PATHOGEN TMDLS FOR CLEAR CREEK 11110103-029

IN ARKANSAS PLANNING SEGMENT 3J

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of the state's water resources (USEPA, 1991).

The study area is part of the Arkansas Department of Environmental Quality (ADEQ) Planning Segment 3J and is located within the Ozark Highlands Ecoregion. This TMDL is for the impaired waterbody Clear Creek Hydologic Unit Code (HUC) 11110103-029 in the Arkansas River Basin in northwestern Arkansas. Land use in the Clear Creek watershed study area consists mostly of pasture, forest, and urban. The designated beneficial uses that have been established by ADEQ for Planning Segment 3J include fishery; primary and secondary contact recreation; domestic; agricultural and industrial water supply.

The numeric water quality criterion that apply to the impaired reach and that were used to calculate the total allowable loads are the primary contact water quality criteria for fecal coliform (FC) bacteria and *Escherichia coli* (E. coli).

The TMDLs for FC and E. coli bacteria were developed using mass balance principles. The TMDL information has been displayed in the load duration curve method. This method illustrates allowable loading at a wide range of streamflow conditions. The seasonal FC and E. coli bacteria TMDLs were developed on the basis of analyses of the Primary Contract Recreation (PCR) water quality criteria, which specifies two seasons. Allowable loads for each season were calculated.

The TMDLs for fecal coliform and E. coli bacteria were separated into PCR summer (May 1 through September 30) and PCR winter (October 1 through April 30) data sets to accommodate the state's seasonal criteria. Secondary Contact Recreation (SCR) has year round criteria limits. The daily projected streamflow data from the USGS gage 07195430 were used to develop flows for Clear Creek.

Table ES.1 Summary of Bacteria TMDLs Clear Creek HUC-reach 11110103-029

Pollutant	Criteria Season	MOS cfu/day	∑ WLA cfu/day	∑ LA cfu/day	TMDL cfu/day	Numeric Criteria
FC	PCR-S	5.44E+10	3.15E+11	1.75E+11	5.44E+11	400 col/100ml
FC	PCR-W/SCR	2.72E+11	1.57E+12	8.74E+11	2.72E+12	2000 col/100ml
E. coli	PCR-S	5.58E+10	3.23E+11	1.80E+11	5.58E+11	410 col/100ml
E. coli	PCR-W/SCR	2.80E+11	1.62E+12	9.00E+11	2.80E+12	2050 col/100ml

PCR-S (primary contact recreation summer) criteria – between May 1 - Sept 30 for pathogens.
PCR-W (primary contact recreation winter) criteria - between Oct. 1 - April 30, criteria may not exceed SCR (secondary contact recreation) criteria limits.

SCR - Year round criteria limits.

cfu/day = colony forming units/day

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1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for fecal coliform (FC) and *Escherichia coli* (E. coli) for one stream reach in northwestern Arkansas. This stream reach was included on the Arkansas Department of Environmental Quality (ADEQ) 2004 Integrated Report (ADEQ, 2004) as not supporting the designated use of primary contact recreation (PCR). The waterbody, pollutants, and priority from the 303(d) list and other information from the Integrated Report are shown below in Table 1.1. The TMDLs in this report address the impairments due to pathogens and were developed in accordance with Section 303(d) of the Federal Clean Water Act and the Environmental Protection Agency's (EPA) regulations in 40 CFR 130.7.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern. The LA is the load allocated to nonpoint sources (NPS), including natural background. The MOS is a percentage of the TMDL that takes into account any lack of knowledge concerning the relationship between pollutant loadings and water quality.

Table 1.1 Pathogen Impaired 3J HUC-Reach Addressed

HUC-Reach Number	Waterbody Name	Impaired Use	Cause of Impairment	Suspected Source	Priority Ranking
11110103-029	Clear Creek	PCR	Pathogen	Unknown	Medium

PCR = Primary Contact Recreation

2.0 STUDY AREA INFORMATION

2.1 General Description

The study area for this project, Clear Creek is located in the Arkansas River Basin in northwestern Arkansas (see Appendix A). The Clear Creek Watershed is in Washington County within the Ozark Highlands Ecoregion. The United States Geological Survey (USGS) HUC-reach for Clear Creek is 11110103-029, which is in the ADEQ Planning Segment 3J. The impaired segment, Clear Creek flows into the Illinois River. See Table 1.1 for segment number, waterbody name, use, impairment, suspected source, and ranking. The drainage area for Clear Creek is 199.2 km^2.

2.2 Soils and Topography

The soils and topography information was obtained from soil surveys for Washington County (USDA, 2004). The soils and topography of the Clear Creek study area are loamy and silty, deep, moderately well drained to well drained, nearly level to gently sloping soils on terraces and flood plains.

2.3 Land Use

Land use data for the study area were obtained from the GEOSTOR database, which is maintained by the Center for Advanced Spatial Technology (CAST) at the University of Arkansas in Fayetteville. These data were based on satellite imagery from 2004. Refer to Appendix A figure B for the land use map. The land use percentages for Clear Creek HUC-reach 11110103-029 are shown in Table 2.1. This area is being developed rapidly; almost 27.3% of the study area is classified as urban. These data indicate that pasture (35.8%), forest (33.9%), and urban (27.3%) are the predominant land uses.

Table 2.1 Land Use for Clear Creek HUC-reach 11110103-029

Land Use	Acres	Km^2	Percentage Area
Pasture	17600	71.2	35.8%
Forest	16685	67.5	33.9%
Urban	13424	54.3	27.3%
Barren	1295	5.3	2.6%
Water	210	0.9	0.4%
Total	49214	199.2	100.0%

2.4 Flow Characteristics

The USGS flow gage (07195430) was used to project the flow information for Clear Creek: Illinois River south of Siloam Springs, AR (USGS 07195430). Information for this flow gage is summarized in Table 2.2.

Table 2.2 Information for Stream Flow Gage Station

Gage Name	Illinois River South of Siloam Springs,
Gage Number	07195430
Location	Illinois River South of Siloam Springs,
Period of record	Jan. 1900 to Aug. 2007
Drainage area	575 square miles

2.5 Water Quality Standards

The beneficial uses by HUC-Reach number are shown below in Table 2.3. There is no narrative criterion for pathogens in the Water Quality Standards for Surface Waters of the State of Arkansas. Below are the numeric criteria for Pathogens from the Arkansas Pollution Control and Ecology Commission Regulation No. 2 (APCEC, 2006).

"Reg. 2.507 Bacteria

The Arkansas Department of Health has the responsibility of approving or disapproving surface waters for public water supply and of approving or disapproving the suitability of specifically delineated outdoor bathing places for body contact recreation, and it has issued rules and regulations pertaining to such uses.

For the purposes of this regulation, all streams with watersheds less than 10 mi^2 shall not be designated for primary contact unless and until site verification indicates that such use is attainable. No mixing zones are allowed for discharges of bacteria.

A) Primary Contact Waters - Between May 1 and September 30, the fecal coliform content shall not exceed a geometric mean of 200 col/100 ml nor a monthly maximum of 400 col/100 ml. Alternatively, in these waters, *Escherichia coli* colony counts shall not exceed a geometric mean of more than 126 col/100 ml. or a monthly maximum value of not more than 298 col/100 ml in lakes, reservoirs and Extraordinary Resource Waters or 410 col/100 ml in other rivers and streams. During the remainder of the calendar year, these criteria may be exceeded, but at no time shall these counts exceed the level necessary to support secondary contact recreation (below).

(B) Secondary Contact Waters - The fecal coliform content shall not exceed a geometric mean of 1000 col/100 ml nor a monthly maximum of 2000 col/100 ml. E. coli values shall not exceed the geometric mean of 630 col/100 ml or a monthly maximum of 1490 col/100 ml for lakes, reservoirs and Extraordinary Resource Waters and 2050 col/100 ml for other rivers and streams."

As specified in EPA's regulations at 40 CFR 130.7(b) (2), applicable water quality standards include antidegradation requirements. Arkansas' antidegradation policy is listed in Sections 2.201 through 2.204 of Regulation No. 2 (APCEC, 2006). These sections are summarized below:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

Beneficial uses are listed below in Table 2.3.

Table 2.3 Designated Uses on Selected HUC-Reach

HUC-Reach Number	Designated Uses
11110103-029	AWS, DWS, FS, IWS, PCR, SCR

AWS	- Agricultural Water Supply
DWS	- Domestic Water Supply
FS	- Fishery Stream
IWS	- Industrial Water Supply
PCR	- Primary Contact Recreation
SCR	- Secondary Contact Recreation

3.0 SOURCE ANALYSIS

An important part of TMDL analysis is the identification of individual sources, or source subcategories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these sources. Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 40CFR §122.2, a point source is defined as “any discernable, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discreet fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged.” The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point source discharges can be described by broad subcategories: 1) NPDES regulated municipal and industrial wastewater treatment facilities (WWTF); 2) NPDES regulated industrial and municipal storm water discharges; 3) NPDES regulated indirect industrial and industrial non-process wastewater discharges; and 4) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For the purposes of this TMDL, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

3.1 Nonpoint Sources

Fecal coliform and E. coli bacteria are produced by all warm-blooded animals, including wildlife such as mammals and birds. In developing bacteria TMDLs, it is essential to identify the potential for bacteria contributions from wildlife by watershed. Wildlife is naturally attracted to riparian corridors of streams and rivers. With direct access to the stream channel, wildlife can be a concentrated source of bacteria loading to a waterbody. Fecal coliform bacteria from wildlife are also deposited onto land surfaces, where it may be washed into nearby streams by rainfall runoff. Currently there are insufficient data available to estimate populations of wildlife and avian species by watershed. Consequently, it is difficult to assess the magnitude of contributions from wildlife species as a general category.

The predominant land uses for the listed reach in planning segment 3J are forest (33.9%), pasture (35.8%), and urban (27.3%); therefore, the most probable source of fecal coliform and E. coli bacteria are from wildlife and domestic animals living in the area. Run off from the pastures can contribute fecal coliform and E. coli to the study area. It is presently unknown to what extent these sources contribute to pathogen loads. The Arkansas Water Quality Standard does not provide exclusion for wildlife and domestic animal bacteria contributions. Therefore, there is no compelling reason to identify the quantity of these sub-sources.

3.2 Point Sources

Both treated and untreated sanitary wastewater contains fecal coliform and E. coli bacteria. If they are classified with a SIC code of 4952 (Sewerage Systems), they must have pathogen requirements in the effluent monitoring data, submitted on Discharge Monitoring Reports (DMR). Information for point source discharges in the study area was obtained by searching the Permit Compliance System on the EPA web site (PCS, 2005) and the Arkansas 2004 Integrated Report (ADEQ, 2004). The search yielded 1 Waste Water Treatment Plant (WWTP) point source discharger, and 4 Municipal Separate Storm Sewer Systems (MS4 permits) at this time for the Clear Creek Watershed in planning segment 3J. See Table 3.1 below. There are 4 known MS4 permits in the Clear Creek watershed addressed in this TMDL report. The 4 MS4 permits were assigned individual wasteload allocation. See appendix A Figure A for the watershed map.

Table 3.1 Point Source Inventory for Clear Creek Watershed

NPDES Permit No.	Facility	Receiving Waters	Comments
AR0020010	Fayetteville, City of - Noland Plant WWTP outfall 002	UT; Mud Creek; Clear Creek; Illinois River	AR11110103-029
ARR040010	City of Fayetteville **MS4**	Clear Creek Watershed	stormwater permit
ARR040038	City of Johnson **MS4**	Clear Creek Watershed	stormwater permit
ARR040019	City of Springdale **MS4**	Clear Creek Watershed	stormwater permit
ARR040023	Washington County **MS4**	Clear Creek Watershed	stormwater permit
ARG160003	Landfill	no discharge	no discharge
AR0020010	Fayetteville, City of - Noland Plant WWTP outfall 001	White River; Beaver Lake; White River	outside study area

3.3 Regulated Storm Water Discharges

Municipal storm water runoff is covered under the NPDES Permit Program. Storm water NPDES permits establish controls “to the maximum extent practicable” (MEP). Regulated storm water discharges that may contain pathogens consist of those small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more (USEPA, 1996).

The MS4 Phase II program must include measurable goals. The goals include the following six minimum measures, and evaluation and reporting efforts:

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

Small MS4s serving urbanized areas are required to obtain a storm water permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. There are four (4) MS4 stormwater permits for cities/counties in Clear Creek HUC 11110103-029. See Land use Map in Appendix A figure B.

Table 3.2 MS4 Permits for Clear Creek Watershed

Municipal Area	NPDES Permit No.	Permit Expiration Date
City of Springdale	ARR040019	March 31, 2009
City of Johnson	ARR040038	March 31, 2009
City of Fayetteville	ARR040010	March 31, 2009
Washington County	ARR040023	March 31, 2009

4.0 EXISTING WATER QUALITY

Total fecal coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food.

A specific subgroup of this collection is the fecal coliform bacteria, the most common member being E. coli. These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water might have been contaminated by pathogens or disease producing bacteria or viruses that can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or non-point sources of human and animal waste (USEPA, 2001).

Clear Creek HUC-reach 11110103-029 is included on the 2004 Arkansas 303(d) list due to exceedences of numeric criteria for pathogens (ADEQ, 2004). ADEQ historical water quality data was analyzed.

4.1 Observed Data

Bacteria monitoring data at ARK0010C for Clear Creek was obtained from ADEQ (PCS, 2005). Monitoring data is shown in Table 4.1 below. The samples collected at station ARK0010C from October through April did not have any exceedances of the water quality criterion of 2,000 colonies/100 ml. Each sampling location had exceedances of the primary contact criterion of 400 colonies/100 ml during the May 1 through September 30. The geometric mean from May 1 thru September 30 exceeded the E. coli criterion of 126 col/100 ml.

Table 4.1 Observed Data for Bacteria

FY2006 E. coli Monitoring Data / **FY1999 FC Monitoring Data**
Primary Contact Recreation (May 1 - Sept 30)

HUC 11110103-029	**ARK0010C**	HUC 11110103-029	**ARK0010C**
DD-MM-YY	E. coli	DD-MM-YY	Fecal coliform
10-Oct-05			
23-Jan-06			
11-Apr-06		19-Apr-99	6
23-May-06	80	3-May-99	88
19-Jun-06	72	7-Jun-99	80
17-Jul-06		12-Jul-99	420
28-Aug-06	700	9-Aug-99	600
6-Sep-06	69		
11-Sep-06	750	13-Sep-99	600
19-Sep-06	200		
26-Sep-06	150		
27-Sep-06	50		
# samples exceeding	2	# samples exceeding	3
# samples collected	8	# samples collected	5

4.2 Trends and Patterns in Observed Data

Because of the limited number of samples, no distinct trends or patterns were found in the reported monitoring results. The highest E. coli bacteria concentrations were observed during the summer months and usually during low-flow conditions. Limited sample collection data during high-flow periods limit the comparability of low-flow and high-flow monitoring results.

5.0 TMDL DEVELOPMENT

A TMDL is the total amount of a pollutant that can be assimilated by the receiving waterbody while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis for establishing water quality-based controls (USEPA, 1991).

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. The TMDL must include an implicit or explicit margin of safety (MOS) to account for the lack of knowledge in the relationship between pollutant loads and the quality of the receiving waterbody. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDLs for some pollutants are expressed as a mass loading (e.g., pounds per day). TMDLs for bacteria can be expressed in terms of organism counts per day, in accordance with 40 CFR 130.2(l).

5.1 TMDL Analytical Approach

The methodology used for the TMDLs in this report is the load duration curve (LDC). Loading capacity varies as a function of the flow present in the stream, these TMDLs represent a continuum of desired loads over all flow conditions, rather than fixed at a single value. The basic elements of this procedure are documented on the Kansas Department of Health and Environment web site (KDHE, 2005). This method was used to illustrate allowable loading at a wide range of flows. The steps for how this methodology was applied for the TMDLs in this report can be summarized as follows:

Develop a flow duration curve.
Convert the flow duration curve to a load duration curve per specific impairment.
Plot observed loads with load duration curves.
Calculate TMDL, MOS, WLA, and LA (see Section 5.2).

5.2 Flow Duration Curve

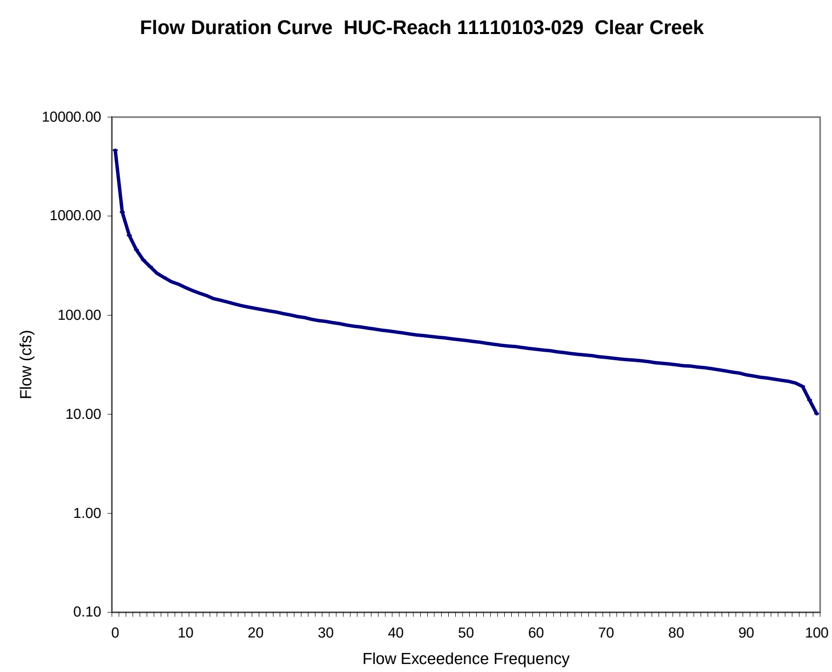
Flow duration curves are graphical representations of the flow characteristics of a stream at a given site. Flow duration curves utilize the historical hydrologic record from stream USGS gages to forecast future recurrence frequencies. The most basic method to estimate flows at an un-gaged site involves 1) identifying an upstream or downstream flow gage; 2) calculating the contributing drainage areas of the un-gaged sites and the flow gage; and 3) calculating daily flows at the un-gaged site by using the flow at the gage site multiplied by the drainage area ratio. More complex approaches may also consider watershed rainfall, land use, and the hydrologic properties of soil. Flow duration curves are a type of cumulative distribution function.

In the event no coincident flow data are available for a segment, but flow gage(s) are present upstream and/or downstream, flows will be estimated for the segment from an upstream or downstream gage using a watershed area ratio method derived by delineating subwatersheds. Drainage subbasins will first be delineated for all the impaired 303(d)-listed segment, along with all USGS flow station located in the 8-digit HUCs with the impaired stream.

A flow duration curve was developed using the downstream flow gage (USGS 07195430) and the Clear Creek drainage area ratio for the TMDLs. Daily projected streamflow measurements for each data set were sorted in increasing order, and the percentile ranking of each flow was calculated.

The flow duration curve represents the fraction of flow observations that exceed a given flow at the site of interest. Daily stream flow measurements were sorted in increasing order, and the percentile ranking of each flow was calculated. More specifically, the observed flow values are first ranked from highest to lowest, then, for each observation, the percentage of observations exceeding that flow is calculated. The flow value (cubic feet per second) is read from the ordinate (y-axis), which is typically on a logarithmic scale since the high flows would otherwise overwhelm the low flows. The flow exceedance frequency is read from the abscissa (x-axis), which is numbered from 0 to 100 percent, and is not logarithmic. The lowest measured flow occurs at an exceedence frequency of 100 percent indicating that flow has equaled or exceeded this value 100 percent of the time, while the highest measured flow is found at an exceedence frequency of 0 percent. The median flow occurs at a flow exceedence frequency of 50 percent. The flow exceedence percentiles for the HUC-reach addressed in this report are provided in Appendix B. While the number of observations required to develop a flow duration curve is not rigorously specified, a flow duration curve is usually based on more than 1 year of observations, and encompasses inter-annual and seasonal variation. Ideally, the drought of record and flood of record are included in the observations. The long term flow gage station operated by the USGS was utilized (USGS, 2005). A typical semi-log flow duration curve exhibits a sigmoid shape, bending upward near the flow duration of 0 percent and downward at a frequency near 100 percent, often with a relatively constant slope in between. For sites that on occasion exhibit no flow, the curve will intersect the abscissa at a frequency less than 100 percent. As the number of observations at a site increases, the line of the LDC tends to appear smoother. However, at extreme low and high flow values, flow duration curves may exhibit a “stair step” effect due to the USGS flow data rounding conventions near the limits of quantization. Figure 5.1 is the flow duration curve for Clear Creek. The plot shows the flow on the Y-axis. The X-axis shows the frequency on which the plotted flow is exceeded. Points at the left end of the plot (0 through 10 percent) represent high-flow conditions where only 0 through 10 percent of the flow exceeds the plotted point. Points on the right end of the plot (90 to 100 percent) represent low-flow conditions.

Figure 5.1 Clear Creek Flow Duration Curve.



5.3 Load Duration Curve

The flows from the flow duration curve was multiplied by the appropriate fecal coliform and E. coli bacteria numeric criterion concentration (Section 2.4) to compute an allowable load duration curve (LDC). Each LDC is a plot of colony forming units (cfu) per day versus the flow exceedence frequency from the flow duration curve.

A typical semi-log load duration curve exhibits a sigmoidal shape, bending upward near the flow duration of 0 percent and downward at a frequency near 100 percent, often with a relatively constant slope in between. At extreme low and high flow values, load duration curves may exhibit a "stair step" effect due to the USGS flow data rounding conventions near the limits of quantitation.

5.4 Observed Loads

Observed loads were calculated by multiplying the observed concentration of the parameter of concern by the flow on the sampling day for each sampling station and season. These observed loads were then plotted versus the flow exceedence frequency of the flow on the sampling day and placed on the same plot as the LDC.

These plots provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the LDC represent conditions where observed water quality concentrations exceed the numeric criterion. Observed loads plotted below the LDC represent conditions where observed water quality concentrations were less than numeric criterion.

The LDC is beneficial when analyzing monitoring data to develop an implementation plan, because it presents corresponding flow information and monitoring results plotted as a load. This approach allows the monitoring data to be placed in relation to their place in the flow continuum. Assumptions of the probable source or sources of the impairment can then be made from the plotted data.

5.5 TMDLs

The LDC shows the calculation of the TMDL at any flow rather than at a single critical flow. The official TMDL number is reported as a single number, but the curve is provided to demonstrate the value of the acceptable load at any flow. This will allow analysis of load cases in the future for different flows. The tables in Appendix B are provided for calculating the load at any flow for the HUC-Reach. Curves are displayed in Appendix C.

The fecal coliform and E. coli loads (or the y-value of each point) are calculated by multiplying the numeric criterion by the instantaneous flow (cubic feet per second) from the same site and time, with appropriate volumetric and time unit conversions.

TMDL (cfu/day) = Numeric Criteria * flow (cfs) * unit conversion factor

Where: Numeric Criteria PCR-S = 400 cfu/100ml (fecal coliform) or 410 cfu/100ml (E. coli).

Numeric Criteria PCR-W/SCR = 2,000 cfu/100ml (fecal coliform) or 2,050 cfu/100ml (E. coli).

Unit conversion factor = 24,465,751 100 ml /cfs

Each TMDL for the table was calculated as the 50th percentile on the LDC. Table 5.1 presents the TMDLs and allocations for the Clear Creek in this report.

Table 5.1 Summary of Bacteria TMDLs Clear Creek

Pollutant	Criteria Season	MOS cfu/day	∑ WLA cfu/day	∑ LA cfu/day	TMDL cfu/day	Numeric Criteria
FC	PCR-S	5.44E+10	3.15E+11	1.75E+11	5.44E+11	400 col/100ml
FC	PCR-W/SCR	2.72E+11	1.57E+12	8.74E+11	2.72E+12	2000 col/100ml
E. coli	PCR-S	5.58E+10	3.23E+11	1.80E+11	5.58E+11	410 col/100ml
E. coli	PCR-W/SCR	2.80E+11	1.62E+12	9.00E+11	2.80E+12	2050 col/100ml

PCR-S (primary contact recreation summer) criteria – between May 1 - Sept 30 for pathogens.
PCR-W (primary contact recreation winter) criteria - between Oct. 1 - April 30, criteria may not exceed SCR (secondary contact recreation) criteria limits.

SCR - Year round criteria limits.
cfu/day = colony forming units/day

5.6 Wasteload Allocation

The WLA portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. There is one known permitted facilities discharging sanitary wastewater into the Clear Creek HUC-reach 11110103-029 and four MS4 NPDES permits in the study area.

Point Source Loading = monthly average flow rates (mgd) * monthly maximum corresponding fecal coliform or E. coli criteria (cfu/100ml) * unit conversion factor (100ml/mgd)

Where:

Unit conversion factor = 37,854,120 100 ml/mgd

The point source individual WLA's are shown in Table.5.2.

Three municipal and one County MS4 permits operate in the Clear Creek watershed (one WWTP facility under permit by Arkansas Department of Environmental Quality (ADEQ) was identified for this TMDL). Loading capacity was allocated to the MS4 permits based on the proportion of drainage area that they represent. The Load Allocation (LA) multiplied by (the MS4 urban area divided by the Clear Creek watershed area) equals the MS4 area weighted wasteload allocation. The MS4 area weighted wasteload allocation was subdivided using the area of each of the MS4s to arrive at the 4 individual weighted MS4 allocations. The total Wasteload Allocation (WLA) is the sum of 4 individual weighted MS4 allocations and the wasteload allocation for the Fayetteville WWTP. The MS4 area weighted wasteload allocation was subtracted from the Load Allocation to give the total LA. Pollutants of concern in these TMDLs are Fecal Coliform and E. coli. Wasteload allocations for all NPDES permits in the impaired assessment units are shown in Table 5.2.

Table 5.2 Wasteload Allocations for NPDES Permits

		400col/100ml	2000col/100ml	410col/100ml	2050col/100ml	
NPDES Permit #	**Facility**	**PCR-S FC**	**PCR-W/SCR FC**	**PCR-S E coli**	**PCR-W-SCR E coli**	
		Wasteload Allocations - (cfu/day)				
		River Reach AR11110103-029				**Expires**
AR0020010	Fayetteville WWTP outfall 002 [**flow = 6.0 MGD**]	9.08E+10	4.54E+11	9.31E+10	4.66E+11	7/31/2010
ARR040010	City of Fayetteville **MS4**	1.09E+11	5.43E+11	1.12E+11	5.59E+11	3/31/2009
ARR040038	City of Johnson **MS4**	1.60E+10	8.00E+10	1.64E+10	8.24E+10	3/31/2009
ARR040019	City of Springdale **MS4**	5.25E+10	2.62E+11	5.38E+10	2.70E+11	3/31/2009
ARR040023	Washington County **MS4**	4.65E+10	2.32E+11	4.77E+10	2.39E+11	3/31/2009

PCR-S (primary contact recreation summer) criteria- between May 1 - Sept 30 for pathogens.
PCR-W (primary contact recreation winter) criteria-between Oct 1 - Apr 30, criteria may not exceed SCR (secondary contact recreation) criteria limits.
SCR - Year round criteria limits.
cfu/day = colony forming units/day

5.7 Load Allocation

The load allocation is the portion of the TMDL assigned to natural background loadings as well as nonpoint sources such as septic tanks, wildlife, and agricultural practices. The LA was calculated by subtracting the WLA, and MOS from the total TMDL. LAs were not allocated to separate nonpoint sources; due to the lack of available source characterization data. The LAs are presented in Table 5.1.

5.8 Seasonality and Critical Conditions

The federal regulations at 40 CFR 130.7 require that TMDLs be established at levels necessary to attain and maintain the applicable narrative and numerical WQS with seasonal variations. Determinations of TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters. For these TMDLs, FC and E coli bacteria loadings for the waterbody reach with primary contact recreation (between May 1 and September 30) as the designated use were determined for winter and summer on the basis of seasonal water quality criteria, thus accounting for seasonality.

By accounting for critical conditions, the TMDLs make sure that water quality standards are maintained for infrequent occurrences and not only for average conditions. The LDC includes all flows, so it includes any critical conditions. The LDC method has the benefit of including more than one critical condition.

5.9 Margin of Safety

Both section 303(d) of the Clean Water Act and the regulations at 40 CFR 130.7 require that TMDLs incorporate a MOS to account for any lack of knowledge concerning the relationship between effluent limitations and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly using conservative assumptions in establishing the TMDL. These TMDLs use an explicit MOS.

5.10 Future Growth

Compliance with these TMDLs is based on keeping the bacteria concentrations in the selected waters below the criterion limits that were set for the sites. Future growth for existing or new point sources is not limited by these TMDLs as long as they do not cause bacteria to exceed the criterion limits. The assimilative capacity of the streams will increase as the amount of flow in the stream increases. Increases in flow will allow for increased loadings. The LDC and tables will guide the determination of the assimilative capacity of the stream including the future growth.

6.0 OTHER RELEVANT INFORMATION

ADEQ has established a comprehensive program for monitoring the quality of the State’s surface waters. ADEQ collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state’s surface waters, to develop a long-term data base for long term trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state’s biennial 305(b) report (Water Quality Inventory) and the 303(d) list of impaired waters, which are issued as a single document titled Arkansas Integrated

Water Quality Monitoring and Assessment Report (ADEQ, 2004).

7.0 STORMWATER IMPLEMENTATION

7.1 Storm water permitting Requirements and Presumptive Best Management practices (BMPs) Approach

7.1.1 Background

The National Pollutant Discharge Elimination System (NPDES) permitting program for stormwater discharges was established under the Clean Water Act as the result of a 1987 amendment. The Act specifies the level of control to be incorporated into the NPDES stormwater permitting program depending on the source (industrial versus municipal stormwater). These programs contain specific requirements for the regulated communities/facilities to establish a comprehensive stormwater management program (SWMP) or storm water pollution prevention plan (SWPPP) to implement any requirements of the total maximum daily load (TMDL) allocation. [See 40 CFR §130.]

Storm water discharges are highly variable both in terms of flow and pollutant concentration, and the relationships between discharges and water quality can be complex. For municipal stormwater discharges in particular, the current use of system-wide permits and a variety of jurisdiction-wide BMPs, including educational and programmatic BMPs, does not easily lend itself to the existing methodologies for deriving numeric water quality-based effluent limitations. These methodologies were designed primarily for process wastewater discharges which occur at predictable rates with predictable pollutant loadings under low flow conditions in receiving waters. EPA has recognized these problems and developed permitting guidance for stormwater permits. [See “Interim Permitting Approach for Water Quality-Based Effluent Limitations in Stormwater Permits” (EPA-833-D-96-00, Date published: 09/01/1996)]

Due to the nature of storm water discharges, and the typical lack of information on which to base numeric water quality-based effluent limitations (expressed as concentration and mass), EPA recommends an interim permitting approach for NPDES storm water permits which is based on BMPs. “The interim permitting approach uses best management practices (BMPs) in first-round storm water permits, and expanded or better-tailored BMPs in subsequent permits, where necessary, to provide for the attainment of water quality standards.” (*ibid.*)

A monitoring component is also included in the recommended BMP approach. “Each storm water permit should include a coordinated and cost-effective monitoring program to gather necessary information to determine the extent to which the permit provides for attainment of applicable water quality standards and to determine the appropriate conditions or limitations for subsequent permits.” (*ibid.*) This approach was further elaborated in a guidance memo issued in 2002. [See Memorandum from Robert Wayland, Director of OWOW and James Hanlon, Director of OWM to Regional Water Division Directors: “Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit requirements Based on Those WLAs ” (Date published: 11/22/2002)] “The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and nonstructural BMPs) that address storm water discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. …… If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the storm water component of the TMDL, EPA recommends that the TMDL reflect this." This BMP-based approach to stormwater sources in TMDLs is also recognized and described in the most recent EPA guidance. [See "TMDLs To Stormwater Permits Handbook" (DRAFT), EPA, November 2008]

This TMDL adopts the EPA recommended approach and relies on appropriate BMPs for implementation. No numeric effluent limitations are required or anticipated for municipal stormwater discharge permits.

7.1.2 Specific SWMP/SWPPP Requirements

As discussed in the Arkansas Small MS4 NPDES permit, if a TMDL assigns an individual WLA specifically to a MS4's stormwater discharge, ADEQ's permit specifies that the WLA must be include as a measurable goal for the stormwater management program (SWMP).

Examples of activities that the MS4 may conduct to be consistent with the WLA include:

- Monitoring to evaluate program compliance, the appropriateness of identified best management practices, and progress toward achieving identified measurable goals, and

Development of a schedule for implementation of additional controls and/or BMPs (if necessary) based on monitoring results, to ensure compliance with applicable TMDLs.

8.0 PUBLIC PARTICIPATION

When EPA establishes TMDLs, Federal regulations require EPA to publicly notice and seek comment concerning the TMDLs. Pursuant to a May 2000 consent decree, these TMDLs were prepared by EPA. After development of the draft version of these TMDLS, EPA prepared a notice seeking comments, information, and data from the general public and any other interested parties. The notice for the public review period was published in the Federal Register on August 12, 2009, and the review period closed on September 11, 2009.

One specific comment was received from ADEQ addressing the TMDLs in this report. The comment and EPA's responses are included in Appendix E of this TMDL. EPA will provide the final version of these TMDLs to ADEQ for implementation and incorporation into ADEQ's current water quality management plan.

9.0 REFERENCES

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APPENDIX_A

Watershed and Land Cover Maps

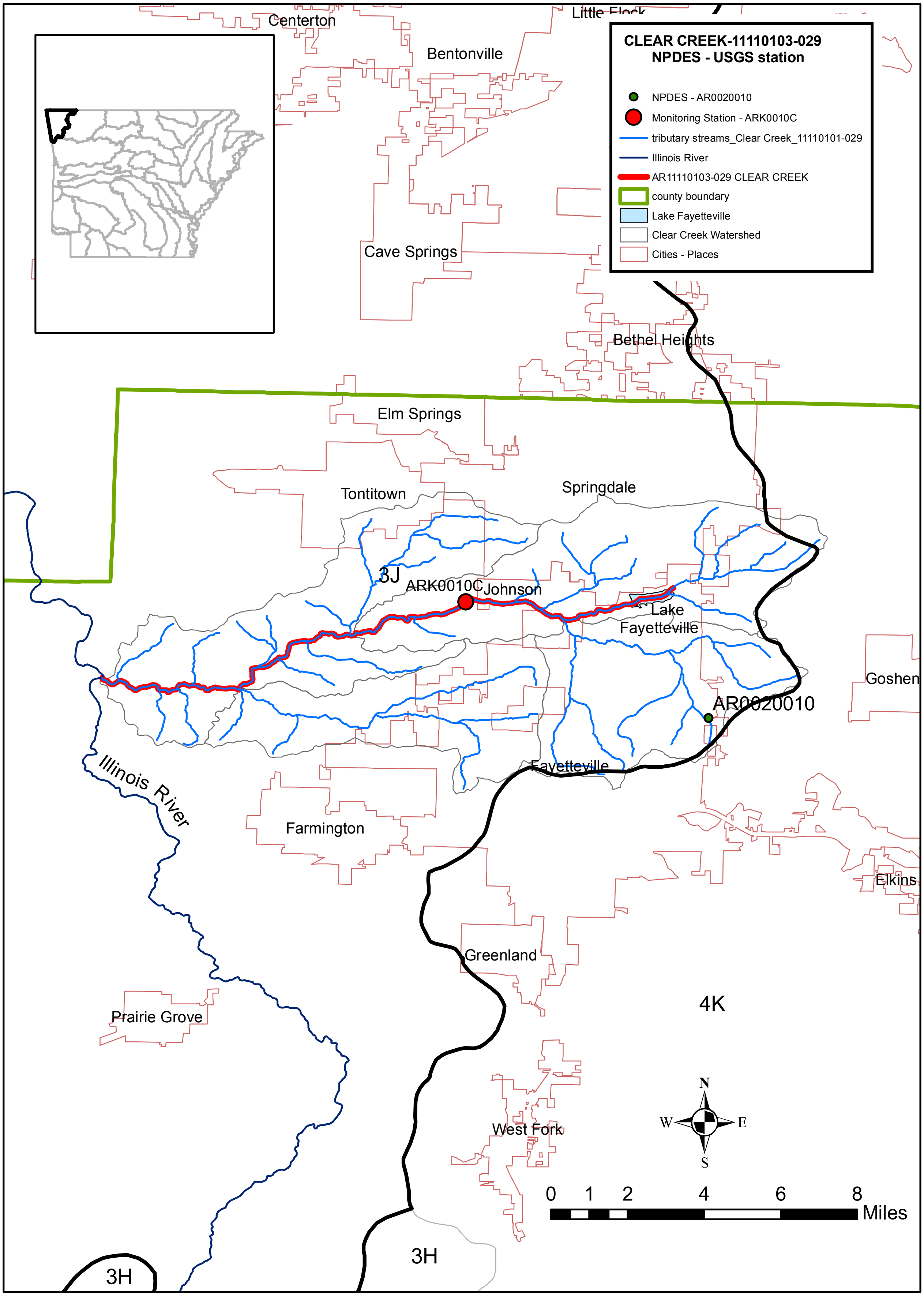
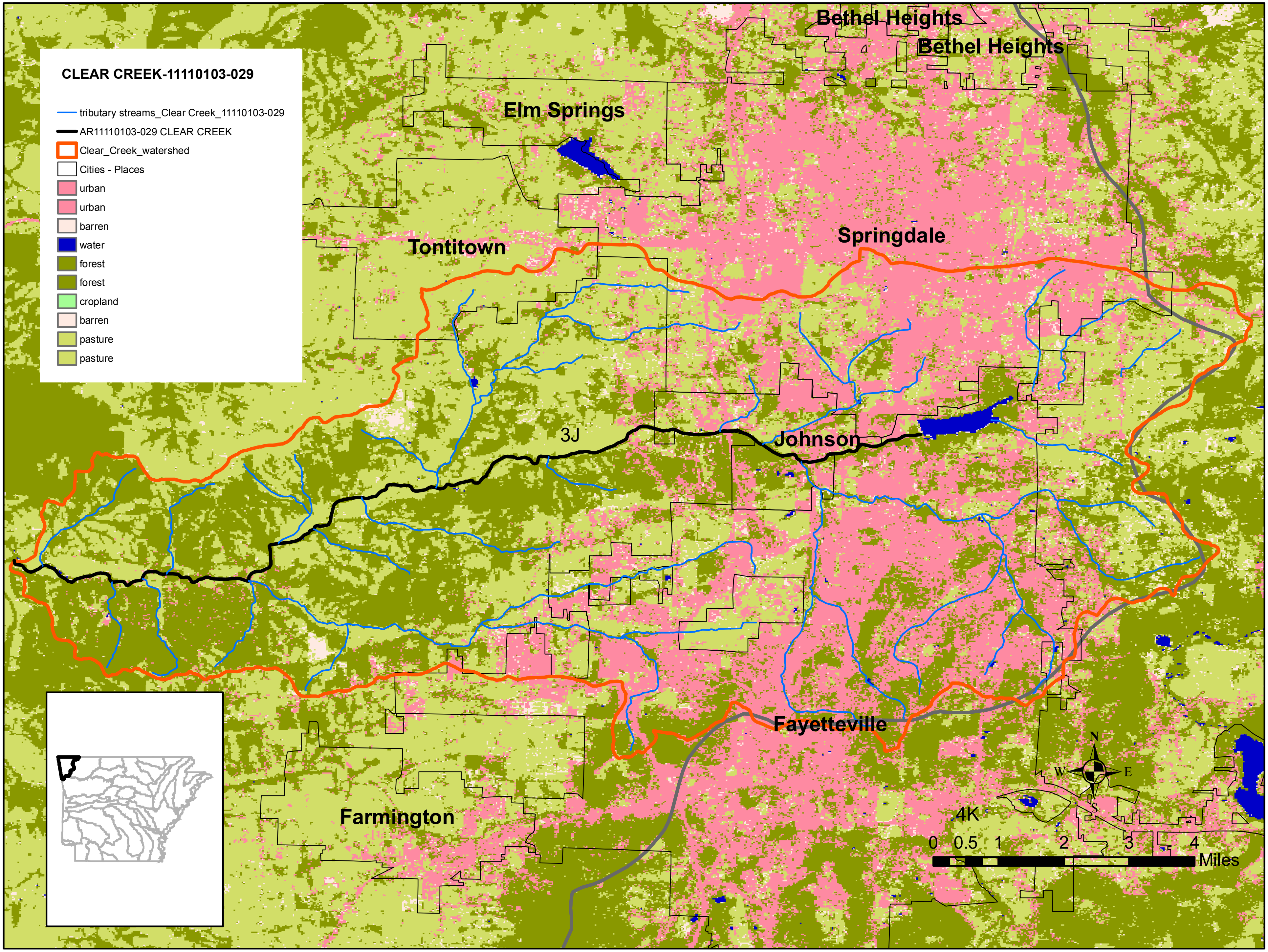

CLEAR CREEK-11110103-029
NPDES - USGS station
NPDES - AR0020010
Monitoring Station - ARK0010C
tributary streams_Clear Creek_11110101-029
Illinois River
AR11110103-029 CLEAR CREEK
county boundary
Lake Fayetteville
Clear Creek Watershed
Cities - Places
Centerton
Bentonville
Cave Springs
Bethel Heights
Elm Springs
Tontitown
Springdale
3J
ARK0010C
Johnson
Lake
Fayetteville
Goshen
AR0020010
Fayetteville
Illinois River
Farmington
Elkins
Greenland
4K
Prairie Grove
N
W
E
S
West Fork
0 1 2 4 6 8
Miles
3H
3H

FIGURE A



CLEAR CREEK-11110103-029
tributary streams_Clear Creek_11110103-029
AR11110103-029 CLEAR CREEK
Clear_Creek_watershed
Cities - Places
urban
urban
barren
water
forest
forest
cropland
barren
pasture
pasture
Bethel Heights
Bethel Heights
Elm Springs
Tontitown
Springdale
3J
Johnson
Fayetteville
Farmington
4K
0 0.5 1 2 3 4
Miles
N
W
E
S

FIGURE B

APPENDIX_B

Flow Frequency, Load, and Flow Tables

FC Criteria: 400 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
0	4.53213E+13	4631.10
1	1.07199E+13	1095.40
2	6.2466E+12	638.30
3	4.47332E+12	457.10
4	3.52698E+12	360.40
5	3.01516E+12	308.10
6	2.58163E+12	263.80
7	2.3448E+12	239.60
8	2.12852E+12	217.50
9	2.01011E+12	205.40
10	1.85842E+12	189.90
11	1.73609E+12	177.40
12	1.62746E+12	166.30
13	1.5433E+12	157.70
14	1.4425E+12	147.40
15	1.3877E+12	141.80
16	1.328E+12	135.70
17	1.26928E+12	129.70
18	1.22329E+12	125.00
19	1.18219E+12	120.80
20	1.14695E+12	117.20
21	1.11368E+12	113.80
22	1.08139E+12	110.50
23	1.05203E+12	107.50
24	1.01288E+12	103.50
25	9.83523E+11	100.50
26	9.5025E+11	97.10
27	9.23827E+11	94.40
28	8.90553E+11	91.00
29	8.63152E+11	88.20
30	8.47494E+11	86.60
31	8.22049E+11	84.00
32	8.04434E+11	82.20
33	7.78011E+11	79.50
34	7.60396E+11	77.70
35	7.4278E+11	75.90
36	7.25165E+11	74.10
37	7.09507E+11	72.50
38	6.91891E+11	70.70
39	6.76233E+11	69.10
40	6.6449E+11	67.90

FC Criteria: 400 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
41	6.47853E+11	66.20
42	6.32195E+11	64.60
43	6.18494E+11	63.20
44	6.08708E+11	62.20
45	5.96964E+11	61.00
46	5.85221E+11	59.80
47	5.77392E+11	59.00
48	5.65648E+11	57.80
49	5.55862E+11	56.80
50	5.44118E+11	55.60
51	5.34332E+11	54.60
52	5.22588E+11	53.40
53	5.09866E+11	52.10
54	4.96165E+11	50.70
55	4.88336E+11	49.90
56	4.7855E+11	48.90
57	4.72678E+11	48.30
58	4.60935E+11	47.10
59	4.53106E+11	46.30
60	4.43319E+11	45.30
61	4.3549E+11	44.50
62	4.27661E+11	43.70
63	4.17875E+11	42.70
64	4.10046E+11	41.90
65	4.02217E+11	41.10
66	3.94388E+11	40.30
67	3.88516E+11	39.70
68	3.82644E+11	39.10
69	3.72858E+11	38.10
70	3.66986E+11	37.50
71	3.60136E+11	36.80
72	3.52307E+11	36.00
73	3.48392E+11	35.60
74	3.44478E+11	35.20
75	3.38606E+11	34.60
76	3.32734E+11	34.00
77	3.24905E+11	33.20
78	3.19033E+11	32.60
79	3.15119E+11	32.20
80	3.09247E+11	31.60

FC Criteria: 400 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
81	3.03375E+11	31.00
82	2.99461E+11	30.60
83	2.93589E+11	30.00
84	2.89674E+11	29.60
85	2.81845E+11	28.80
86	2.75974E+11	28.20
87	2.68145E+11	27.40
88	2.60316E+11	26.60
89	2.54444E+11	26.00
90	2.44658E+11	25.00
91	2.38786E+11	24.40
92	2.30957E+11	23.60
93	2.27042E+11	23.20
94	2.2117E+11	22.60
95	2.16277E+11	22.10
96	2.10405E+11	21.50
97	2.02576E+11	20.70
98	1.86918E+11	19.10
99	1.3603E+11	13.90
100	98841635454	10.10

FC Criteria: 2000 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
0	2.26607E+14	4631.10
1	5.35996E+13	1095.40
2	3.1233E+13	638.30
3	2.23666E+13	457.10
4	1.76349E+13	360.40
5	1.50758E+13	308.10
6	1.29081E+13	263.80
7	1.1724E+13	239.60
8	1.06426E+13	217.50
9	1.00505E+13	205.40
10	9.29209E+12	189.90
11	8.68045E+12	177.40
12	8.13731E+12	166.30
13	7.7165E+12	157.70
14	7.2125E+12	147.40
15	6.93849E+12	141.80
16	6.64E+12	135.70
17	6.34642E+12	129.70
18	6.11644E+12	125.00
19	5.91093E+12	120.80
20	5.73477E+12	117.20
21	5.56841E+12	113.80
22	5.40693E+12	110.50
23	5.26014E+12	107.50
24	5.06441E+12	103.50
25	4.91762E+12	100.50
26	4.75125E+12	97.10
27	4.61913E+12	94.40
28	4.45277E+12	91.00
29	4.31576E+12	88.20
30	4.23747E+12	86.60
31	4.11025E+12	84.00
32	4.02217E+12	82.20
33	3.89005E+12	79.50
34	3.80198E+12	77.70
35	3.7139E+12	75.90
36	3.62582E+12	74.10
37	3.54753E+12	72.50
38	3.45946E+12	70.70
39	3.38117E+12	69.10
40	3.32245E+12	67.90

FC Criteria: 2000 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
41	3.23927E+12	66.20
42	3.16098E+12	64.60
43	3.09247E+12	63.20
44	3.04354E+12	62.20
45	2.98482E+12	61.00
46	2.9261E+12	59.80
47	2.88696E+12	59.00
48	2.82824E+12	57.80
49	2.77931E+12	56.80
50	2.72059E+12	55.60
51	2.67166E+12	54.60
52	2.61294E+12	53.40
53	2.54933E+12	52.10
54	2.48083E+12	50.70
55	2.44168E+12	49.90
56	2.39275E+12	48.90
57	2.36339E+12	48.30
58	2.30467E+12	47.10
59	2.26553E+12	46.30
60	2.2166E+12	45.30
61	2.17745E+12	44.50
62	2.13831E+12	43.70
63	2.08938E+12	42.70
64	2.05023E+12	41.90
65	2.01108E+12	41.10
66	1.97194E+12	40.30
67	1.94258E+12	39.70
68	1.91322E+12	39.10
69	1.86429E+12	38.10
70	1.83493E+12	37.50
71	1.80068E+12	36.80
72	1.76153E+12	36.00
73	1.74196E+12	35.60
74	1.72239E+12	35.20
75	1.69303E+12	34.60
76	1.66367E+12	34.00
77	1.62453E+12	33.20
78	1.59517E+12	32.60
79	1.57559E+12	32.20
80	1.54624E+12	31.60

FC Criteria: 2000 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
81	1.51688E+12	31.00
82	1.4973E+12	30.60
83	1.46795E+12	30.00
84	1.44837E+12	29.60
85	1.40923E+12	28.80
86	1.37987E+12	28.20
87	1.34072E+12	27.40
88	1.30158E+12	26.60
89	1.27222E+12	26.00
90	1.22329E+12	25.00
91	1.19393E+12	24.40
92	1.15478E+12	23.60
93	1.13521E+12	23.20
94	1.10585E+12	22.60
95	1.08139E+12	22.10
96	1.05203E+12	21.50
97	1.01288E+12	20.70
98	9.34592E+11	19.10
99	6.80148E+11	13.90
100	4.94208E+11	10.10

E. coli Criteria: 410 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
0	4.64544E+13	4631.10
1	1.09879E+13	1095.40
2	6.40276E+12	638.30
3	4.58515E+12	457.10
4	3.61516E+12	360.40
5	3.09054E+12	308.10
6	2.64617E+12	263.80
7	2.40342E+12	239.60
8	2.18173E+12	217.50
9	2.06036E+12	205.40
10	1.90488E+12	189.90
11	1.77949E+12	177.40
12	1.66815E+12	166.30
13	1.58188E+12	157.70
14	1.47856E+12	147.40
15	1.42239E+12	141.80
16	1.3612E+12	135.70
17	1.30102E+12	129.70
18	1.25387E+12	125.00
19	1.21174E+12	120.80
20	1.17563E+12	117.20
21	1.14152E+12	113.80
22	1.10842E+12	110.50
23	1.07833E+12	107.50
24	1.0382E+12	103.50
25	1.00811E+12	100.50
26	9.74006E+11	97.10
27	9.46922E+11	94.40
28	9.12817E+11	91.00
29	8.84731E+11	88.20
30	8.68681E+11	86.60
31	8.426E+11	84.00
32	8.24545E+11	82.20
33	7.97461E+11	79.50
34	7.79405E+11	77.70
35	7.6135E+11	75.90
36	7.43294E+11	74.10
37	7.27244E+11	72.50
38	7.09189E+11	70.70
39	6.93139E+11	69.10
40	6.81102E+11	67.90

E. coli Criteria: 410 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
41	6.64049E+11	66.20
42	6.48E+11	64.60
43	6.33957E+11	63.20
44	6.23926E+11	62.20
45	6.11888E+11	61.00
46	5.99851E+11	59.80
47	5.91827E+11	59.00
48	5.79789E+11	57.80
49	5.69758E+11	56.80
50	5.57721E+11	55.60
51	5.4769E+11	54.60
52	5.35653E+11	53.40
53	5.22613E+11	52.10
54	5.0857E+11	50.70
55	5.00545E+11	49.90
56	4.90514E+11	48.90
57	4.84495E+11	48.30
58	4.72458E+11	47.10
59	4.64433E+11	46.30
60	4.54402E+11	45.30
61	4.46378E+11	44.50
62	4.38353E+11	43.70
63	4.28322E+11	42.70
64	4.20297E+11	41.90
65	4.12272E+11	41.10
66	4.04248E+11	40.30
67	3.98229E+11	39.70
68	3.9221E+11	39.10
69	3.8218E+11	38.10
70	3.76161E+11	37.50
71	3.69139E+11	36.80
72	3.61114E+11	36.00
73	3.57102E+11	35.60
74	3.5309E+11	35.20
75	3.47071E+11	34.60
76	3.41053E+11	34.00
77	3.33028E+11	33.20
78	3.27009E+11	32.60
79	3.22997E+11	32.20
80	3.16978E+11	31.60

E. coli Criteria: 410 col/100ml. HUC-Reach 11110103-029 PCR-S

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
81	3.1096E+11	31.00
82	3.06947E+11	30.60
83	3.00929E+11	30.00
84	2.96916E+11	29.60
85	2.88892E+11	28.80
86	2.82873E+11	28.20
87	2.74848E+11	27.40
88	2.66823E+11	26.60
89	2.60805E+11	26.00
90	2.50774E+11	25.00
91	2.44755E+11	24.40
92	2.36731E+11	23.60
93	2.32718E+11	23.20
94	2.267E+11	22.60
95	2.21684E+11	22.10
96	2.15666E+11	21.50
97	2.07641E+11	20.70
98	1.91591E+11	19.10
99	1.3943E+11	13.90
100	1.01313E+11	10.10

E. coli Criteria: 2050 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
0	2.32272E+14	4631.10
1	5.49396E+13	1095.40
2	3.20138E+13	638.30
3	2.29258E+13	457.10
4	1.80758E+13	360.40
5	1.54527E+13	308.10
6	1.32308E+13	263.80
7	1.20171E+13	239.60
8	1.09087E+13	217.50
9	1.03018E+13	205.40
10	9.52439E+12	189.90
11	8.89746E+12	177.40
12	8.34074E+12	166.30
13	7.90941E+12	157.70
14	7.39282E+12	147.40
15	7.11195E+12	141.80
16	6.80601E+12	135.70
17	6.50508E+12	129.70
18	6.26935E+12	125.00
19	6.0587E+12	120.80
20	5.87814E+12	117.20
21	5.70762E+12	113.80
22	5.5421E+12	110.50
23	5.39164E+12	107.50
24	5.19102E+12	103.50
25	5.04056E+12	100.50
26	4.87003E+12	97.10
27	4.73461E+12	94.40
28	4.56409E+12	91.00
29	4.42365E+12	88.20
30	4.3434E+12	86.60
31	4.213E+12	84.00
32	4.12272E+12	82.20
33	3.98731E+12	79.50
34	3.89703E+12	77.70
35	3.80675E+12	75.90
36	3.71647E+12	74.10
37	3.63622E+12	72.50
38	3.54594E+12	70.70
39	3.4657E+12	69.10
40	3.40551E+12	67.90

E. coli Criteria: 2050 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

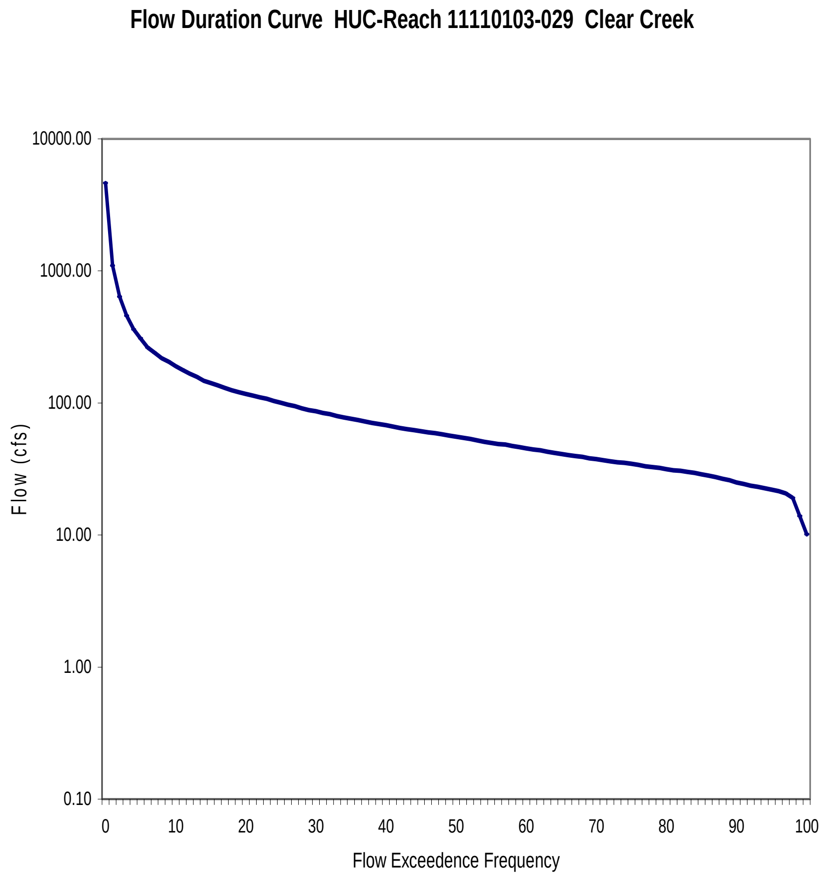
Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
41	3.32025E+12	66.20
42	3.24E+12	64.60
43	3.16978E+12	63.20
44	3.11963E+12	62.20
45	3.05944E+12	61.00
46	2.99926E+12	59.80
47	2.95913E+12	59.00
48	2.89895E+12	57.80
49	2.84879E+12	56.80
50	2.78861E+12	55.60
51	2.73845E+12	54.60
52	2.67827E+12	53.40
53	2.61306E+12	52.10
54	2.54285E+12	50.70
55	2.50272E+12	49.90
56	2.45257E+12	48.90
57	2.42248E+12	48.30
58	2.36229E+12	47.10
59	2.32217E+12	46.30
60	2.27201E+12	45.30
61	2.23189E+12	44.50
62	2.19176E+12	43.70
63	2.14161E+12	42.70
64	2.10149E+12	41.90
65	2.06136E+12	41.10
66	2.02124E+12	40.30
67	1.99115E+12	39.70
68	1.96105E+12	39.10
69	1.9109E+12	38.10
70	1.8808E+12	37.50
71	1.8457E+12	36.80
72	1.80557E+12	36.00
73	1.78551E+12	35.60
74	1.76545E+12	35.20
75	1.73536E+12	34.60
76	1.70526E+12	34.00
77	1.66514E+12	33.20
78	1.63505E+12	32.60
79	1.61498E+12	32.20
80	1.58489E+12	31.60

E. coli Criteria: 2050 col/100ml. HUC-Reach 11110103-029 PCR-W/SCR

Flow Exceedence Frequency	Load (cfu/day)	Flow (cfs)
81	1.5548E+12	31.00
82	1.53474E+12	30.60
83	1.50464E+12	30.00
84	1.48458E+12	29.60
85	1.44446E+12	28.80
86	1.41437E+12	28.20
87	1.37424E+12	27.40
88	1.33412E+12	26.60
89	1.30402E+12	26.00
90	1.25387E+12	25.00
91	1.22378E+12	24.40
92	1.18365E+12	23.60
93	1.16359E+12	23.20
94	1.1335E+12	22.60
95	1.10842E+12	22.10
96	1.07833E+12	21.50
97	1.01288E+12	20.70
98	9.34592E+11	19.10
99	6.80148E+11	13.90
100	4.94208E+11	10.10

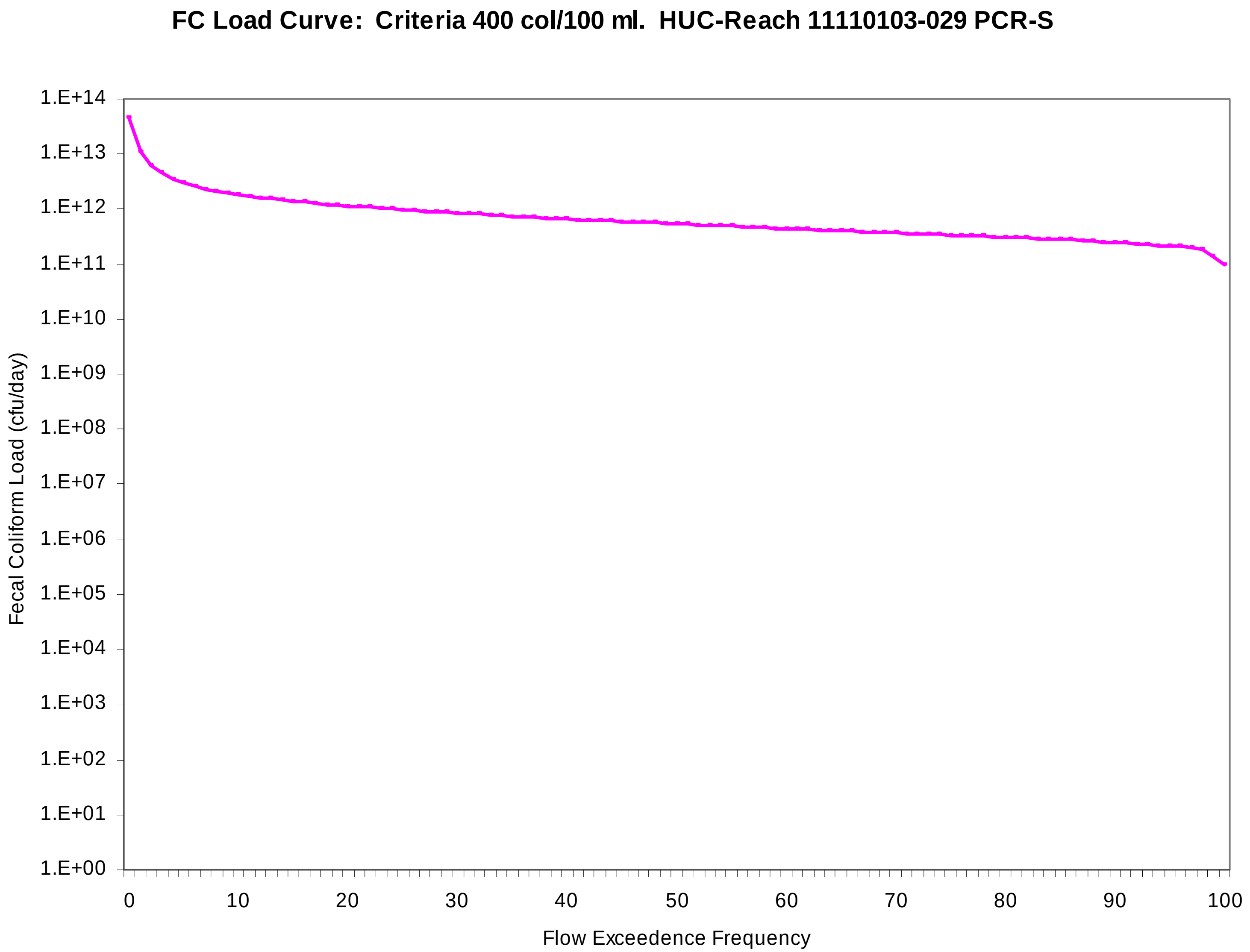
APPENDIX_C

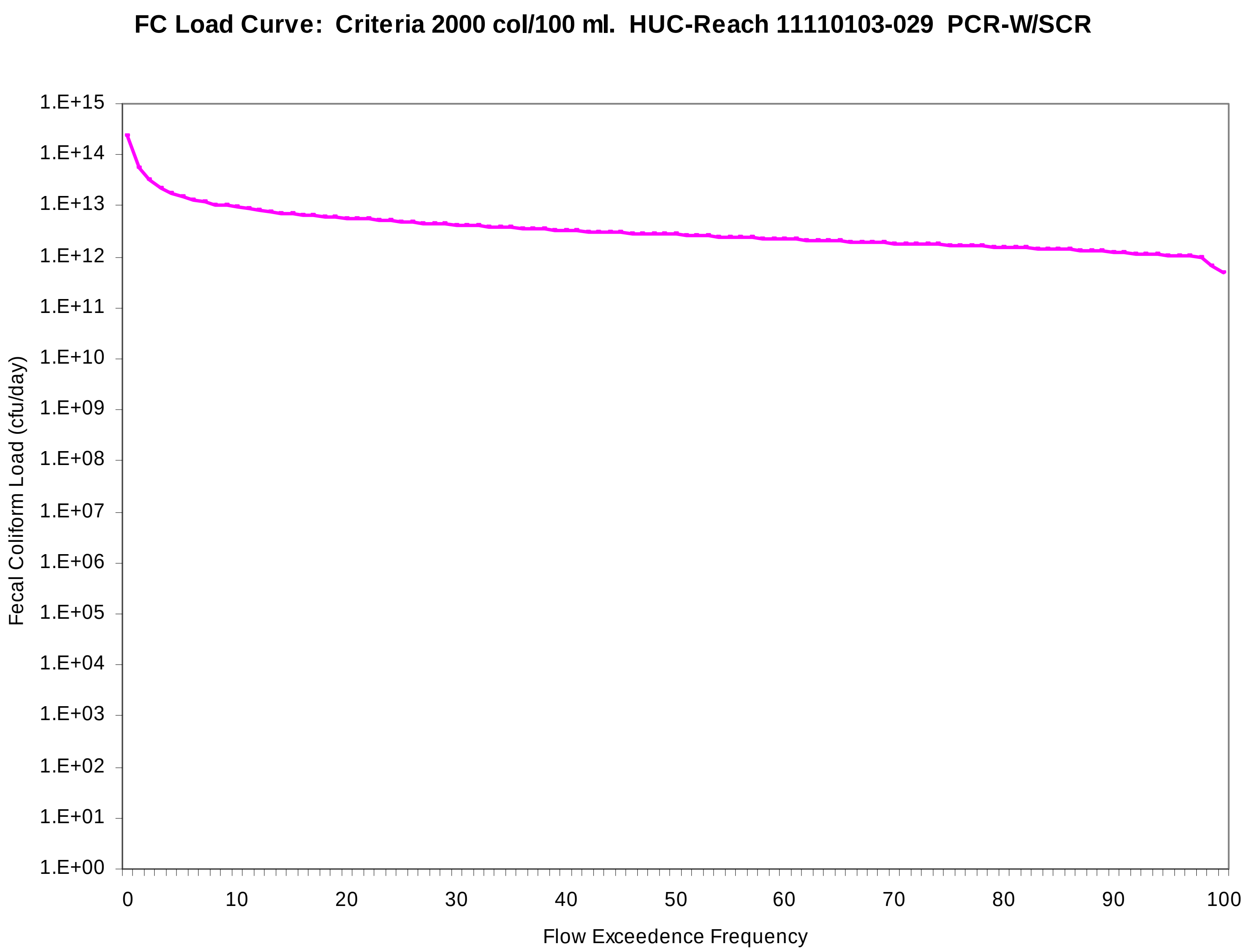
Flow Duration Curve


Flow Duration Curve HUC-Reach 11110103-029 Clear Creek
10000.00
1000.00
100.00
10.00
1.00
0.10
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedence Frequency

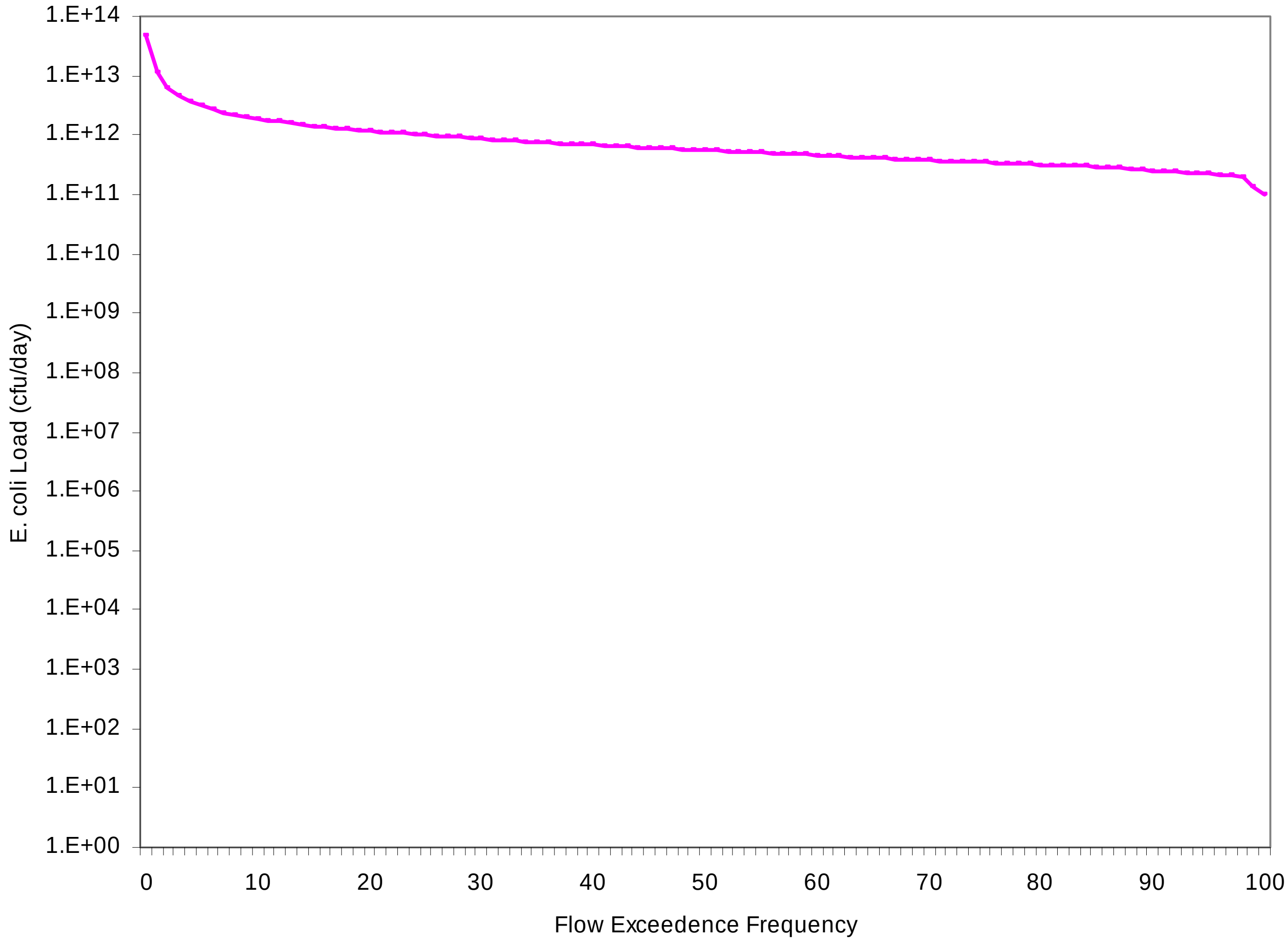
APPENDIX_D

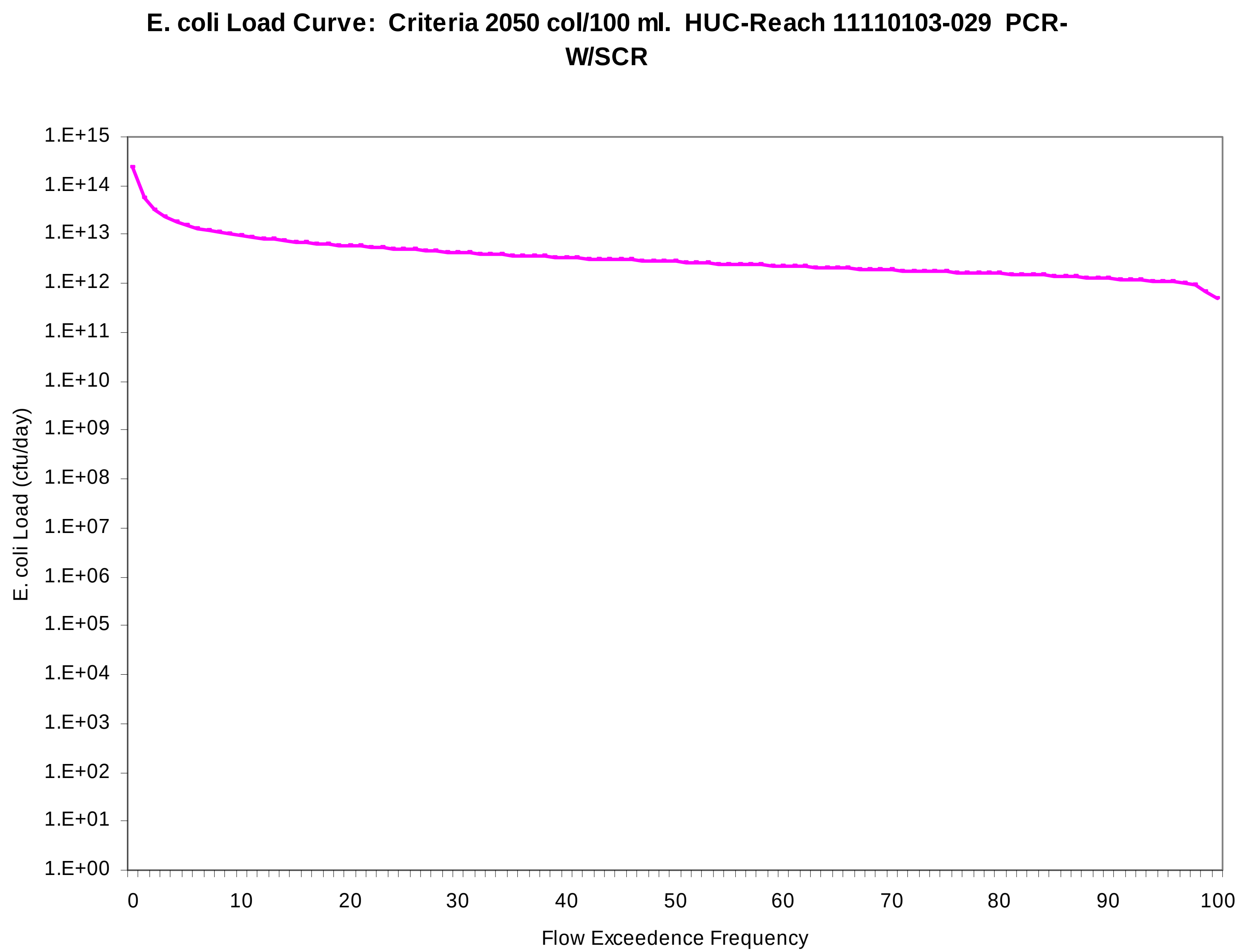
Load Duration Curves for FC and E. coli Bacteria


FC Load Curve: Criteria 400 col/100 ml. HUC-Reach 11110103-029 PCR-S
Fecal Coliform Load (cfu/day)
1.E+14
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
1.E+08
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedence Frequency


FC Load Curve: Criteria 2000 col/100 ml. HUC-Reach 11110103-029 PCR-W/SCR
1.E+15
1.E+14
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
1.E+08
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Fecal Coliform Load (cfu/day)
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedence Frequency

E. coli Load Curve: Criteria 410 col/100 ml. HUC-Reach 11110103-029 PCR-S




E. coli Load Curve: Criteria 2050 col/100 ml. HUC-Reach 11110103-029 PCR-W/SCR
1.E+15
1.E+14
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
1.E+08
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
E. coli Load (cfu/day)
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedence Frequency

APPENDIX E

Response to Comment

Comment one received on September 11, 2009, from Mr. J. Benefield, P.E., Deputy Director of ADEQ.

ADEQ states that the documents refer to the "Primary Contact Recreation – summer or winter standard". They state that these are not standards listed in Arkansas's Regulation No. 2. To be consistent with Regulation No. 2, they request that they be referred to as "Primary Contact Recreation" and "Secondary Contact Recreation".

Response:

After a thorough search of the Clear Creek Pathogen Total Maximum Daily Load, the specific language ("Primary Contact Recreation – summer or winter standard") was not found. PCR-S criteria and PCR-W criteria are utilized to give clarification when denoting the seasonal criteria as stated in "Regulation 2.507". Primary Contact Recreation and Secondary Contact Recreation are employed for designated or impaired use classification.