TMDLS FOR SULFATE IN THE UPPER CORNIE BAYOU WATERSHED, ARKANSAS

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards, and to develop total maximum daily loads (TMDLs) for those waterbodies. A TMDL is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody. This report presents TMDLs that have been developed for sulfate for five reaches in the upper Cornie Bayou watershed in Arkansas (reaches 08040206-015, -016, -716, -816, and -916) in Arkansas.

The upper Cornie Bayou watershed is located in southern Arkansas, in Columbia and Union Counties. The study area for this report consists of the watersheds for the five stream reaches mentioned above. The study area covers approximately 451 square miles and is mostly forested. The study area is located within Planning Segment 2E and within the Gulf Coastal Plain ecoregion.

These stream reaches were included on the final 2004 Arkansas 303(d) list for not supporting their designated uses of agricultural and industrial water supply. The 2004 Integrated Report cited turbidity, sulfate and zinc as the primary pollutants causing impairment and resource extraction as the suspected source of contamination. The impairments from turbidity and zinc are not addressed in this report; only the sulfate impairments are addressed in this report.

Arkansas Department of Environmental Quality (ADEQ) historical water quality data were available for one routine monitoring station in the study area (on Big Cornie Creek). These data were analyzed for basic statistics, statistics and visually examined for long-term trends, seasonal patterns, and relationships between concentration and flow. The only noticeable pattern was that the highest sulfate concentrations occurred during relatively low flows.

Because the streams in the study area flow directly into Louisiana, water quality standards for both Arkansas and Louisiana were considered. Both states have similar criteria for sulfates. This resulted in sulfate criteria for Louisiana (i.e., downstream criteria) that were equal to or less stringent than the criterion that applies to these streams in Arkansas. Therefore, the

TMDLs were calculated to meet the Louisiana criterion. These allowable loads will not cause violations of Louisiana sulfate criteria at the state line.

The TMDLs in this report were developed using the load duration curve methodology. This method illustrates allowable loading at a wide range of stream flow conditions. The steps for applying this methodology for the TMDLs in this report were:

1. Developing a flow duration curve,
2. Converting the flow duration curve to load duration curves,
3. Plotting observed loads with load duration curves,
4. Calculating the TMDL components, and
5. Calculating percent reductions.

Each TMDL was calculated as the total loading represented by the area under the load duration curve (i.e., the total loading over all flows). An explicit margin of safety (MOS) was established as 10% of each TMDL. Wasteload allocations (WLAs) were calculated for point source discharges that were known to have a source of sulfate.

The sulfate WLAs for treated sanitary wastewater were calculated using an effluent concentration of 41 mg/L, which was a median of municipal effluent values compiled from across Arkansas during the time that the TMDL was being developed. The sulfate WLAs for other dischargers were based on either their monthly average permit limit (66 mg/L for Great Lakes Central Outfall 003) or the instream criterion from the water quality standards (41 mg/L for Great Lakes South Outfall 002).

The load allocations (LAs) for nonpoint sources were calculated as the TMDL minus the MOS and WLA.

A percent reduction values were calculated using observed data from Big Cornie Creek and the Arkansas water quality standard of 30 mg/L. This was done by applying a uniform percent reduction factor to the actual loads until the number of loads exceeding the allowable loads was less than or equal to an acceptable number based on ADEQ’s assessment methodology and water quality standards. The percent reduction values is presented in Appendix C for informational purposes only.

The results of the TMDL calculations and percent reduction calculations are summarized in Tables ES.1.

Table ES.1. Summary of sulfate TMDLs.

Stream Reach	Stream Name	Loads (tons/day of sulfate)			
		WLA	LA	MOS	TMDL
08040206-015	Big Cornie Creek	0	9.24	1.03	10.27
08040206-016	Little Cornie Creek	0	0.65	0.07	0.72
08040206-716	Little Cornie Bayou	0.83	4.30	0.57	5.70
08040206-816	Little Cornie Bayou	0.04	5.85	0.65	6.54
08040206-916	Walker Branch	0.13	0.13	0.03	0.29

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

LIST OF TABLES

1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for sulfate for five stream reaches in the Upper Cornie Bayou watershed, which is in the Ouachita River basin in southern Arkansas (Table 1.1). These stream reaches were included on the draft and final versions of the 2004 303(d) list for Arkansas as not supporting their designated uses of agricultural and industrial water supply (Arkansas Department of Environmental Quality (ADEQ) 2005a; United States Environmental Protection Agency (USEPA) 2006)). Suspected sources of contamination, suspected causes of impairment, and priority rankings from the 2004 Integrated Report are shown in Table 1.1. The impairments due to turbidity and zinc are not addressed in this final report; however, these items are still present within the Appendices along with percent reduction calculations for the original draft that was written to the Arkansas water quality standard of 30 mg/L and therefore not protective of downstream state standard of 25 mg/L. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and USEPA regulations at Title 40 Code of Federal Regulations (CFR) Part 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. 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, 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. Information from the 2004 303 (d) list for TMDLs in this report.

Reach Number	Stream Name	Impaired Use	Pollutants Cause Impairment	Suspected Source of Pollutants	Category	Priority
08040206-015	Big Cornie Creek	Agricultural & Industrial Water Supply	Sulfate	Resource extraction	5b	Low
08040206-016	Little Cornie Creek	Agricultural & Industrial Water Supply	Sulfate	Resource extraction	5b	Low
08040206-716	Little Cornie Bayou	Agricultural & Industrial Water Supply	Sulfate	Resource extraction	5b	Low
08040206-816	Little Cornie Bayou	Agricultural & Industrial Water Supply	Sulfate	Resource extraction	5b	Low
08040206-916	Walker Branch	Agricultural & Industrial Water Supply	Sulfate	Resource extraction	5b	Low

Note: 1. The impairment for reach 08040206-015 was determined based on monitoring data collected within that reach. The impairments for each of the other four reaches were determined by evaluation.
2. The impairments due to turbidity and zinc are not addressed in this report.

2.0 BACKGROUND INFORMATION

2.1 General Information

The study area for this report consists of the watersheds for the five stream reaches listed in Table 1.1. These reaches are located in the upper Cornie Bayou watershed in southern Arkansas as shown on Figure A.1 in Appendix A. The study area covers parts of Union and Columbia Counties and is in the Gulf Coastal ecoregion. The study area is in United States Geological Survey (USGS) Hydrologic Unit 08040206 and is part of ADEQ Planning Segment 2E.

2.2 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. The spatial distribution of these land uses is shown on Figure A.2 (located in Appendix A) and land use percentages are shown in Table 2.1. These data indicate that the majority of the study area is forested (94.1%).

Table 2.1. Land use percentages for the study area (CAST 2005).

Land Use Category	Percentage of Study Area
Urban	0.4%
Barren or Bare Soil	0.1%
Water	0.3%
Forest	94.1%
Soybeans	0.0%
Rice	0.0%
Cotton	0.0%
Other Crops	0.0%
Pasture/Forages	5.1%
TOTAL	**100.0%**

2.3 Description of Hydrology

The TMDLs in this report were developed using USGS stream flow data from a gaging station on Little Cornie Bayou. Selected information for this gage is summarized in Table 2.2. The location of the gage is shown on Figure A.1 in Appendix A.

Table 2.2. Information for USGS stream flow gaging station (USGS 2006).

Gage name:	Little Cornie Bayou near Lillie, Louisiana
Gage number:	07366200
Descriptive location:	State Hwy 15 east of Lillie, Louisiana
Period of record:	October 1955 – present
Drainage area:	208 square miles
Mean flow:	216 cfs

*Note: According to USGS topographic maps, the spelling of stream names in this watershed changes from “Cornie” in Arkansas to “Corney” in Louisiana. Both spellings refer to the same streams.

2.4 Water Quality Standards

Water quality criteria and designated uses for Arkansas waterbodies are listed by ecoregion in Regulation No. 2 (Arkansas Pollution Control and Ecology Commission (APCEC) 2007). The upper Cornie Bayou watershed lies within the Gulf Coastal Plain ecoregion. The designated uses for the stream reaches addressed in this report are perennial Gulf Coastal fishery; primary contact recreation (where drainage areas exceed 10 square miles); secondary contact recreation; and domestic , industrial, and agricultural water supply. Although the drainage area of Walker Branch is less than 10 square miles, it has a designated use of perennial fishery rather than seasonal fishery because it has a point source discharge with a design flow greater than 1.0 cfs.

Section 2.511 of Regulation No. 2 includes a list of stream-specific numeric criteria for sulfate and other dissolved minerals. The streams addressed in this report that have stream-specific sulfate criteria are Big Cornie Creek, Little Cornie Creek, and Little Cornie Bayou. For those streams not specifically listed in Section 2.511, the regulation defines a “significant modification of the water quality” for sulfate in the Gulf Coastal ecoregion as an instream concentration of 41 mg/L (31 mg/L plus 1/3 of 31 mg/L). Such modification is not allowable without setting stream-specific criteria. Therefore, this numeric criterion for sulfate

(41 mg/L) applies to Walker Branch. The sulfate criterion for each reach is shown in Table 2.3. The below criterion is applicable to all of the reaches addressed in this report.

Table 2.3. Numeric criteria for sulfate.

Stream Name	Stream Reach	Sulfate Criterion (mg/L)
Big Cornie Creek	08040206-015	25
Little Cornie Creek	08040206-016	10
Little Cornie Bayou	08040206-716	25
Little Cornie Bayou	08040206-816	25
Walker Branch	08040206-916	41 (ecoregion criterion)

As specified in USEPA's regulations at 40 CFR 130.7 (b)(2), applicable water quality standards include antidegradation requirements. Arkansas' antidegradation policy is listed in Sections 2.201-2.204 of Regulation No. 2. These sections impose the following requirements:

1. Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
2. 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.
3. For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
4. 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.

2.5 Point Sources

Information for point source discharges in the study area was obtained by searching the USEPA Permit Compliance System (PCS 2007), reviewing ADEQ files, and reviewing information found in the 305(b) report (ADEQ 2005b). The search yielded six facilities with point source discharges. The only facility that had permit limits for the pollutants addressed in this report was Great Lakes Chemical Corporation Central Plant (AR0001171), which had limits for sulfate. Search results are summarized in Table 2.4. Locations of the permitted facilities are shown on Figure A.1 in Appendix A.

Table 2.4. Inventory of permitted point sources discharging in study area.

NPDES Permit Number	Facility Name	Facility Type	Type of discharge	Receiving Waters	Included in TMDLs
AR0000680	Great Lakes Chemical Corp-South Plant	Industrial inorganic chemicals	Stormwater runoff, sanitary wastewater	Walker Branch (Reach 916)	No
AR0001171	Great Lakes Chemical Corp-Central Plant	Industrial inorganic chemicals	Stormwater runoff	Little Cornie Bayou (Reach 716)	Yes
AR0022179	City Of Junction City	Sewerage system	Sanitary wastewater	Little Cornie Bayou (Reach 816)	No
AR0047813	Oak Manor Water & Wastewater Public Facility Board	Land subdividers & dev., ex. cem	Sanitary wastewater	Jay Dison Spring Branch, Little Cornie Bayou (Reach 716)	No
AR0047945	Gunnels Mill, Inc.	Sawmills & planing mills, gen.	Wet deck and stormwater	Tributary, Big Cornie Creek (Reach 015)	No
AR0048461	Del-Tin Fiber L.L.C.	Reconstituted wood products	Non-contact cooling water, boiler blowdown	Tributary, Little Cornie Bayou (Reach 716)	No

Permit information for Great Lakes Central (AR0001171) was taken from their currently effective permit, which was issued in late 2003. This permit was modified in early 2007, but the modified permit was appealed. As of March 2008, the appeals have not been resolved, however in July of the same year it appears that the permit was finalized and the modification effective date was August 2008. The existing monthly average permit limit of 66 mg/L remains the same on this 2008 permit as on the previously effective permit (issued late 2003). The current 2008 permit expired on December 31, 2008.

2.6 Nonpoint Sources

The 2004 Integrated Report specifies resource extraction as the suspected source of pollutants causing impairments for the stream reaches addressed in this report (ADEQ 2005b). Parts of Columbia and Union Counties have been classified as an area with a concentration of mineral operations (USGS 2004). In the 1920s, oil and gas extraction began throughout this area of Arkansas. While oil and gas extraction has declined significantly in this area, these activities have left a legacy of land and water quality impacts that may contribute to high sulfate levels in the streams. Clay and lignite are also present within the study area (AGC 2001), although there is no indication that extraction of these minerals occurs in this area (USGS 2004).

2.7 Previous Water Quality Studies

Two use attainability analyses (UAAs) have been conducted on Little Cornie Bayou (Table 2.5). Only the 1990-91 UAA included collection of water quality data in the stream reaches addressed in this report. Water quality sampling for the 2006 UAA was conducted upstream of the stream reaches addressed in this report (GBMc 2006). During the 1990 summer intensive water quality sampling for the Great Lakes Chemical South UAA, sulfate concentrations in Little Cornie Bayou and Walker Branch ranged from <1 mg/L to 4 mg/L. During the 1991 spring intensive water quality sampling, sulfate concentrations in Little Cornie Bayou ranged from 8 mg/L in the headwaters to 4 mg/L near the state line, and Walker Branch sulfate concentrations were 3 mg/L and 4 mg/L. (FTN 1991).

Table 2.5. Little Cornie Bayou UAAs.

Company	Year	Parameters	TMDL Streams Sampled
Great Lakes Chemical Corporation Central Plant	2006	Chloride, sulfate, total dissolved solids	None
Great Lakes Chemical Corporation South Plant	1990-91	Chloride, sulfate, total dissolved solids	Little Cornie Bayou, Walker Branch

3.0 EXISTING WATER QUALITY FOR SULFATE

3.1 General Description of Data

Routine water quality data have been collected by ADEQ at one site in the study area. This site is OUA0002 and it is located on Big Cornie Creek (within reach 08040206-015). The location of this sampling site is shown on Figure A.1 (Appendix A). Sulfate data for the OUA0002 site were obtained from the ADEQ web site. The individual data are listed in Tables B.1 (Appendix B) and a summary of the data is shown in Table 3.1. No routine monitoring data are known to exist within the last 20 years for the other four stream reaches addressed in this report.

Table 3.1. Summary of sulfate data for OUA0002 site.

Parameter	Sulfate (mg/L)
Period of record	9/25/90 – 4/3/07
Number of values	180
Minimum	<0.04
Maximum	585
Median	8.0
Criterion from Water Quality Standards	30
Number of values exceeding criterion	21
Percent of values exceeding criterion	12%

3.2 Long-Term Trends

A time series plot of the sulfate data was developed to identify any long-term trends in concentration (Figures B.1 in Appendix B). The majority of sulfate concentrations measured in Big Cornie Creek are less than 20 mg/L (Figure B.1). However, beginning in 1998, sulfate concentrations between 20 mg/L and 300 mg/L began occurring every year, with one value over 550 mg/L. Some unusually high concentrations, greater than 200 mg/L, occurred in 2002 and 2003.

3.3 Seasonal Patterns

A seasonal plot of sulfate was developed to determine if seasonal concentration patterns were visually evident (Figures B.2 in Appendix B). No seasonal patterns were visually evident for sulfate. High sulfate concentrations (> 50 mg/L) occurred at different times throughout the year.

3.4 Relationships Between Concentration and Flow

A plot of sulfate concentration versus stream flow was also developed to examine any correlation between concentration and flow (Figure B.3 in Appendix B). The flow values in this plot are from the USGS gage on Little Corney Bayou near Lillie, LA (07366200). The sulfate versus flow plot (Figure B.5) shows that all the sulfate concentrations greater than 30 mg/L (the criterion for the sampled reach) occurred when flow was less than 200 cfs at the gage. Sulfate concentrations greater than 50 mg/L all occurred when flows were less than 40 cfs at the gage.

3.5 Summary

High sulfate concentrations began appearing during low flow conditions in Big Cornie Creek in 1998. High concentrations during low flow suggests either a point source of sulfate (possibly unpermitted since the only permitted discharge in the watershed is far upstream of the sampling site and is not permitted for sulfate) or high sulfate concentrations in subsurface inflow to the creek. Sulfate concentrations measured in the Cockfield Aquifer between 1950 and 1987 in Union and Columbia Counties ranged from <1 mg/L to 55 mg/L, with an average of 12 mg/L (USGS 2007). More recent groundwater sulfate measurements for the area were not located, making it impossible to prove or discount groundwater as a possible source of high sulfate concentrations.

4.0 TMDL DEVELOPMENT

4.1 Seasonality and Critical Conditions

USEPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standards. Therefore, the historical data and analyses discussed in Section 3.0 were used to evaluate whether there were certain flow conditions or certain periods of the year that could be used to characterize critical conditions. The highest concentrations of sulfate occurred during low flows, but there was not a consistent relationship with flow. Seasonal patterns were not apparent in the observed sulfate data. Based on these analyses, the TMDLs in this report were not developed on a seasonal basis. The methodology used to develop these TMDLs (load duration curve) addresses a wide range of flow conditions.

4.2 Water Quality Target

The water quality targets for sulfate were simply the numeric criteria from the state water quality standards (Section 2.4). Sulfate can easily be expressed as mass, so there was no need to use a surrogate parameters.

4.3 Methodology for TMDL Calculations

The methodology used for these TMDLs was the load duration curve. Because 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 2007). 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:

1. Develop a flow duration curve (Section 4.4).
2. Convert the flow duration curve to load duration curves (Section 4.5).
3. Calculate TMDL, MOS, WLA, and LA (Sections 4.6 – 4.8).
4. Plot observed loads with load duration curves (Section 4.9).
5. Calculate percent reductions located within the Appendix (Section 4.10).

4.4 Flow Duration Curve

A flow duration curve was developed for each stream reach being addressed in this report using data from the USGS flow gage on Little Cornie Bayou near Lillie, Louisiana (07366200). The daily flows per unit area for this gage were multiplied by the drainage area of each reach to develop a flow duration curve for each reach. The daily stream flow values for each reach were sorted in increasing order and the percentile ranking of each flow was calculated. The data from the Little Cornie Bayou gage were used because the load duration methodology requires that the same flow data be used for developing the flow duration as for calculating observed loads from sampling data. Little Cornie Bayou runs parallel to Big Cornie Creek before their confluence, and the gage near Lillie was the only flow gage in the area with data during the years that water quality sampling occurred. The flow duration curves for these TMDLs are shown on Figures C.1 through C.5 (in Appendix C). The horizontal axis for the flow duration plot is percent exceedance, which is 100% minus percentile ranking.

4.5 Load Duration Curves

The flows from the flow duration curves were multiplied by the target concentration (from Section 4.2) to calculate duration curves of allowable load. Each load duration curve is a plot of pounds per day versus the percent exceedances from the flow duration curve. The load duration curves for sulfate are presented in Appendix C (Figures C.6 through C.10). Calculations for these load duration curves are shown in Table C.1.

The load duration curve is beneficial when analyzing monitoring data with its corresponding flow information plotted as a load. This allows the monitoring data to be plotted in relation to its place in the flow continuum. Assumptions of the probable source or sources of the impairment can often be made from the plotted data.

The load duration curve shows the calculation of the TMDL at all flows, rather than at a single critical flow. The TMDL 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 flow regimes.

4.6 TMDL and MOS

Each TMDL was calculated as the area under the load duration curve. The TMDL calculations are shown in Table C.1.

Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include an MOS to account for any lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. An explicit MOS was established as 10% of each TMDL. Table 4.1 summarizes the TMDLs.

It should be noted that the values for TMDL, MOS, and LA have changed slightly from the draft version of this report because an error in the flow per unit area calculations has now been corrected in addition to the use of a more strict downstream state standard that is protective of Louisiana. The methodology for these calculations has not changed from the draft report.

Table 4.1. Summary of sulfate TMDLs.

		Loads (tons/day of sulfate)			
Stream Reach	**Stream Name**	**WLA**	**LA**	**MOS**	**TMDL**
08040206-015	Big Cornie Creek	0	9.24	1.03	10.27
08040206-016	Little Cornie Creek	0	0.65	0.07	0.72
08040206-716	Little Cornie Bayou	0.83	4.30	0.57	5.70
08040206-816	Little Cornie Bayou	0.04	5.85	0.65	6.54
08040206-916	Walker Branch	0.13	0.13	0.03	0.29

4.7 Point Source Loads

WLAs were calculated for point source discharges that were known to have sources of sulfate. Loads from other point sources were assumed to be negligible. Each WLA was calculated as the design flow multiplied times an appropriate effluent concentration and a conversion factor.

The effluent concentration of sulfate for Great Lakes Central Plant Outfall 003 was set to the existing monthly average permit limit of 66 mg/L. This was the only point source discharge in the study area with a permit limit for sulfate. The effluent concentration of sulfate for point sources discharging treated sanitary wastewater (Great Lakes South Outfall 003, Oak Manor, and Junction City) was set to 41 mg/L, which is the median of effluent concentrations measured in 18 different domestic wastewater discharges across the state (data are shown in Appendix E). The effluent concentration of sulfate for Great Lakes South Outfall 002 was set to the criterion for its receiving stream (41 mg/L for Walker Branch) because a small amount of sulfate (6 mg/L) was measured in the priority pollutant scan for that discharge as reported in the facility's permit renewal application. The sulfate WLA calculations are shown in Table C.3 (Appendix C).

Future growth for any existing or new point sources in the study area is not limited by these TMDLs if the effluent concentrations of sulfate are less than the instream criteria in the Arkansas water quality standards. If effluent concentrations exceed the instream criteria, future growth can still occur if it can be shown that sufficient dilution exists at the location of the discharge during the time periods when discharges will occur, such that the discharge will not cause or contribute to exceedances of criteria in the immediate receiving stream or farther downstream (including stream reaches in Louisiana). Future changes in point source loads do not require a revision to the TMDL report as long as the total load (point source plus nonpoint source) does not exceed the TMDL.

4.8 Nonpoint Source Loads

The LA for nonpoint sources in each TMDL was set equal to the TMDL minus the MOS and the WLA. Calculations for the LAs and other TMDL components are shown in Table C.1.

4.9 Observed Loads

Observed loads were calculated for the Big Cornie Creek sampling site by multiplying each observed concentration of the parameters of interest by the flow on the sampling day. These observed loads were then plotted versus the percent exceedances of the flow on the sampling day and placed on the same plot as the load duration curve (Figure C.6 in Appendix C for sulfate).

These plots provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the load duration curve (identified as "TMDL" curve in the legend of the load duration curves) represent conditions where observed loads exceed the loads corresponding to the numeric criterion. Observed loads below the load duration curve represent conditions where observed loads were less than loads corresponding to the numeric criterion (i.e., not violating water quality standards).

5.0 OTHER RELEVANT INFORMATION

In accordance with Section 106 of the Federal Clean Water Act and under its own authority, 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*.

6.0 PUBLIC PARTICIPATION

When USEPA establishes a TMDL, federal regulations require USEPA to notify the public and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, these TMDLs were prepared under contract to USEPA. After development of the draft version of these TMDLs, USEPA prepared a notice seeking comments, information, and data from the general public and affected public concerning these draft TMDLs. The notice for the public review period was published in the Federal Register on December 17, 2007, and the review period closed on January 16, 2008. Comments were submitted during the public review period and these TMDLs have been revised accordingly. The public comments and USEPA's responses are included in a separate document. USEPA has transmitted the final TMDLs to ADEQ for implementation and for incorporation into ADEQ's current water quality management plan.

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APPENDIX A

Maps

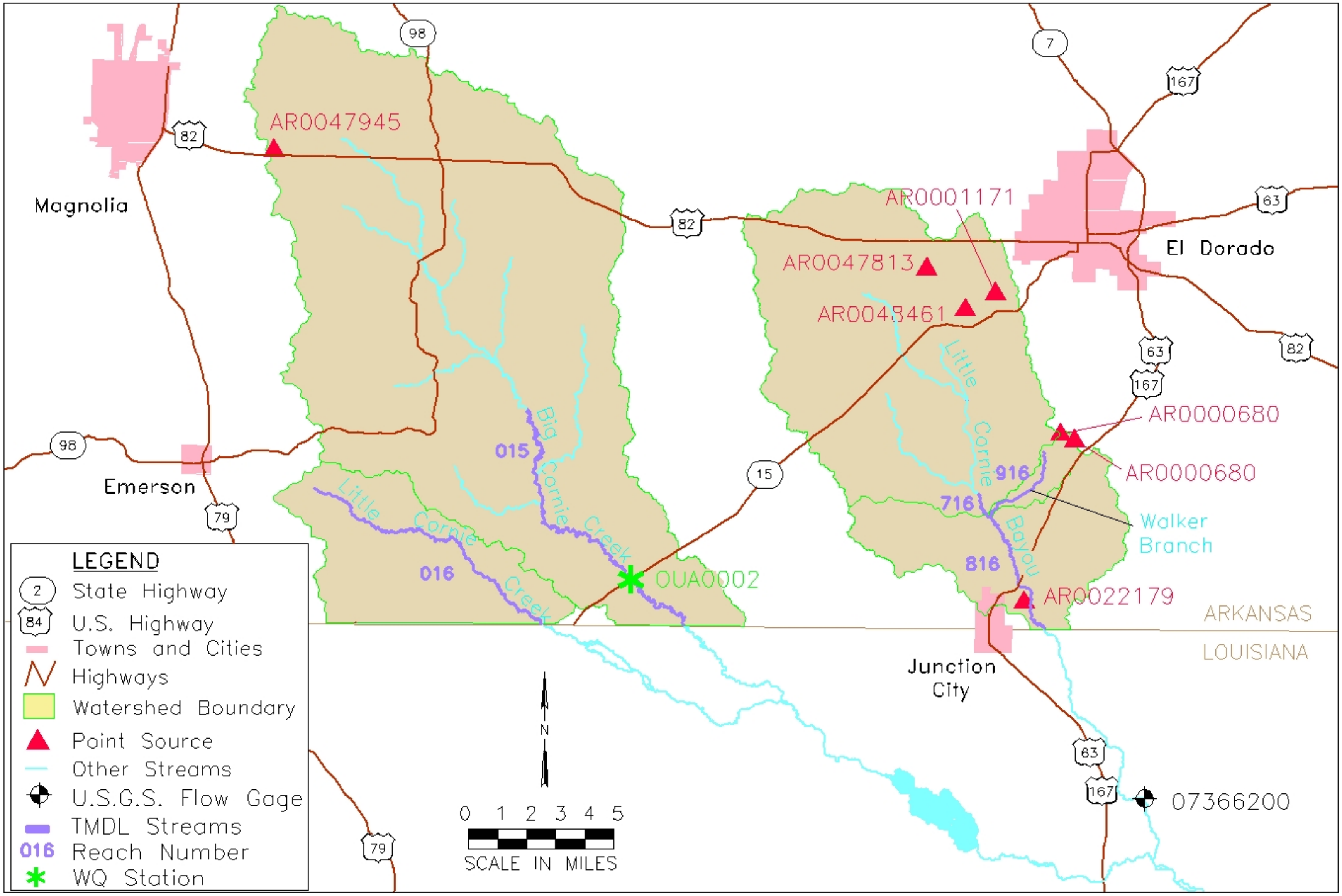

Figure A.1. Map of study area.

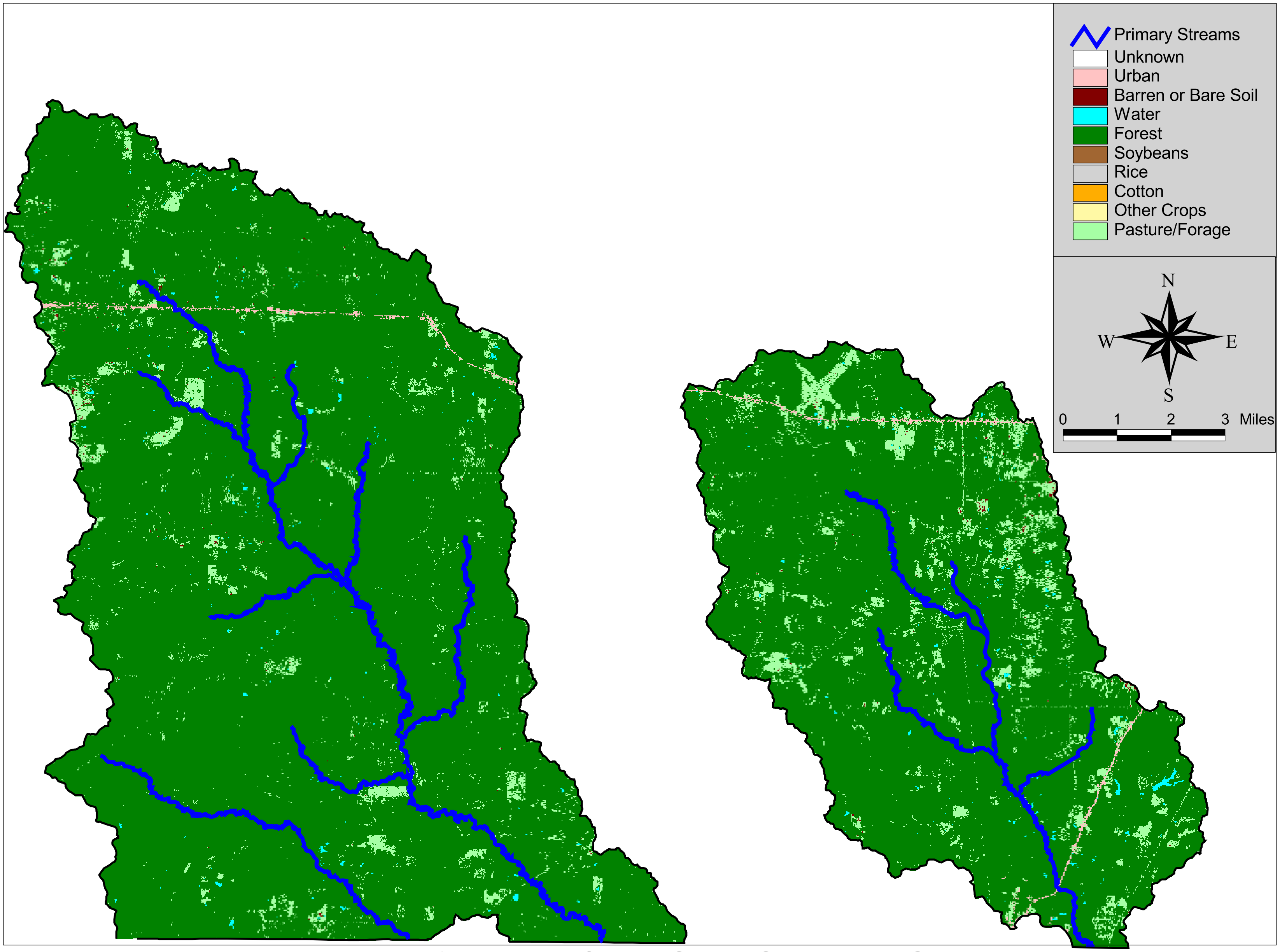

Figure A.2. Land use for Big Cornie Creek, Little Cornie Creek, Little Cornie Bayou, and Walker Branch watersheds.

APPENDIX B

Historical Water Quality Data

Table B.1. Sulfate data collected at Cornie Bayou near Three Creeks (OUA0002).

Date Collected	Sulfate (mg/L)
9/25/1990	4.0
10/16/1990	6.0
11/6/1990	9.0
12/11/1990	13.0
1/22/1991	12.0
2/19/1991	29.0
3/26/1991	36.0
4/16/1991	11.0
5/21/1991	7.0
6/18/1991	36.0
7/16/1991	8.0
8/20/1991	6.0
11/12/1991	14.0
12/10/1991	8.4
1/21/1992	10.0
2/25/1992	9.0
3/17/1992	17.5
4/21/1992	41.9
5/19/1992	10.9
6/16/1992	6.5
7/21/1992	7.4
8/18/1992	5.8
9/15/1992	7.3
10/13/1992	8.1
11/9/1992	8.4
12/8/1992	11.5
1/26/1993	12.5
2/23/1993	13.4
3/23/1993	11.1
5/4/1993	8.8
5/17/1993	11.2
6/29/1993	9.6
8/10/1993	11.7
9/7/1993	4.4
10/12/1993	9.5
11/9/1993	6.9
12/21/1993	12.3
1/25/1994	12.5
2/14/1994	8.8
3/14/1994	9.0
4/18/1994	7.3
5/23/1994	8.9
6/27/1994	9.3
7/18/1994	5.9
8/15/1994	6.0
9/26/1994	6.7
10/24/1994	11.6
11/29/1994	10.5

Date Collected	Sulfate (mg/L)
12/20/1994	7.9
2/13/1995	10.1
3/27/1995	9.9
4/24/1995	5.2
5/22/1995	4.1
6/19/1995	7.6
7/18/1995	5.0
8/7/1995	2.7
9/18/1995	5.8
10/16/1995	8.3
11/14/1995	7.6
12/18/1995	10.8
1/30/1996	13.1
2/20/1996	11.7
3/12/1996	11.3
4/23/1996	9.0
5/21/1996	6.3
6/17/1996	20.0
7/16/1996	10.6
8/6/1996	12.4
9/10/1996	15.4
10/1/1996	13.5
11/19/1996	11.8
12/17/1996	16.0
1/28/1997	12.7
2/25/1997	7.9
3/11/1997	10.3
4/15/1997	13.6
5/13/1997	10.4
6/10/1997	9.3
7/22/1997	7.1
8/26/1997	4.2
9/30/1997	2.4
10/28/1997	7.9
11/18/1997	10.6
12/15/1997	10.9
1/20/1998	8.6
2/17/1998	6.8
3/17/1998	5.3
4/14/1998	5.9
5/19/1998	3.2
6/9/1998	4.8
7/21/1998	1.0
8/11/1998	3.2
9/1/1998	13.2
9/29/1998	7.8
11/16/1998	29.9
12/22/1998	9.2
1/26/1999	25.9
2/23/1999	7.0

Date Collected	Sulfate (mg/L)
3/23/1999	7.2
4/28/1999	4.9
5/25/1999	4.4
6/29/1999	5.5
7/27/1999	3.0
8/17/1999	144.0
9/21/1999	1.6
10/19/1999	3.1
12/20/1999	129.7
1/25/2000	134.5
2/29/2000	7.0
3/27/2000	9.9
4/24/2000	7.8
5/30/2000	4.8
6/27/2000	4.0
7/25/2000	61.3
10/17/2000	5.1
11/7/2000	261.6
12/19/2000	9.4
1/30/2001	9.2
2/27/2001	7.6
3/26/2001	5.3
4/17/2001	4.3
5/22/2001	4.0
6/19/2001	74.4
8/20/2001	1.5
9/18/2001	3.5
10/23/2001	7.5
11/19/2001	3.9
12/11/2001	25.1
1/14/2002	8.0
2/26/2002	6.7
3/26/2002	5.6
4/23/2002	97.6
5/28/2002	3.9
6/25/2002	3.1
7/23/2002	4.3
8/20/2002	3.2
11/5/2002	6.6
12/3/2002	115.0
1/21/2003	8.9
2/25/2003	5.6
3/25/2003	6.5
4/15/2003	5.9
5/20/2003	4.1
6/17/2003	3.6
7/15/2003	185.0
8/12/2003	3.9
9/23/2003	2.3
10/14/2003	5.1

Date Collected	Sulfate (mg/L)
12/16/2003	5.0
1/20/2004	8.0
2/17/2004	8.0
3/16/2004	27.1
4/13/2004	5.0
5/11/2004	238.0
5/15/2004	4.5
7/20/2004	53.7
8/17/2004	5.1
10/19/2004	11.0
11/30/2004	5.3
12/14/2004	6.7
2/22/2005	6.8
3/28/2005	36.0
4/26/2005	4.8
5/23/2005	3.6
6/21/2005	4.4
9/27/2005	68.0
10/25/2005	585.0
11/29/2005	6.7
12/27/2005	9.4
1/17/2006	< 0.04
2/14/2006	11.7
4/18/2006	4.7
5/16/2006	196.0
6/27/2006	247.0
9/26/2006	322.0
12/5/2006	93.5
1/2/2007	8.1
2/6/2007	11.6
3/13/2007	9.0
4/3/2007	5.8

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Table B.2. Zinc data collected at Cornie Bayou near Three Creeks (OUA0002).

Date Collected	Zinc (µg/L)
1/9/1995	19.3
2/13/1995	20.7
3/27/1995	23.6
4/24/1995	22.9
5/22/1995	18.4
6/19/1995	18.8
7/18/1995	46.8
8/7/1995	66.4
9/18/1995	20.9
10/16/1995	10.0
11/14/1995	9.9
12/18/1995	48.4
1/30/1996	16.2
2/20/1996	13.5
3/12/1996	54.6
4/23/1996	17.9
5/21/1996	26.4
6/17/1996	129.0
7/16/1996	54.4
9/10/1996	40.6
11/19/1996	33.4
1/28/1997	26.5
3/11/1997	29.0
7/21/1998	40.1
9/1/1998	20.3
11/16/1998	37.8
1/26/1999	29.5
3/23/1999	25.0
5/25/1999	15.5
7/27/1999	52.0
9/21/1999	68.0
1/25/2000	42.4
3/27/2000	20.7
5/30/2000	37.9
12/19/2000	25.3
1/30/2001	24.2
3/26/2001	26.8
5/22/2001	38.0
7/24/2001	8.1
9/18/2001	13.2
11/19/2001	8.9
5/28/2002	59.3
7/23/2002	304.0
11/5/2002	69.8
1/21/2003	43.6
3/25/2003	31.4
5/20/2003	68.4
7/15/2003	1,560.0

Date Collected	Zinc (µg/L)
9/23/2003	354.0
1/20/2004	115.0
3/16/2004	13.4
5/11/2004	17.0
7/20/2004	20.5
11/30/2004	60.5
3/28/2005	80.4
5/23/2005	69.9
9/27/2005	58.9
11/29/2005	76.5
1/17/2006	30.8
9/26/2006	6.4
1/2/2007	15.8
3/13/2007	14.0

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Figure B.1. Time series plot of Sulfate in Big Cornie Bayou near Three Creeks (OUA0002)

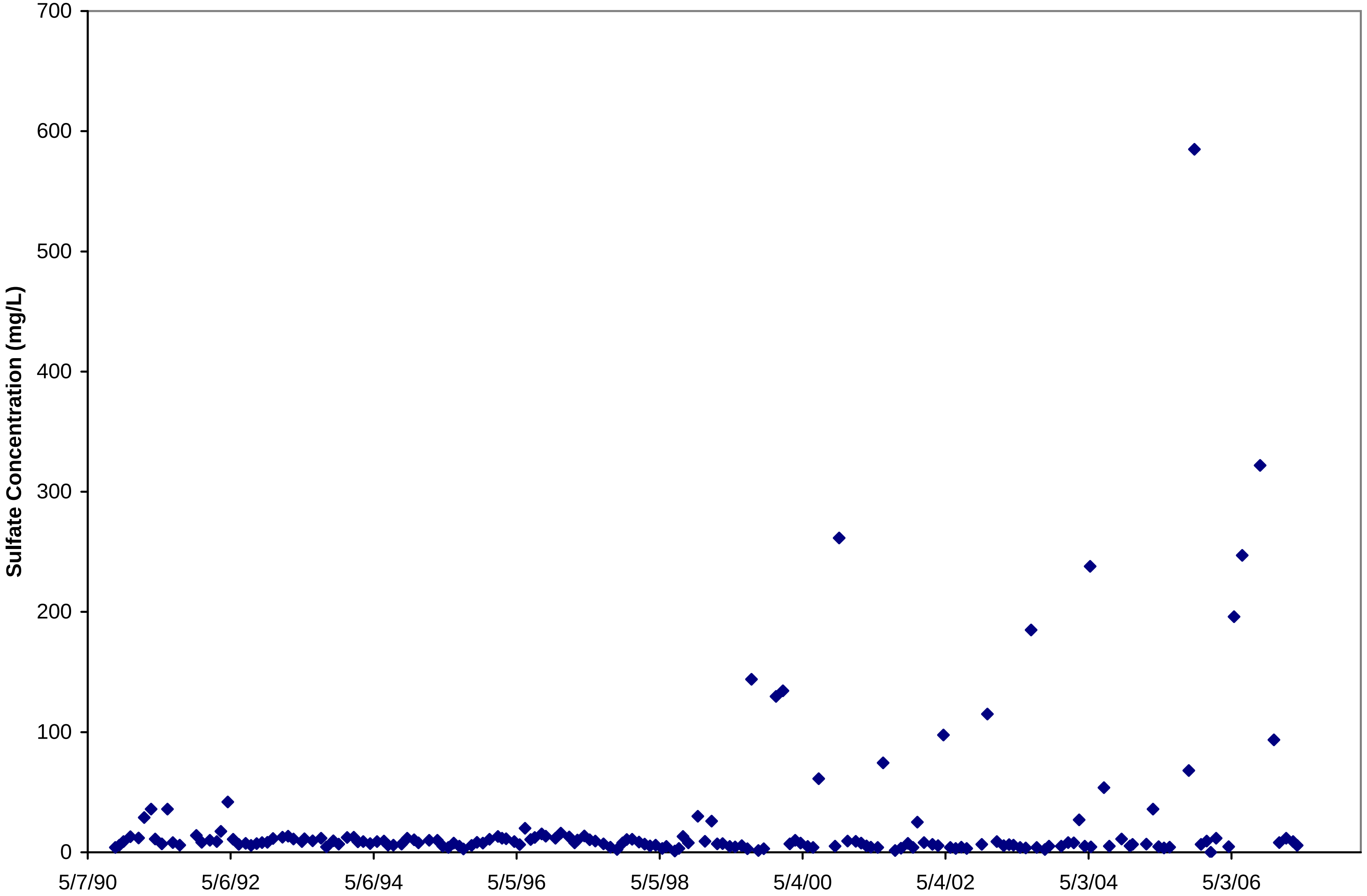


Figure B.2. Time series plot of Zinc in Big Cornie Bayou near Three Creeks (OUA0002)

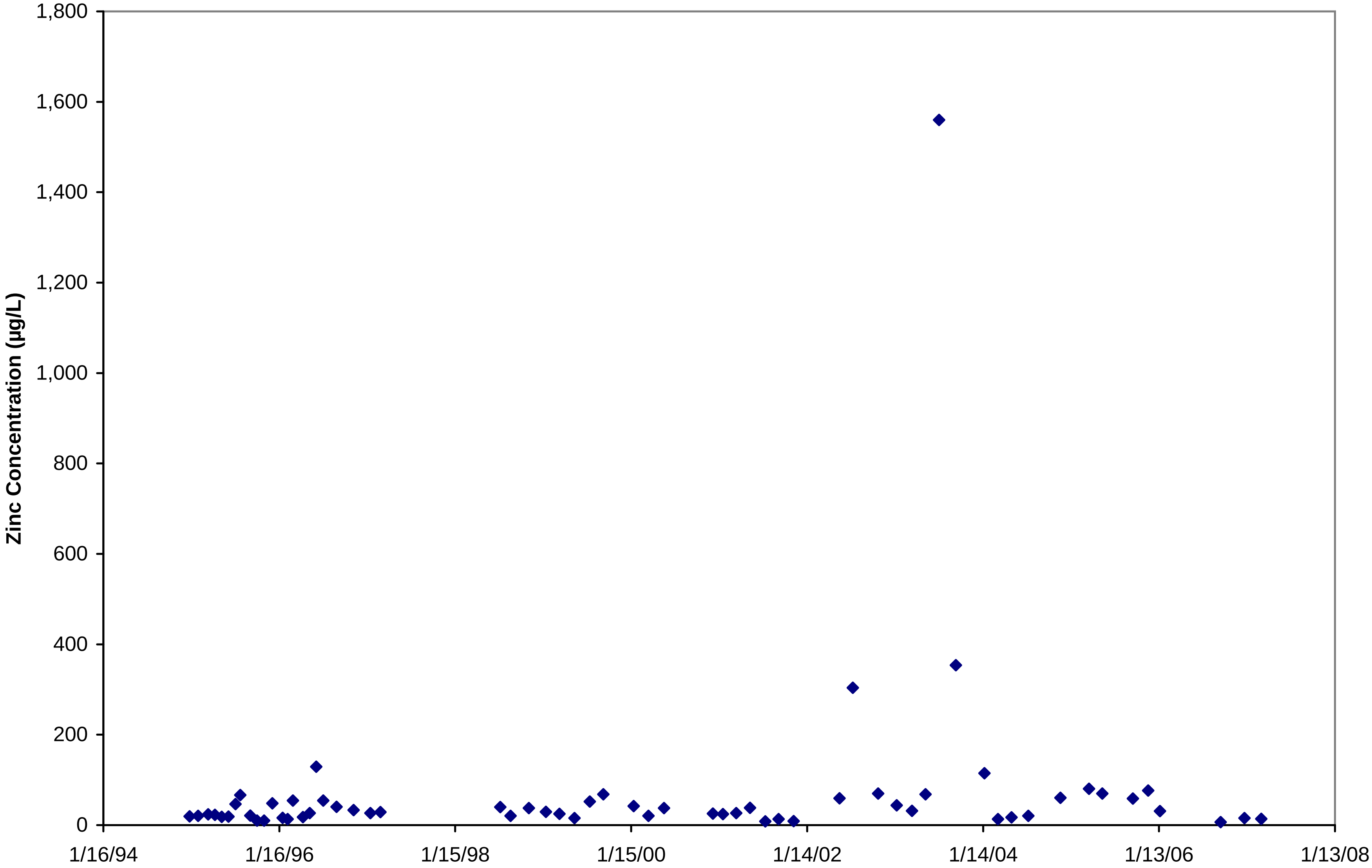


Figure B.3. Seasonal Plot of Sulfate in Big Cornie Bayou near Three Creeks (OUA0002)

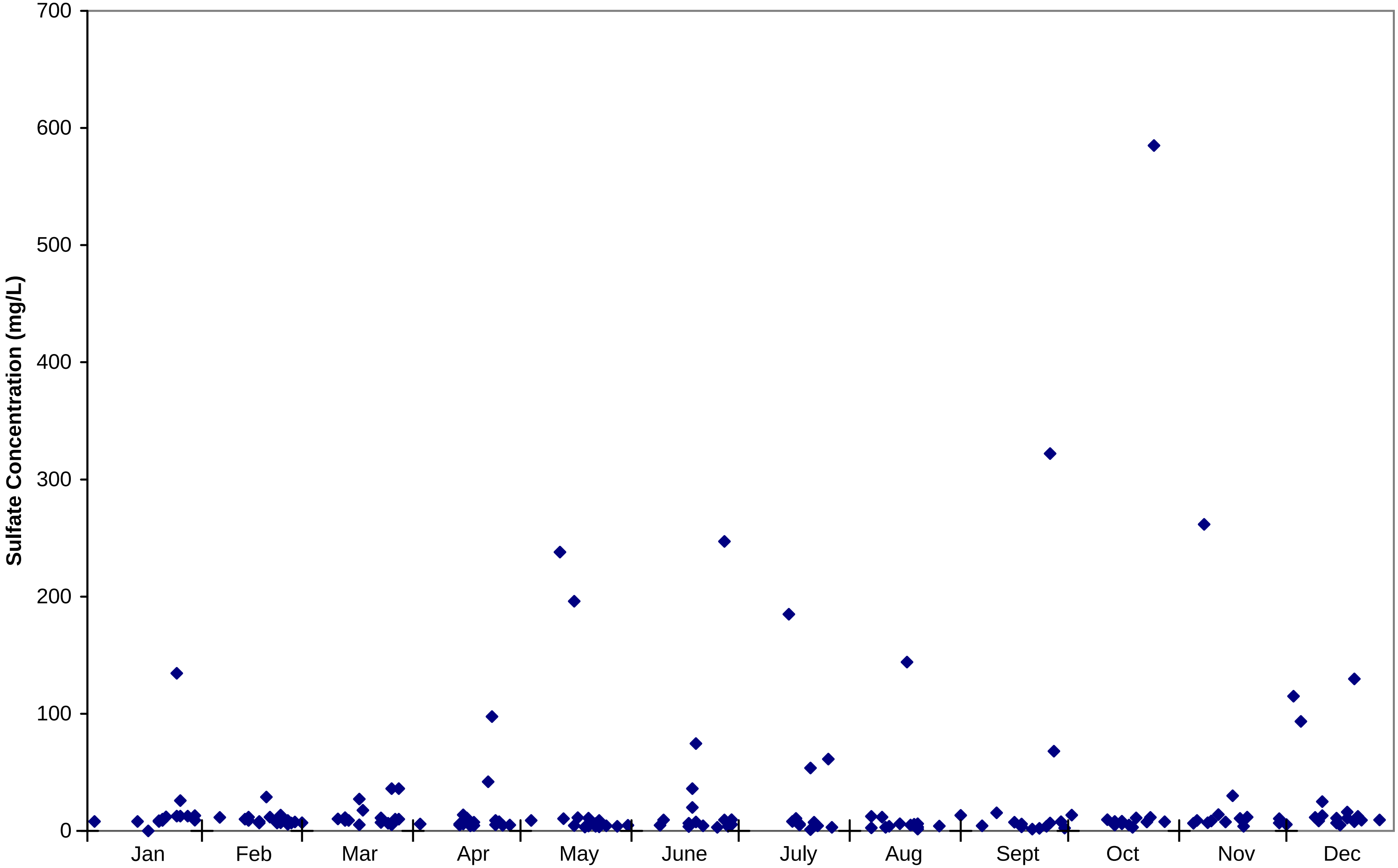


Figure B.4. Seasonal Plot of Zinc in Big Cornie Bayou near Three Creeks (OUA0002)

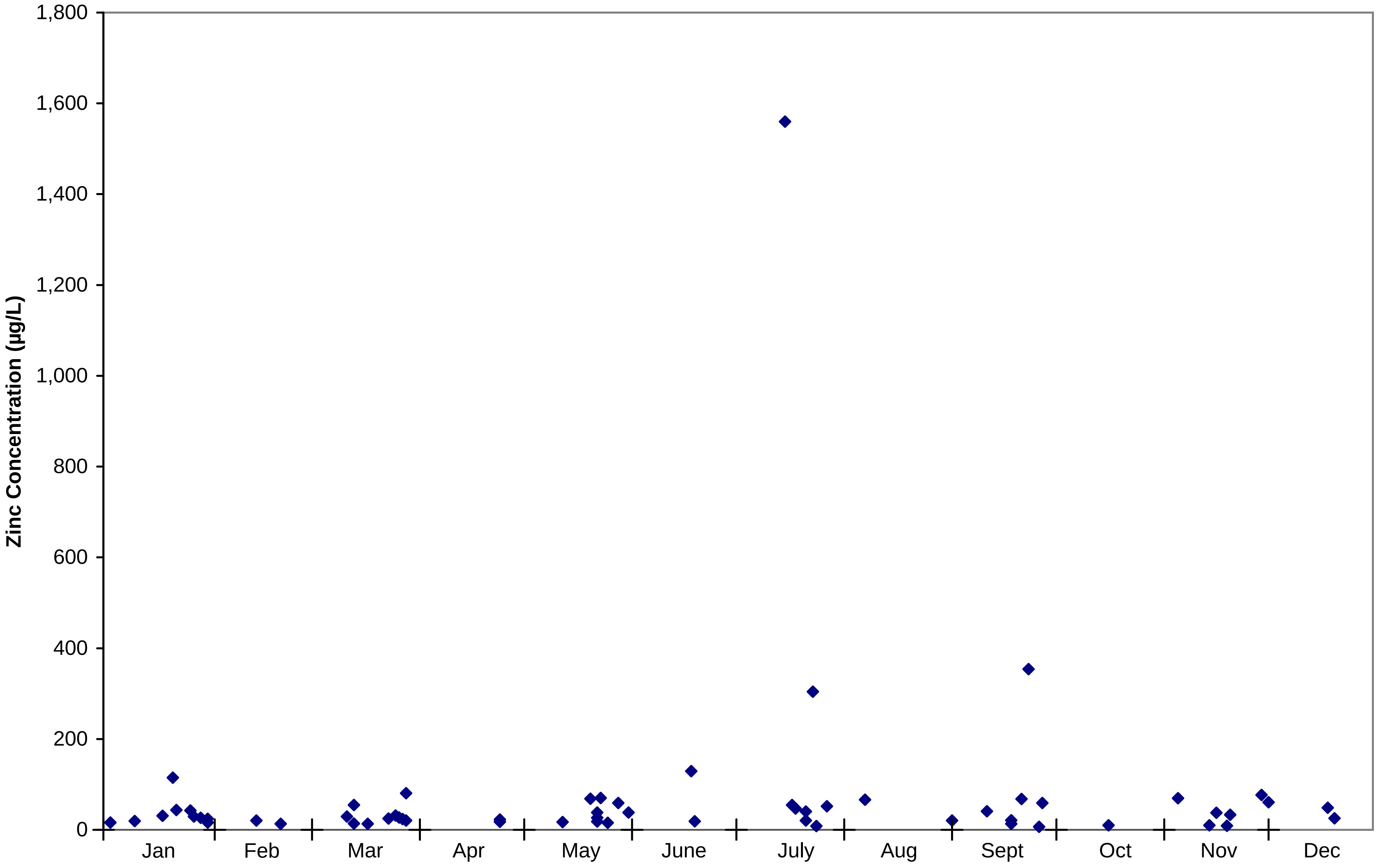


Figure B.5. Sulfate vs flow for Big Cornie Bayou near Three Creeks (OUA0002)

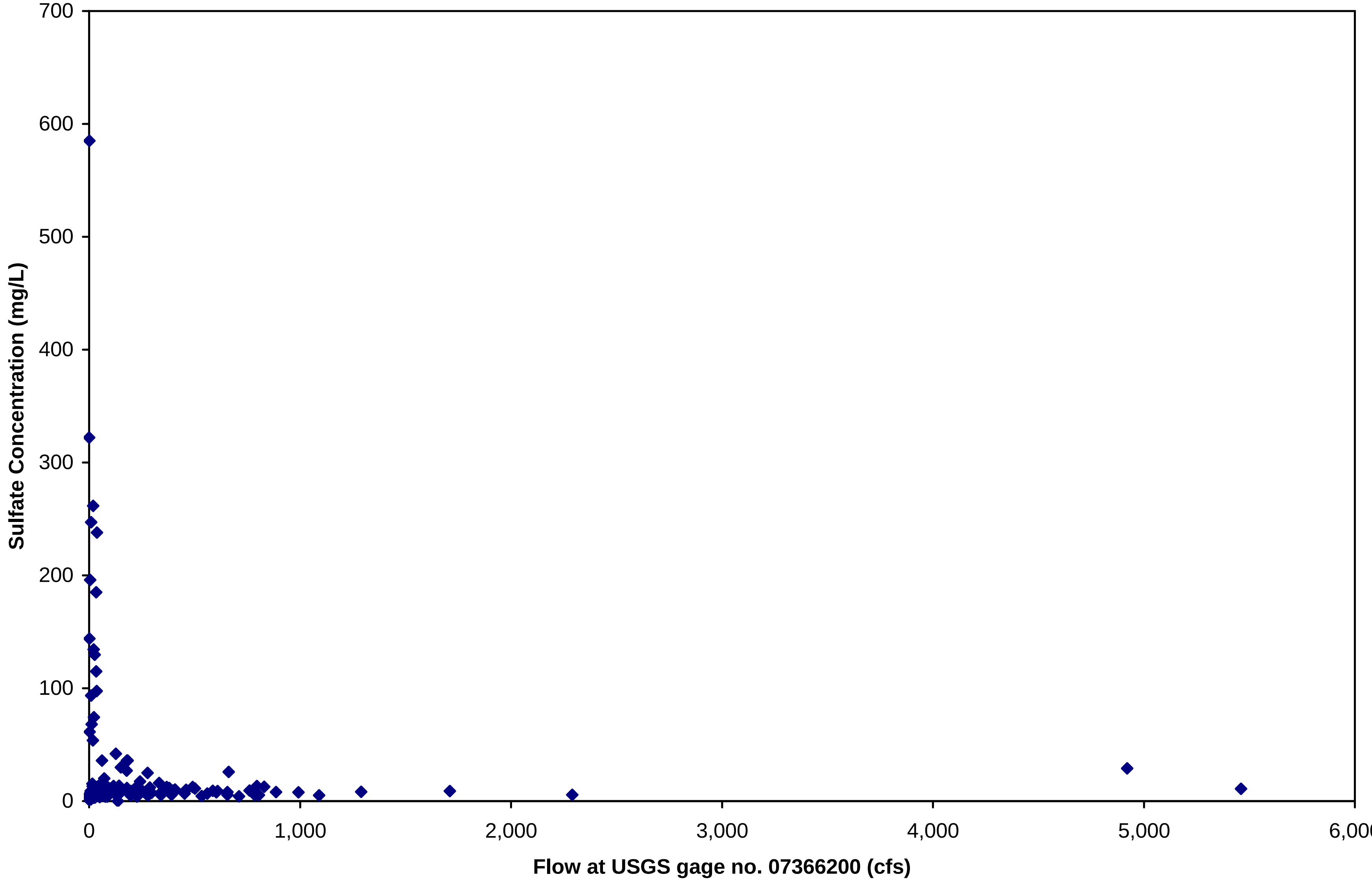
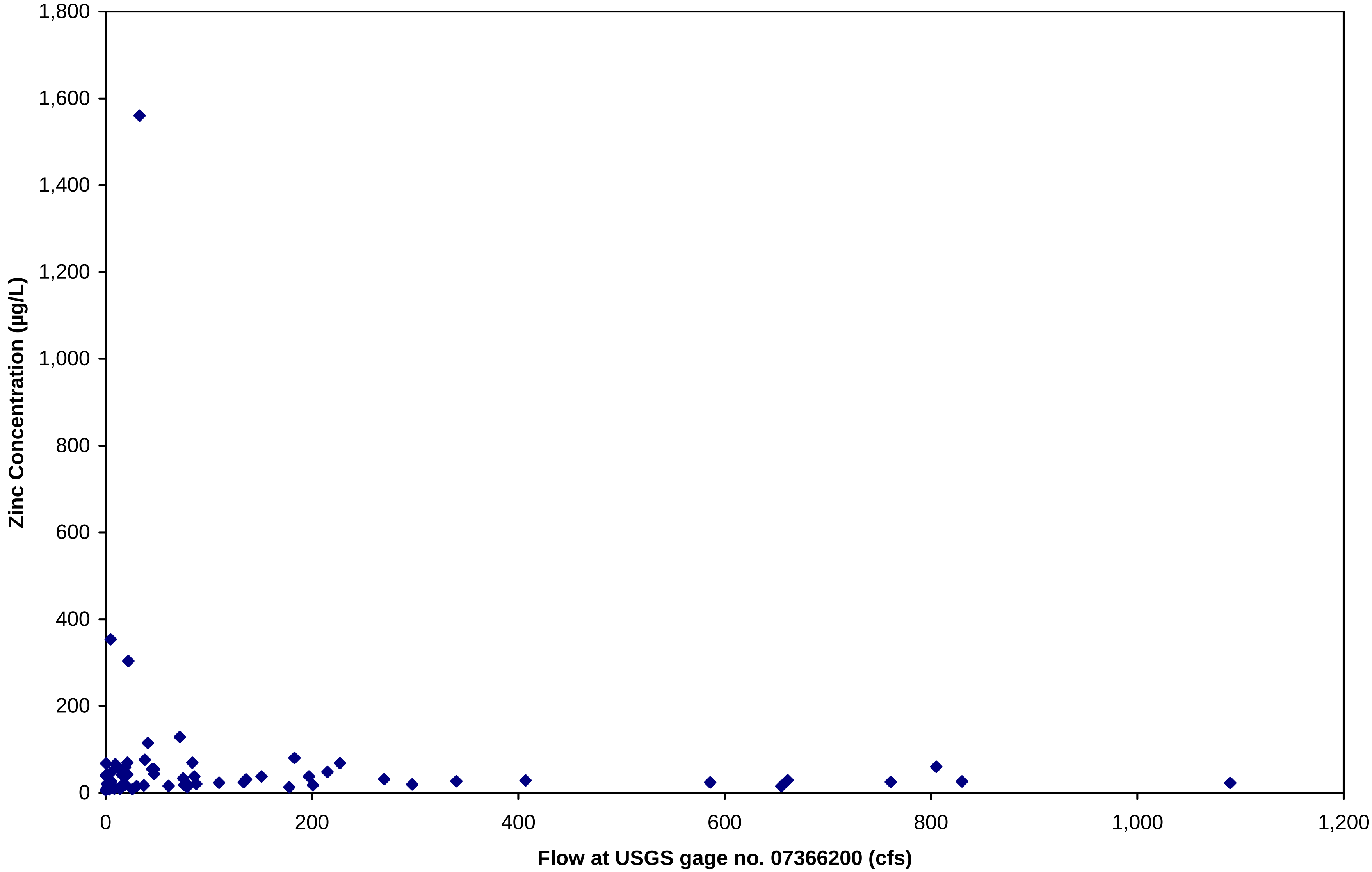


Figure B.6. Zinc vs flow for Big Cornie Bayou near Three Creeks (OUA0002)



APPENDIX C

Sulfate TMDLs

TABLE C.1. ALLOWABLE LOAD FOR SO4 FOR BIG CORNIE CREEK, LITTLE CORNIE CREEK, LITTLE CORNIE BAYOU, AND WALKER BRANCH.

				Big Cornie Creek (08040206-015) 25 mg/L = SO4 Criterion 189.1 mi^2 = drainage area of reach				Little Cornie Creek (08040206-016) 10 mg/L = SO4 Criterion 33.3 mi^2 = drainage area of reach				Little Cornie Bayou (08040206-716) 25 mg/L = SO4 Criterion 104.9 mi^2 = drainage area of reach				Little Cornie Bayou (08040206-816) 25 mg/L = SO4 Criterion 120.4 mi^2 = drainage area of reach				Walker Branch (08040206-916) 41 mg/L = SO4 Criterion 3.2 mi^2 = drainage area of reach			
Little Corney Bayou flow at USGS gage (cfs)	Flow (cfs/mi^2)	Percent exceed-ance for flows	Width on plot between data points (unitless)	Estimated Big Cornie Creek flow (cfs)	Big Cornie Creek Assimilative capacity, or TMDL (tons/day)	Big Cornie Creek TMDL - MOS (tons/day)	Big Cornie Creek Area under TMDL curve (width times assimilative capacity) (tons/day)	Estimated Little Cornie Creek flow (cfs)	Little Cornie Creek Assimilative capacity, or TMDL (tons/day)	Little Cornie Creek TMDL - MOS (tons/day)	Little Cornie Creek Area under TMDL curve (width times assimilative capacity) (tons/day)	Estimated Little Cornie Bayou flow (cfs)	Little Cornie Bayou Assimilative capacity, or TMDL (tons/day)	Little Cornie Bayou TMDL - MOS (tons/day)	Little Cornie Bayou Area under TMDL curve (width times assimilative capacity) (tons/day)	Estaimted Little Cornie Bayou flow (cfs)	Little Cornie Bayou Assimilative capacity, or TMDL (tons/day)	Little Cornie Bayou TMDL - MOS (tons/day)	Little Cornie Bayou Area under TMDL curve (width times assimilative capacity) (tons/day)	Estimated Walker Branch flow (cfs)	Walker Branch Assimilative capacity, or TMDL (tons/day)	Walker Branch TMDL - MOS (tons/day)	Walker Branch Area under TMDL curve (width times assimilative capacity) (tons/day)
0.00	3.83E-06	100.000	0.626	0.189	4.885E-05	4.396E-05	3.059E-07	1.276E-04	3.441E-06	3.097E-06	2.155E-08	4.019E-04	2.710E-05	2.439E-05	1.697E-07	4.613E-04	3.110E-05	2.799E-05	1.948E-07	1.226E-05	1.356E-06	1.220E-06	8.490E-09
0.01	3.83E-05	98.747	0.660	1.891	4.885E-04	4.396E-04	3.223E-06	1.276E-03	3.441E-05	3.097E-05	2.270E-07	4.019E-03	2.710E-04	2.439E-04	1.788E-06	4.613E-03	3.110E-04	2.799E-04	2.052E-06	1.226E-04	1.356E-05	1.220E-05	8.944E-08
0.02	7.66E-05	98.680	0.063	3.782	9.770E-04	8.793E-04	6.119E-07	2.552E-03	6.882E-05	6.194E-05	4.310E-08	8.038E-03	5.420E-04	4.878E-04	3.394E-07	9.226E-03	6.220E-04	5.598E-04	3.896E-07	2.452E-04	2.711E-05	2.440E-05	1.698E-08
0.03	1.15E-04	98.622	0.067	5.673	1.465E-03	1.319E-03	9.818E-07	3.828E-03	1.032E-04	9.290E-05	6.916E-08	1.206E-02	8.129E-04	7.316E-04	5.446E-07	1.384E-02	9.331E-04	8.398E-04	6.251E-07	3.678E-04	4.067E-05	3.660E-05	2.725E-08
0.04	1.53E-04	98.546	0.070	7.564	1.954E-03	1.759E-03	1.366E-06	5.103E-03	1.376E-04	1.239E-04	9.622E-08	1.608E-02	1.084E-03	9.755E-04	7.578E-07	1.845E-02	1.244E-03	1.120E-03	8.697E-07	4.904E-04	5.423E-05	4.880E-05	3.791E-08
0.05	1.92E-04	98.482	0.051	9.455	2.442E-03	2.198E-03	1.245E-06	6.379E-03	1.720E-04	1.548E-04	8.770E-08	2.010E-02	1.355E-03	1.219E-03	6.907E-07	2.307E-02	1.555E-03	1.400E-03	7.927E-07	6.130E-04	6.778E-05	6.101E-05	3.455E-08
0.06	2.30E-04	98.445	0.035	11.346	2.931E-03	2.638E-03	1.025E-06	7.655E-03	2.065E-04	1.858E-04	7.216E-08	2.411E-02	1.626E-03	1.463E-03	5.683E-07	2.768E-02	1.866E-03	1.680E-03	6.523E-07	7.356E-04	8.134E-05	7.321E-05	2.843E-08
0.07	2.68E-04	98.412	0.032	13.237	3.419E-03	3.077E-03	1.096E-06	8.931E-03	2.409E-04	2.168E-04	7.718E-08	2.813E-02	1.897E-03	1.707E-03	6.078E-07	3.229E-02	2.177E-03	1.959E-03	6.976E-07	8.582E-04	9.490E-05	8.541E-05	3.041E-08
The rows between 98.412 and 0.044 percent exceedances are not shown for the sake of brevity.																							
6,820	2.61E+01	0.044	0.006	1289662.000	3.331E+02	2.998E+02	1.941E-02	8.701E+02	2.347E+01	2.112E+01	1.367E-03	2.741E+03	1.848E+02	1.663E+02	1.077E-02	3.146E+03	2.121E+02	1.909E+02	1.236E-02	8.362E+01	9.246E+00	8.321E+00	5.386E-04
7,180	2.75E+01	0.038	0.006	1357738.000	3.507E+02	3.157E+02	2.043E-02	9.161E+02	2.471E+01	2.223E+01	1.439E-03	2.886E+03	1.946E+02	1.751E+02	1.133E-02	3.312E+03	2.233E+02	2.010E+02	1.301E-02	8.803E+01	9.734E+00	8.760E+00	5.671E-04
8,210	3.15E+01	0.032	0.006	1552511.000	4.010E+02	3.609E+02	2.336E-02	1.047E+03	2.825E+01	2.542E+01	1.646E-03	3.300E+03	2.225E+02	2.002E+02	1.296E-02	3.787E+03	2.553E+02	2.298E+02	1.488E-02	1.007E+02	1.113E+01	1.002E+01	6.484E-04
8,840	3.39E+01	0.026	0.006	1671644.000	4.318E+02	3.886E+02	2.516E-02	1.128E+03	3.042E+01	2.738E+01	1.772E-03	3.553E+03	2.395E+02	2.156E+02	1.396E-02	4.078E+03	2.749E+02	2.474E+02	1.602E-02	1.084E+02	1.198E+01	1.079E+01	6.982E-04
11,400	4.37E+01	0.020	0.006	2155740.000	5.569E+02	5.012E+02	3.244E-02	1.454E+03	3.923E+01	3.530E+01	2.285E-03	4.582E+03	3.089E+02	2.780E+02	1.800E-02	5.259E+03	3.546E+02	3.191E+02	2.066E-02	1.398E+02	1.545E+01	1.391E+01	9.004E-04
13,800	5.29E+01	0.015	0.006	2609580.000	6.741E+02	6.067E+02	3.927E-02	1.761E+03	4.748E+01	4.274E+01	2.766E-03	5.546E+03	3.740E+02	3.366E+02	2.179E-02	6.366E+03	4.292E+02	3.863E+02	2.500E-02	1.692E+02	1.871E+01	1.684E+01	1.090E-03
19,100	7.32E+01	0.009	0.006	3611810.000	9.330E+02	8.397E+02	5.436E-02	2.437E+03	6.572E+01	5.915E+01	3.829E-03	7.677E+03	5.176E+02	4.658E+02	3.015E-02	8.811E+03	5.940E+02	5.346E+02	3.461E-02	2.342E+02	2.589E+01	2.330E+01	1.509E-03
19,300	7.39E+01	0.003	0.006	3649630.000	9.428E+02	8.485E+02	5.492E-02	2.462E+03	6.641E+01	5.977E+01	3.869E-03	7.757E+03	5.230E+02	4.707E+02	3.047E-02	8.903E+03	6.003E+02	5.402E+02	3.497E-02	2.366E+02	2.616E+01	2.355E+01	1.524E-03
						Total area under TMDL curve for Sulfate (tons/day) =	10.27			Total area under TMDL curve for Sulfate (tons/day) =	0.72			Total area under TMDL curve for Sulfate (tons/day) =	5.70			Total area under TMDL curve for Sulfate (tons/day) =	6.54			Total area under TMDL curve for Sulfate (tons/day) =	0.29
Explicit MOS (tons/day) = TMDL × 10% =							1.03				0.07				0.57				0.65				0.03
WLA for poiont suorces (tons/day) (from Table C.2) =							0.00				0.00				0.83				0.04				0.13
LA for nonpoint sources (tons/day) = TMDL - WLA =							9.24				0.65				4.30				5.85				0.13

Table C.2 Sulfate WLA Calculations

Permit	Facility Name	Receiving Reach[A]	Outfall	Flowrate (MGD)	SO4 (mg/L)	Individual Loads (lbs/day)
AR0000680	Great Lakes Chemical Corporation - South Plant	916	002	0.77	41[C]	263.43
			003	0.0135	41[D]	4.62
AR0001171	Great Lakes Chemical Corporation - Central Plant	716	003	2.92[B]	66[E]	1608.09
AR0047813	Oak Manor Water & Wastewater Public Facility Board	716	001	0.15	41[D]	51.32
AR0022179	City of Junction City	816	001	0.26	41[D]	88.95

Notes: A. This is the first impaired reach that the discharge drains into.

B. This is the flow for this outfall from page 14 of the fact sheet for the final 2004 permit.

C. Water quality criterion for Walker Branch.

D. Median of sulfate values measured in treated domestic wastewater throughout Arkansas.

E. Final 2004 monthly average permit limit.

Reach	Cumulative SO_4 Loads (lbs/day)	Cumulative SO_4 Loads (tons/day)
Reach 916	268.04	0.13
Reach 816	88.95	0.04
Reach 716	1,659.41	0.83

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TABLE C.3. SULFATE PERCENT REDUCTION FOR BIG CORNIE CREEK 08040206-015

TSS Target =	30 mg/L	Error check for reduction is / is not needed:	ok
Explicit MOS (% of TMDL) =	10%	Error check for less or more reduction needed:	ok
TSS Target reduced by MOS =	27 mg/L		
Percent reduction =	25%		

		Flow on Sampling Day							
Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
9/25/1990	4.0	14.0	10.1	74.44	0.11	0.08	0.82	0.74	Yes
10/16/1990	6.0	14.0	10.1	74.44	0.16	0.12	0.82	0.74	Yes
11/6/1990	9.0	40.0	29.0	53.99	0.70	0.53	2.34	2.11	Yes
12/11/1990	13.0	40.0	29.0	53.99	1.02	0.76	2.34	2.11	Yes
1/22/1991	12.0	288.0	208.7	19.69	6.75	5.06	16.88	15.19	Yes
2/19/1991	29.0	4920.0	3564.5	0.17	278.78	209.08	288.39	259.55	Yes
3/26/1991	36.0	61.0	44.2	44.21	4.29	3.22	3.58	3.22	Yes
4/16/1991	11.0	5460.0	3955.7	0.10	117.35	88.01	320.04	288.04	Yes
5/21/1991	7.0	133.0	96.4	30.11	1.82	1.36	7.80	7.02	Yes
6/18/1991	36.0	179.0	129.7	26.09	12.59	9.44	10.49	9.44	Yes
7/16/1991	8.0	11.0	8.0	77.91	0.17	0.13	0.64	0.58	Yes
8/20/1991	6.0	23.0	16.7	66.11	0.27	0.20	1.35	1.21	Yes
11/12/1991	14.0	49.0	35.5	49.36	1.34	1.01	2.87	2.58	Yes
12/10/1991	8.4	1290.0	934.6	2.87	21.10	15.82	75.61	68.05	Yes
1/21/1992	10.0	460.0	333.3	12.72	8.96	6.72	26.96	24.27	Yes
2/25/1992	9.0	406.0	294.1	14.63	7.14	5.35	23.80	21.42	Yes
3/17/1992	17.5	241.0	174.6	22.20	8.24	6.18	14.13	12.71	Yes
4/21/1992	41.9	126.0	91.3	30.82	10.32	7.74	7.39	6.65	No
5/19/1992	10.9	38.0	27.5	55.22	0.81	0.61	2.23	2.00	Yes
6/16/1992	6.5	76.0	55.1	39.46	0.97	0.72	4.45	4.01	Yes
7/21/1992	7.4	20.0	14.5	68.62	0.29	0.22	1.17	1.06	Yes
8/18/1992	5.8	19.0	13.8	69.49	0.21	0.16	1.11	1.00	Yes
9/15/1992	7.3	16.0	11.6	72.29	0.23	0.17	0.94	0.84	Yes
10/13/1992	8.1	13.0	9.4	75.59	0.21	0.15	0.76	0.69	Yes
11/9/1992	8.4	27.0	19.6	62.77	0.44	0.33	1.58	1.42	Yes
12/8/1992	11.5	48.0	34.8	49.84	1.08	0.81	2.81	2.53	Yes

Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
1/26/1993	12.5	491.0	355.7	11.80	11.99	8.99	28.78	25.90	Yes
2/23/1993	13.4	116.0	84.0	32.00	3.04	2.28	6.80	6.12	Yes
3/23/1993	11.1	502.0	363.7	11.44	10.89	8.17	29.42	26.48	Yes
5/4/1993	8.8	246.0	178.2	21.94	4.24	3.18	14.42	12.98	Yes
5/17/1993	11.2	100.0	72.4	34.46	2.19	1.64	5.86	5.28	Yes
6/29/1993	9.6	83.0	60.1	37.85	1.55	1.17	4.87	4.38	Yes
8/10/1993	11.7	28.0	20.3	61.93	0.64	0.48	1.64	1.48	Yes
9/7/1993	4.4	1.7	1.2	94.53	0.01	0.01	0.10	0.09	Yes
10/12/1993	9.5	17.0	12.3	71.30	0.32	0.24	1.00	0.90	Yes
11/9/1993	6.9	23.0	16.7	66.11	0.31	0.23	1.35	1.21	Yes
12/21/1993	12.3	77.0	55.8	39.22	1.85	1.39	4.51	4.06	Yes
1/25/1994	12.5	87.0	63.0	36.94	2.12	1.59	5.10	4.59	Yes
2/14/1994	8.8	1710.0	1238.9	1.65	29.47	22.10	100.23	90.21	Yes
3/14/1994	9.0	609.0	441.2	8.75	10.71	8.03	35.70	32.13	Yes
4/18/1994	7.3	296.0	214.4	19.30	4.22	3.17	17.35	15.62	Yes
5/23/1994	8.9	38.0	27.5	55.22	0.66	0.50	2.23	2.00	Yes
6/27/1994	9.3	41.0	29.7	53.46	0.75	0.56	2.40	2.16	Yes
7/18/1994	5.9	18.0	13.0	70.37	0.21	0.16	1.06	0.95	Yes
8/15/1994	6.0	8.8	6.4	80.82	0.10	0.08	0.52	0.46	Yes
9/26/1994	6.7	3.5	2.5	90.32	0.05	0.03	0.21	0.18	Yes
10/24/1994	11.6	380.0	275.3	15.75	8.61	6.46	22.27	20.05	Yes
11/29/1994	10.5	81.0	58.7	38.23	1.66	1.25	4.75	4.27	Yes
12/20/1994	7.9	992.0	718.7	4.32	15.35	11.51	58.15	52.33	Yes
2/13/1995	10.1	79.0	57.2	38.79	1.56	1.17	4.63	4.17	Yes
3/27/1995	9.9	110.0	79.7	32.90	2.13	1.60	6.45	5.80	Yes
4/24/1995	5.2	1090.0	789.7	3.68	11.07	8.31	63.89	57.50	Yes
5/22/1995	4.1	76.0	55.1	39.46	0.61	0.46	4.45	4.01	Yes
6/19/1995	7.6	19.0	13.8	69.49	0.28	0.21	1.11	1.00	Yes
7/18/1995	5.0	4.8	3.5	87.44	0.05	0.04	0.28	0.25	Yes
8/7/1995	2.7	9.4	6.8	79.95	0.05	0.04	0.55	0.50	Yes
9/18/1995	5.8	1.2	0.9	95.55	0.01	0.01	0.07	0.06	Yes
10/16/1995	8.3	14.0	10.1	74.44	0.23	0.17	0.82	0.74	Yes
11/14/1995	7.6	8.5	6.2	81.27	0.13	0.09	0.50	0.45	Yes
12/18/1995	10.8	215.0	155.8	23.42	4.54	3.40	12.60	11.34	Yes

Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
1/30/1996	13.1	61.0	44.2	44.21	1.56	1.17	3.58	3.22	Yes
2/20/1996	11.7	79.0	57.2	38.79	1.81	1.35	4.63	4.17	Yes
3/12/1996	11.3	45.0	32.6	51.30	0.99	0.75	2.64	2.37	Yes
4/23/1996	9.0	201.0	145.6	24.43	3.53	2.65	11.78	10.60	Yes
5/21/1996	6.3	5.3	3.8	86.34	0.07	0.05	0.31	0.28	Yes
6/17/1996	20.0	72.0	52.2	40.64	2.81	2.11	4.22	3.80	Yes
7/16/1996	10.6	47.0	34.1	50.33	0.97	0.73	2.75	2.48	Yes
8/6/1996	12.4	368.0	266.6	16.20	8.92	6.69	21.57	19.41	Yes
9/10/1996	15.4	16.0	11.6	72.29	0.48	0.36	0.94	0.84	Yes
10/1/1996	13.5	795.0	576.0	5.88	20.97	15.73	46.60	41.94	Yes
11/19/1996	11.8	75.0	54.3	39.78	1.73	1.30	4.40	3.96	Yes
12/17/1996	16.0	332.0	240.5	17.67	10.38	7.78	19.46	17.51	Yes
1/28/1997	12.7	830.0	601.3	5.43	20.60	15.45	48.65	43.79	Yes
2/25/1997	7.9	603.0	436.9	8.88	9.31	6.98	35.35	31.81	Yes
3/11/1997	10.3	407.0	294.9	14.58	8.19	6.14	23.86	21.47	Yes
4/15/1997	13.6	142.0	102.9	29.20	3.77	2.83	8.32	7.49	Yes
5/13/1997	10.4	55.0	39.8	46.62	1.12	0.84	3.22	2.90	Yes
6/10/1997	9.3	399.0	289.1	14.96	7.25	5.44	23.39	21.05	Yes
7/22/1997	7.1	13.0	9.4	75.59	0.18	0.14	0.76	0.69	Yes
8/26/1997	4.2	27.0	19.6	62.77	0.22	0.17	1.58	1.42	Yes
9/30/1997	2.4	3.0	2.2	91.47	0.01	0.01	0.18	0.16	Yes
10/28/1997	7.9	88.0	63.8	36.79	1.36	1.02	5.16	4.64	Yes
11/18/1997	10.6	58.0	42.0	45.39	1.20	0.90	3.40	3.06	Yes
12/15/1997	10.9	49.0	35.5	49.36	1.04	0.78	2.87	2.58	Yes
1/20/1998	8.6	257.0	186.2	21.35	4.31	3.23	15.06	13.56	Yes
2/17/1998	6.8	560.0	405.7	9.81	7.44	5.58	32.82	29.54	Yes
3/17/1998	5.3	786.0	569.4	5.99	8.17	6.13	46.07	41.46	Yes
4/14/1998	5.9	63.0	45.6	43.48	0.73	0.55	3.69	3.32	Yes
5/19/1998	3.2	22.0	15.9	66.94	0.14	0.10	1.29	1.16	Yes
6/9/1998	4.8	26.0	18.8	63.62	0.25	0.18	1.52	1.37	Yes
7/21/1998	1.0	0.01	7.24E-03	100.00	2.03E-05	1.52E-05	5.86E-04	5.28E-04	Yes
8/11/1998	3.2	19.0	13.8	69.49	0.12	0.09	1.11	1.00	Yes
9/1/1998	13.2	17.0	12.3	71.30	0.44	0.33	1.00	0.90	Yes
9/29/1998	7.8	21.0	15.2	67.77	0.32	0.24	1.23	1.11	Yes

Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
11/16/1998	29.9	151.0	109.4	28.30	8.82	6.62	8.85	7.97	Yes
12/22/1998	9.2	392.0	284.0	15.17	7.06	5.30	22.98	20.68	Yes
1/26/1999	25.9	661.0	478.9	7.85	33.45	25.09	38.74	34.87	Yes
2/23/1999	7.0	99.0	71.7	34.70	1.36	1.02	5.80	5.22	Yes
3/23/1999	7.2	134.0	97.1	29.99	1.88	1.41	7.85	7.07	Yes
4/28/1999	4.9	62.0	44.9	43.83	0.60	0.45	3.63	3.27	Yes
5/25/1999	4.4	30.0	21.7	60.48	0.26	0.20	1.76	1.58	Yes
6/29/1999	5.5	655.0	474.5	7.99	7.04	5.28	38.39	34.55	Yes
7/27/1999	3.0	16.0	11.6	72.29	0.09	0.07	0.94	0.84	Yes
8/17/1999	144.0	1.3	0.9	95.34	0.37	0.27	0.08	0.07	No
9/21/1999	1.6	0.5	0.3	97.19	0.00	0.00	0.03	0.02	Yes
10/19/1999	3.1	6.5	4.7	84.15	0.04	0.03	0.38	0.34	Yes
12/20/1999	129.7	26.0	18.8	63.62	6.59	4.94	1.52	1.37	No
1/25/2000	134.5	21.0	15.2	67.77	5.52	4.14	1.23	1.11	No
2/29/2000	7.0	142.0	102.9	29.20	1.94	1.45	8.32	7.49	Yes
3/27/2000	9.9	88.0	63.8	36.79	1.70	1.28	5.16	4.64	Yes
4/24/2000	7.8	25.0	18.1	64.45	0.38	0.28	1.47	1.32	Yes
5/30/2000	4.8	197.0	142.7	24.73	1.86	1.39	11.55	10.39	Yes
6/27/2000	4.0	21.0	15.2	67.77	0.16	0.12	1.23	1.11	Yes
7/25/2000	61.3	1.8	1.3	94.34	0.22	0.16	0.11	0.09	No
10/17/2000	5.1	0.2	0.1	98.03	0.00	0.00	0.01	0.01	Yes
11/7/2000	261.6	19.0	13.8	69.49	9.71	7.28	1.11	1.00	No
12/19/2000	9.4	761.0	551.3	6.35	13.98	10.48	44.61	40.15	Yes
1/30/2001	9.2	586.0	424.5	9.24	10.57	7.93	34.35	30.91	Yes
2/27/2001	7.6	340.0	246.3	17.38	5.08	3.81	19.93	17.94	Yes
3/26/2001	5.3	340.0	246.3	17.38	3.51	2.64	19.93	17.94	Yes
4/17/2001	4.3	711.0	515.1	6.96	5.99	4.49	41.68	37.51	Yes
5/22/2001	4.0	86.0	62.3	37.11	0.67	0.50	5.04	4.54	Yes
6/19/2001	74.4	23.0	16.7	66.11	3.35	2.51	1.35	1.21	No
8/20/2001	1.5	8.0	5.8	81.98	0.02	0.02	0.47	0.42	Yes
9/18/2001	3.5	2.0	1.4	93.88	0.01	0.01	0.12	0.11	Yes
10/23/2001	7.5	11.0	8.0	77.91	0.16	0.12	0.64	0.58	Yes
11/19/2001	3.9	26.0	18.8	63.62	0.20	0.15	1.52	1.37	Yes
12/11/2001	25.1	277.0	200.7	20.27	13.58	10.19	16.24	14.61	Yes

Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
1/14/2002	8.0	69.0	50.0	41.58	1.08	0.81	4.04	3.64	Yes
2/26/2002	6.7	144.0	104.3	28.96	1.87	1.40	8.44	7.60	Yes
3/26/2002	5.6	390.0	282.5	15.29	4.29	3.22	22.86	20.57	Yes
4/23/2002	97.6	36.0	26.1	56.60	6.87	5.15	2.11	1.90	No
5/28/2002	3.9	19.0	13.8	69.49	0.15	0.11	1.11	1.00	Yes
6/25/2002	3.1	14.0	10.1	74.44	0.09	0.06	0.82	0.74	Yes
7/23/2002	4.3	22.0	15.9	66.94	0.19	0.14	1.29	1.16	Yes
8/20/2002	3.2	27.0	19.6	62.77	0.17	0.13	1.58	1.42	Yes
11/5/2002	6.6	84.0	60.9	37.59	1.08	0.81	4.92	4.43	Yes
12/3/2002	115.0	33.0	23.9	58.55	7.41	5.56	1.93	1.74	No
1/21/2003	8.9	47.0	34.1	50.33	0.82	0.61	2.75	2.48	Yes
2/25/2003	5.6	2290.0	1659.1	0.96	25.15	18.86	134.23	120.81	Yes
3/25/2003	6.5	270.0	195.6	20.64	3.41	2.56	15.83	14.24	Yes
4/15/2003	5.9	72.0	52.2	40.64	0.83	0.62	4.22	3.80	Yes
5/20/2003	4.1	227.0	164.5	22.82	1.81	1.36	13.31	11.98	Yes
6/17/2003	3.6	50.0	36.2	48.90	0.35	0.26	2.93	2.64	Yes
7/15/2003	185.0	33.0	23.9	58.55	11.93	8.95	1.93	1.74	No
8/12/2003	3.9	5.1	3.7	86.77	0.04	0.03	0.30	0.27	Yes
9/23/2003	2.3	4.9	3.5	87.22	0.02	0.02	0.29	0.26	Yes
10/14/2003	5.1	2.5	1.8	92.58	0.02	0.02	0.15	0.13	Yes
12/16/2003	5.0	50.0	36.2	48.90	0.49	0.37	2.93	2.64	Yes
1/20/2004	8.0	41.0	29.7	53.46	0.64	0.48	2.40	2.16	Yes
2/17/2004	8.0	886.0	641.9	5.01	13.76	10.32	51.93	46.74	Yes
3/16/2004	27.1	178.0	129.0	26.17	9.42	7.07	10.43	9.39	Yes
4/13/2004	5.0	279.0	202.1	20.14	2.74	2.06	16.35	14.72	Yes
5/11/2004	238.0	37.0	26.8	55.94	17.21	12.90	2.17	1.95	No
5/15/2004	4.5	534.0	386.9	10.43	4.66	3.50	31.30	28.17	Yes
7/20/2004	53.7	18.0	13.0	70.37	1.89	1.42	1.06	0.95	No
8/17/2004	5.1	7.7	5.6	82.35	0.08	0.06	0.45	0.41	Yes
10/19/2004	11.0	34.0	24.6	57.92	0.73	0.55	1.99	1.79	Yes
11/30/2004	5.3	805.0	583.2	5.73	8.38	6.29	47.19	42.47	Yes
12/14/2004	6.7	453.0	328.2	12.89	5.91	4.43	26.55	23.90	Yes
2/22/2005	6.8	121.0	87.7	31.36	1.61	1.20	7.09	6.38	Yes
3/28/2005	36.0	183.0	132.6	25.84	12.87	9.65	10.73	9.65	Yes

Date	Observed SO4 at OUA0002 (mg/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual sulfate load (tons/day)	Reduced sulfate load (tons/day)	Allowable sulfate load before MOS (tons/day)	Allowable sulfate load with MOS incorporated (tons/day)	Reduced load less than or equal to allow. load?
4/26/2005	4.8	36.0	26.1	56.60	0.33	0.25	2.11	1.90	Yes
5/23/2005	3.6	21.0	15.2	67.77	0.15	0.11	1.23	1.11	Yes
6/21/2005	4.4	17.0	12.3	71.30	0.14	0.11	1.00	0.90	Yes
9/27/2005	68.0	12.0	8.7	76.74	1.59	1.20	0.70	0.63	No
10/25/2005	585.0	1.1	0.8	95.75	1.26	0.94	0.06	0.06	No
11/29/2005	6.7	38.0	27.5	55.22	0.50	0.37	2.23	2.00	Yes
12/27/2005	9.4	37.0	26.8	55.94	0.68	0.51	2.17	1.95	Yes
1/17/2006	0.02	136.0	98.5	29.76	0.01	0.00	7.97	7.17	Yes
2/14/2006	11.7	179.0	129.7	26.09	4.09	3.07	10.49	9.44	Yes
4/18/2006	4.7	3.2	2.3	91.02	0.03	0.02	0.19	0.17	Yes
5/16/2006	196.0	5.3	3.8	86.34	2.03	1.52	0.31	0.28	No
6/27/2006	247.0	0.01	7.24E-03	100.00	4.83E-03	3.62E-03	5.86E-04	5.28E-04	No
9/26/2006	322.0	0.01	7.24E-03	100.00	6.29E-03	4.72E-03	5.86E-04	5.28E-04	No
12/5/2006	93.5	10.0	7.2	78.91	1.83	1.37	0.59	0.53	No
1/2/2007	8.1	655.0	474.5	7.99	10.30	7.73	38.39	34.55	Yes
2/6/2007	11.6	45.0	32.6	51.30	1.02	0.76	2.64	2.37	Yes
3/13/2007	9.0	7.6	5.5	82.46	0.13	0.10	0.45	0.40	Yes
4/3/2007	5.8	128.0	92.7	30.64	1.45	1.09	7.50	6.75	Yes

Total number of values of loads =	180
Allowable % of exceedances of loads =	10%
Allowable no. of exceedances of loads =	18
No. of exceedances before reductions of loads =	24
No. of exceedances after reductions of loads =	18

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Figure C.1. Flow duration curve for Big Cornie Creek (08040206-015)

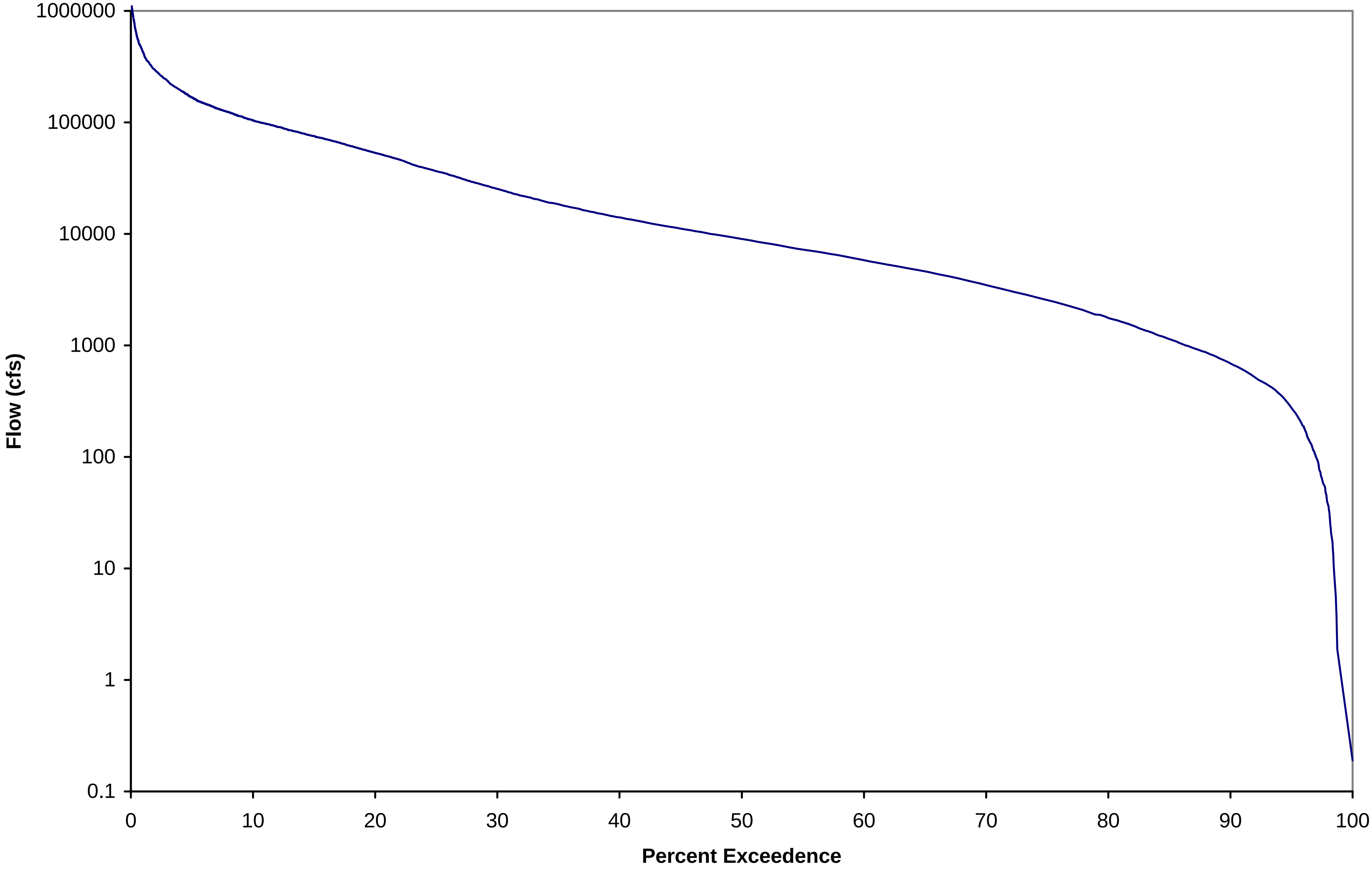


Figure C.2. Flow duration curve for Little Cornie Creek (08040206-016)

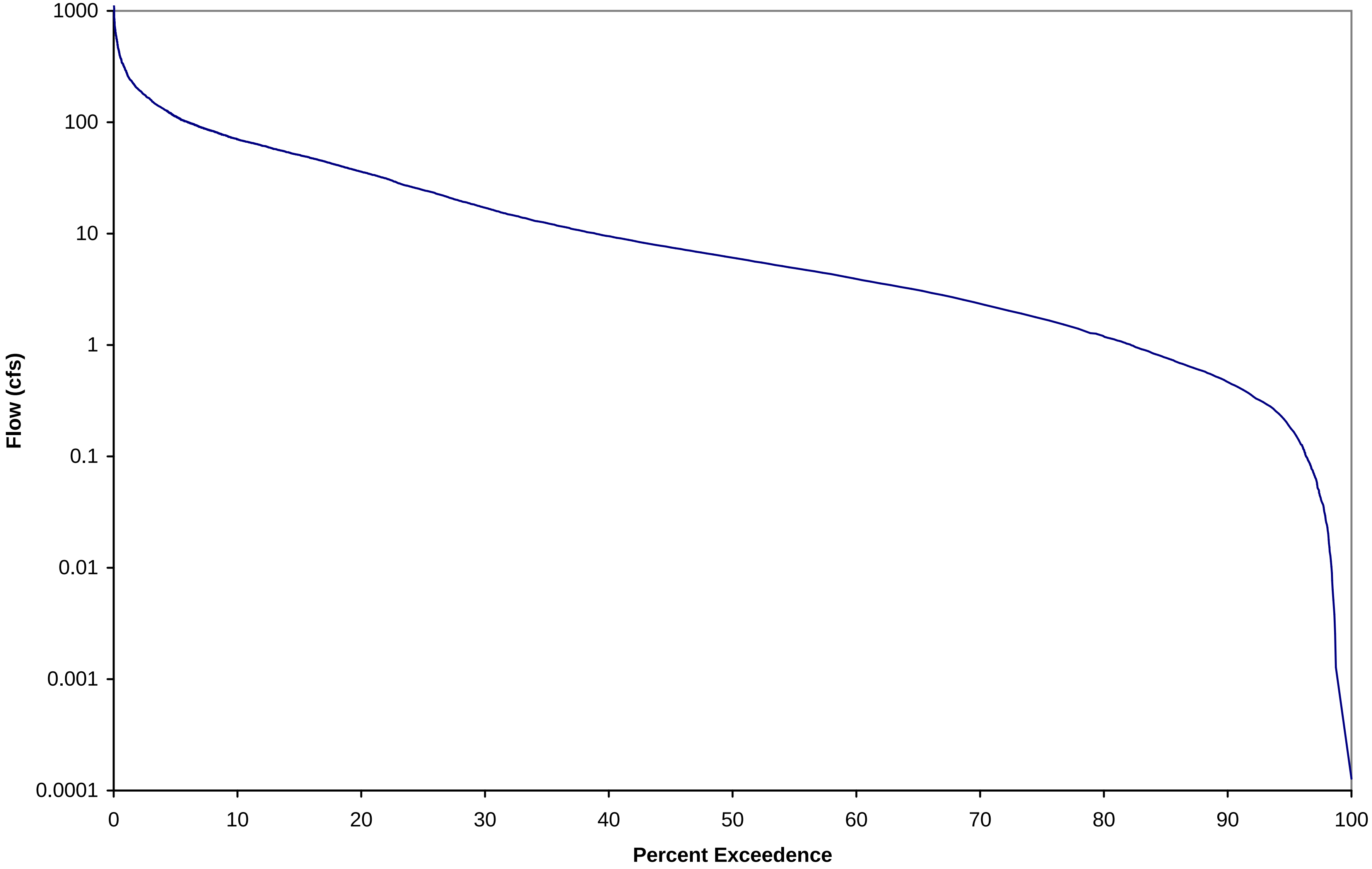


Figure C.3. Flow duration curve for Big Cornie Bayou (08040206-716)

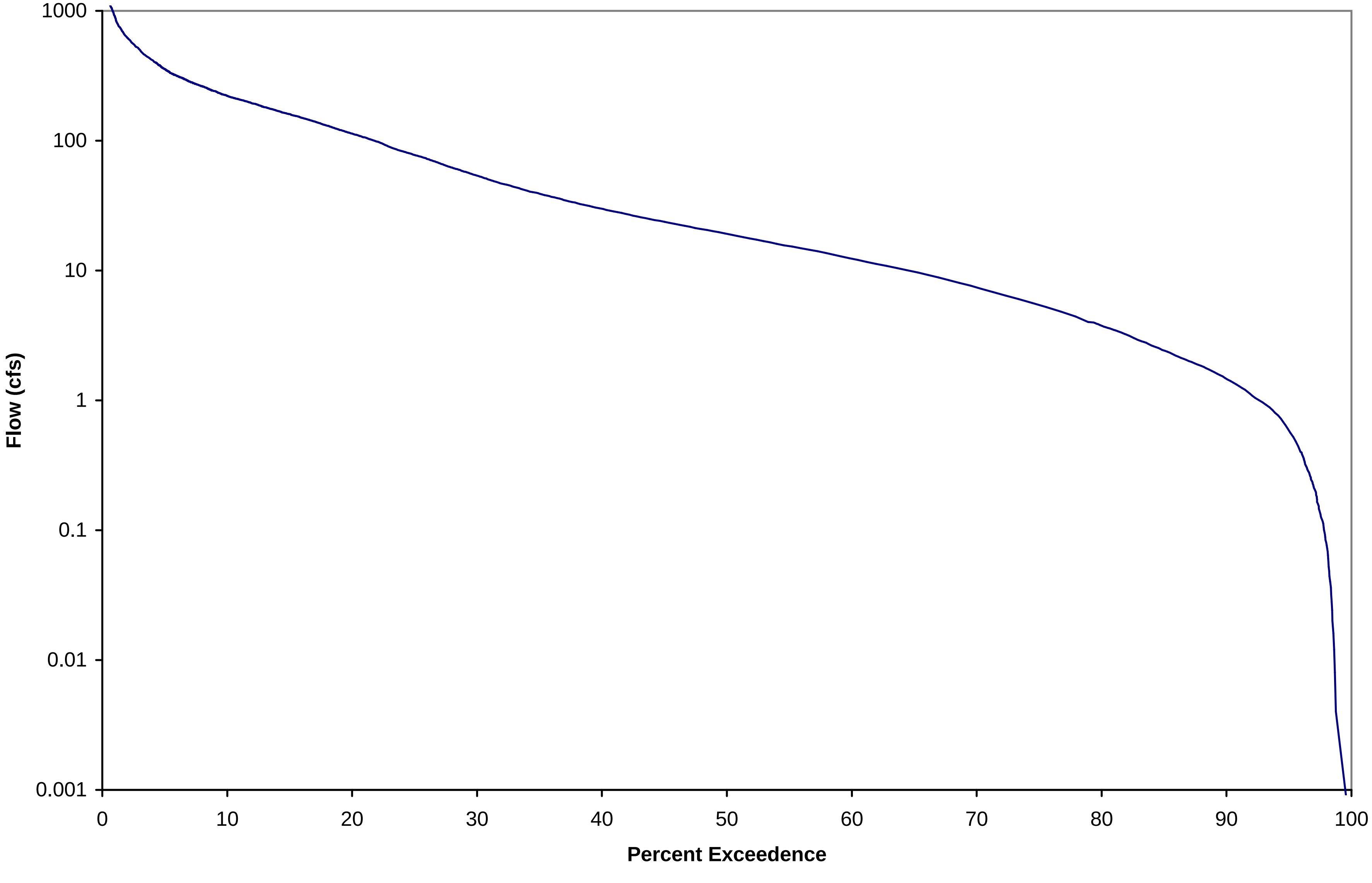


Figure C.4. Flow duration curve for Little Cornie Bayou (08040206-816)

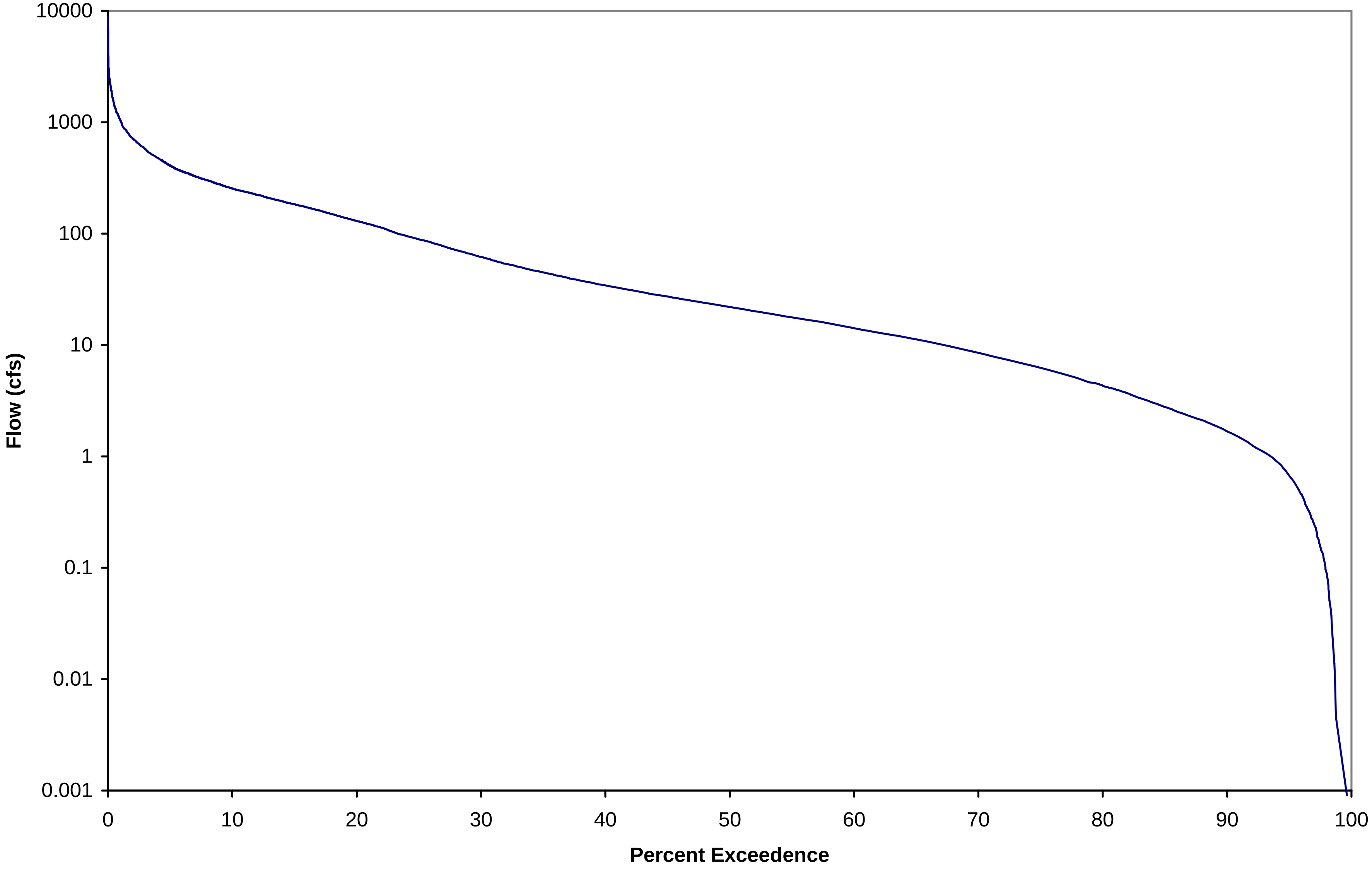


Figure C.5. Flow duration curve for Walker Branch (08040206-916)

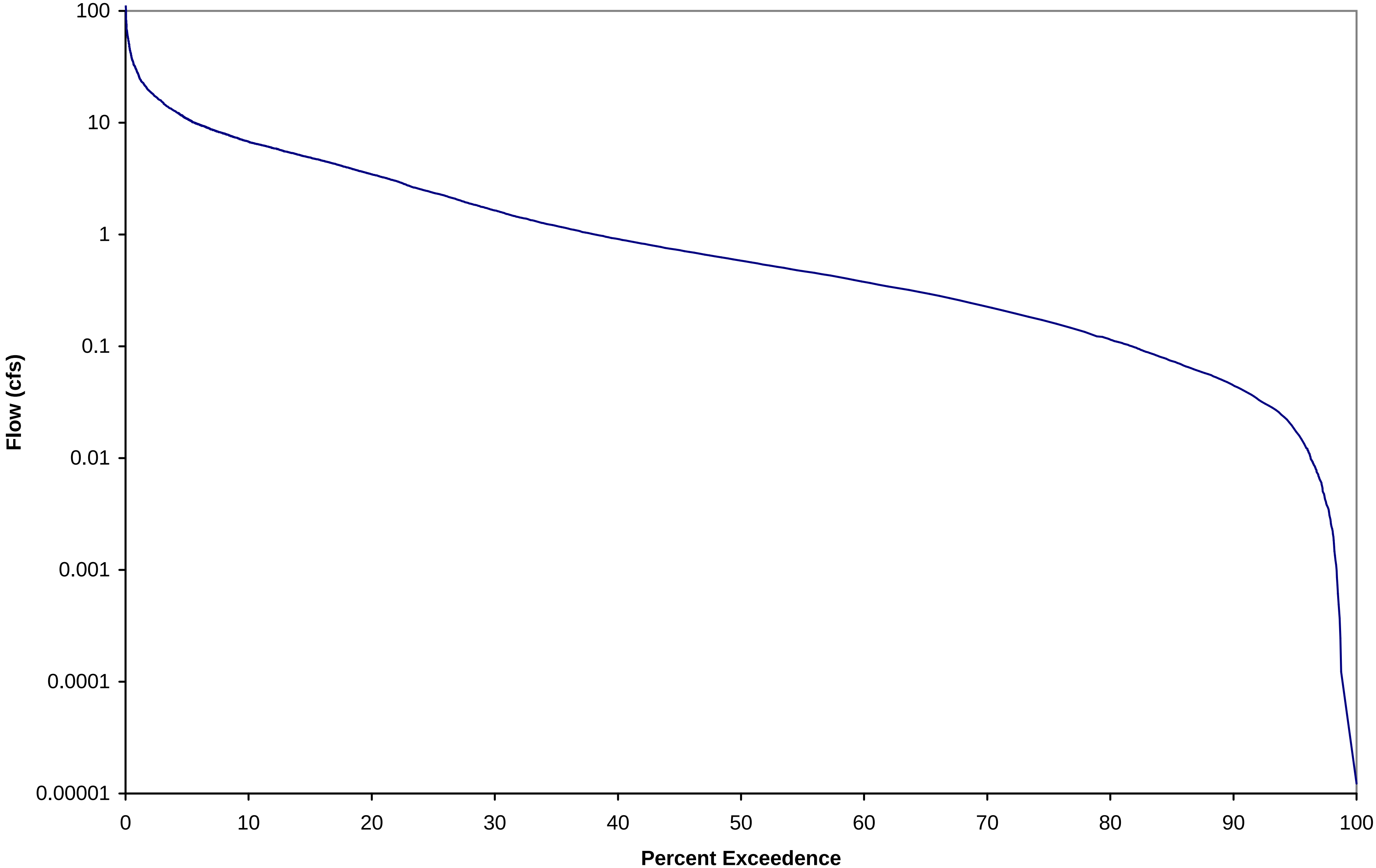


Figure C.6. Sulfate load duration curve for Big Cornie Creek (08040206-015)

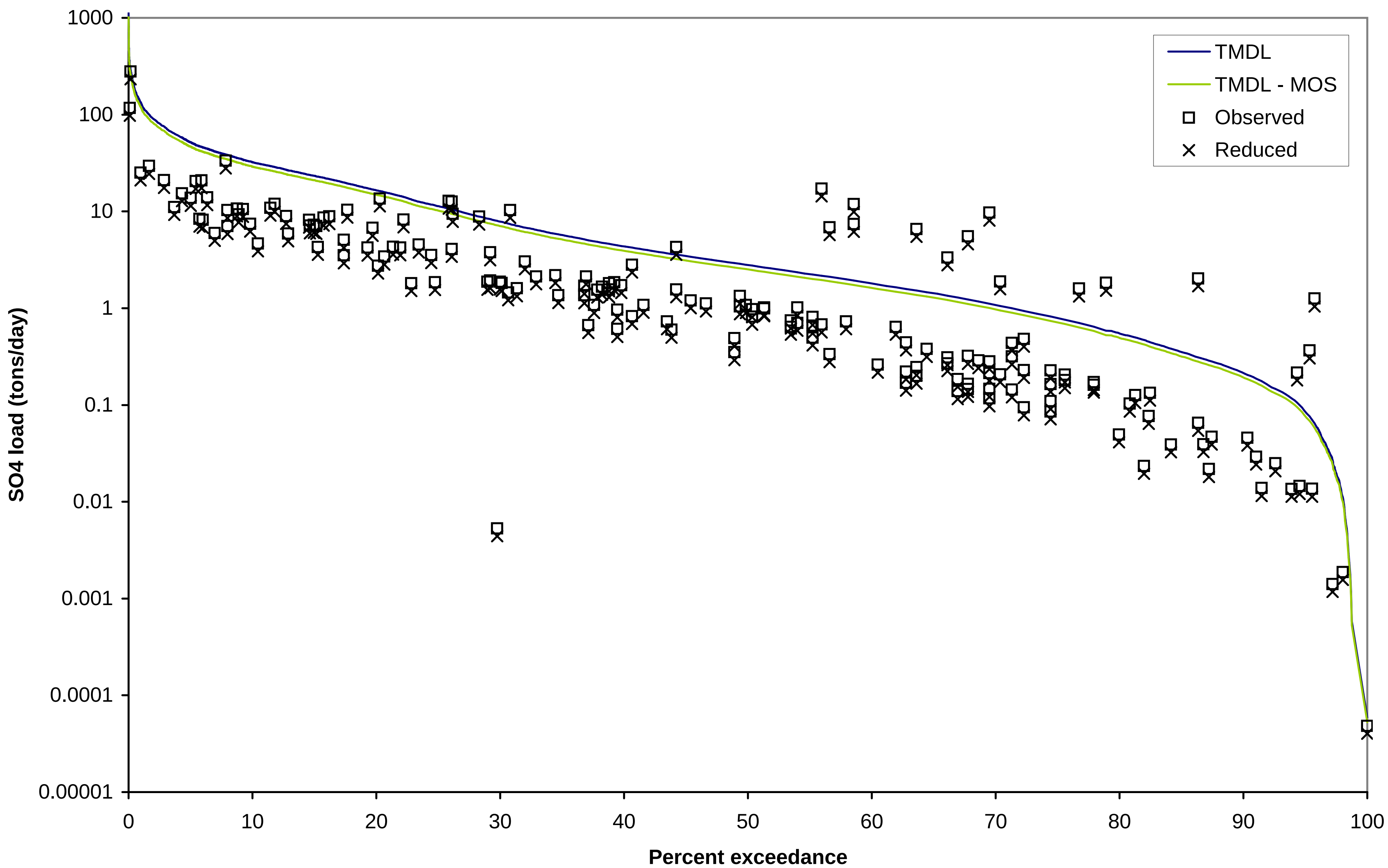
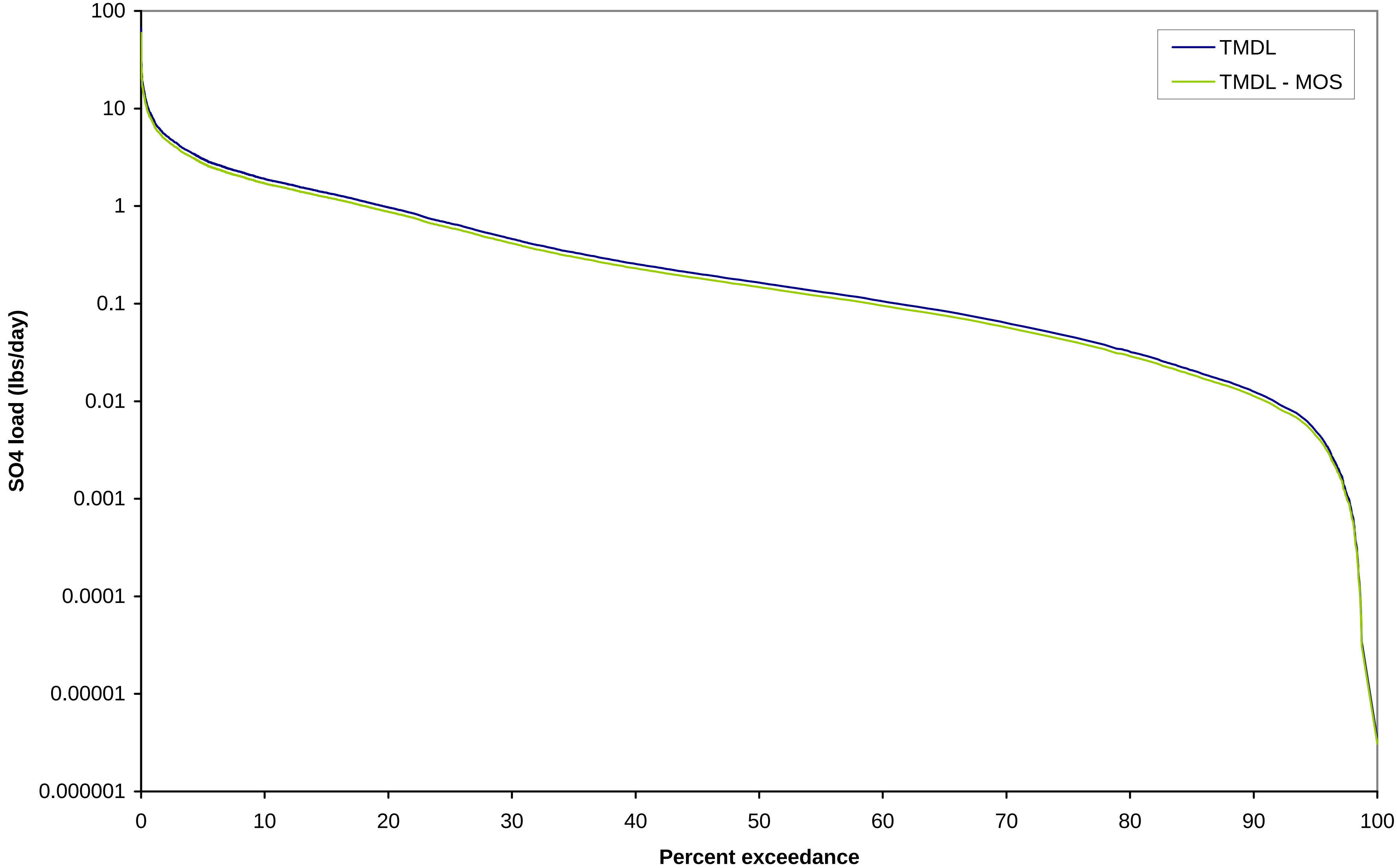


Figure C.7. Sulfate load duration curve for Little Cornie Creek (08040206-016)



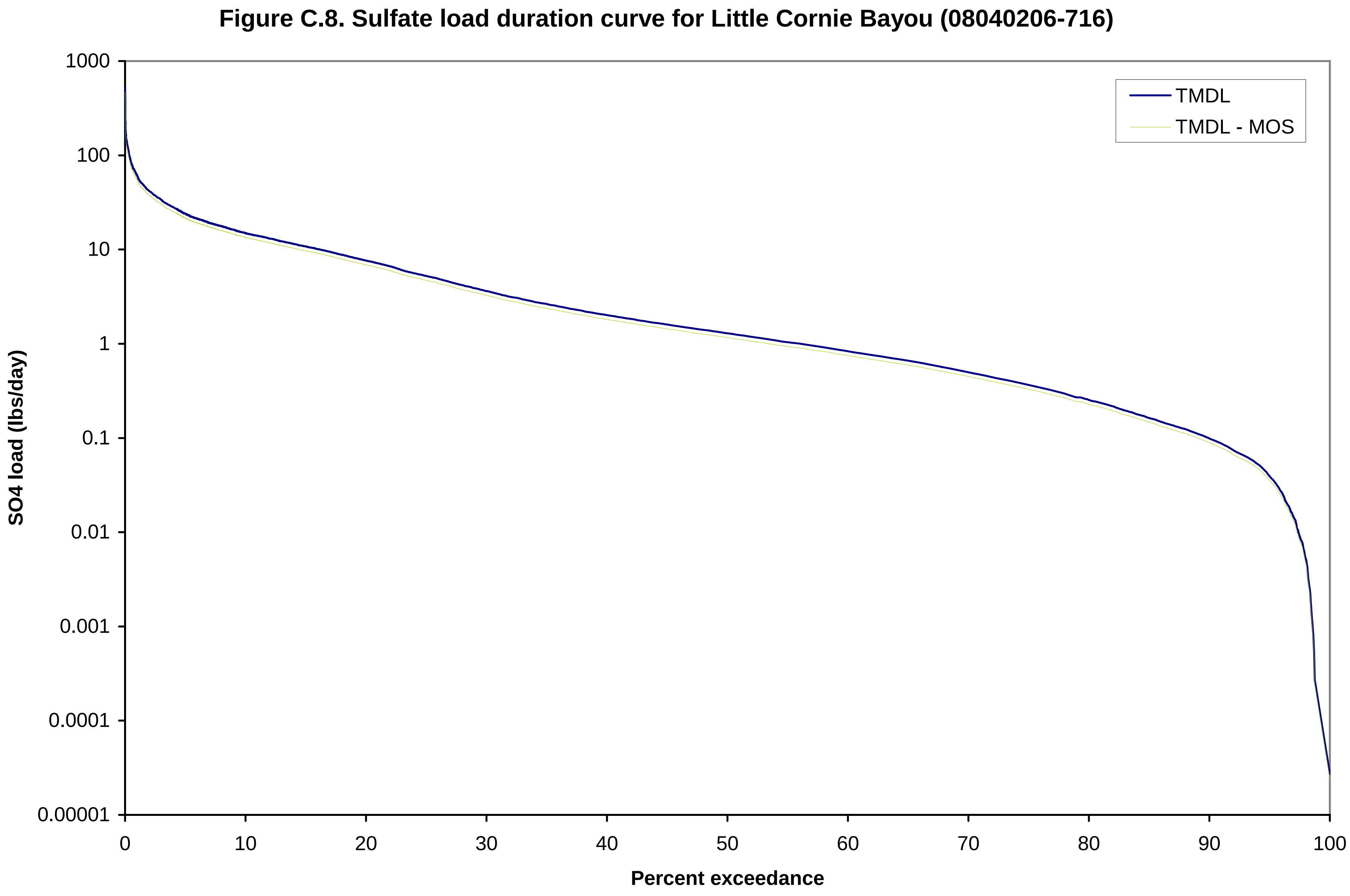


Figure C.8. Sulfate load duration curve for Little Cornie Bayou (08040206-716)
1000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
SO4 load (lbs/day)
0
10
20
30
40
50
60
70
80
90
100
Percent exceedance
TMDL
TMDL - MOS

Figure C.9. Sulfate load duration curve for Little Cornie Bayou (08040206-816)

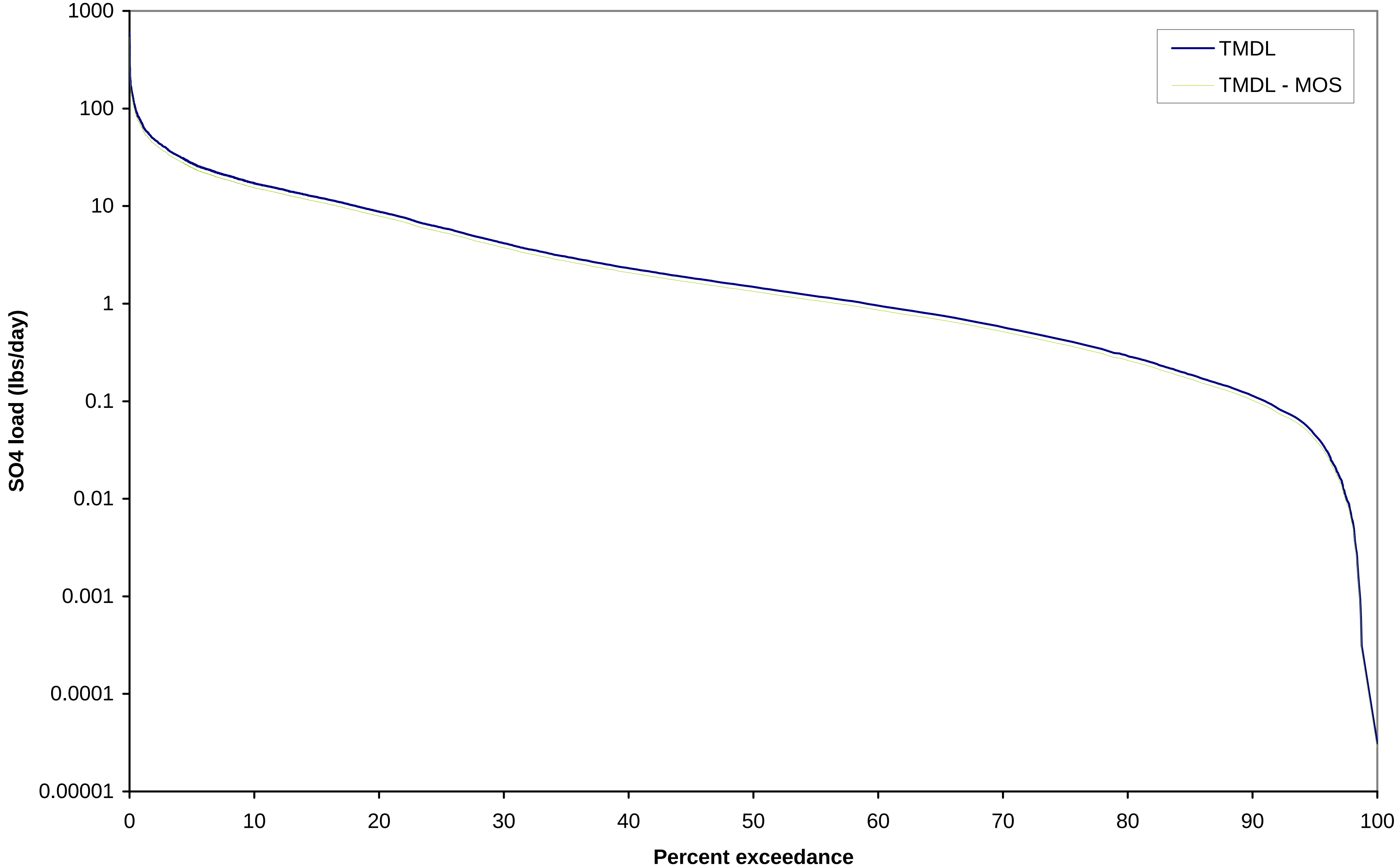
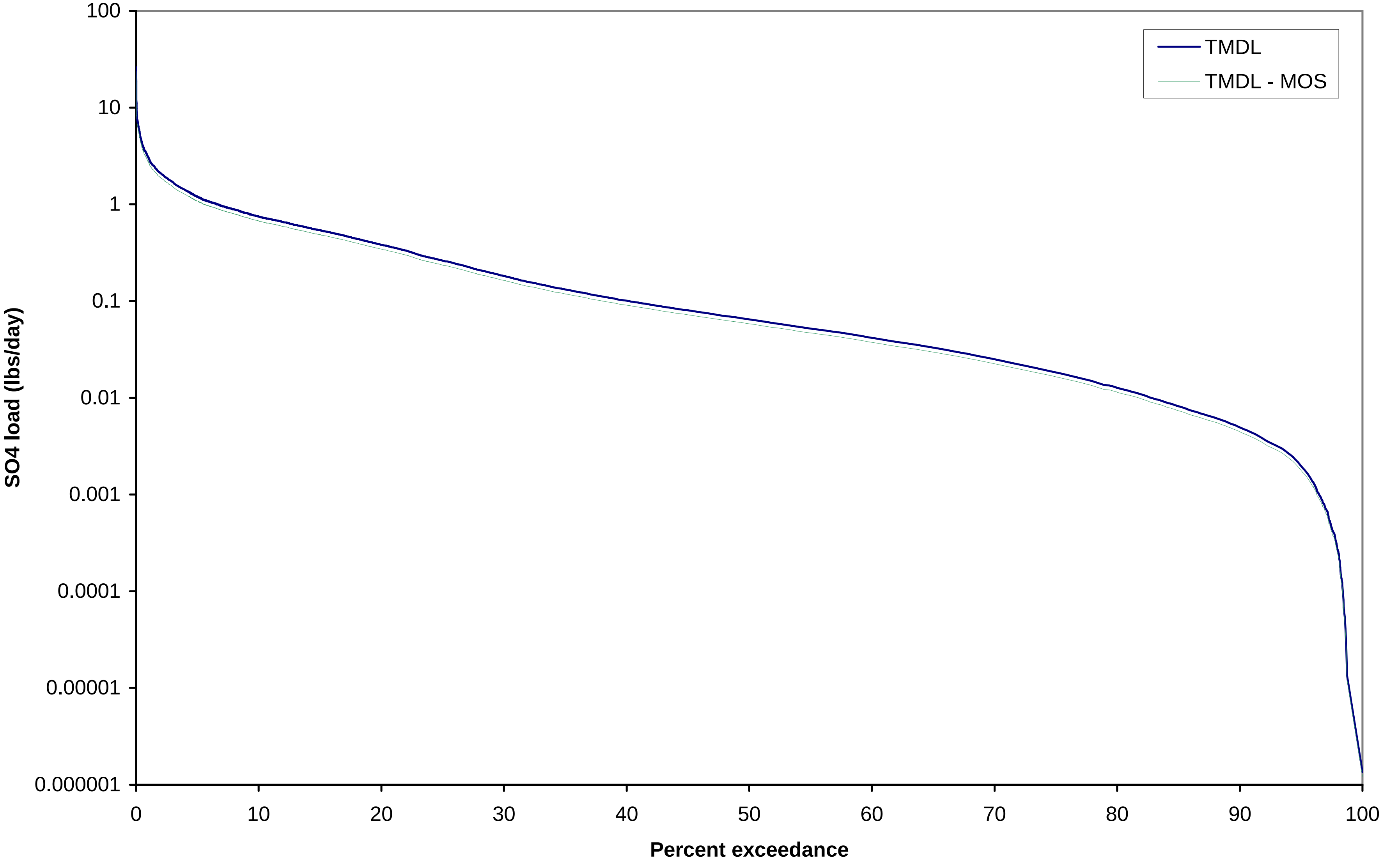


Figure C.10. Sulfate load duration curve for Walker Branch (08040206-916)



APPENDIX D

Zinc TMDLs

TABLE D.1. ALLOWABLE LOAD FOR ZINC FOR BIG CORNIE CREEK, LITTLE CORNIE CREEK, LITTLE CORNIE BAYOU, AND WALKER BRANCH.

38.7 ug/L = Zn Criterion for all reaches

				Big Cornie Creek (08040206-015) 189.1 mi^2 = drainage area of reach				Little Cornie Creek (08040206-016) 33.3 mi^2 = drainage area of reach				Little Cornie Bayou (08040206-716) 104.9 mi^2 = drainage area of reach				Little Cornie Bayou (08040206-816) 120.4 mi^2 = drainage area of reach				Walker Branch (08040206-916) 3.2 mi^2 = drainage area of reach			
Little Corney Bayou flow at USGS gage (cfs)	Flow per unit area (cfs/mi^2)	Percent exceed-ance	Width on plot between data points (unitless)	Estimated Big Cornie Creek flow (cfs)	Big Cornie Creek Assimilative capacity, or TMDL (lbs/day)	Big Cornie Creek TMDL - MOS (lbs/day)	Big Cornie Creek Area under TMDL curve (width times assimilative capacity) (lbs/day)	Estimated Little Cornie Creek flow (cfs)	Little Cornie Creek Assimilative capacity, or TMDL (lbs/day)	Little Cornie Creek TMDL - MOS (lbs/day)	Little Cornie Creek Area under TMDL curve (width times assimilative capacity) (lbs/day)	Estimated Little Cornie Bayou flow (cfs)	Little Cornie Bayou Assimilative capacity, or TMDL (lbs/day)	Little Cornie Bayou TMDL - MOS (lbs/day)	Little Cornie Bayou Area under TMDL curve (width times assimilative capacity) (lbs/day)	Estaimted Little Cornie Bayou flow (cfs)	Little Cornie Bayou Assimilative capacity, or TMDL (lbs/day)	Little Cornie Bayou TMDL - MOS (lbs/day)	Little Cornie Bayou Area under TMDL curve (width times assimilative capacity) (lbs/day)	Estimated Walker Branch flow (cfs)	Walker Branch Assimilative capacity, or TMDL (lbs/day)	Walker Branch TMDL - MOS (lbs/day)	Walker Branch Area under TMDL curve (width times assimilative capacity) (lbs/day)
0.00	3.83E-06	100.000	0.626	0.001	1.512E-04	1.361E-04	9.472E-07	0.000	2.663E-05	2.397E-05	1.668E-07	4.019E-04	8.390E-05	7.551E-05	5.254E-07	4.613E-04	9.629E-05	8.666E-05	6.031E-07	1.226E-05	2.559E-06	2.303E-06	1.603E-08
0.01	3.83E-05	98.747	0.660	0.007	1.512E-03	1.361E-03	9.978E-06	0.001	2.663E-04	2.397E-04	1.757E-06	4.019E-03	8.390E-04	7.551E-04	5.535E-06	4.613E-03	9.629E-04	8.666E-04	6.353E-06	1.226E-04	2.559E-05	2.303E-05	1.689E-07
0.02	7.66E-05	98.680	0.063	0.014	3.025E-03	2.722E-03	1.894E-06	0.003	5.326E-04	4.794E-04	3.336E-07	8.038E-03	1.678E-03	1.510E-03	1.051E-06	9.226E-03	1.926E-03	1.733E-03	1.206E-06	2.452E-04	5.119E-05	4.607E-05	3.206E-08
0.03	1.15E-04	98.622	0.067	0.022	4.537E-03	4.083E-03	3.040E-06	0.004	7.990E-04	7.191E-04	5.353E-07	1.206E-02	2.517E-03	2.265E-03	1.686E-06	1.384E-02	2.889E-03	2.600E-03	1.935E-06	3.678E-04	7.678E-05	6.910E-05	5.144E-08
0.04	1.53E-04	98.546	0.070	0.029	6.049E-03	5.444E-03	4.229E-06	0.005	1.065E-03	9.588E-04	7.447E-07	1.608E-02	3.356E-03	3.020E-03	2.346E-06	1.845E-02	3.852E-03	3.467E-03	2.693E-06	4.904E-04	1.024E-04	9.213E-05	7.157E-08
0.05	1.92E-04	98.482	0.051	0.036	7.562E-03	6.806E-03	3.855E-06	0.006	1.332E-03	1.198E-03	6.788E-07	2.010E-02	4.195E-03	3.775E-03	2.138E-06	2.307E-02	4.815E-03	4.333E-03	2.454E-06	6.130E-04	1.280E-04	1.152E-04	6.523E-08
0.06	2.30E-04	98.445	0.035	0.043	9.074E-03	8.167E-03	3.172E-06	0.008	1.598E-03	1.438E-03	5.586E-07	2.411E-02	5.034E-03	4.530E-03	1.760E-06	2.768E-02	5.778E-03	5.200E-03	2.020E-06	7.356E-04	1.536E-04	1.382E-04	5.368E-08
0.07	2.68E-04	98.412	0.032	0.051	1.059E-02	9.528E-03	3.392E-06	0.009	1.864E-03	1.678E-03	5.973E-07	2.813E-02	5.873E-03	5.285E-03	1.882E-06	3.229E-02	6.740E-03	6.066E-03	2.160E-06	8.582E-04	1.791E-04	1.612E-04	5.740E-08
The rows between 98.412% and 0.044% exceedances are not shown for the sake of brevity.																							
6,820	26.13	0.044	0.006	4941.234	1.031E+03	9.283E+02	6.009E-02	870.138	1.816E+02	1.635E+02	1.058E-02	2.741E+03	5.722E+02	5.150E+02	3.333E-02	3.146E+03	6.567E+02	5.910E+02	3.826E-02	8.362E+01	1.745E+01	1.571E+01	1.017E-03
7,180	27.51	0.038	0.006	5202.061	1.086E+03	9.773E+02	6.326E-02	916.069	1.912E+02	1.721E+02	1.114E-02	2.886E+03	6.024E+02	5.421E+02	3.509E-02	3.312E+03	6.914E+02	6.222E+02	4.028E-02	8.803E+01	1.838E+01	1.654E+01	1.071E-03
8,210	31.46	0.032	0.006	5948.318	1.242E+03	1.117E+03	7.234E-02	1047.483	2.187E+02	1.968E+02	1.274E-02	3.300E+03	6.888E+02	6.199E+02	4.013E-02	3.787E+03	7.906E+02	7.115E+02	4.606E-02	1.007E+02	2.101E+01	1.891E+01	1.224E-03
8,840	33.87	0.026	0.006	6404.766	1.337E+03	1.203E+03	7.789E-02	1127.862	2.354E+02	2.119E+02	1.372E-02	3.553E+03	7.416E+02	6.675E+02	4.321E-02	4.078E+03	8.512E+02	7.661E+02	4.959E-02	1.084E+02	2.262E+01	2.036E+01	1.318E-03
11,400	43.68	0.020	0.006	8259.540	1.724E+03	1.552E+03	1.004E-01	1454.483	3.036E+02	2.732E+02	1.769E-02	4.582E+03	9.564E+02	8.608E+02	5.572E-02	5.259E+03	1.098E+03	9.880E+02	6.395E-02	1.398E+02	2.918E+01	2.626E+01	1.700E-03
13,800	52.87	0.015	0.006	9998.391	2.087E+03	1.878E+03	1.216E-01	1760.690	3.675E+02	3.308E+02	2.141E-02	5.546E+03	1.158E+03	1.042E+03	6.745E-02	6.366E+03	1.329E+03	1.196E+03	7.742E-02	1.692E+02	3.532E+01	3.179E+01	2.058E-03
19,100	73.18	0.009	0.006	13838.352	2.889E+03	2.600E+03	1.683E-01	2436.897	5.087E+02	4.578E+02	2.963E-02	7.677E+03	1.602E+03	1.442E+03	9.335E-02	8.811E+03	1.839E+03	1.655E+03	1.071E-01	2.342E+02	4.888E+01	4.399E+01	2.848E-03
19,300	73.95	0.003	0.006	13983.257	2.919E+03	2.627E+03	1.700E-01	2462.414	5.140E+02	4.626E+02	2.994E-02	7.757E+03	1.619E+03	1.457E+03	9.433E-02	8.903E+03	1.858E+03	1.673E+03	1.083E-01	2.366E+02	4.939E+01	4.445E+01	2.878E-03
				Total area under TMDL curve for zinc (lbs/day) =			31.80	Total area under TMDL curve for zinc (lbs/day) =			5.60	Total area under TMDL curve for zinc (lbs/day) =			17.64	Total area under TMDL curve for zinc (lbs/day) =			20.25	Total area under TMDL curve for zinc (lbs/day) =			0.54
Explicit MOS (tons/day) = TMDL × 0% =							3.18				0.56				1.76				2.02				0.05
WLA for poiont suorces (tons/day) (from Table C.2) =							0.00				0.00				0.94				0.00				0.29
LA for nonpoint sources (tons/day) = TMDL - WLA =							28.62				5.04				14.94				18.23				0.20

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Table D.2 Zinc WLA Calculations

Permit	Facility Name	Receiving Reach[A]	Outfall	Flowrate (MGD)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Individual Dissolved Loads (lbs/day)
AR0000680	Great Lakes Chemical Corporation - South Plant	916	002	0.77	140[C]	45.4[E]	0.29
			003	0.0135	no source	no source	--
AR0001171	Great Lakes Chemical Corporation - Central Plant	716	003	2.92[B]	119[E]	38.7[D]	0.94
AR0047813	Oak Manor Water & Wastewater Public Facility Board	716	001	0.15	no source	no source	--
AR0022179	City of Junction City	816	001	0.26	no source	no source	--

Notes: A. This is the first impaired reach that the discharge drains into.
B. This is the flow for this outfall from page 14 of the fact sheet for the final 2004 permit.
C. Concentration measured in Priority Pollutant Scan.
D. Water quality criterion for receiving stream.
E. Converted between total and dissolved concentrations using information in CCP.

Reach	Cumulative dissolved Zn Loads (lbs/day)
Reach 916	0.29
Reach 716	0.94

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TABLE D.3. PERCENT REDUCTION FOR BIG CORNIE CREEK 08040206-015

Zn Criterion for Big Cornie Creek = 38.7 ug/L
Explicit MOS (% of TMDL) = 10%

Error check for reduction is / is not needed: ok
Error check for less or more reduction needed: ok

Percent reduction = 51%

Date	Observed Zn at OUA0002 (ug/L)	Flow on Sampling Day: Little Corney Bayou flow at USGS gage (cfs)	Flow on Sampling Day: Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual Zn load (lbs/day)	Reduced Zn load (lbs/day)	Allowable Zn load before MOS (lbs/day)	Allowable Zn load with MOS incorporated (lbs/day)	Reduced load less than or equal to allow. load?
1/9/1995	19.3	297.00	215.172	19.25	22.3993	10.9757	44.9147	40.4233	Yes
2/13/1995	20.7	79.00	57.234	38.79	6.3903	3.1312	11.9470	10.7523	Yes
3/27/1995	23.6	110.00	79.693	32.90	10.1444	4.9708	16.6351	14.9716	Yes
4/24/1995	22.9	1090.00	789.687	3.68	97.5402	47.7947	164.8386	148.3547	Yes
5/22/1995	18.4	76.00	55.061	39.46	5.4645	2.6776	11.4933	10.3440	Yes
6/19/1995	18.8	19.00	13.765	69.49	1.3958	0.6840	2.8733	2.5860	Yes
7/18/1995	46.8	4.80	3.478	87.44	0.8778	0.4301	0.7259	0.6533	Yes
8/7/1995	66.4	9.40	6.810	79.95	2.4390	1.1951	1.4215	1.2794	Yes
9/18/1995	20.9	1.20	0.869	95.55	0.0980	0.0480	0.1815	0.1633	Yes
10/16/1995	10.0	14.00	10.143	74.44	0.5471	0.2681	2.1172	1.9055	Yes
11/14/1995	9.9	8.50	6.158	81.27	0.3288	0.1611	1.2854	1.1569	Yes
12/18/1995	48.4	215.00	155.764	23.42	40.6635	19.9251	32.5140	29.2626	Yes
1/30/1996	16.2	61.00	44.193	44.21	3.8616	1.8922	9.2249	8.3024	Yes
2/20/1996	13.5	79.00	57.234	38.79	4.1676	2.0421	11.9470	10.7523	Yes
3/12/1996	54.6	45.00	32.602	51.30	9.6012	4.7046	6.8053	6.1247	Yes
4/23/1996	17.9	201.00	145.621	24.43	14.0595	6.8892	30.3968	27.3572	Yes
5/21/1996	26.4	5.30	3.840	86.34	0.5468	0.2679	0.8015	0.7214	Yes
6/17/1996	129.0	72.00	52.163	40.64	36.2947	17.7844	10.8884	9.7996	No
7/16/1996	54.4	47.00	34.051	50.33	9.9912	4.8957	7.1077	6.3969	Yes
9/10/1996	40.6	16.00	11.592	72.29	2.5384	1.2438	2.4196	2.1777	Yes
11/19/1996	33.4	75.00	54.336	39.78	9.7888	4.7965	11.3421	10.2079	Yes
1/28/1997	26.5	830.00	601.321	5.43	85.9499	42.1155	125.5193	112.9674	Yes
3/11/1997	29.0	407.00	294.865	14.58	46.1226	22.6001	61.5498	55.3948	Yes
7/21/1998	40.1	0.00	0.001	100.00	0.0002	0.0001	0.0002	0.0001	Yes
9/1/1998	20.3	17.00	12.316	71.30	1.3485	0.6608	2.5709	2.3138	Yes
11/16/1998	37.8	151.00	109.397	28.30	22.3044	10.9291	22.8354	20.5519	Yes
1/26/1999	29.5	661.00	478.884	7.85	76.1982	37.3371	99.9618	89.9656	Yes
3/23/1999	25.0	134.00	97.081	29.99	13.0908	6.4145	20.2646	18.2381	Yes
5/25/1999	15.5	30.00	21.735	60.48	1.8171	0.8904	4.5368	4.0832	Yes
7/27/1999	52.0	16.00	11.592	72.29	3.2512	1.5931	2.4196	2.1777	Yes
9/21/1999	68.0	0.46	0.333	97.19	0.1222	0.0599	0.0696	0.0626	Yes
1/25/2000	42.4	21.00	15.214	67.77	3.4794	1.7049	3.1758	2.8582	Yes

Date	Observed Zn at OUA0002 (ug/L)	Little Corney Bayou flow at USGS gage (cfs)	Flow at downstream end of 08040206-015 (cfs)	Percent exceedance for flow on sampling day	Actual Zn load (lbs/day)	Reduced Zn load (lbs/day)	Allowable Zn load before MOS (lbs/day)	Allowable Zn load with MOS incorporated (lbs/day)	Reduced load less than or equal to allow. load?
3/27/2000	20.7	88.00	63.755	36.79	7.1183	3.4880	13.3081	11.9773	Yes
5/30/2000	37.9	197.00	142.723	24.73	29.1761	14.2963	29.7919	26.8127	Yes
12/19/2000	25.3	761.00	551.332	6.35	75.2362	36.8657	115.0846	103.5761	Yes
1/30/2001	24.2	586.00	424.547	9.24	55.4159	27.1538	88.6197	79.7577	Yes
3/26/2001	26.8	340.00	246.324	17.38	35.6070	17.4474	51.4175	46.2758	Yes
5/22/2001	38.0	86.00	62.306	37.11	12.7704	6.2575	13.0056	11.7051	Yes
7/24/2001	8.1	3.50	2.536	90.32	0.1108	0.0543	0.5293	0.4764	Yes
9/18/2001	13.2	2.00	1.449	93.88	0.1032	0.0506	0.3025	0.2722	Yes
11/19/2001	8.9	26.00	18.837	63.62	0.9042	0.4431	3.9319	3.5387	Yes
5/28/2002	59.3	19.00	13.765	69.49	4.4028	2.1574	2.8733	2.5860	Yes
7/23/2002	304.0	22.00	15.939	66.94	26.1347	12.8060	3.3270	2.9943	No
11/5/2002	69.8	84.00	60.857	37.59	22.9116	11.2267	12.7032	11.4328	Yes
1/21/2003	43.6	47.00	34.051	50.33	8.0077	3.9238	7.1077	6.3969	Yes
3/25/2003	31.4	270.00	195.611	20.64	33.1295	16.2335	40.8316	36.7484	Yes
5/20/2003	68.4	227.00	164.458	22.82	60.6741	29.7303	34.3288	30.8959	Yes
7/15/2003	1560.0	33.00	23.908	58.55	201.1685	98.5726	4.9905	4.4915	No
9/23/2003	354.0	4.90	3.550	87.22	6.7783	3.3214	0.7410	0.6669	No
1/20/2004	115.0	41.00	29.704	53.46	18.4248	9.0282	6.2004	5.5803	No
3/16/2004	13.4	178.00	128.958	26.17	9.3207	4.5671	26.9186	24.2267	Yes
5/11/2004	17.0	37.00	26.806	55.94	2.4579	1.2044	5.5954	5.0359	Yes
7/20/2004	20.5	18.00	13.041	70.37	1.4419	0.7066	2.7221	2.4499	Yes
11/30/2004	60.5	805.00	583.209	5.73	190.3149	93.2543	121.7386	109.5647	Yes
3/28/2005	80.4	183.00	132.580	25.84	57.4948	28.1725	27.6747	24.9073	No
5/23/2005	69.9	21.00	15.214	67.77	5.7361	2.8107	3.1758	2.8582	Yes
9/27/2005	58.9	12.00	8.694	76.74	2.7620	1.3534	1.8147	1.6333	Yes
11/29/2005	76.5	38.00	27.530	55.22	11.3597	5.5662	5.7467	5.1720	No
1/17/2006	30.8	136.00	98.530	29.76	16.3686	8.0206	20.5670	18.5103	Yes
9/26/2006	6.4	0.00	0.001	100.00	0.0000	0.0000	0.0002	0.0001	Yes
1/2/2007	15.8	655.00	474.537	7.99	40.4408	19.8160	99.0544	89.1490	Yes
3/13/2007	14.0	7.60	5.506	82.46	0.4158	0.2037	1.1493	1.0344	Yes

Total number of values of loads =	62
Allowable % of exceedances of loads =	10%
Allowable no. of exceedances of loads =	7
No. of exceedances before reductions of loads =	27
No. of exceedances after reductions of loads =	7

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Table D.3
Percent Reductions

Figure D.1. Zinc Load duration curve for Big Cornie Creek (08040206-015)

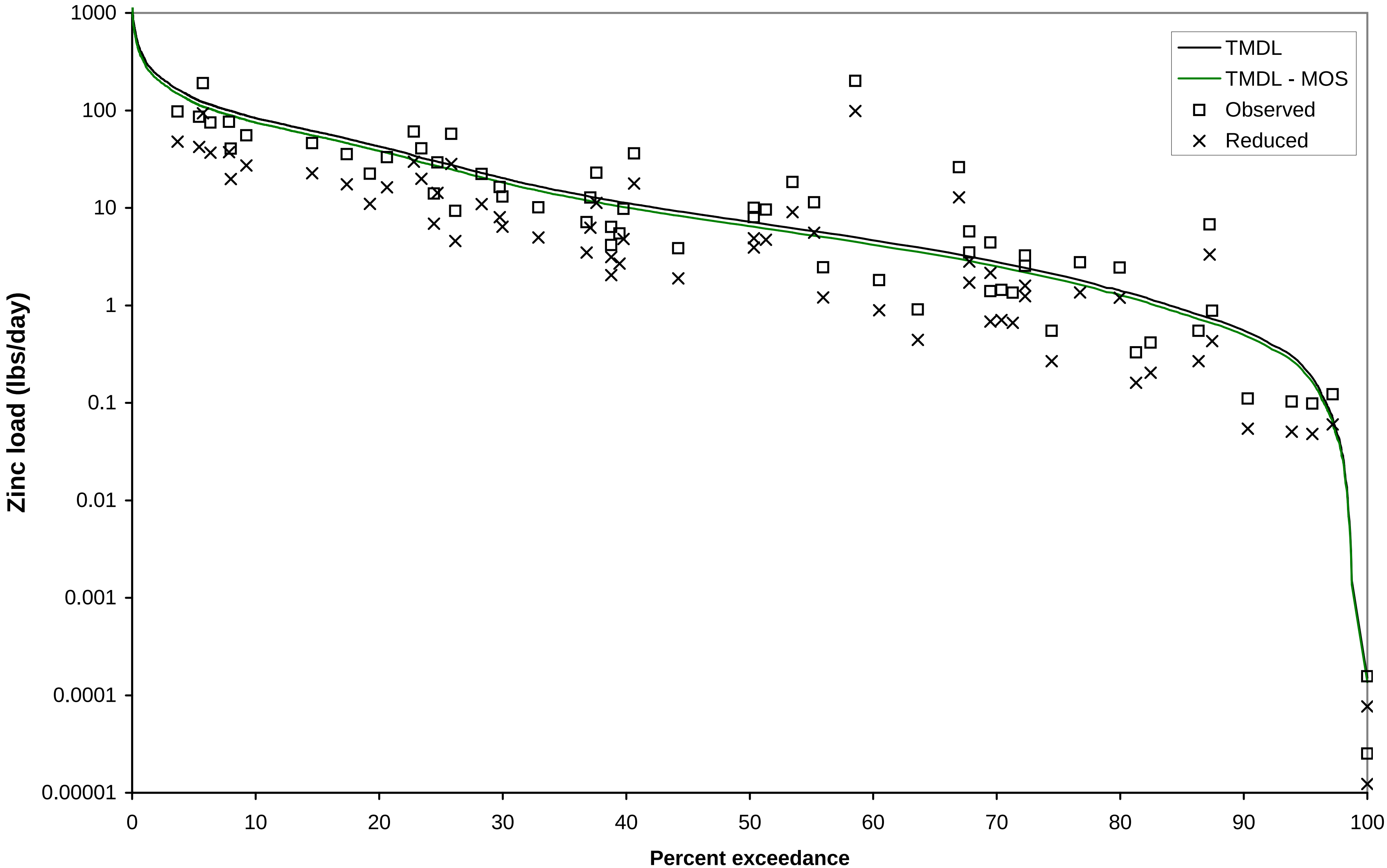


Figure D.2. Zinc Load duration curve for Little Cornie Creek (08040206-016)

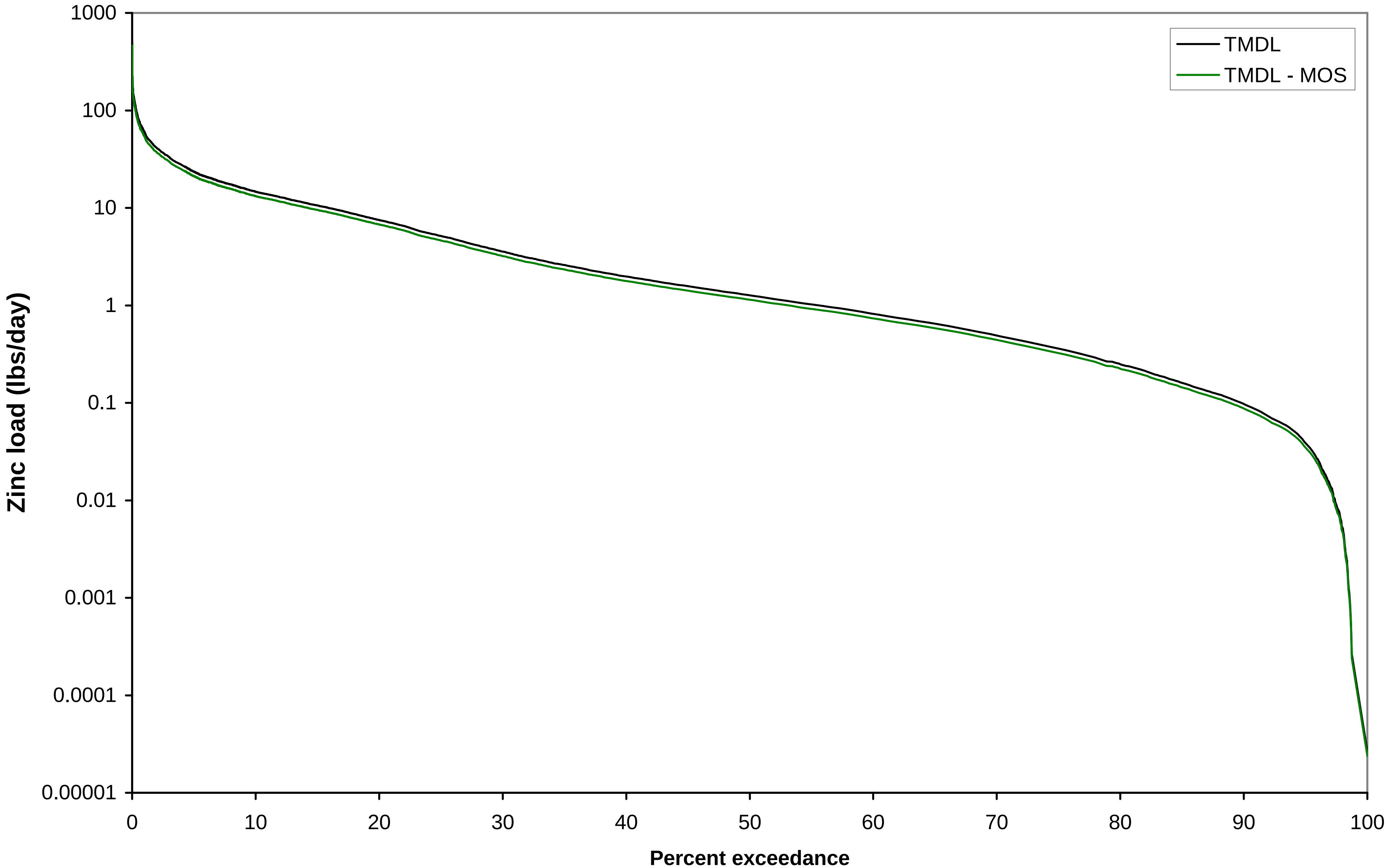


Figure D.3. Zinc Load duration curve for Little Cornie Batyou (08040206-716)

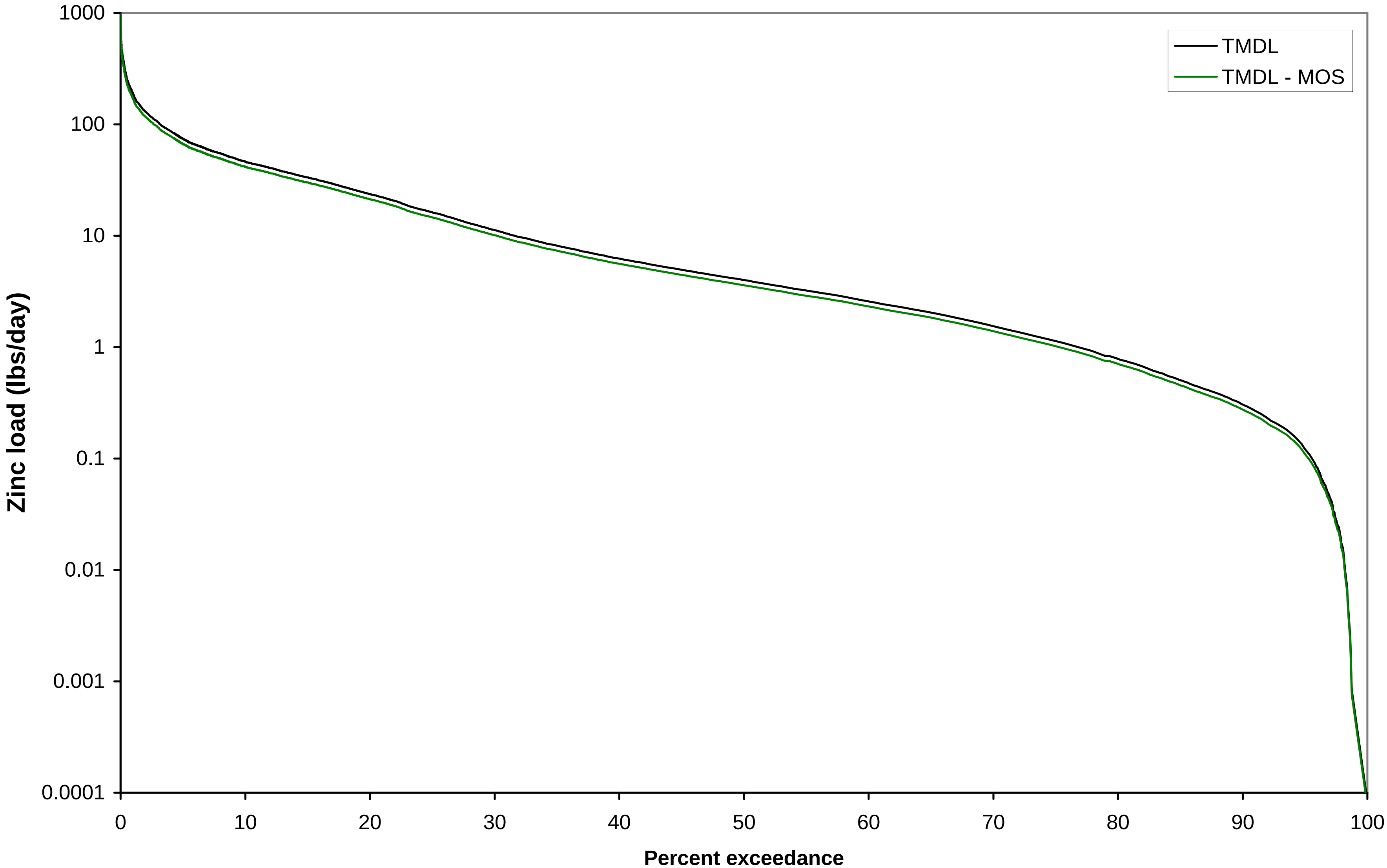


Figure D.4. Zinc Load duration curve for Little Cornie Batyou (08040206-816)

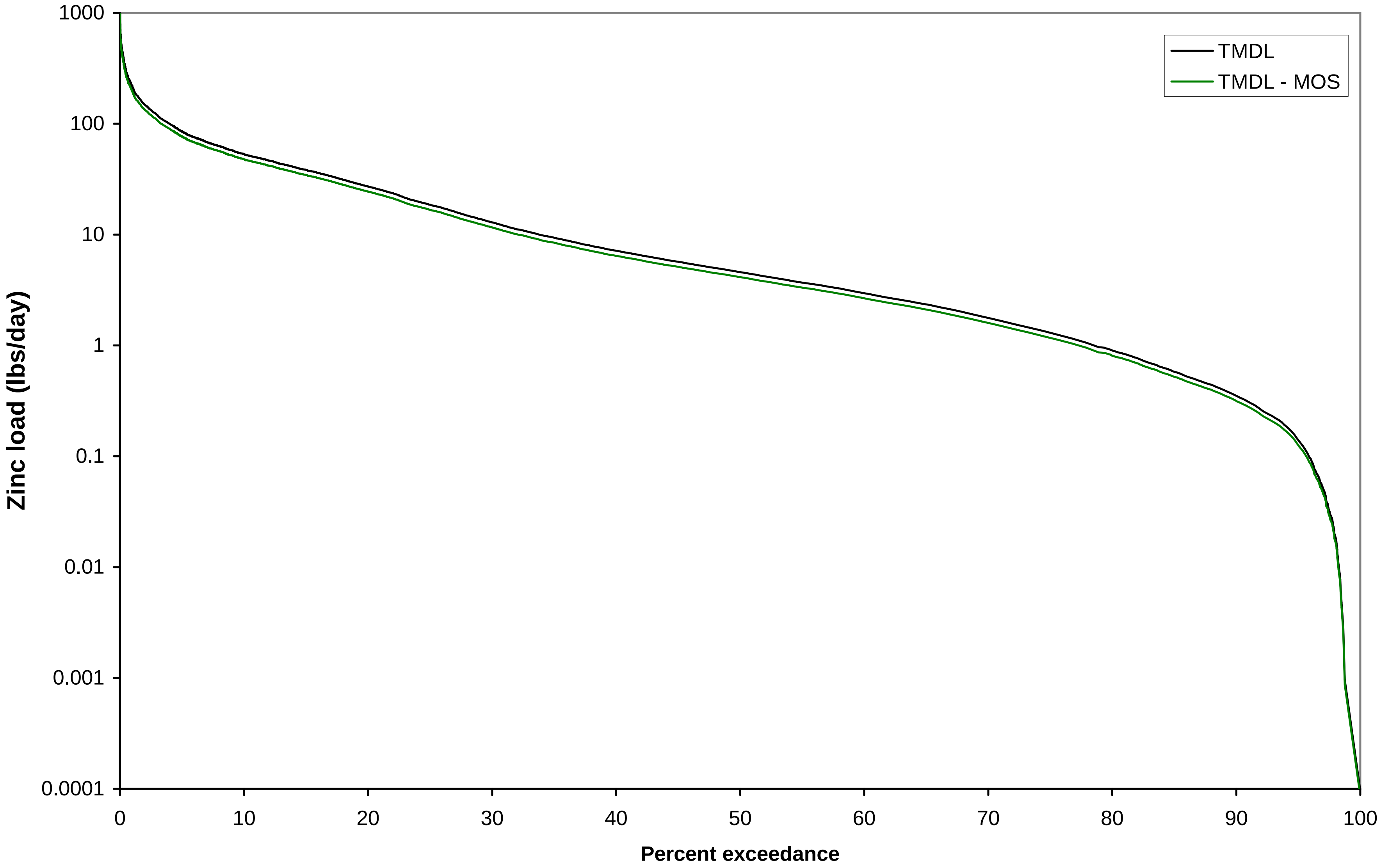
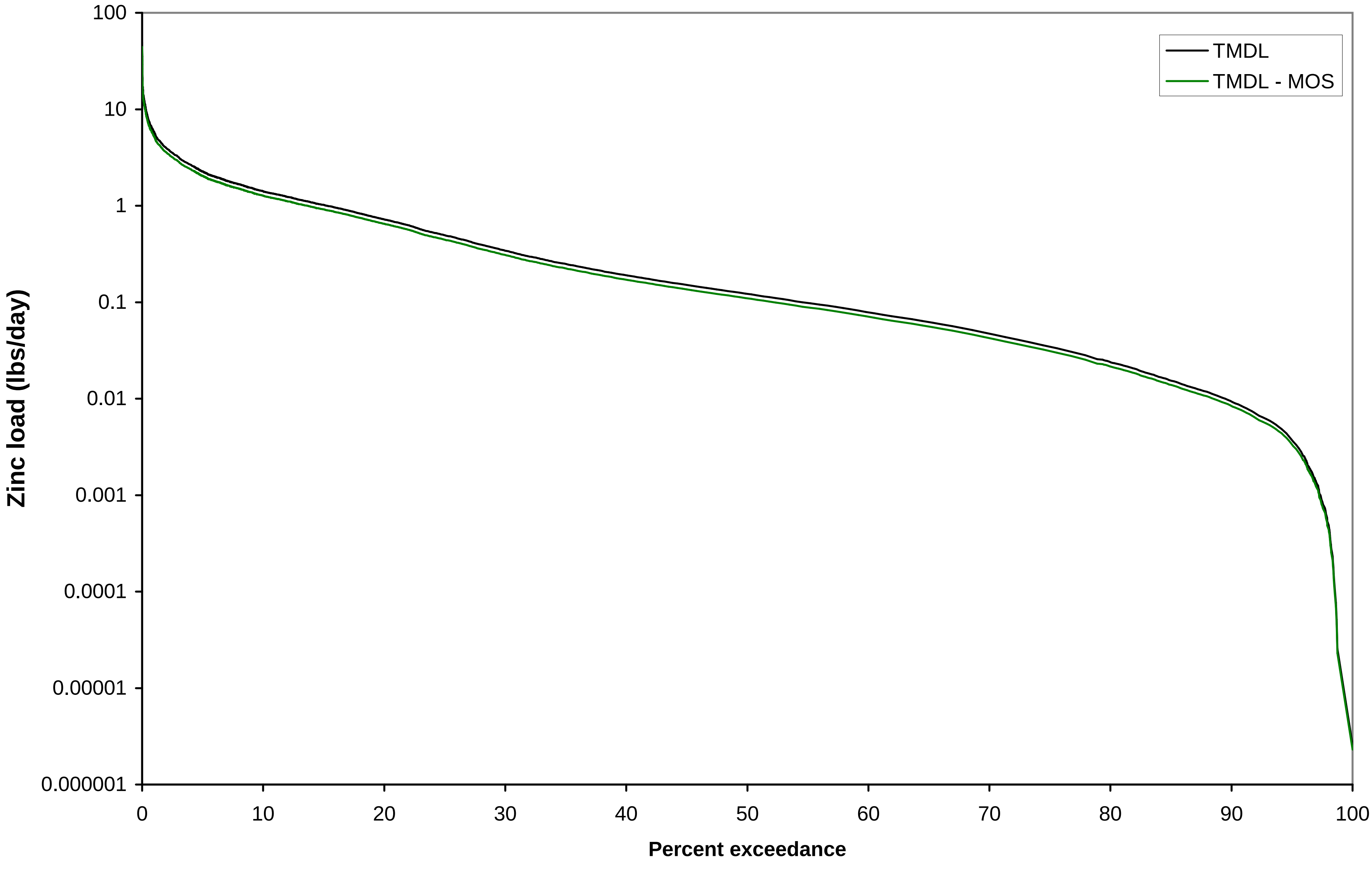


Figure D.5. Zinc Load duration curve for Little Cornie Batyou (08040206-916)



APPENDIX E

Municipal Effluent Data for Dissolved Minerals

EFFLUENT CONCENTRATIONS OF DISSOLVED MINERALS IN ARKANSAS

From ADEQ field surveys (referenced by report number), EPA STORET database, ambient water quality data on ADEQ web site, and NPDES applications

	Sampling	Station	Individual conc's (mg/L)			Average conc's (mg/L)			Median conc's (mg/L)			ADEQ report number or
Municipal discharger	Date	ID	Chloride	Sulfate	TDS	Chloride	Sulfate	TDS	Chloride	Sulfate	TDS	other source
City of Siloam Springs	7/27/1993	SAG08E	104.0	28.7	422							WQ95-12-2
	9/13/1993	SAG08E	90.1	34.8	402							WQ95-12-2
	10/18/1993	SAG08E	67.7	35.7	337							WQ95-12-2
	11/16/1993	SAG08E	47.4	22.4	270							WQ95-12-2
	1/24/1934	SAG08E	90.6	26.5	392							WQ95-12-2
	4/11/1994	SAG08E	10.8	18.8	265							WQ95-12-2
	6/28/1994	SAG08E	121.0	21.2	468							WQ95-12-2
Average =						75.9	26.9	365				
Median =									90.1	26.5	392	
City of Bentonville	8/14/1996	TBC02E	74.2	73.9	454	74.2	73.9	454	74.2	73.9	454	WQ97-05-2
Village Wastewater North	8/14/1996	LSC06E	36.2	41.4	245	36.2	41.4	245	36.2	41.4	245	WQ97-05-2
City of Fordyce	7/30/1996	JUG03E	49.8	26.8	368	49.8	26.8	368	49.8	26.8	368	WQ97-06-2
City of Nashville	9/03/1997	RED0051	51.3	134.0	409							WQ00-05-1
	9/22/1998	RED0051	39.6	114.0	332							ADEQ web site
	8/01/2000	RED0051	38.1	--	--							STORET
	1/08/2001	RED0051	12.2	--	--							STORET
	3/12/2001	RED0051	2.8	--	--							STORET
	6/18/2001	RED0051	19.2	--	--							STORET
	9/04/2001	RED0051	20.9	--	--							STORET
Average =						26.3	124.0	371				
Median =									20.9	124.0	371	
City of Waldron	8/31/1994	POTEW	43.0	35.0	312							WQ94-11-1
	9/07/1994	POTEW	37.0	34.0	262							WQ94-11-1
Average =						40.0	34.5	287				
Median =									40.0	34.5	287	
City of Mena	7/29/1992	Station 1	39.2	50.3	195	39.2	50.3	195	39.2	50.3	195	WQ94-01-1
City of Berryville	8/28/1991	Station 5	167.0	--	217	167.0	--	217	167.0	--	217	WQ92-06-1
City of Huntsville	7/21/1992	Station E	140.0	27.7	589							WQ93-03-1
	7/22/1992	Station E	136.0	28.7	648							WQ93-03-1
	9/15/1992	Station E	126.0	33.6	545							WQ93-03-1
Average =						134.0	30.0	594				
Median =									136.0	28.7	589	
City of Mountain Home	9/01/1993	HIC02E	78.3	24.8	405	78.3	24.8	405	78.3	24.8	405	WQ95-02-1
City of Conway	7/09/1996	SDC01E	59.8	211.0	503	59.8	211.0	503	59.8	211.0	503	WQ97-05-1
City of Russellville	7/01/1996	WIG01E	52.7	41.3	324	52.7	41.3	324	52.7	41.3	324	WQ97-06-1

Municipal discharger	Sampling Date	Station ID	Individual conc's (mg/L) Chloride	Individual Sulfate	Individual TDS	Average conc's (mg/L) Chloride	Average Sulfate	Average TDS	Median conc's (mg/L) Chloride	Median Sulfate	Median TDS	ADEQ report number or other source
City of Prairie Grove	4/11/1995	MFI01E	23.2	--	--							STORET
	5/09/1995	MFI01E	14.2	--	--							STORET
	5/22/1995	MFI01E	47.4	38.9	--							STORET
	6/27/1995	MFI01E	43.5	36.2	--							STORET
	7/10/1995	MFI01E	51.9	38.8	--							STORET
	8/01/1995	MFI01E	47.9	39.9	--							STORET
	9/18/1995	MFI01E	47.1	--	--							STORET
	9/25/1995	MFI01E	51.1	35.6	--							STORET
	10/24/1995	MFI01E	52.2	39.7	--							STORET
	11/13/1995	MFI01E	47.2	38.0	--							STORET
	11/14/1995	MFI01E	45.5	43.3	--							STORET
	1/09/1996	MFI01E	49.4	49.8	--							STORET
	1/15/1996	MFI01E	54.9	51.0	--							STORET
	1/23/1996	MFI01E	43.1	43.9	--							STORET
	2/27/1996	MFI01E	48.9	52.8	--							STORET
	3/19/1996	MFI01E	43.7	51.7	--							STORET
	4/15/1996	MFI01E	41.6	52.0	--							STORET
	5/14/1996	MFI01E	36.4	44.1	--							STORET
	6/01/1996	MFI01E	41.7	43.3	--							STORET
Average =						43.7	43.7	--				
Median =									47.1	43.3	--	
City of Arkadelphia	2006?	--	--	--	278	--	--	278	--	--	278	NPDES applic.
City of McGehee	2005?	--	--	--	219	--	--	219	--	--	219	NPDES applic.
City of Mitchellville	2006?	--	--	--	180	--	--	180	--	--	180	NPDES applic.
City of Calion	2006?	--	--	--	513	--	--	513	--	--	513	NPDES applic.
City of Norphlet	2004?	--	--	--	191	--	--	191	--	--	191	NPDES applic.
Overall averages =						67.5	60.7	336				
Overall medians =									52.7	41.4	324	

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EPA Responses to Comments for TMDLs in Cornie Bayou (Basin in Arkansas)

Prepared for:

United States Environmental Protection Agency, Region 6
Water Quality Protection Division
Permits, Oversight, and TMDL Team
Dallas, TX

Prepared by:

Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, VA 22030

September 16, 2008

CONTENTS

PLEASE NOTE: Throughout this document there are references to other comments and responses. For brevity and the reader's convenience, hyperlinks to these other comments and responses are provided. The hyperlinks are *underlined and italicized*. By pressing "Control" and clicking a hyperlink, the reader can go directly to the cross-referenced comments. Comment numbers and request numbers start over in each letter. References to comment numbers are within the current letter unless otherwise noted. Please note that in 2010 the TMDL was revisited in order to assure that Louisiana, the downstream State, Standards (wqs) were considered within the TMDL in accordance with 40 CFR 131.10(b) Regs.

CORNIE BAYOU WATERSHED COMMENTS AND RESPONSES

GBM^c & Associates Comments

219 Brown Lane Bryant, AR 72022 (501) 847-7077 (501) 847-7943 fax

January 16, 2008

Ms. Diane Smith,
Environmental Protection Specialist
Water Quality Protection Division,
U.S. Environmental Protection Agency Region 6
1445 Ross Ave
Dallas, TX 75202-2733

Re: Comments – TMDLs for Sulfate and Zinc in the Upper Cornie Bayou Watershed, Arkansas. Document Dated October 16, 2007.

Dear Ms. Smith:

In accordance with the Federal Register Notice of December 17, 2007 (Volume 72, Number 241) we offer the following comments on the TMDLs for the Stream Reaches listed n the referenced document.

Our comments are as follows:

GBM^c Comment 1.

The TMDL procedure is based on documentation developed by the Kansas Department of Health and Environment but is not presented in detail in the report. There is no justification provided in the report as supporting the procedure as appropriate for the development of TMDLs in Arkansas. It is an overly simplistic approach which does not take into account the fact that in accordance with Regulation 2. 501 of the Arkansas Pollution Control and Ecology Commission there are flow conditions during which water quality criteria are not applicable. For example, dissolved minerals standards such as sulfate are not applicable when stream flows are less than 4cfs.

EPA Response to GBMc 1:

The load-duration method has been used to prepare TMDLs for several years in Arkansas and in many other states around the country. Load-duration is a widely accepted empirical model that does not require a case-by-case justification for use. The reference to the Kansas documentation is to provide information beyond the overview provided in this document. Additional documentation for using the load-duration approach throughout the United States is available on the EPA Web site at *http://www.epa.gov/OWOW/TMDL/duration_curve_guide_aug2007.pdf*. The simplicity of the load-duration method is not a disqualification for use.

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

Actually, the load-duration method is well suited for conservative constituents, and it is comprehensive because it incorporates the entire range of flows, not just critical flow. The load-duration method is a powerful tool for assessment, TMDL development, and TMDL implementation. Information can be extracted from the figures and tables after the TMDL is established.

EPA believes that the final sentence of this comment is not consistent with the intent of Regulation No. 2. The critical flow value of 4 cfs for dissolved minerals in small streams is intended for permitting calculations for small streams where data are insufficient to estimate a harmonic mean flow. Many small unnamed tributary streams have a flow of less than 4 cfs during a large percentage of the time. Allowing numeric criteria for dissolved minerals to be exceeded a large percentage of the time would not be consistent with the intent of Regulation No. 2 to protect aquatic life.

As stated in the TMDL report, the allowable loads were calculated as the area under the load duration curve.[1] Most of the allowable loading occurs at high flows, not at flows less than 4 cfs. None of the allowable point source loads were reduced on the basis of the assimilative capacity that occurs when stream flows are less than 4 cfs. These TMDLs are not contrary to the Regulation 2.501 language that states that there is a criteria exception for low flow.

GBM[c] Comment 2.

The procedure utilized in the development of the TMDLs does not consider or incorporate the critical flow for point source dischargers as defined in Regulation No. 2. 106 of the Arkansas Pollution Control and Ecology Commission.

In addition, the flows referenced in the TMDL from Great Lakes Chemical Company discharge into Walker Branch (GLCC-002) is not representative of discharge history. The discharge is retained storm waters and is discharged on a sporadic basis (not a continuous discharge) depending on storm events and is operated to comply with NPDES permit requirements for Chronic WET testing. The flow utilized in the TMDL represents a maximum discharge event. Therefore the loadings are artificially inflated (See comments submitted in response to recent draft NPDES permit).

EPA Response to GBMc 2:

This TMDL is established as the assimilative capacity of the stream at the numeric criterion specified in the Arkansas Water Quality Standards, and it will be protective of standards and designated uses during critical conditions. Dischargers are irrelevant at this stage of TMDL development.

High effluent flow rates were used to be conservative by creating effluent loadings that would rarely be exceeded. These flow rates were generally taken from fact sheets in existing permits. The current permit for Great Lakes South allows it to discharge any time, not just during storms.

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

GBM[c] Comment 3.

The regulatory framework for the sulfate TMDLs is flawed. A site specific sulfate criterion for one of the stream reaches involved in the TMDL was approved by the Arkansas Pollution Control and Ecology Commission on June 22, 2007. This new criterion should have been considered in the development of the sulfate TMDLS and had they been incorporated, the sulfate TMDL would not have been required since the evaluation criteria requiring 10% exceedance would not have been attained.

EPA Response to GBMc 3:

The site-specific criterion for sulfate (25 mg/L for Little Cornie Bayou) was used in these TMDLs and was shown in Table 2.3 in the report. EPA did not reevaluate the assessment results for sulfate for this stream because that is not the purpose of a TMDL. Best Professional Judgment was used on numeric criteria in the June 22, 2007 Regulation 2 would be approved by EPA. The previous versions of Regulation 2 had been approved after additional submittals and clarifications on wordings. The use of old values would have required recalculations by ADEQ on every TMDL. At the time of the permit preparation after the issuance of this TMDL, ADEQ would need to verify that the current approved criterion was still what was specified in the TMDL. This is the procedure on every permit regardless if it has a TMDL on the segment.

GBM[c] Comment 4.

The regulatory requirement of the completion of the zinc TMDLs is flawed. The 2004 303(d) list theses segments under category 5c which states the data utilized for listing is questionable and should be verified or new data used in the development of any TMDL. The TMDL did not provide any verification of historical data or present new analytical data to support the listing. Therefore the basis of the TMDL is not in accordance with the 2004 303(d) listing. Nor was the public allowed the opportunity to comment on any change to the 5c status.

EPA Response to GBMc 4:

EPA public noticed a draft TMDL containing zinc for the Cornie Bayou Basin, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to the comments in reference to Sulfates at that time. [1]

GBM[c] Comment 5.

There is no in-stream data for segments of Little Cornie Bayou in the TMDL (Reach 08040206-016, 716, 816, 916). In the absence of actual data, there are only assumptions related to contributions to the zinc concentration to the loading in Cornie Creek.

EPA Response to GBMc 5:

EPA public noticed a draft TMDL containing zinc for the Cornie Bayou Basin, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to the comments in reference to Sulfates at that time. [1]

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

GBMc Comment 6.

The data used in the preparation of the TMDLs is inadequate. As stated on page 3-1 no routine monitoring data are known to exist within the last 20 years for four of the stream reaches addressed in the TMDL. As such, there is no data concerning ambient water quality concentrations during times when stream flows area at or above the applicable critical flows.

In addition, the ADEQ data on which the TMDL was based is from a monitoring station, OUA002, on Big Cornie Creek (Reach 08040206-015). The OUA002 station is located above the confluence with Little Cornie Bayou (Reaches 08040206-016, 716, 816 and 916) and there is no stream data from LCB utilized in the development of the TMDL for Little Cornie Bayou. ADEQ data does not document Big Cornie Creek downstream of the confluence with Little Cornie Bayou. There is no data on which of the Little Cornie Bayou Reaches the TMDL is based.

EPA Response to GBMc 6:

See response to *Comment 4* & *Comment 5*. No revision is necessary.

GBMc Comment 7.

The TMDLs do not contain clearly defined control strategies or recommended regulatory actions to achieve the required loading reductions to come into compliance with the water quality standards. It is too nebulous for the public to understand what actins are being required to achieve the loading reductions. Any actions incumbent upon landowners or NPDES dischargers should be clearly explained. The normal TMDL process links required loading reductions (to meet in-stream criteria) to the WLA's and LA's of known excessive loadings in the watershed. It appears that insufficient data exists at this time to effectively complete a TMDL in the Cornie Bayou watershed if the only identified sources for loading reductions currently discharge concentrations below the in-stream criterion.

EPA Response to GBMc 7:

The TMDL regulations at 40 CFR 130.7 do not specifically mention control strategies as required elements for TMDL reports. Subsequent EPA Guidance has prescribed that implementation is not a required part of EPA approval action on a TMDL. Although, EPA does not discourage implementation plans in TMDL documents, implementation plans can be produced later as part of a follow-up process. The WQMP update provides one such vehicle where point source WLA's should be implemented, along with NPDES permits and within the NPS programs. These TMDLs are focused on only the required elements. The implementation actions and load reductions are part of the TMDL implementation process undertaken with the stakeholders.

GBMc Comment 8.

The TMDL documentation (Page 2-4) contains language from Regulation No. 2 regarding Arkansas' Antidegradation Policy, but does not provide any context to its applicability to the TMDL process or any explanation of why it is provided.

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

EPA Response to GBMc 8:

The antidegradation policy is included as a required element to specify all parts of the water quality standards. The comment is correct: The policy will not apply to every stream segment in the state. It was not a controlling factor for these TMDLs.

GBM[c] Comment 9.

The assumption presented in Section 3.5 of the TMDL of "…an unpermitted point source in the watershed of Big Cornie Bayou." Are not supported by documentation developed and dismisses the potential for a background for zinc in soils and/or stream sediments.

EPA Response to GBMc 9:

EPA public noticed a draft TMDL containing zinc for the Cornie Bayou Basin, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to the comments in reference to Sulfates at that time. [1]

GBM[c] Comment 10.

The TMDLs approach is overly conservative in that it provides for a 10% Margin of Safety (MOS), yet also incorporates conservative assumptions. It is not appropriate to utilize both in the preparation of a TMDL.

EPA Response to GBMc 10:

The margin of safety (MOS) can be implicit or explicit or both. Conservative assumptions are a way to provide an implicit MOS. Conservative assumptions have other purposes other than to provide an implicit MOS. Conservative assumptions are not prohibited when using an explicit MOS. There are no strict requirements on how large an MOS should be. It is normal practice to use conservative assumptions even when including an explicit MOS. For comparison purposes, the Louisiana Department of Environmental Quality sometimes uses an explicit MOS of 20 percent in addition to conservative assumptions. EPA does not consider it overly conservative to use a 10 percent explicit MOS in addition to conservative assumptions.

GBM[c] Comment 11.

The TMDL is inconsistent in its assignment of WLA's to point source dischargers. On page 4-4 it states that "Loads from other point sources were assigned to be negligible" and goes on to not assign WLA's for sulfate or zinc to these dischargers. However a sulfate WLA was assigned to GLCC South outfall 002 even though the sulfate data indicated it was less than one-sixth of the criterion, a "negligible" amount. In addition, a WLA for zinc was assigned to GLCC Centeral outfall 003 even though it did not meet the reasonable potential screening of the ADEQ CPP.

EPA Response to GBMc 11:

The dischargers to the HUC-reach were evaluated and Best Professional Judgment was used to provide and allocations were provided to those that may

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

need to discharge the pollutant of concern. Without an allocation of the WLA a discharger cannot discharge any of the pollutant of concern. If during the next permit cycle it was discovered that a discharger did need an allocation, an analysis would be need to be performed to see if a re-allocation could be done. If permit application documents indicate that a discharger does not need an allocation provided in a TMDL, that allocation would be available for future growth of other facilities. During the permit process, if the sulfate concentrations in GLCC South outfall 002 are not high enough to create a reasonable potential for violating water quality standards, ADEQ could omit limits for those parameters in the permit and still be consistent with the TMDL as required by federal regulations. The WLAs are still valid even if the discharge does not create a reasonable potential for violating water quality standards.[1]

GBM[c] Comment 12.

The simplistic TMDL approach is biased in the favor of allocations to non-point sources. The proposed allocations locks point source discharges into discharging at current loadings while giving the vast majority of the loadings to uncontrolled non-point sources.

EPA Response to GBMc 12:

40 CFR 130.7 requires the assignment of the TMDL to WLAs and LAs, which are for point sources and nonpoint sources, respectively. To be included in the WLA, a point source must be in the stream reach that represents the TMDL. Point sources of conservative material pollutants on upstream segments will have their load shown as LAs on downstream segments. This might inflate the LAs on downstream segments and make it appear that the LA is too large.

The last paragraph of section 4.7 (Point Source Loads) documents the fact that point source loads may increase in the future as long as the effluent concentrations are less than or equal to the water quality standards. A sentence has been added to this paragraph to clarify that future changes in point source loads do not require a revision to the TMDL report as long as the total load (point source plus nonpoint source) does not exceed the TMDL.

GBM[c] Request 1.

That USEPA revise the TMDLs in accordance with the requirements of Regulation No. 2 of the Arkansas Pollution Control and Ecology Commission.

EPA Response to GBMc to Request 1:

As described in the responses to various comments above, EPA believes that these TMDLs are already consistent with the current approved Regulation No. 2. No revision is necessary.

GBM[c] Request 2.

That in the revision process, the TMDLs for both zinc and sulfate be amended to increase the wasteload allocations by a factor of 2 for the purpose of providing future growth for point source dischargers.

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

EPA Response to GBMc to Request 2:

See response to *Comment 12*. Future growth of point sources may occur, but only under discharge scenarios that will not cause exceedances of water quality standards. No revision is necessary. As mentioned earlier, EPA public noticed a draft TMDL containing zinc for the Cornie Bayou Basin, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to the comments in reference to zinc at that time [1]

GBM^c Request 3.

That the TMDL be revised to clearly state the control strategies to achieve the proposed reductions and the process for public involvement in those actions.

EPA Response to GBMc to Request 3:

The control strategies to achieve any reductions are not part of this TMDL report. These strategies are typically included in the TMDL implementation plan, which is separate from this document. Reasonable assurances are needed when point sources are given a more-than-equitable share of the load. This was not the case in this document. Please contact ADEQ for information on post TMDL implementation undertaken with watershed groups, stakeholders, and public involvement. No revision to the TMDL report is necessary.

GBM^c Request 4.

We also request that in its response to these comments that the USEPA provide an explanation of its understanding of the process by which TMDL allocations are to be translated into NPDES permit limits and incorporated into the Arkansas Water Quality Management Plan. In particular we are interested in opportunities for additional public comment and the process by which the TMDL can be appealed (if necessary).

EPA Response to GBMc to Request 4:

There are three to five steps in taking a WLA from a TMDL to a permit limit:

1. EPA approves the TMDL.
2. ADEQ, with public participation, adopts the TMDL as a WQMP update for the general conditions of the document and the load distribution scenario. Reallocations of the TMDL may be made at this time.
3. The TMDL implementation plan is developed with stakeholder involvement. Reallocations of the TMDL may be made at this time. At this point a Watershed Restoration Plan may be submitted, if necessary, and funds may be requested under section 319.
4. The WQMP is updated with detailed plans and permit loads.
5. When permits are up for renewal, the WQMP limits will be reviewed and updated, if necessary, prior to permit issuance.

All of these steps have public involvement, which is specified in ADEQ procedures. The state is initially responsible for establishing TMDLs; the state could revise an established TMDL if it so chooses. If conditions change or

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

> standards change to the extent that controls in the WQMP are no longer needed, the WQMP may be updated. The WQMP is a living document that evolves over time.

Lastly, GLCC is currently evaluating conditions of its discharge to Walker Branch (Reach 080402206-816). Based on recent field data, the aquatic life use is currently being maintained and is not impaired. In the review of data, the TMDL contractor appears to have overlooked data which does not support the development of a TMDL. Although effluent data was used to justify listing based on analytical chemistry, the available historical data related to discharge WET testing was not utilized in the evaluation to demonstrate that the aquatic life use is being maintained in the receiving stream (Walker Branch) and Little Cornie Bayou.

We greatly appreciate the opportunity to present these comments and look forward to the response.

Sincerely,
GBM^c & ASSOCIATES

Vince Blubaugh
Principal

EPA Response to GBMc:

> EPA's contractor did not obtain whole-effluent toxicity (WET) data from permittees because those data are not necessary for developing TMDLs for specific parameters such as sulfates. Even if the WET data from GLCC South do not show toxicity, the discharge is still prohibited from causing or contributing to instream exceedances of numeric criteria for individual chemical parameters. No revision to the TMDL report is necessary. [1]

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.

Great Lakes Chemical Corporation Comments

The comments from Great Lakes Chemical Corporation for the Cornie Bayou watershed report are exactly the same as the comments from GBM^c & Associates. Please see the *GBM^c & Associates* [CTRL + click hyperlink] comments and responses.

[1] EPA noticed the comments provided in reference to zinc, however the zinc TMDL for the Cornie Bayou Basin will be released at a later date and we will respond to those comments at that time.