Total Maximum Daily Loads
For Pathogen Indicators
Volga River, Iowa

2006

Iowa Department of Natural Resources
Watershed Improvement Section

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1. INTRODUCTION AND SUMMARY

Table 1.1 Volga River TMDL Summary

Waterbody Name:	Volga River, two contiguous impaired segments (see Table 1.2)
Use Designation Classes, impaired segments:	Class A, recreational Class B (WW), aquatic life
Major River Basin:	Turkey River Basin
Pollutants:	Pathogen indicator, *E. coli* bacteria
Pollutant Sources:	Point, Nonpoint
Impaired Use:	Recreational Primary Contact, March 15 to November 15
Watershed Area: Total	406 square miles
Stream Length: Headwaters in Fayette County to Turkey River confluence	66 miles
Target: Pathogen Indicator Concentration:	The targets for the two Volga River segments are the Iowa Water Quality Standard (WQS) numeric limits for *E. coli,* a geometric mean of 126 E. coli organisms/100 ml or a sample maximum of 235 *E. coli* organisms /100ml
Wasteload Allocations (WLA):	The wasteload allocations for this report can be found in **Tables 3.6** and **3.7** in Section 3.
Load allocations, existing loads, and load reductions needed to achieve target concentrations	The load allocations, existing loads, and load reductions for this report can be found in the **Load Allocation** sub-section of **Section 3.4** and in **Figures 7** and **8**.

1.1 Introduction

This report consists of a Total Maximum Daily Load (TMDL) for two impaired segments of the Volga River. These segments are listed in Table 1.2.

Table 1.2. Two impaired segments requiring TMDLs

Volga River Impaired Segment	Segment description	Segment length	Iowa Counties
IA 01-VOL-0010-Segment 1	Mouth to Cox Creek	16.1 miles	Clayton
IA 01-VOL-0010-Segment 2	Cox Creek to bridge in Volga City	11.0 miles	Clayton

Segment 1 runs 16.1 miles from the confluence with the Turkey River to Cox Creek. The direct tributaries to this segment are, east to west, Bear, Doe, Honey, and Cox Creeks draining three HUC 12 sub-watersheds. Segment 2 of reach IA 01-VOL-0010 of the Volga River flows into this segment at Cox Creek. There are three cities in the segment's three HUC 12's; Strawberry Point, Edgewood, and Littleport none of which have wastewater treatment plants discharging to the Volga River (Strawberry Point has new wastewater treatment facilities under construction that are scheduled for completion in 2006.)

Segment 2 runs 11.0 miles from Cox Creek to the bridge in Volga City. The direct tributaries to this segment are, east to west, Hewett, Pine, and Nagle Creeks directly draining two HUC 12 sub-watersheds. The City of Volga wastewater treatment plant discharges directly to the impaired segment of the Volga.

The two segments in the Volga River are included in the 2004 Iowa 303(d) List as impaired by excessive indicator bacteria (fecal coliform) (Table 1.2). As such, total maximum daily loads (TMDLs) must be developed for these waters in accordance with the Clean Water Act (CWA). Based on the strategy of a basin wide approach, as well as the hydrologic connections, TMDLs have been developed and are included in this document for both waterbody segments. In 2004, the Iowa Department of Natural Resources (IDNR) opted to convert from fecal coliform to *Escherichia coli* (*E. coli*) bacteria as the indicator for primary contact recreation assessment. Although *E. coli* may be a better indicator of human health issues, the analyses in this TMDL are based on fecal coliform because of data considerations and the fact that the TMDL is expressed as a percentage reduction in loading and the target is set at the *E. coli* standard. This document presents TMDLs for indicator bacteria that are designed to allow the Volga River segments IA 01-VOL-0010_ 1 and IA 01-VOL-0010_2 to fully support their designated uses. The information contained herein should be considered 2 TMDLs.

Background: The Federal Clean Water Act requires the Iowa Department of Natural Resources (IDNR) to develop a TMDL for waters that have been identified on the state's 303(d) list as impaired by a pollutant. Two segments of the Volga River have been identified as impaired by the pathogen indicator *E. coli* (Table 1.2). The purpose of the Volga River TMDL's is to estimate the maximum pathogen indicator "loads" that can be delivered from the watershed and still meet the Iowa Water Quality Standards (WQS). Complying with the WQS limits for *E. coli* will provide full support for the Volga River primary contact recreational designated use.

TMDL development and implementation is often an iterative process that requires re-evaluation of existing information, analysis of new data as it becomes available, and the refinement of analytical procedures. This process is frequently referred to as phasing. Phasing TMDL's is an approach to managing water quality used when the origin, nature and sources of water quality impairments are not completely understood. In Phase 1, the waterbody load capacity, existing pollutant load in excess of this capacity, and the source load allocations are estimated based on the resources and information available.

The TMDLs presented in this report represent Phase 1 in the development of a project to improve Volga River water quality. The evaluation process will continue as more data and the resources to analyze it are made available, allowing for improved understanding of the specific problems that are causing the impairment. This will lead to stakeholder driven solutions and more effective management practices. Continued monitoring will help determine what management practices result in load reductions and the attainment of water quality standards. These monitoring activities are continuing components of the Iowa ambient monitoring program.

- 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.

The first phase of these TMDLs sets specific and quantified targets for pathogen indicator concentrations in the river and allocates allowable loads to all sources. Phase 2 will consist of implementing the follow-up monitoring plan, evaluating collected data, and readjusting the allocations and management practices, if needed.

Required components. This TMDL 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:

1. Name and geographic location of the impaired or threatened waterbodies for which the TMDLs are being established:

Table 1.3 Impaired segments locations

Volga River Segment	Segment location
Reach - IA 01-VOL-0010 Segment 1	Tributary of Turkey R., Mouth (S36, T92N, R4W, Clayton Co.) to confluence with Cox Cr. near Mederville (S21, T92N, R5W, Clayton Co.)
Reach - IA 01-VOL-0010 Segment 2	From Cox Cr. (S21, T92N, R5W, Clayton Co.) to bridge crossing in Volga (north line, S10, T92N, R6W, Clayton Co.).

2. Identification of the pollutant and applicable water quality standards:
The pollutants causing the water quality impairments are the pathogen indicators E. coli and fecal coliform. Designated uses assigned to the above-identified segments include: primary contact recreation and aquatic life. The Class A (primary contact recreation) uses remain assessed (monitored) as “not supported” due to consistently high levels of indicator bacteria. The applicable water quality standards for *E. coli* bacteria are a season geometric mean of 126/100ml for and a single sample maximum value of 235 counts/100 ml.

3. Quantification of the pollutant load that may be present in the waterbody and still allows attainment and maintenance of the water quality standards:
Because bacteria are expressed as a density of bacterial colonies (e.g., counts per 100 ml), mass load is not relevant to assessing the level of contamination. The targets are therefore still expressed as counts per 100 ml as is the standard. However, these concentrations are compared against the existing data at various flow conditions in a duration analysis.

4. Identification of pollution source categories:
Both point and nonpoint sources of pathogen indicators have been identified as the cause of the primary contact recreation use impairment for the 2 impaired segments of the Volga River.

5. Wasteload allocations for pollutants from point sources:
The wasteload allocations for point source dischargers to the Volga River will be equivalent to the water quality criteria associated with the primary contact recreation beneficial use. Therefore, the WLA is a monthly geometric mean of 126 counts per 100ml and a maximum daily value of 235 counts /100 ml for facilities discharging directly to the impaired reaches or a higher value for those contributing to tributaries of the impaired reaches.

6. Load allocations for pollutants from nonpoint sources:
The load allocations assigned to these TMDLs will be based upon the 126/ 100 ml – applicable target water quality criteria for *E. coli* from the Iowa Water Quality Standards.

7. A margin of safety:
These TMDLs contain an explicit margin of safety. Specifically, the target was set for Fecal Coliform Bacteria at a level corresponding to the *E. coli* water quality standard.

8. Consideration of seasonal variation:
These TMDLs were developed based on the Iowa water quality standards primary contact recreation season that runs from March 15 to November 15.

9. Allowance for reasonably foreseeable increases in pollutant loads:
There was no allowance for future growth included in these TMDLs because current watershed land uses are predominantly agricultural and the addition/deletion of animal feeding operations (which could increase or decrease pathogen indicator loading) cannot be predicted or quantified at this time.

10. Implementation plan:
Although not required by the current regulations, an implementation plan is outlined in Section 3 of this TMDL document. Implementation of the reduction for *E. coli* will be carried out through a combination of regulatory and non-regulatory activities. Point sources will be regulated under the auspice of the National Pollutant Discharge Elimination System and the Rules and Regulations pertaining to Livestock Waste Control. Nonpoint source pollution will be addressed using available programs, technical advice, information and education and financial incentives.

2. VOLGA RIVER, DESCRIPTION AND HISTORY

The Volga River and its watershed (Table 2.1 and Figure 1) are located in northeast Iowa and are divided between two landform regions, the Paleozoic Plateau and the Iowan Surface. The river headwaters originates in the Iowan Surface, a region with a slightly inclined to gently rolling topography with long slopes and low relief. By contrast, the Paleozoic Plateau, much different than the rest of the state, is a landscape of deeply carved narrow valleys bounded by high rolling hills, steep rock bluffs, and woodlands.

2.1 The Stream and its Hydrology

The Volga River is a tributary to the Turkey River flowing through a deep narrow valley bounded by rock bluffs and high hills. It is a relatively small stream with water levels that can quickly fluctuate during major precipitation events. The average rainfall in the east half of the Volga River watershed is 33 inches/year and in the western half is 35 inches/year.

Table 2.1 The Volga River and its watershed

Waterbody Name:	Volga River
Hydrologic Unit Code, 8 digit:	07060004
IDNR Waterbody ID:	IA 01-VOL-0010, Segment 1 IA 01-VOL-0010, Segment 2
Location of impaired segments:	Mouth at Turkey River confluence (S36, T92N, R4W, Clayton Co.) to bridge crossing in Volga (S10, T92N, R6W, Clayton Co.).
Impaired segment tributaries:	Segment 1 Bear Creek Doe Creek Honey Creek Cox Creek Segment 2 Hewett Creek Pine Creek Nagle Creek Volga River (upstream segments)
Receiving Waterbody:	Turkey River
Total Length of Impaired Segments:	Total = 36.6 miles IA 01-VOL-0010_1 = 16.1 miles IA 01-VOL-0010_2 = 11 miles
Watershed Area:	406 square miles draining 13 HUC 12 sub-watersheds

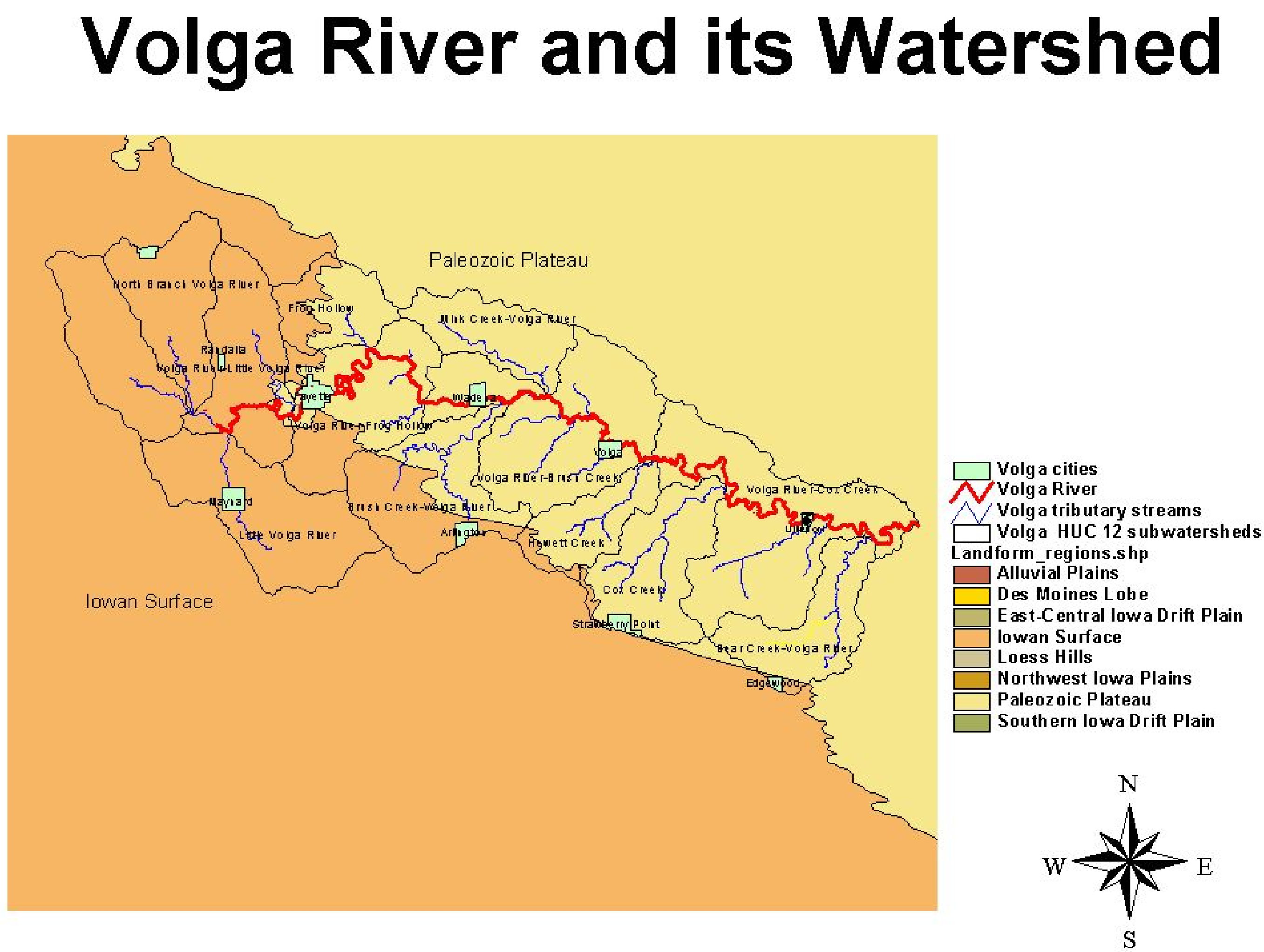

Figure 1. The Volga River and its watershed

Major tributaries to the impaired segments of the Volga River are:

- Segment 1
  - Bear Creek
  - Doe Creek
  - Honey Creek
  - Cox Creek
- Segment 2
  - Hewett Creek
  - Pine Creek
  - Nagle Creek

Because of the relatively short period of record for the Littleport USGS discharge gage, a regression analysis was used to synthesize a longer period. This analysis was based on nearby Roberts Creek and produced a significant relationship. The synthetic flow created was actual flow at the Volga gage or, if not available, the estimated flow from the regression.

Table 2.2 Regression Analysis

Site number	5412100	5412400
Station Name	Roberts Creek above Saint Olaf, IA (RC-2)	Volga River at Littleport, IA
Latitude	425549	424514
Longitude	912303	912208
Altitude, feet	826.73	720
HUC 8	7060004	7060004
Drainage area, square miles	70.7	348
Discharge begin date	3/25/1986	9/16/1999
Discharge end date	9/30/2001	9/30/2004

2.2 The Watershed

The Volga River originates in Fayette County and flows generally southeast for to the Turkey River at Elkport in Clayton County. The watershed area is 406 square miles and most of it is located in the Paleozoic Plateau ecoregion described previously. Agriculture is the primary land use and includes row crop farming, small grains, hay production and pasture land. Livestock feeding operations are found in the watershed with beef and hog operations the most common. Wildlife species present in the area include whitetail deer, red fox, beavers, raccoons, ring-necked pheasants, mourning doves, and numerous other species of songbirds, waterfowl, reptiles and amphibians. The density of deer in the watershed is one of the highest in the state.

Table 2.3 Land use in the Volga River Watershed

Land Use	Acres	Percent
Built-up	5,200	2%
Cropland	109,193	42%
Pastureland	88,394	34%
Forest	54,597	21%

In general, the soils in the Volga River watershed are loess and exposed bedrock. The geology is mantled karst and karst, an irregular limestone region with sinks, underground streams, and caves. On the Paleozoic Plateau side of the watershed the soils are Downs and Fayette; loess ridges with till and bedrock. On the Iowan Surface side they are Kenyon, Clyde, and Floyd; loamy till.

3. TMDL FOR PATHOGEN INDICATORS ON THE IMPAIRED SEGMENTS

3.1 Problem Identification

The 1998 Iowa Section 305b Assessment Report divides the Volga River into two reaches of four segments. The first two segments of the IA-01-VOL-0010 reach are the impaired waterbodies that this TMDL addresses. Segment 1 (IA 01-VOL-0010_1) is 16.1 miles long and extends from the Turkey River confluence to the Cox Creek confluence. Segment 2 (IA 01-VOL-0010_2) is 11 miles long and runs from the Cox Creek confluence to the bridge crossing in Volga. Table 1 in Section 1 describes these segments.

The designated uses of the two reaches are different. Segment 1: Class A, Primary Contact Recreation, and Class B, Warm Water Aquatic Life; Segment 2: B(WW), but is not designated for contact recreation.

The following paragraphs are the basis for the 305b assessment and comments for the impaired Volga River segments. The 305b report determined that the two segments should be included on the Iowa 303d list of impaired waters.

> *Mouth to Cox Creek, Waterbody ID No.: IA 01-VOL-0010_1*
> From the 1998 and 2004 305b reports:
>
> Class A (primary contact recreation) uses were assessed (evaluated) as "not supported" based on levels of indicator bacteria that violate state water quality standards. The Class B(WW) aquatic life uses were assessed (evaluated) as "fully supported" based on results of ambient physical/chemical monitoring. Fish consumption uses remain "not assessed" due to the lack of recent fish contaminant monitoring in this river segment. The source of data for this assessment are the results of IDNR/UHL monthly monitoring conducted from March to November, 2001, near Osborne (Site 34) and Volga (Site 35) in support of TMDL development for this river segment.
>
> *Cox Creek to bridge crossing in Volga. Waterbody ID No. IA 01-VOL-0010_2*
> From the 1998 report:
>
> Class A (primary contact recreation) uses were assessed (evaluated) as "not supported" based on levels of indicator bacteria that violate state water quality standards. The Class B(WW) aquatic life uses were assessed (evaluated) as "fully supported" based on results of ambient physical/chemical monitoring. Fish consumption uses remain "not assessed" due to the lack of recent fish contaminant monitoring in this river segment. The source of data for this assessment is the results of IDNR/UHL monthly monitoring conducted from March to November, 2001, near Osborne (Site 34) and Volga (Site 35) in support of TMDL development for this river segment.

These segments of the Volga River are on the State of Iowa 303d list of impaired waters for fecal coliform bacteria. Fecal coliform bacteria sources could include wastewater treatment plant discharges, urban storm sewers, septic tanks, wildlife, runoff from fields were manure has been applied, and feedlots. Bacteria problems often accompany heavy rainfall events.

Impaired Beneficial Uses and Applicable Water Quality Standards - Pathogen Indicator Water Quality Standards

The applicable designated uses and water quality standards for pathogen indicators are found in *Iowa Administrative Code 567, Chapter 61, Water Quality Standards.*

61.3(3)a. Class "A" waters. Waters which are designated as Class "A1," "A2," or "A3" in subrule 61.3(5) are to be protected for primary contact, secondary contact, and children's recreational uses. The general criteria of subrule 61.3(2) and the following specific criteria apply to all Class "A" waters.

(1) The Escherichia coli (*E. coli*) content shall not exceed the levels noted in the Bacteria Criteria Table when the Class "A1," "A2," or "A3" uses can reasonably be expected to occur. Class A1 is Primary Contact Recreational Use, Class A2 is Secondary Contact Recreational Use, and Class A3 is Children's Recreational Use. When a waterbody is designated for more than one of the recreational uses, the most stringent criteria for the appropriate season shall apply.

Table 3.1 *E. Coli* Bacteria Criteria (organisms/100 ml of water)

Use	Geometric Mean	Sample Maximum
Class A1		
3/15 – 11/15	126	235
11/16 – 3/14	Does not apply	Does not apply
Class A2 (Only)		
3/15 – 11/15	630	2880
11/16 – 3/14	Does not apply	Does not apply
Class A2		
Year-Round	630	2880
Class A3		
3/15 - 11/15	126	235
11/16 - 3/14	Does not apply	Does not apply

Relationship of *E. coli* to fecal coliform

To explore the relationship of *E.coli* to Fecal Bacteria, a regression was performed on the data from the Volga River near Elkport for the years 1999-2004. The following relationship was found which demonstrates that using fecal coliform information to assess current conditions and develop percentage reduction targets may be appropriate. The TMDL targets for fecal coliform are set at the same values as the *E. coli* standard based on this analysis. The *E. coli* is expected to be a subset of the fecal coliform and the ratio should not exceed 1, which is also the upper quartile as shown in the following statistics in Table 3.2.

Table 3.2. Relationship of *E. coli* to fecal coliform

Descriptive Statistics: Ratio of *E.coli* to fecal coliform bacteria

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Variable   N  N*    Mean  SE Mean   StDev  Minimum      Q1  Median      Q3
Ratio     63   0  0.8200   0.0278  0.2210   0.2500  0.7097  0.8696  1.0000
```

Data Sources
The water quality monitoring and flow data used in the development of this TMDL project originates from the IDNR ambient monitoring program sampling site near Elkport, Iowa and the USGS gage station at Littleport, Iowa. The water quality data was collected from 1999 to 2004 and includes fecal coliform and E. coli bacteria and the measured flow at the time the sampling was done at Elkport. The USGS gage data used is the daily average flow from the station at Littleport, which is about 10 miles upstream from Elkport. The Littleport USGS gage did not begin operating before September 1999. Discharge values used for modeling prior to gage operation were estimated by regressing Roberts Creek gage data against the Volga gage data and synthesized as previously described. The Elkport fecal coliform and instantaneous flow data can be found in Appendix B.

3.2 Pollution Source Assessment

Point Sources, Wastewater Treatment Plants
The point sources of *E. coli* bacteria in the Volga River watershed include six municipal and one private wastewater treatment plants (wwtp). Currently, none of these treatment facilities have E. coli or fecal coliform effluent limits but may be potential sources. Table 3.2 lists the seven facilities. Six of these treatment plants are controlled discharge lagoons and one is a continuously discharging aerated lagoon.

Table 3.3 Permitted facilities in the Volga River Watershed

Name	Receiving Stream	Facility type	Population Equivalent	Design ADW Flow (MGD)	Design AWW Flow (MGD)
Arlington wwtp	Brush Creek	Facultative lagoon	677	NA	0.075
Fayette wwtp	Volga River	Aerated lagoon	2006	0.122	0.175
Hawkeye wwtp	N. Branch Volga River	Facultative lagoon (2004)	575	NA	0.071
Maynard wwtp	Little Volga River	Facultative lagoon	629	NA	0.081
Prairie View Care Facility	Coulee Creek	Facultative lagoon	228	NA	0.0095
Volga wwtp	Volga river	Facultative lagoon	365	NA	0.034
Wadena wwtp	Volga River	Facultative lagoon	377	NA	0.0127

Livestock Feeding Operations
Livestock operations, in the Volga River watershed, range in size from small farms with a few animals to large feeding operations. Open feedlots are unroofed or partially roofed animal feeding operations in which no crop, vegetation, or forage growth or residue cover is maintained during the period that animals are confined in the operation. Runoff from open feedlots can deliver substantial quantities of pathogen indicators, nutrients and oxygen demanding materials to a waterbody dependent upon factors such as proximity to a water surface, number and type of livestock and manure controls. Open feedlots with more than 1,000 animal units are required to have an operating permit or NPDES permit. In addition, Iowa has a voluntary registration program for open feedlots.

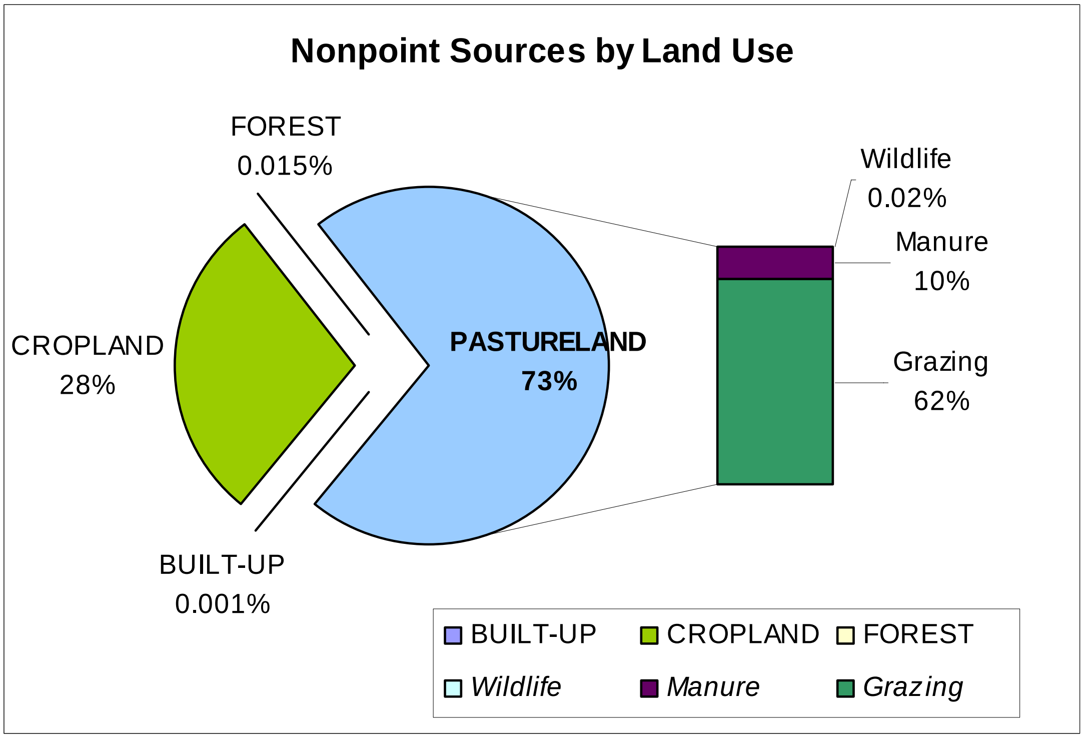
Confinement animal feeding operations (CAFOs) are animal feeding operations in which animals are confined to areas that are totally roofed. CAFOs typically utilize earthen or concrete structures to contain and store manure prior to land application. Nutrients and bacterial loading from CAFOs are delivered via runoff from land-applied manure or from leaking/failing storage structures. Currently, CAFOs with more than 500 animal units must have an approved manure management plan. Regardless of size, all CAFOs must report manure releases (IDNR AFO website, 2005).

Nonpoint Sources
The nonpoint sources of *E. coli* include contributors that do not have localized points of release into a stream. In the Volga River watershed these sources are:

- Land application of hog and cattle manure
- Land application of poultry litter
- Grazing animals
- Cattle contributions directly deposited in stream
- Failing septic systems
- Urban runoff

The contributions from each of these sources are estimated using information available. Chart 3.1, below, shows *E. coli* nonpoint contribution by land use. EPA contacted several agencies to refine the data assumptions made in determining the fecal loading. The IDNR and Iowa State University (ISU) wildlife biologists provided information regarding deer and geese populations in the watershed. County sanitarians estimated the failure of septic tank systems in the state. The Natural Resources Conservation Service (NRCS) and ISU researchers provided valuable information on manure application practices and loading rates for hog farms and cattle operations. The location and magnitude of these loads are related to the different land uses in the Volga River Watershed. The IDNR TMDL Fact Sheet for the Volga River provided land use cover data for the watershed, which was used in this TMDL.

Chart 3.1. Nonpoint Sources of *E. coli* by Land Use



Livestock Estimates for the Watershed
Table 3.4 provides the estimated number of animals in the Volga River Watershed, including dairy cows, beef cattle, and hogs. The animal inventory estimates are based on the 2002 Census of Agriculture, which was conducted in December of that year. Participants were asked to report the number of animals present at that time. Although livestock inventory can vary throughout the year depending on sale and slaughter rates, it is assumed that the Census number is representative of the average population for the year. The county level data was reduced by calculating the percentage of the county that is part of the watershed, assuming an even distribution of livestock.

Table 3.4 Estimated animals in the watershed.

Diary Cows	Beef Cattle	Hogs	Chickens	Sheep	Horses
7,420	41,435	117,927	96,369	2,415	646

Land Application of Manure and Litter
Land application of manure is a potential contributor of bacteria to receiving waterbodies due to rain event runoff. Manure application rates vary monthly according to management practices currently used in the area. In general, the majority of manure is applied during the months of October, November, and December in this area of Iowa. Cattle manure is assumed to be applied to cropland and pastureland, whereas hog and poultry litter is only applied to cropland. While there are some alternative uses of poultry litter, such as utilization as cattle feed, almost all poultry litter is used as fertilizer. It is assumed horse manure is applied only to pastureland. Chart 3.3 compares the

percentages of *E. coli* contribution between the various types of land application manures, poultry litter and wildlife.

While manure application is one aspect of the bacterial loading, other factors also affect the observed concentrations. As mentioned in the TMDL, runoff conditions are strongly tied to elevated bacteria levels, but the cause and effect relations to manure applications timing was not established. Chart 3.2 depicts the bacterial observations throughout the year suggesting that there is decreased concentration in the winter time, perhaps due to frozen conditions, bacterial activity, and lack of direct runoff.

Chart 3.2 Bacteria data by month

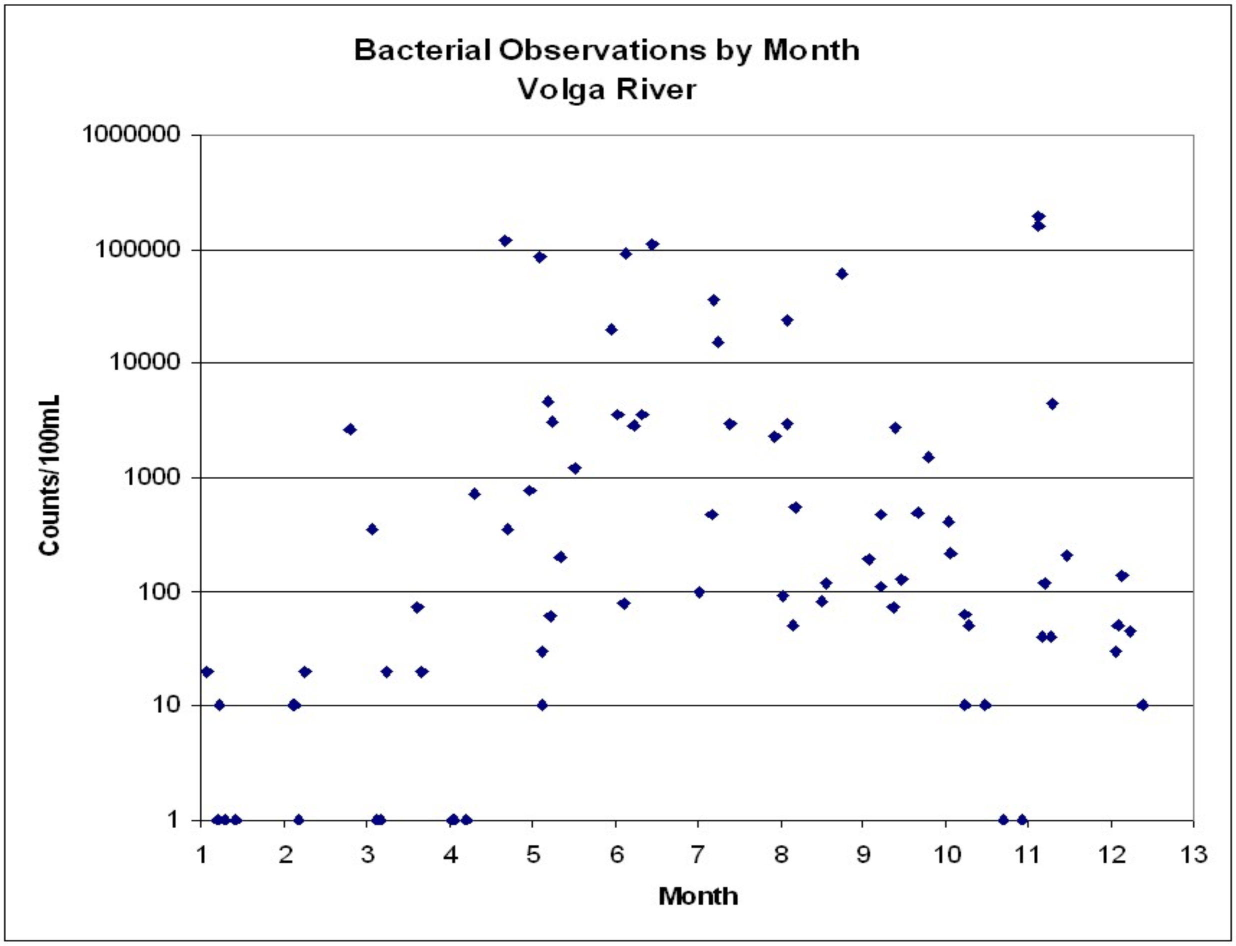
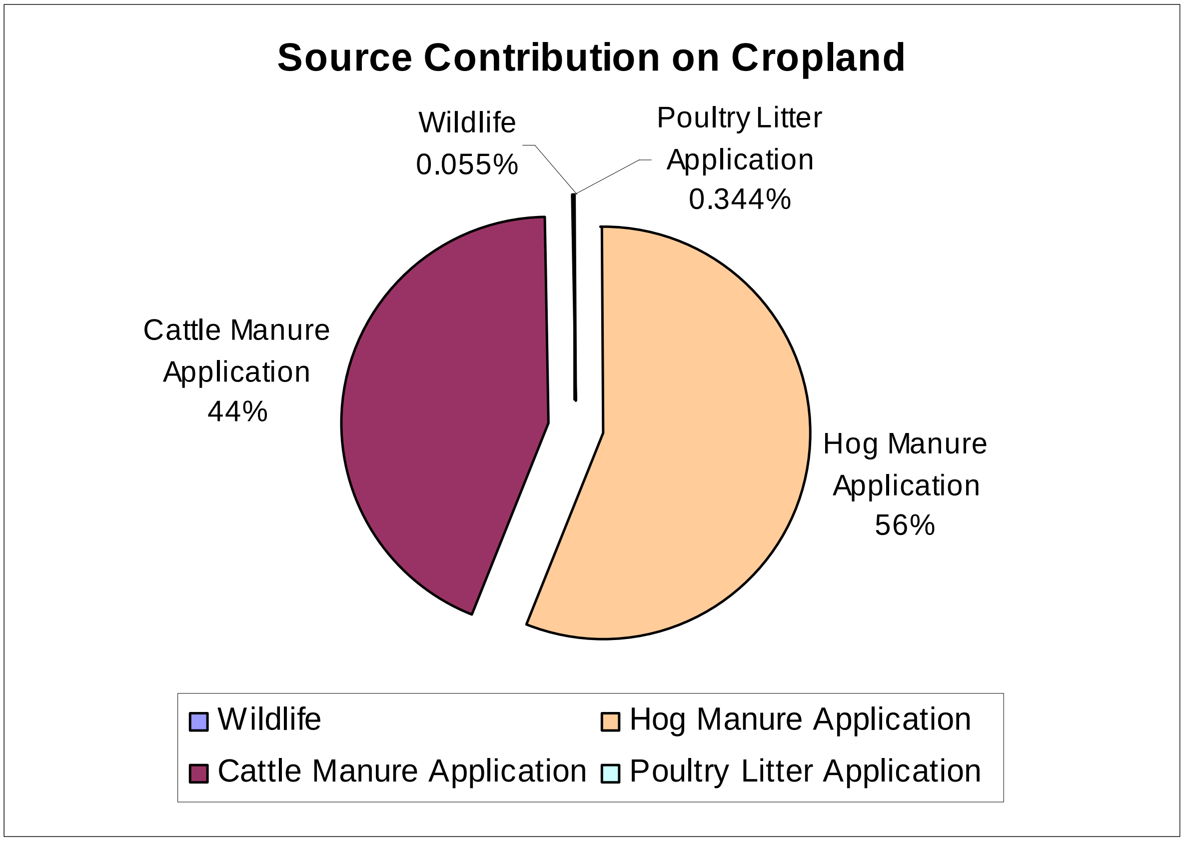


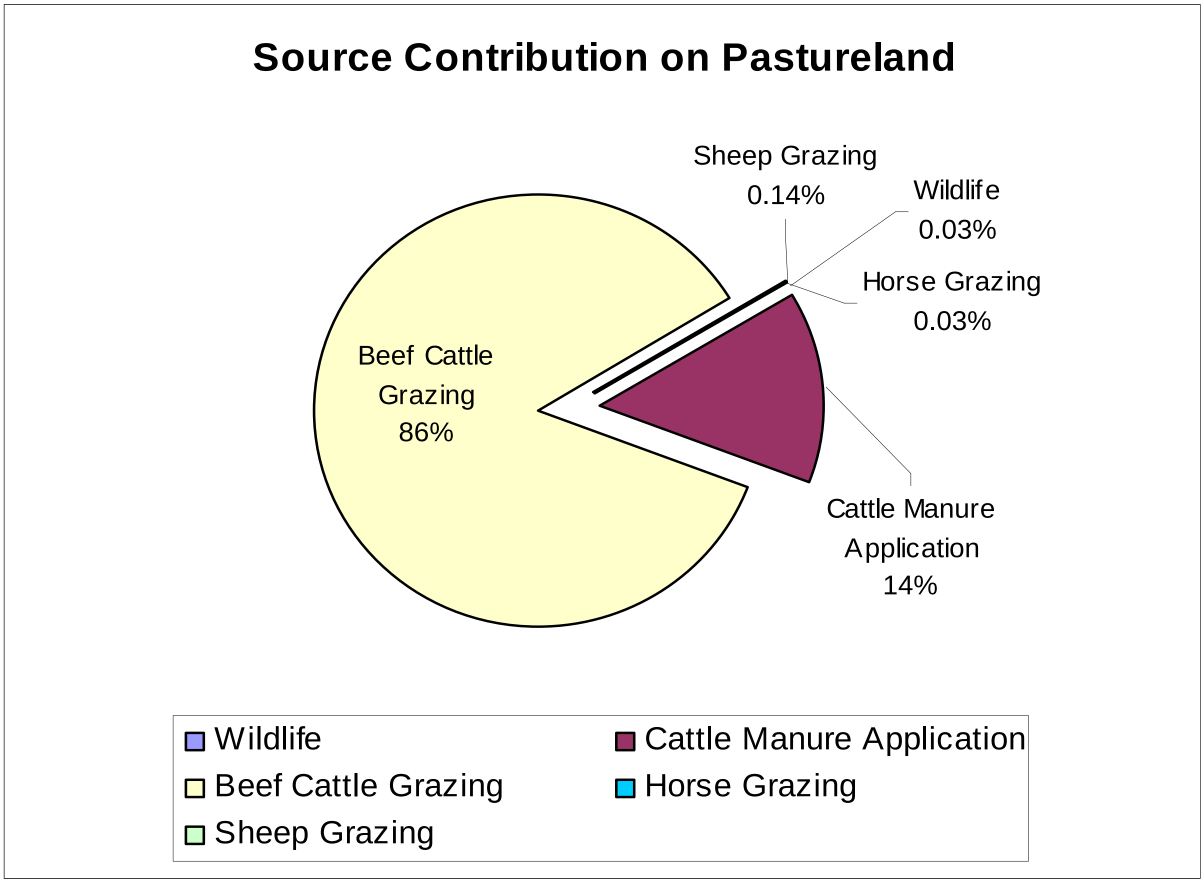
Chart 3.3 Cropland *E. coli* from land application manure, litter and wildlife.



Grazing Animals

Cattle, horses, and sheep spend time grazing on pastureland and deposit manure onto the land. During a rain event, a portion of this fecal matter is available for wash-off and delivery to receiving waterbodies. Chart 3.3 shows pastureland *E. coli* sources by percentage of contribution.

Chart 3.4 Pastureland *E. coli* from animal grazing, manure application and wildlife.



The bacterial tool described below is used to estimate source contributions assuming that dairy cattle are confined in feedlots, and thus their waste is applied as manure. Access to pastureland for grazing cattle varies throughout the year. According to researchers at Iowa State University, cattle are 80% confined from January to March. During the spring and summer months (April through October) they spend 100% of their time grazing. In November and December, they have slightly reduced access and spend approximately 80% of their time grazing (Russell, personal communication). The grazing schedule for sheep is similar to cattle except that sheep tend to be fully confined during the months of January through March. It is assumed that horses are primarily grazing and spend negligible time confined. As such, they directly deposit manure to pastureland.

Cattle Contributions Deposited Directly In-stream

Cattle often have direct access to streams that run through pastureland. In Iowa the majority of cattle have direct access to a stream (approximately 90%). *E. coli* bacteria deposited in these streams by grazing cattle are modeled as a direct input of bacteria to the stream. Preliminary research data in Iowa indicate that cattle spend one to six percent of their time in streams from April through December (Russell, personal communication).

Failed Septic Tank Systems. Septic systems may deliver bacteria loads to surface waters due to malfunctions, failures, or direct pipe discharges. Properly operating septic systems treat the wastewater and dispose of the water through a network of perforated pipes in trenches called a lateral field. The systems can fail when the field lines are broken, or the underground substrate is clogged or flooded. The septic water reaches the surface and is then available for wash-off into the stream. Direct bypasses from septic tanks to a stream also lead to bacteria contamination. In efforts to keep wastewater from seeping up in a drain field, pipes are sometimes laid from the septic tanks or the field lines to the nearest stream.

The number of septic systems is estimated from the watershed area normalized count of septic systems in each county (based on 1990 U.S. Census). EPA contacted county sanitarians for estimated rates of failure and normalized the rates based on the percentage of each county contained in the watershed to obtain an estimate for the Volga River Basin. It is estimated that 60 percent are currently failing in the watershed. Table 3.5 displays information regarding septic systems in the watershed. The failure rates were obtained from county sanitarians. All other data were obtained from the U.S. Census Bureau (1990).

Table 3.5 Septic system information for each county in the Volga River Watershed

VOLGA RIVER	Counties			
	Clayton	Delaware	Fayette	Summary
Septic tanks or cesspools	770	1	1099	1870
Household size	2.28	2.43	2.36	2.33
Number of persons served	8707	8764	7714	4353
Failure rate	50%	50%	65%	60%

Built-up Areas

Pathogen contributions from urban areas may come from runoff through stormwater sewers (e.g. residential, commercial, industrial, and road transportation), illicit discharges of sanitary wastes, and runoff contribution from improper disposal of waste materials. The failure of sewer and septic systems and subsequent migration with stormwater runoff is also a potentially significant source. There are ten incorporated communities are entirely or partially in the Volga River watershed and make up 2% of land use. See Appendix A for a land use map.

Natural background conditions. Wildlife in the Volga River Watershed contributes *E. coli* bacteria onto the land surface where it is available for wash-off during a rain event. In the Volga River model, wildlife is accounted for by considering contributions from deer, geese, and raccoons. Countywide deer population estimates were obtained from IDNR wildlife biologists. These estimates were used to calculate an estimate for the watershed based on the percentage of each county within the watershed. The deer population is estimated to be 15 animals per square mile for this area. Geese populations are difficult to estimate. The estimate of 3 geese per square mile was used based on other Iowa TMDLs and conversations with wildlife biologists. Information regarding raccoon populations was obtained from Iowa State University researchers.

The raccoon population in this part of Iowa varies seasonally from approximately 15 animals per square mile to 75 animals per square mile (Clark, personal communication). The tool used to estimate the bacteria contribution from various sources is limited in its ability to represent seasonal variation. Due to this, an average value of 45 animals per square mile was used for pastureland and forest cover. The minimum density estimate of 15 animals per square miles was used for cropland with the understanding that it may be marginal or unsuitable habitat during portions of the year.

While these methods may overestimate the populations sometimes, they compensate for the inability to obtain data for other wildlife populations, such as ducks, beaver, opossum, squirrel, and rabbit. The estimates are limited by the assumption that the wildlife population remains constant throughout the year, and that wildlife is present on all land classified as forest land, pastureland, cropland, and wetlands. It is also assumed that the wildlife is evenly distributed throughout the land use types.

3.3 TMDL Target

Modeling Approach

The modeling approach uses a flow duration analysis to display excursions above the standard at different flow conditions. The flow was both measured and simulated for a period from 1986 to 2004 at the Volga River Gage located at Littleport. Because this location integrates the whole watershed, it is used as the target location for the two impaired segments of this TMDL. The result of this synthesis is shown in Figure 2.

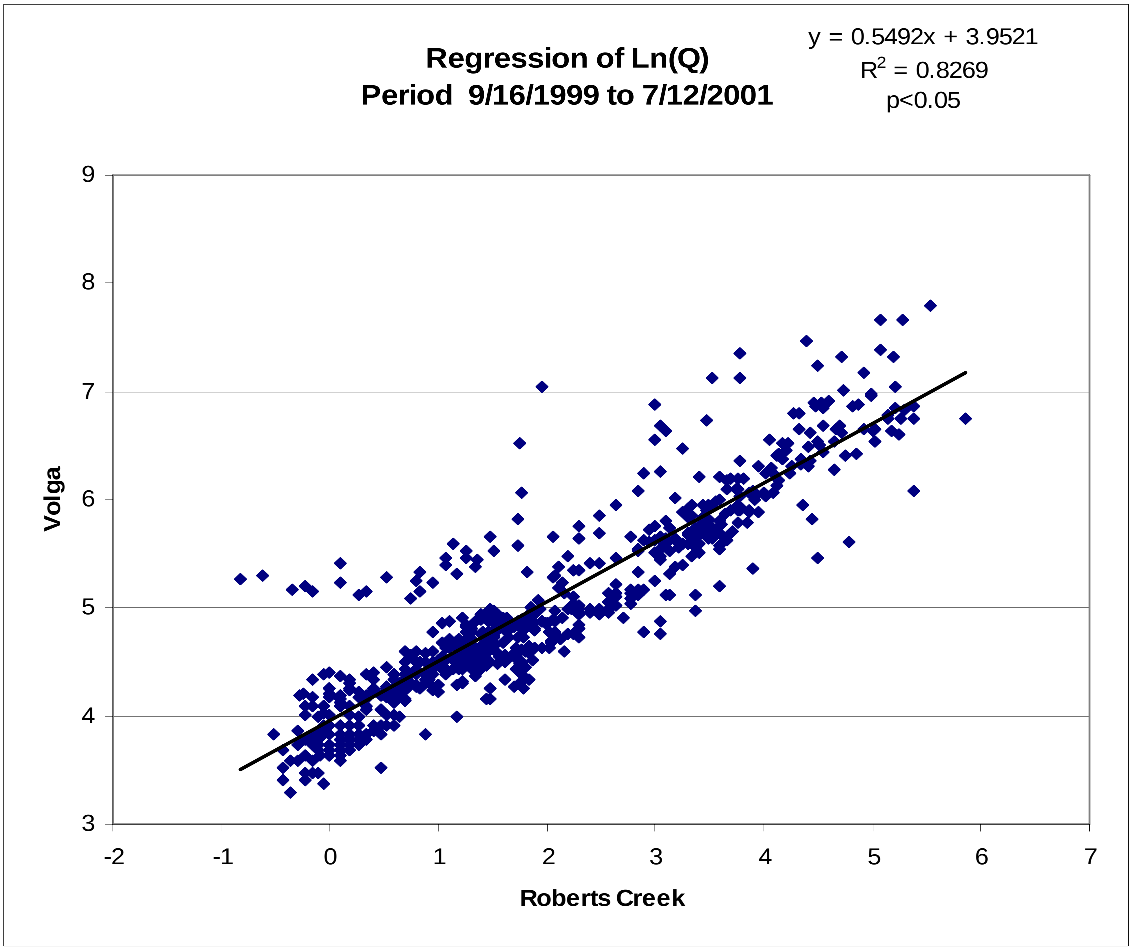


Figure 2 Relationship used to extend Volga Flow Record

Figure 3 shows the distribution of flow. The data is plotted against a statistically derived scale (Pearson Probability). A naturally flowing system will plot near a straight line. Although this is generally the case for this analysis, the extreme high flow deviation from a straight line may be an artifact of the regression mentioned above and the low flow deviation is an artifact of rounding and the statistical method.

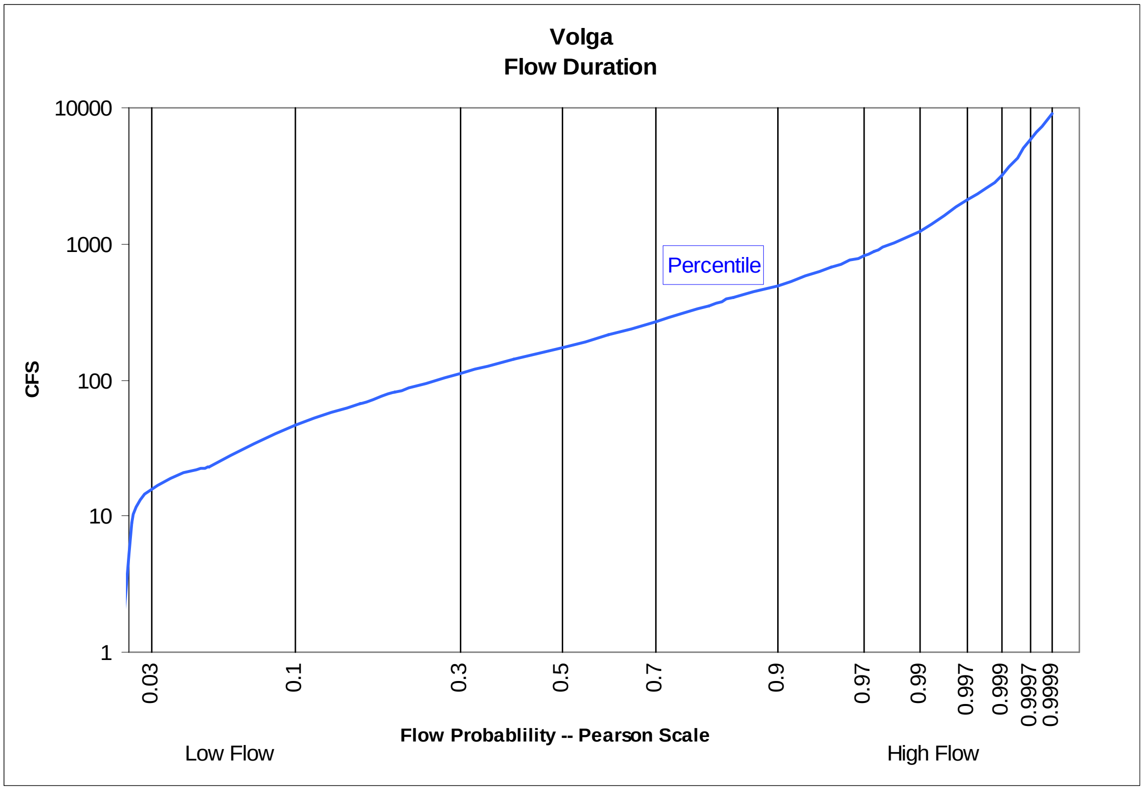


Figure 3 Probability that flow will exceed the value shown on the y axis

The flow record was evaluated to separate baseflow from surface runoff. A digital filter technique (Eckhardt, 2004) was used to separate the hydrograph. An example of the baseflow separation is shown in Figure 4.

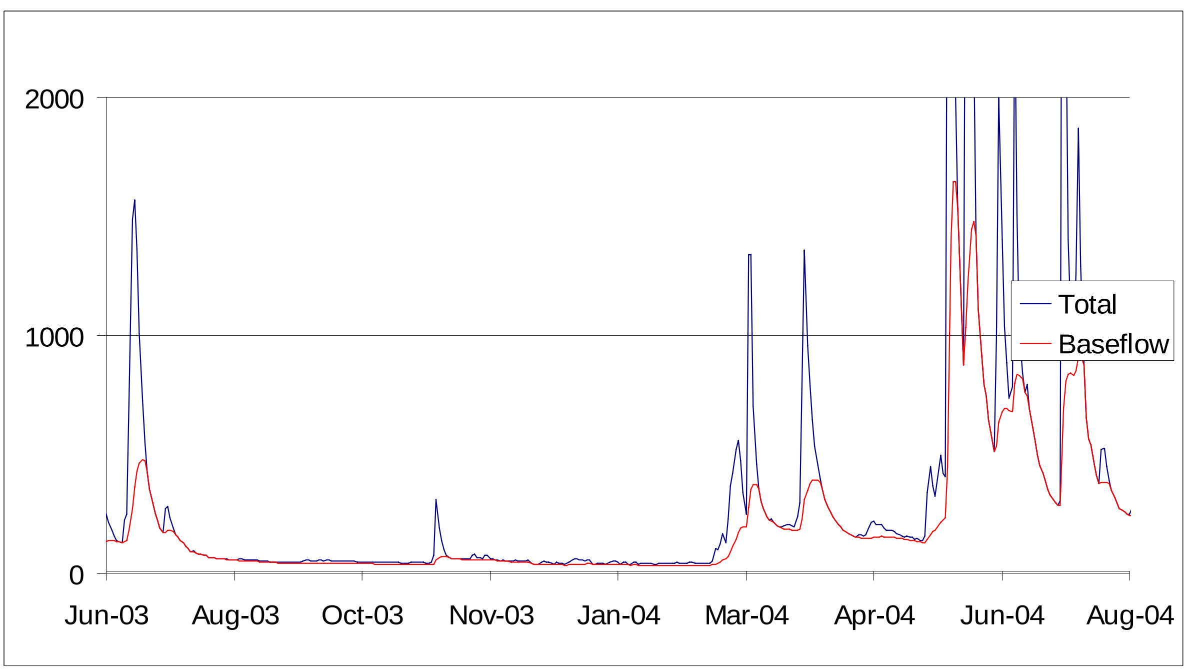


Figure 4 Example time period depicting the baseflow separation

Results of the source inventory were used to estimate nonpoint source loading by using EPAs “Bacterial Indicator Tool” (BIT) Spreadsheet. The nonpoint source daily loading from the BIT was assumed to contribute only during surface runoff conditions as identified by the base flow separation, otherwise it was allowed to accumulate on the land surface to a maximum multiple of the daily generation determined by optimizing the model efficiency calculation.

This approach is similar to that used in the HSPF (Bicknell, 2000) model and is consistent with that taken in other TMDLs across the country, such as described in the State of Virginia guidance on TMDL development (Virginia, 2003). Contributions of bacterial contamination during base flow periods were attributed to cattle in the streams, septic tanks, and a *generalized loading* that includes contributions from point sources. A *release rate first order equation* was used to simulated how land manure would be released (Shelton, 2003) and another *first order decays for transport of the bacteria* was also used (EPA 2001). To estimate travel times, time of concentration was estimated (Neitsch, 2000.)

Waterbody Pollutant Loading Capacity

As previously explained, waterbody loading capacity cannot be reasonably expressed as a mass per time. Because the risk and corresponding water quality criteria associated with bacteria are based on epidemiological studies relating illness rates to concentration, this TMDL is expressed as a relationship of concentration at a continuum of flow conditions, as shown on the duration curve in Figure 3.

Existing Load

Existing loads are shown in Figure 5. Percent surface runoff is also shown to demonstrate the strong relationship between bacterial concentration and the presence of surface flow. The TMDL target concentrations of bacteria are displayed for both the single sample maximum (SSM) and the geometric mean (GM). Figure 5 shows that when flow is less than the 50^{th} percentile, there are few excursions of the single sample maximum (SSM), whereas at flows above this percentile, surface runoff is much higher as well as the frequency of exceedance of the criteria. The conclusion is that control of nonpoint sources will be required to achieve the standard.

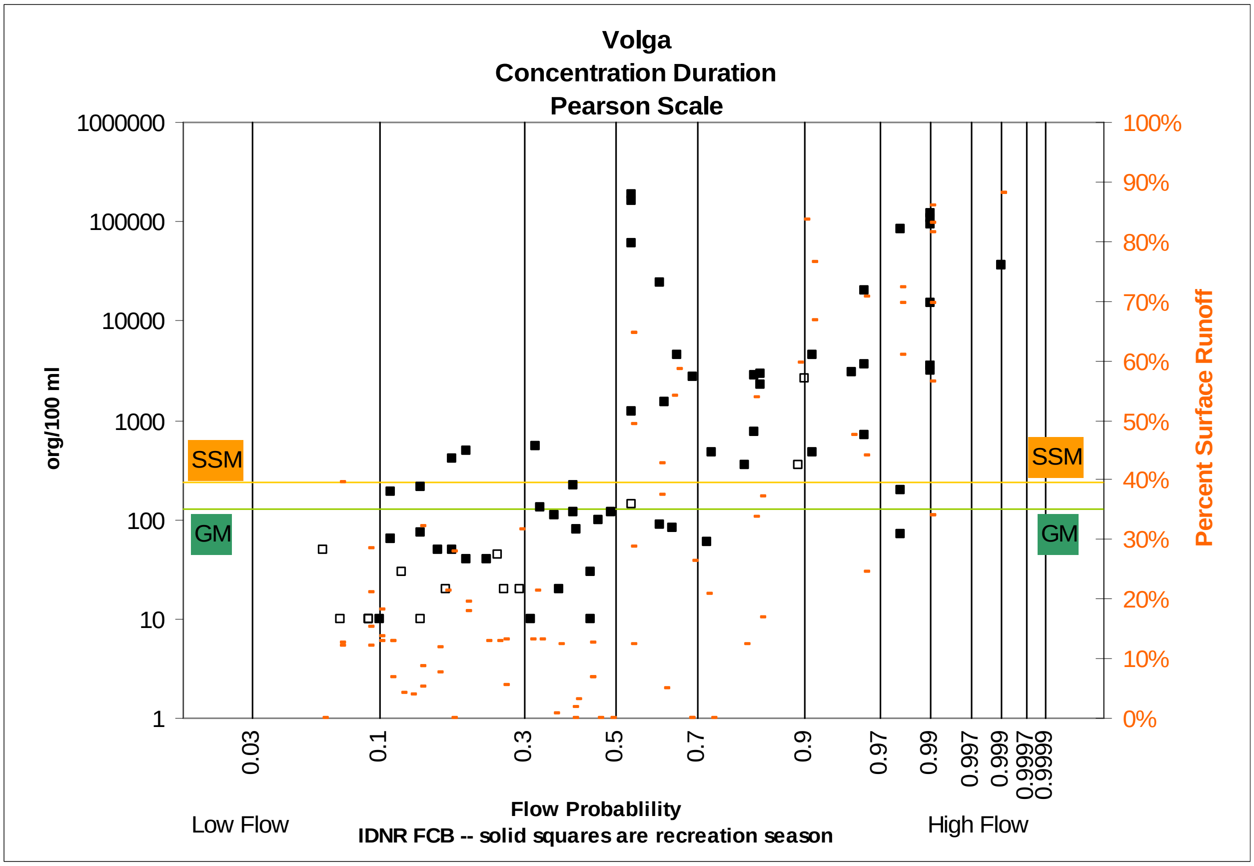


Figure 5 Sample results shown for various flow conditions and the estimated percent coming from surface runoff estimated using the base-flow separation procedure

Linkage of Sources to Target

To link the sources to the target, spreadsheet modeling was performed, as previously described. The modeling results show a relationship between predicted and observed values, as shown below as illustrated by calculated a Nash-Sutcliffe efficiency of 0.40, which is a lower bound acceptance level (wikipedia, 2006 http://en.wikipedia.org/wiki/Nash-Sutcliffe_efficiency_coefficient):

The Nash-Sutcliffe model efficiency coefficient is widely used to assess the predictive power of hydrological models. It is defined as:

$$E = 1 - \frac{\sum_{t=1}^{T}\left(Q_o^t - Q_m^t\right)^2}{\sum_{t=1}^{T}\left(Q_o^t - \overline{Q_o}\right)^2}$$

where Qo is observed discharge, and Qm is modelled discharge. Qt is discharge as time t.

From Predicted Values	6.01E+10	Numerator
	9.97E+10	Denominator
	40%	Nash Sutcliffe E

Figure 6 Model efficiency calculation

Other measures of modeling effectiveness were calculated and are included in the spreadsheet model. The following graphs show modeled geometric means:

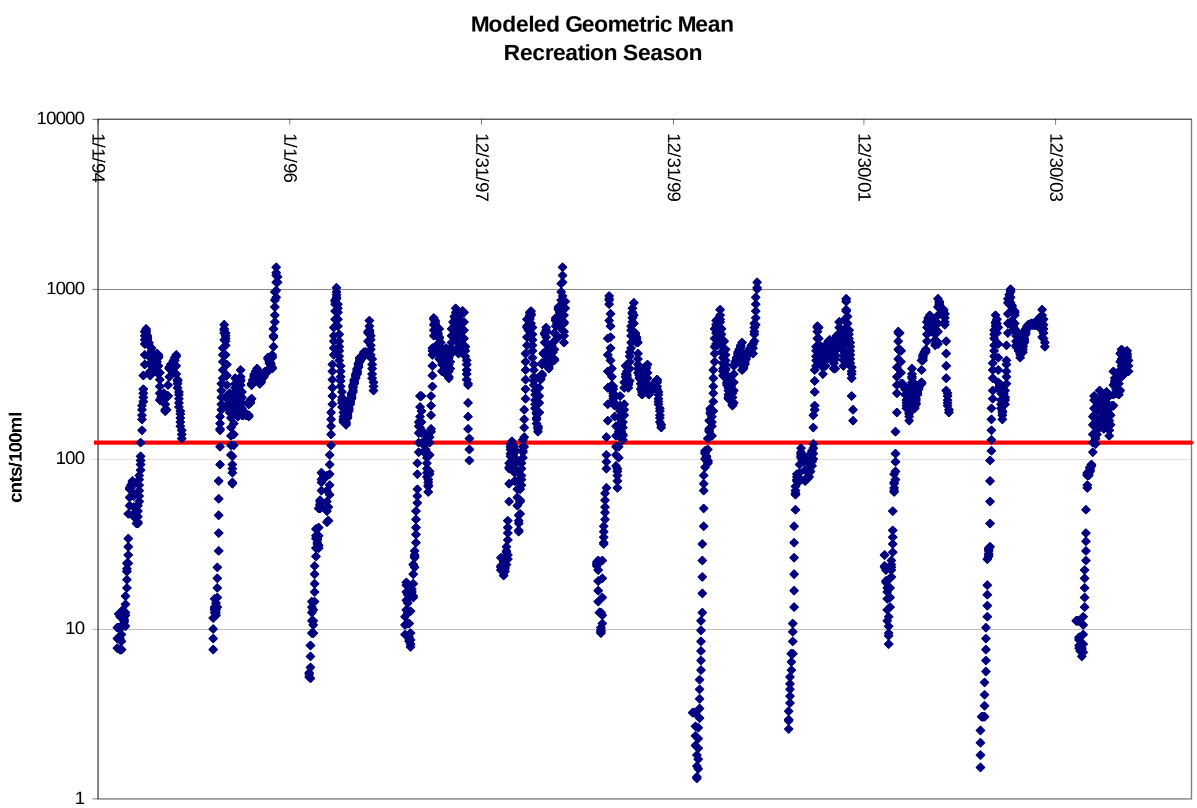


Figure 7 Modeled existing fecal coliform concentrations compared to the E. coli 126 #/100ml standard

3.4 Pollutant Allocations

Wasteload Allocations

The wasteload allocations for the seven treatment facilities discharging to the Volga River or its tributaries are in Table 3.6. If a wwtp discharges directly to the Volga River then the wasteload allocation is the same as the E. coli water quality standard, a geometric mean of 126 organisms/ 100 ml and a single sample maximum of 235 organisms/ 100 ml. These values present the same risk for pathogen exposure as fecal coliform values of 200 organisms/ 100 ml and 400 organisms/ 100 ml, respectively.

Table 3.6. Wastewater Treatment Plant Wasteload Allocations

Treatment facility name	Receiving Stream	Distance to impaired reach, miles	% of bacteria remaining after die-off	Geometric mean.	Single sample max.
Arlington wwtp	Brush Creek	6.6	67%	188	351
Fayette wwtp	Volga River	0	100%	126	235
Hawkeye wwtp	N. Branch Volga R.	10	55%	229	427
Maynard wwtp	Little Volga River	2.5	86%	147	273
Prairie View Care wwtp	Coulee Creek	6.9	66%	191	356
Volga wwtp	Volga River	0	100%	126	235
Wadena wwtp	Volga River	0	100%	126	235

There is only one permitted open feedlot in the watershed. The wasteload allocation for this feedlot is in Table 3.7.

Table 3.7 Permitted Feedlot Wasteload Allocation

NPDES ID	Feedlot Name	Type	Waste Load Allocation [1]
61296	Jirak Feedlot	Beef Cattle - Mature	no discharge

1. No discharge resulting from precipitation events less than or equal to the 25 year, 24 hour precipitation event.

Load Allocation

The load allocation that achieves the water quality standard geometric mean of 126 E. coli organisms/ 100 ml has been modeled and the results are shown in Figure 8. The load reduction required to meet this allocation is the difference between the modeled existing conditions in Figure 7 and the modeled allocation in Figure 8. Reductions are required for non-point source loads such as manure applied to cropland and pasture, and wildlife feces that are transported by precipitation events and those that are relatively constant such as cattle in streams and failed septic tanks. To achieve the standard, there must be 97% reductions in rain driven surface runoff loads and an 85%

reductions in continuous NPS bacterial loads (e.g., septics and cattle in the stream). The results of these reductions are modeled in Figure 8.

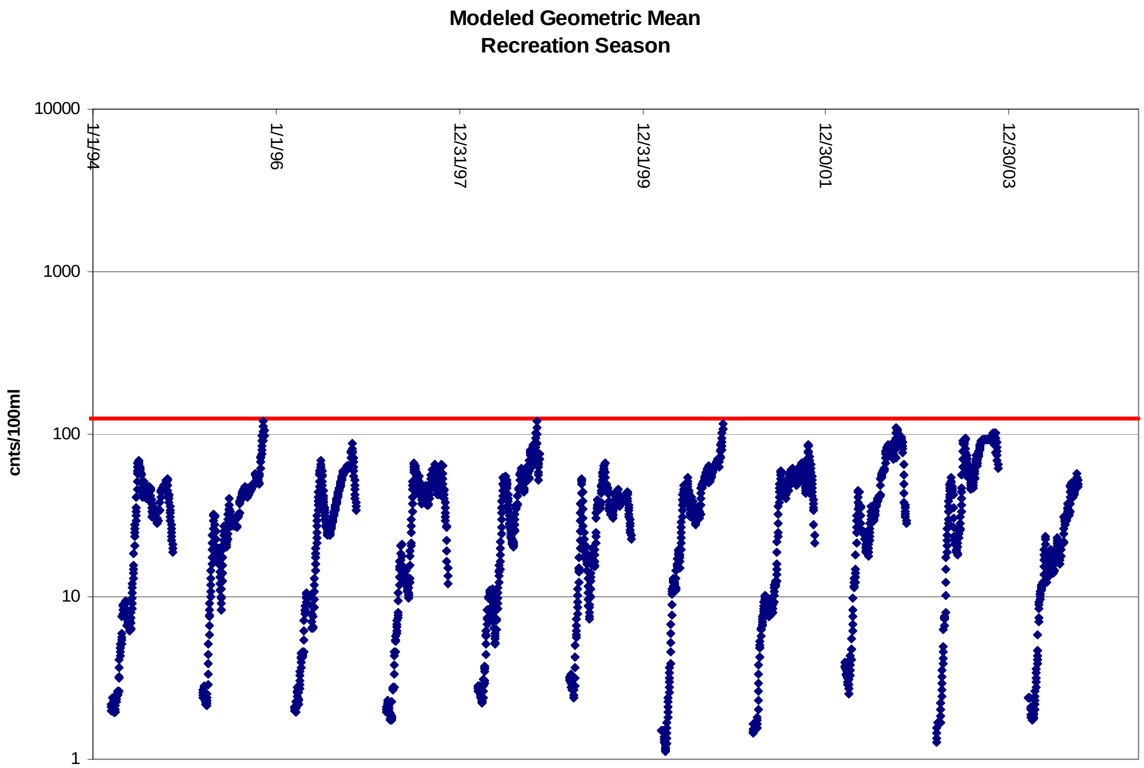


Figure 8 Modeled concentrations based on the TMDL reductions in loads

3.5 Margin of Safety

In 2004, the Iowa Department of Natural Resources (IDNR) opted to convert from fecal coliform to *E. coli* bacteria as the indicator for primary contact recreation assessment. Although *E. coli* may be a better indicator of human health issues for primary contact recreation assessment, it is not used in this TMDL. Because of the data consideration that *E. coli* is a subset of fecal coliform, it follows that in a given sample, the *E. coli* level will always be less than the corresponding fecal coliform level. This TMDL is expressed as a percentage of reduction in loading to achieve a fecal coliform target that is set at the *E. coli* standard. The margin of safety is thereby explicit due to targeting fecal coliform reductions at the *E. coli* standard level.

3.6 Reasonable Assurance

Reasonable assurance means a demonstration that the wasteload and load allocations will be realized through regulatory or voluntary actions. For waterbodies impaired by both point and non-point sources, such as the segments of the Volga River that these TMDLs have been developed for, wasteload allocations may reflect anticipated or expected reductions of pathogen indicators from other sources if those anticipated or expected reductions are supported by a reasonable assurance that they will occur (CFR 40-130.2g).

The TMDL wasteload allocations for the NPDES permitted point sources in the Volga River watershed require that wastewater treatment plants effluent meet the water quality standards for discharges directly to the Volga River. For wastewater treatment plants that discharge to a tributary of the Volga, the effluent must meet the water quality standards where it flows into the Volga as calculated in this report.

These wasteload allocations are implemented through the Iowa NPDES permitting procedure following rules in the Iowa Administrative Code (567-64). For NPDES permitted Iowa feedlots in the Volga River watershed, no discharge is allowed and the wasteload allocation is zero. This means that no permitted point sources are allowed to discharge pathogen indicators at a concentration that causes a violation of the pathogen indicator water quality standards. Further pathogen indicator reductions below the wasteload allocations in this document cannot improve Volga River compliance with the water quality standards.

Reasonable assurance for non-point sources will be accomplished through methods and projects that reduce the impacts of livestock as described in the Section 4 Implementation Plan.

4. IMPLEMENTATION PLAN

An implementation plan is not a required component of a TMDL document but is a useful and logical extension of TMDL development. Implementation plans provide IDNR staff, partners, and watershed stakeholders with insight into water quality problems and can point towards a strategy for improvement.

This strategy should guide the stakeholders and the IDNR in the development of a priority based watershed plan that will implement best management practices with the goal of improving the water quality of the Volga River and meeting the TMDL targets.

The analysis and modeling of the Volga River watershed shows that controlling livestock manure runoff and cattle in streams would need to be a large part of a plan to reduce bacteria. Best management practices include feedlot runoff control; fencing off livestock from streams; alternative livestock watering supply; and buffer strips along the river and tributary corridors to slow and divert runoff. In addition to these sources, failed septic tank systems need to be repaired and wastewater treatment plants need to control the bacteria in their effluent.

As noted in Section 2, open feedlots for cattle with a capacity of 1000 head or more are registered with IDNR. As part of an agreement with EPA, called the Iowa Plan for Open Feed Lots, these operations will be required to have complete runoff controls (to the 25 year, 24 hour storm) or reduce their operations to under 1000 head in 2006. As part of an implementation plan the department can see how many of these plan on implementing run-off controls and how many will be reducing below 1000 head. This is a much improved level of control that should make it possible, with adequate monitoring, to see improvements in water quality downstream of these feedlots. Since feedlots can have major impacts these changes may provide significant pollutant reductions.

It would be useful to create a local watershed advisory committee that could identify high priority areas within the Volga River watershed where resources can be concentrated for the greatest effect. The areas with greatest impact on the river are adjacent to streams. In addition, priority best management practices should be identified for implementation. Since the impairment problem occurs at almost all flow conditions, solutions will need to be implemented for non-point sources with event driven transport, non-point sources that behave like continuous sources such as cattle in streams and failed septic tank systems, and continuous point sources such as wastewater treatment plants.

5. MONITORING

Monitoring of the Volga River will continue to be done at the Turkey River confluence by IDNR at the Elkport ambient site. Data collected at this site is used by the IDNR for its biannual water quality assessments (305b report) of the Volga River. IDNR will continue monthly ambient monitoring at this site.

Due to resource limitations, there are not any plans to continue targeted TMDL monitoring of the mainstem Volga River or its major tributaries. The existing ambient monitoring being done by the IDNR ambient monitoring provides only minimal information for water quality assessment and evaluation of the effectiveness of watershed best management practices. To really understand the Volga River pollutant problems and effectively manage their impact through improvements to controls, additional targeted monitoring is needed.

Phasing TMDLs is an iterative approach to managing water quality that is used when the origin, nature and sources of water quality impairments are not completely understood. In Phase 1, the waterbody load capacity, existing pollutant load in excess of this capacity, and the source load allocations are estimated based on the resources and information available.

These two TMDLs represent Phase 1 in the development of a project to improve Volga River water quality. The value of these evaluations and the effectiveness of their follow-ups are dependent on local activities to improve conditions in the watershed. Without the efforts of watershed citizens, implementation of practices that will remedy the Volga River impairment may not occur. What is needed in a second phase are stakeholder driven solutions and more effective management practices. Continuing targeted monitoring will determine what management practices result in load reductions and the attainment of water quality standards. Summarizing, renewed targeted 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.

The first phase of the Volga River watershed improvement plan is contained in these two TMDLs that set specific and quantified targets for pathogen indicator concentrations in the river and allocate allowable loads to all sources. An effective Phase 2 will require the participation of the watershed stakeholders in the implementation of pollutant controls and continued water quality evaluation. This will require continued targeted monitoring, thorough appraisal of the collected data, the readjustment of allocations, and the modification of management practices as shown to be necessary.

6. PUBLIC PARTICIPATION

The department has put together and implemented a plan to inform the public and stakeholders and get input and response for Volga River watershed TMDL project reports and activities. The plan has included two public meetings held in July 2005 at two locations in the Volga River watershed. The Volga River watershed is located in Fayette and Clayton counties.

The dates and locations of the initial `public meetings were:

Elkader: July 6, 2005, 7 p.m., Clayton County Conservation Center, 6 miles south of Elkader on Hwy. 13 (10 attendees)

Fayette: July 7, 2005, 7 p.m., Wildwood Nature Center, four miles north of Fayette, on Hwy. 150 (8 attendees)

Meeting attendees included county conservation staff, the county engineer, Natural Resource and Conservation Service (NRCS) staff, a reporter, and IDALS staff. The water quality problems in the watershed were discussed at these meetings and comments made have been considered during the development of this document.

A second public meeting was held August 3 in the watershed to discuss and present the draft TMDL. The purpose of this meeting is to provide information related to the draft TMDL and to obtain public and stakeholder input and comments on TMDL development and conclusions. Comments received were reviewed and given consideration and, where appropriate, incorporated into the TMDL.

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8. APPENDIX A WATERSHED MAPS

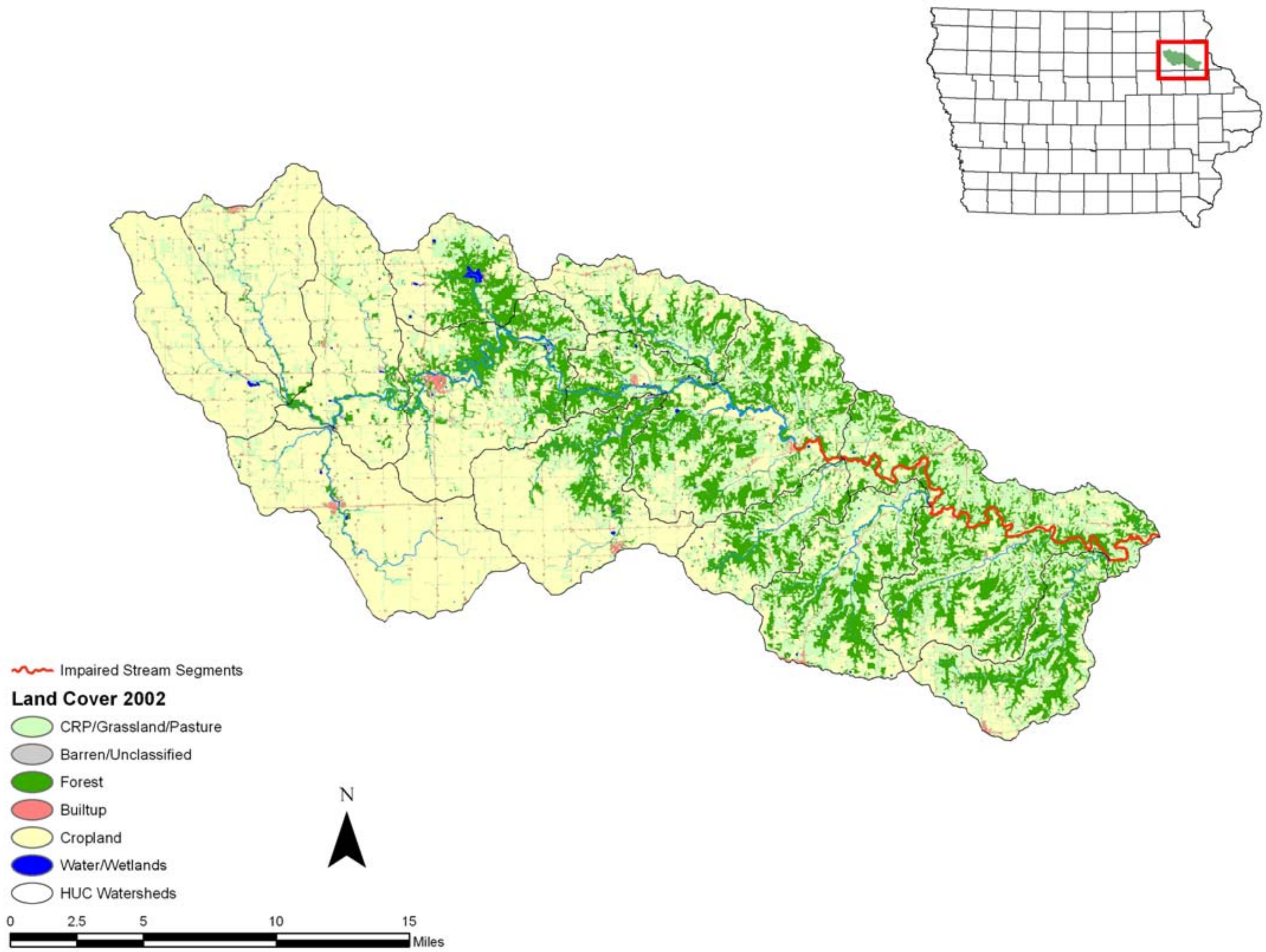

Figure A1 Landuse in the Volga River Watershed

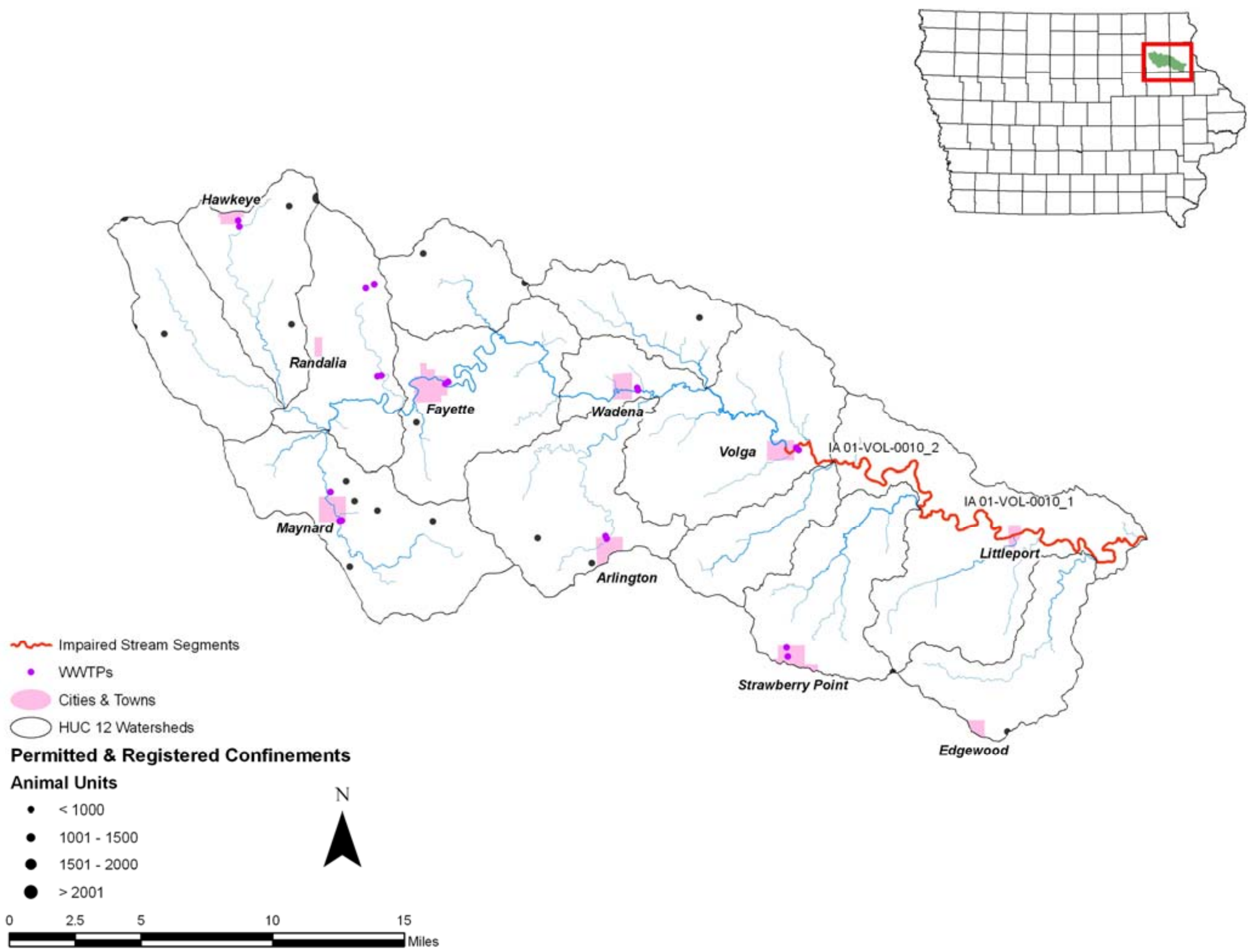

Figure A2 Volga River HUC 12's and the two impaired segments

9. APPENDIX B MONITORING DATA

The following tables contain the data from the Volga River IDNR Ambient Monitoring at the Elkport sampling site. Included in these tables are the fecal coliform data used to calibrate the model and the flow measured at the time of sampling. The water quality criteria for a fecal coliform geometric mean is 200 organisms/100 ml and for the single sample maximum is 400 organisms/ 100 ml.

Table B1 1999 Monitoring Data

Sampling Date	Fecal coliform, org./ 100 ml	Flow, cfs
04/21/99	350	750
05/11/99	200	540
06/10/99	3600	730
07/29/99	2300	850
08/17/99	120	320
09/14/99	130	180
10/07/99	10	150
11/08/99	40	115
12/07/99	45	120

Table B2 2000 Monitoring Data

Sampling Date	Fecal coliform, org./ 100 ml	Flow, cfs
01/13/00	0	85
02/23/00	2600	260
03/21/00	20	140
04/20/00	120000	1350
05/16/00	1200	185
06/14/00	110000	1400
07/12/00	3000	680
08/16/00	82	120
09/20/00	490	73
10/09/00	50	62
11/09/00	4500	225
12/12/00	10	95

Table B3 2001 Monitoring Data

Sampling Date	Fecal coliform, org./ 100 ml	Flow, cfs
01/09/01	0	0
02/07/01	20	0
03/08/01	20	0
03/19/01	72	960
04/09/01	720	730
05/03/01	85000	1050
05/08/01	3100	1850
06/07/01	2800	390
07/05/01	480	310
08/01/01	90	150
08/03/01	24000	300
09/07/01	470	246
09/12/01	2700	240
09/24/01	1500	240
10/02/01	220	150
11/06/01	120	170
12/04/01	140	190

Table B4 2002 Monitoring Data

Sampling Date	Fecal coliform, org./ 100 ml	Flow, cfs
02/05/02	0	65
03/05/02	0	130
04/02/02	0	155
04/29/02	770	410
05/07/02	60	230
05/30/02	20000	820
06/04/02	93000	3300
07/01/02	100	170
08/06/02	550	160
08/23/02	60000	200
09/11/02	73	55
10/01/02	410	74
11/05/02	40	90
12/03/02	50	25

Table B5 2003 Monitoring Data

Sampling Date	Fecal coliform, org./ 100 ml	Flow, cfs
01/07/03	10	34
02/04/03	10	46
03/04/03	0	17
04/01/03	0	68
05/06/03	4600	470
06/03/03	80	145
07/08/03	15000	960
08/05/03	50	93
09/02/03	190	63
10/07/03	64	46
11/04/03	190000	300
12/02/03	30	54

Table B6 2004 Monitoring Data

Sampling Date	**Fecal coliform, org./ 100 ml**	**Flow, cfs**
03/02/04	350	440
04/06/04	0	230
05/04/04	30	190
06/01/04	3500	2600
07/06/04	36000	10500