/4/2015	38.62	170	8/4/2020	24.51	63
6/1/2015	870.57	31	9/9/2020	35.70	460
7/6/2015	1,468.78	Not Detected(3)	10/1/2020	20.04	75
8/3/2015	1,789.77	Not Detected(3)	11/2/2020	13.13	20
9/2/2015	910.45	31	4/5/2021	1,069.97	Not Detected(3)

Date	Flow (cfs)	*E. coli* (orgs/100 ml)	Date	Flow (cfs)	*E. coli* (orgs/100 ml)
5/3/2021	73.34	160	Min =	13.131	5
6/1/2021	421.18	31	1st Quartile =	33.61	20
7/6/2021	420.21	20	Median =	105.1	63
8/4/2021	1,459.05	Not Detected(3)	3rd Quartile =	942.1	170
9/1/2021	111.86	390	Max =	8,657.1	6,700
10/5/2021	20.62	120	Mean(2) =	599.7	68
11/9/2021	90.36	85	Std Dev =	922.5	749

(1) Individual sampling points had *E. coli* values greater than quantification value of 2,419.6 orgs/100 ml. In these cases 2,419.6 orgs/100 ml was used for calculation purposes.
(2) For *E. coli* this is a geomean.
(3) *E. coli* was not detectable. The minimum detection limit is 10 orgs/100/ml. Consequently, 5.0 orgs/100 ml was used in calculations.

Appendix D - Flow Development and WLA Adjustments

The majority of the impaired stream segments are on ungaged streams. Consequently, was necessary to estimate average daily flow rates for those segments using estimation methods.

In all cases the drainage area ratio method was used to estimate average daily flow rates. If stream gages existed on impaired streams, no estimation methods would have been needed since average daily flow rates could be read directly from the gage data. A third method was used when the effluent discharge rates from NPDES permitted facilities exceeded the estimated average daily flow rates in the stream. A brief description of each method is given below.

Drainage Area Ratio (DAR)
This is a common method where average daily flows from a gaged site are transferred to an ungaged site by using the average daily flow at the reference gage multiplied by the ratio of the drainage areas of the unknown site to the reference gage.

Wastewater WLAs Exceed the Streams Loading Capacity (ELC)
In some cases, the WLA from the NPDES permitted facilities exceeds the loading capacity of the stream segment. This occurs when the design flows of the permitted facilities exceed the estimated average daily stream flow within a flow condition. In reality, flow from the treatment facility can never exceed stream flow because the effluent is part of the stream flow. In these cases, the WLA is assigned the TMDL target value less an MOS. A summary of these cases is below.

Table D.1 lists each of the impaired segments, the reference gage used, method used to estimate flow rates, and the watershed that the segment is located in. Reference gage locations are also shown in Figure 4.2, Figure 5.2, and Figure 6.2 for their respective HUC-10s.

Table D.1. Summary of Flow Determinations

Waterbody	Stream Segment	Reference Gage (USGS Gage)	Method	Watershed
Chariton River	IA 05-CHA-1307	06904010	DAR	CC
Chariton River	IA 05-CHA-1308	06904010	DAR	CC
Chariton River	IA 05-CHA-1310	06903400	DAR	WC
Chariton River	IA 05-CHA-1311	06903400	ELC	WC
Chariton River	IA 05-CHA-1312	06903400	ELC	WC
Chariton Creek	IA 05-CHA-1313	06903400	DAR	WC
S. Fork Chariton River	IA 05-CHA-1327	06903700	DAR	SFC
S. Fork Chariton River	IA 05-CHA-1328	06903700	DAR	SFC
Walker Branch	IA 05-CHA-1329	06903700	DAR	SFC
Jordan Creek	IA 05-CHA-1330	06903700	DAR	SFC
Jackson Creek	IA 05-CHA-1332	06903700	ELC	SFC
Ninemile Creek	IA 05-CHA-1335	06903700	DAR	SFC
Honey Creek	IA 05-CHA-1337	06903400	ELC	WC
Wolf Creek	IA 05-CHA-1339	06903400	DAR	WC
Fivemile Creek	IA 05-CHA-1341	06903400	DAR	WC
Honey Creek	IA 05-CHA-2019	06903400	DAR	WC

DAR - Drainage Area Ratio Method
ELC - NPDES Effluent Exceeds Estimated Stream Flow
WC -Wolf Creek - Chariton River HUC-10 Watershed
SFC - South Fork Chariton HUC-10 Watershed
CC - Cooper Creek - Chariton River HUC-10 Watershed

Summary of Cases Where WLA Exceeds the Stream Loading Capacity

Table D.2 through Table D.5 shows the loading capacity and the WLA for the SSM and the GM. Where the WLA exceeds the loading capacity minus the MOS the WLA is assigned the target loading capacity minus the MOS. These cases have been highlighted in bold text.

Chariton River, Segment IA 05-CHA-1311, Wolf Creek - Chariton River Watershed

Table D.2. Adjusted WLA for IA 05-CHA-1311

	Flow Condition	High	Moist	Mid-Range	Dry	Low
SSM	Loading Capacity (orgs/day)	1.80E+12	1.13E+11	2.58E+10	3.86E+09	**1.29E+08**
	WLA (orgs/day)	1.21E+09	1.21E+09	1.21E+09	1.21E+09	**1.21E+09**
	Adjusted WLA (orgs/day)	1.21E+09	1.21E+09	1.21E+09	1.21E+09	***1.16E+08***
GM	Loading Capacity (orgs/day)	9.67E+11	6.07E+10	1.38E+10	2.07E+09	***6.90E+07***
	WLA (orgs/day)	6.53E+08	6.53E+08	6.53E+08	6.53E+08	***6.53E+08***
	Adjusted WLA (orgs/day)	6.53E+08	6.53E+08	6.53E+08	6.53E+08	***6.21E+07***

Chariton River, Segment IA 05-CHA-1312, Wolf Creek - Chariton River Watershed

Table D.3. Adjusted WLA for IA 05-CHA-1312

	Flow Condition	High	Moist	Mid-Range	Dry	Low
SSM	Loading Capacity (orgs/day)	1.24E+12	7.80E+10	1.77E+10	***2.66E+09***	***8.87E+07***
	WLA (orgs/day)	2.42E+09	2.42E+09	2.42E+09	***2.42E+09***	***2.42E+09***
	Adjusted WLA (orgs/day)	2.42E+09	2.42E+09	2.42E+09	***2.40E+09***	***7.98E+07***
GM	Loading Capacity (orgs/day)	6.66E+11	4.18E+10	9.51E+09	***1.43E+09***	***4.76E+07***
	WLA (orgs/day)	1.30E+09	1.30E+09	1.30E+09	***1.30E+09***	***1.30E+09***
	Adjusted WLA (orgs/day)	1.30E+09	1.30E+09	1.30E+09	***1.28E+09***	***4.28E+07***

Jackson Creek, Segment IA 05-CHA-1332, South Fork Chariton River Watershed

Table D.4. Adjusted WLA for IA 05-CHA-1332

	Flow Condition	High	Moist	Mid-Range	Dry	Low
SSM	Loading Capacity (orgs/day)	1.42E+12	1.21E+11	2.94E+10	***4.74E+09***	***8.87E+08***
	WLA (orgs/day)	1.01E+10	1.01E+10	1.01E+10	***1.01E+10***	***1.01E+10***
	Adjusted WLA (orgs/day)	1.01E+10	1.01E+10	1.01E+10	***4.27E+09***	***7.98E+08***
GM	Loading Capacity (orgs/day)	7.63E+11	6.47E+10	1.58E+10	***2.54E+09***	***4.76E+08***
	WLA (orgs/day)	5.42E+09	5.42E+09	5.42E+09	***5.42E+09***	***5.42E+09***
	Adjusted WLA (orgs/day)	5.42E+09	5.42E+09	5.42E+09	***2.29E+09***	***4.28E+08***

Honey Creek, Segment IA 05-CHA-1337, Wolf Creek - Chariton River Watershed

Table D.5. Adjusted WLA for IA 05-CHA-1337

	Flow Condition	High	Moist	Mid-Range	Dry	Low
GM	Loading Capacity (orgs/day)	1.46E+12	9.17E+10	2.09E+10	3.13E+09	***1.04E+08***
	WLA (orgs/day)	1.48E+09	1.48E+09	1.48E+09	1.48E+09	***1.48E+09***
	Adjusted WLA (orgs/day)	1.48E+09	1.48E+09	1.48E+09	1.48E+09	***9.39E+07***

Appendix E - DNR Project Files and Locations

This appendix is primarily for future reference by DNR staff that may wish to access the original spreadsheets, models, maps, figures, and other files utilized in the development of the TMDL.

Table E.1. Project Files and Locations

Directory\folder path	File name	Description
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Data\Raw\WQ Data	Various Files: File Type:.XLSX Raw data for stream segment 1307 & 1308 and raw data for segments upstream of Rathbun Lake.	General Summary of all stream segments. Includes tabs with WQ Data for each stream organized by stream segment and data collection site.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Data\Reduced\Upper_Chariton_Flows	Various files, File Type: .XLS Example: “Wolf Creek HUC10.xlsx”. This is the stream flow calculations for streams in the Wolf Creek HUC10 watershed.	Stream Segment Flow Calculation spreadsheets. The flow calculations are organized by HUC-10 watersheds and subdivided by stream segment.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Modeling\LDC	Various files, File Type: .XLS Example 1: “IA 05-CHA-1308 LDC”. This is the LDC for stream segment IA 05-CHA-1308 on the Chariton River.	Load Duration Curve spreadsheets. The LDC’s are organized by HUC-10 watersheds and subdivided by stream within the listed directory.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Modeling\NPDES	Wasteload Allocations 072922.xlsx	Waste Load Allocation spreadsheets. The WLA’s are organized by HUC-10 watersheds.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Data\Weather	Various files, File Type: .XLS Example: “Climate_RathbunDam_2016-12-13.xlsx”. This file was developed from SWAT data as part of the Rathbun Lake TMDL..	Weather Data. 3 separate files exist for each HUC-10 watershed within the Upper Chariton River watershed.
\\iowa.gov.state.ia.us\data\DNR_GIS_Data\NASS\National_cropland_data_layer\CDL_2014\03RECODE\Grids. (Location of original file)	cdl2014rc, Raster File	National Crop Land Layer. This was used to generate Land Use Coverage data and statistics.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Data\Reduced\Land_Use	Combined LandUse.XLS	Land Use Statistics. The spreadsheet has a separate tab for each HUC-10 watershed in the Upper Chariton River watershed.
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\GIS\GIS_Data	Various shapefiles (.shp) and raster files (.grd)	Used to develop models and maps.

Directory\folder path	File name	Description
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Documents, Presentations\References	Various .pdf and .doc files	References cited in the WQIP and/or utilized to develop model input parameters
\\iowa.gov.state.ia.us\data\DNR_WQB_WIS_TMDL\Draft_TMDLs\UpperChariton-R_00\Data	Various Files Various File Formats	Raw data collected from various sources used to develop the report.

Appendix F - Public Comments

Public Comment:

All public comments received during the public comment period will be placed in this section, along with DNR responses.