

**TMDL FOR TURBIDITY
FOR THE POTEAU RIVER
NEAR FORT SMITH, AR**

**FINAL
December 29, 2005**

TMDL FOR TURBIDITY FOR THE
POTEAU RIVER NEAR FORT SMITH, AR

Prepared for

EPA Region VI
Water Quality Protection Division
Permits, Oversight, and TMDL Team
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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 pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standards for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

The study area for this project is part of the Poteau River watershed near Fort Smith in western Arkansas. The study area is part of the Arkansas Department of Environmental Quality (ADEQ) Planning Segment 3I and is located within the Arkansas River Valley ecoregion. Land use in the study area is about 49% pasture and 28% forest.

Reach 11110105-001 of the Poteau River was included on the draft 2004 Arkansas 303(d) list as not supporting the aquatic life use due to exceedances of numeric criteria for turbidity. The applicable numeric criteria for turbidity for this reach are 21 NTU (“primary” value) and 40 NTU (“storm-flow” value).

ADEQ historical water quality data were available for one location within the study area. These data were analyzed for long term trends, seasonal patterns, relationships between concentration and stream flow, and relationships between turbidity and total suspended solids (TSS). These analyses showed no significant seasonal pattern or relationship between concentration and stream flow, but higher turbidity levels tended to correspond with higher TSS values.

This TMDL was expressed using TSS as a surrogate for turbidity because turbidity cannot be expressed as a mass load. Regressions between TSS and turbidity were developed for both base flow and storm-flow, but the base flow regression was not used to set a target TSS concentration because the correlation was too low. The storm-flow regression equation was used with the numeric turbidity criteria to develop target TSS concentrations of 17 mg/L (corresponding to the primary turbidity criteria of 21 NTU) and 26 mg/L (corresponding to the storm-flow turbidity criterion of 40 NTU).

The TMDL in this report was 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 TMDL in this report were:

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

The load duration curve was developed using multiple target TSS concentrations because Arkansas has different turbidity criterion for different flow conditions. The target TSS concentration corresponding to the primary turbidity criterion was applied between the 100% exceedence of stream flow and the 60% exceedence of stream flow. The target TSS concentration corresponding to the storm-flow turbidity criterion was applied between the 60% exceedence of stream flow and the 0% exceedence of stream flow.

The wasteload allocation (WLA) for point source contributions were set to zero because no point source discharges were identified within the study area. Future growth (i.e. new permits) would not be restricted by this turbidity TMDL.

An implicit margin of safety (MOS) was incorporated through the use of conservative assumptions. The primary conservative assumption was calculating the TMDL assuming that TSS is a conservative parameter and does not settle out of the water column. The TMDL and percent reductions needed are summarized in Table ES.1.

Table ES.1. Summary of TMDL and percent reductions.

Reach ID	Stream Name	Flow Category	Loads (tons/day of TSS)				Percent Reduction Needed
			WLA	LA	MOS	TMDL	
11110105-001	Poteau River	Base flow	0	2.69	0	2.69	34%
		Storm-flow	0	206	0	206	57%

TABLE OF CONTENTS

1.0	INTRODUCTION	1-1
2.0	BACKGROUND INFORMATION	2-1
2.1	General Information.....	2-1
2.2	Soils and Topography	2-1
2.3	Land Use	2-2
2.4	Description of Hydrology	2-2
2.5	Water Quality Standards.....	2-3
2.6	Nonpoint Sources.....	2-4
2.7	Point Sources	2-4
3.0	EXISTING WATER QUALITY FOR TURBIDITY AND TSS	3-1
3.1	General Description of Data	3-1
3.2	Seasonal Patterns	3-2
3.3	Relationships Between Concentration and Flow	3-2
3.4	Relationships Between TSS and Turbidity	3-2
4.0	TMDL DEVELOPMENT.....	4-1
4.1	Seasonality and Critical Conditions.....	4-1
4.2	Water Quality Targets.....	4-1
4.3	Methodology for TMDL Calculations	4-2
4.4	Flow Duration Curve	4-2
4.5	Load Duration Curves.....	4-3
4.6	Observed Loads	4-3
4.7	TMDL and MOS.....	4-4
4.8	Point Source Loads	4-4
4.9	Nonpoint Source Loads.....	4-5
4.10	Percent Reductions.....	4-5
4.11	Future Growth.....	4-6
5.0	OTHER RELEVANT INFORMATION	5-1
6.0	PUBLIC PARTICIPATION	6-1
7.0	REFERENCES	7-1

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

APPENDIX A:	Maps
APPENDIX B:	Long Term Plots of Turbidity and TSS
APPENDIX C:	Seasonal Plots of Turbidity and TSS
APPENDIX D:	Plots of Turbidity and TSS vs Flow
APPENDIX E:	Plots of TSS vs Turbidity
APPENDIX F:	Load Duration Curves and TMDL Calculations

LIST OF TABLES

Table ES.1	Summary of TMDL and percent reduction.....	ii
Table 1.1	303(d) listing for stream reaches in this task order.....	1-1
Table 2.1	Land use percentages for the study area	2-2
Table 2.2	Information for USGS stream flow gaging station.....	2-2
Table 3.1	Summary of ADEQ data for turbidity and TSS data	3-1
Table 3.2	Results of regressions between TSS and turbidity.....	3-3
Table 4.1	Summary of turbidity TMDLs	4-6

1.0 INTRODUCTION

This report presents a total maximum daily load (TMDL) for siltation/turbidity for one reach of the Poteau River in western Arkansas. This stream reach was included on the final Arkansas 2002 Section 303(d) list (EPA 2003) and the draft 2004 Section 303(d) list (Arkansas Department of Environmental Quality (ADEQ) 2005a) as not supporting the designated use of aquatic life. This stream reach has been consistently included on previous 303(d) lists since 1998. The sources of contamination and causes of impairment from the draft 2004 303(d) listing are shown below in Table 1.1. The TMDL in this report was developed in accordance with Section 303(d) of the Federal Clean Water Act and the Environmental Protection Agency's (EPA) regulations in 40 CFR 130.7.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standards for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern. The LA is the load allocated to nonpoint sources, 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. 303(d) listing for stream reach in this task order.

Reach No.	Stream Name	Sources	Causes	Category	Priority
11110105-001	Poteau River	Surface erosion	Siltation/turbidity	5a	Medium

2.0 BACKGROUND INFORMATION

2.1 General Information

The study area for this report is the part of the Poteau River watershed in western Arkansas and eastern Oklahoma near Fort Smith (see Figure A.1 in Appendix A). The Poteau River watershed is in the Arkansas River Valley ecoregion and in ADEQ Planning Segment 3I. The Poteau River is also in United States Geological Survey (USGS) Hydrologic Unit 11110105.

The impaired reach of the Poteau River (11110105-001) is 2 miles long and ends at the mouth of the Poteau River where it flows into the Arkansas River. This 2-mile reach forms the boundary between Arkansas and Oklahoma. The drainage area of the Poteau River at its mouth is approximately 1,888 square miles (COE 2002).

The Oklahoma Department of Environmental Quality (ODEQ) defines reach OK220100010010_00 as the Poteau River from the confluence of James Fork to the mouth; therefore, reach OK220100010010_00 actually overlaps ADEQ reach 11110105-001. Based on the ODEQ reach boundaries, the study area for this report was defined as the Poteau River basin downstream of James Fork (see Figure A.1). The study area covers 121 square miles in Sebastian County, Arkansas and LeFlore County, Oklahoma.

2.2 Soils and Topography

The soils information was obtained from the State Soil Geographic (STATSGO) database, which is maintained by the Natural Resources Conservation Service (NRCS). The STATSGO soils data are developed on a 1:250,000 scale and are not as detailed as the county soil surveys (prepared at a 1:24,000 scale), but they are useful for showing general soil characteristics for large areas. The two predominant soil textures in the study area are silt loam (about 50% of the study area) and fine sandy loam (about 30% of the study area).

Topography information was obtained from the soil survey for LeFlore County (United States Department of Agriculture (USDA) 1983). The topography of the study area is variable. The flood plains along the Arkansas River and the Poteau River are nearly level to gently undulating, while the southern edge of the study area includes steep, mountainous areas between

the Poteau River and James Fork. Much of the remainder of the study area consists of low ridges adjacent to rolling savannah areas.

2.3 Land Use

Land use data for the study area were obtained from USGS National Land Cover Data (NLCD) (USGS 1992). The spatial distribution of these land use 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 most of the study area consists of pasture or forest.

Table 2.1. Land use percentages for the study area.

Land use	Percentage of study area
Urban	12.5%
Barren/Fallow	0.2%
Water	5.7%
Forest (all types)	27.5%
Pasture	49.4%
Cropland	4.7%
Total	100.0%

2.4 Description of Hydrology

Average precipitation for the study area is about 40 inches per year (USGS 1985). There was one USGS flow gage in the study area: Poteau River near Panama, Oklahoma. Information for this gage is summarized in Table 2.2.

Table 2.2. Information for USGS stream flow gaging station (USGS 2005a).

Gage name:	Poteau River near Panama, OK
Gage number:	07249413
Descriptive location:	County Road bridge, 1.5 miles east of Panama, OK, 0.8 miles downstream from James Fork
Period of record:	October 1989 – December 1990, May 1992 – September 2004
Drainage area:	1,767 square miles
Mean daily flow:	2,344 cfs
Median daily flow:	556 cfs

2.5 Water Quality Standards

Water quality standards for Arkansas waterbodies are listed by ecoregion in Regulation No. 2 (APCEC 2004a). Designated uses for the Poteau River in Arkansas include primary and secondary contact recreation; public, industrial, and agricultural water supply; and perennial Arkansas River Valley fishery.

Section 2.503 of Regulation No. 2 provides both a narrative criterion and numeric criteria that apply to siltation/turbidity. The general narrative criterion is: “There shall be no distinctly visible increase in turbidity of receiving waters attributable to municipal, industrial, agricultural, other waste discharges or instream activities.” The numeric turbidity criteria for streams in the Arkansas River Valley ecoregion are 21 NTU (“primary” value) and 40 NTU (“storm-flow” value). The regulation also states that “the non-point source runoff shall not result in the exceedance of the in stream storm-flow values in more than 20% of the ADEQ ambient monitoring network samples taken in not less than 24 monthly samples.”

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

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

The Oklahoma turbidity standard that applies to the Poteau River is 50 NTU (OWRB 2003). However, a large portion of the Poteau River in Oklahoma just upstream of Reach 11110105-001 is currently unassessed (ODEQ 2002).

2.6 Nonpoint Sources

According to the 2004 303(d) list, the source of turbidity for Poteau River is listed as surface erosion, which includes erosion from agriculture activities, unpaved road surfaces, and unstable stream banks.

2.7 Point Sources

Information for point source discharges in the study area was obtained by searching the Permit Compliance System on the EPA web site (PCS 2005). The search yielded no facilities with point source discharges in the study area.

3.0 EXISTING WATER QUALITY FOR TURBIDITY AND TSS

3.1 General Description of Data

Turbidity and TSS data have been collected by ADEQ at one site in the study area. The location of this sampling site is shown on Figure A.1 (located in Appendix A). TSS data are discussed here because TSS is needed as a surrogate parameter for expressing this siltation/turbidity TMDL. These turbidity and TSS data were obtained from the ADEQ web site (ADEQ 2005b) and are summarized in Table 3.1. The individual data are listed in Table B.1 and shown graphically as time series plots on Figures B.1 and B.2 (located in Appendix B).

Table 3.1. Summary of ADEQ data for turbidity and TSS.

Station	Description	Parameter	Count	Min.	Median	Average	Max.
ARK0014	Poteau River near Ft. Smith, AR	Turbidity	160	2	45	49.6	203
		TSS	156	3	24	33.9	285

Table B.1 includes a comparison between the observed turbidity data and the numeric water quality criteria. This comparison required the observed data to be separated into base flow data (to be compared with the “primary” criterion) and storm-flow data (to be compared with the “storm-flow” criterion). It was assumed here that the lowest 40% of stream flow values represent flow conditions without significant influence from storm runoff and that stream flow values above the 40th percentile would have some influence from storm runoff. The turbidity data were considered to be base flow data when the flow on the sampling day at the USGS gage on the Poteau River near Panama, OK was 259 cfs or less (the 40th percentile flow, or the flow that was exceeded 60% of the time). The turbidity data were considered to be storm-flow data when the flow on the sampling day at the USGS gage on the Poteau River near Panama, OK was more than 259 cfs. Table B.1 shows that, during 1990 through 2004, the turbidity data at station ARK0014 exceeded the applicable criteria 70% of the time during base flow conditions and 70% of the time during storm-flow conditions.

3.2 Seasonal Patterns

Seasonal plots of turbidity and TSS are shown on Figures C.1 and C.2 (located in Appendix C). These plots showed no significant seasonal pattern.

3.3 Relationships Between Concentration and Flow

Plots of turbidity and TSS versus stream flow were also developed to examine any correlation between flow and these two parameters (Figures D.1 and D.2, located in Appendix D). These plots showed no noticeable relationship between concentration and flow.

3.4 Relationships Between TSS and Turbidity

Plots and regression analyses were used to examine relationships between TSS and turbidity. The regressions were performed using the natural logarithms of the data (rather than the raw data values) because most data such as turbidity and TSS fit a lognormal distribution better than a normal distribution.

Separate plots and regression analyses were developed for base flow conditions and storm-flow conditions to be consistent with the numeric criteria for turbidity. The plot and linear regression for base flow conditions (Figure E.1) uses only the base flow data. The plot and linear regression for storm-flow conditions (Figure E.2) uses all of the data regardless of flow on the sampling day. The data collected under base flow conditions were included in the storm-flow regression in order to maximize the accuracy of the lower end of the regression line that corresponds to turbidity values near the numeric criteria.

The plot for storm-flow conditions showed a noticeable correlation, with higher turbidity levels tending to correspond with higher TSS concentrations. The results of the linear regression analyses are summarized in Table 3.2.

The strength of the linear relationship is measured by the coefficient of determination (R^2) calculated during the regression analysis (Zar 1996). The R^2 value is the percentage of the total variation in \ln TSS that is explained or accounted for by the fitted regression (\ln turbidity). For example, in the storm-flow regression in Table 3.2, 35% of the variation in TSS is accounted

for by turbidity and the remaining 65% of variation in TSS is unexplained. The unexplained portion is attributed to factors other than the measured value of turbidity.

Table 3.2. Results of regressions between TSS and turbidity.

Sampling Station	Category	Regression Equation	Number of Data	R ²	Significance Level (P value)
ARK0014	Base flow	$\ln \text{TSS} = 0.282 * \ln \text{Turbidity} + 2.001$	55	0.16	0.0027
	Storm-flow	$\ln \text{TSS} = 0.606 * \ln \text{Turbidity} + 1.017$	125	0.35	4.9×10^{-13}

Note: Regression results in shaded row were not used for TMDL development.

These regressions show a portion of the measurement of the turbidity (NTU) is explained by the measured concentration of TSS. The perfect explanation of the measurement of turbidity to the measurement of TSS would require collecting and analyzing a large amount of data. A number of the items effecting this perfect explanation of the relationship would need to be known. A partial list of the items effecting the relationship follows:

- Velocity of the water at the time of sampling;
- Carbonaceous biochemical oxygen demand (CBOD) concentration;
- Ammonia concentration;
- Nitrate concentration;
- Phosphorus concentration;
- Algal mass in the water column;
- Bacteria mass in the water;
- Measured color of the water;
- Mass of the organic component of the TSS;
- Mass of the material passing through the filter during the TSS analysis;
- Grain size distribution of the inorganic portion of the TSS;
- Specific gravity of the different sizes of inorganic solids particles;
- Hydrograph for the stream;
- Position on the hydrograph (i.e., rising limb, falling limb) at the time of sampling;
- Number of overlapping rainfall events represented by this sample day;
- Magnitude of each of the rainfall events represented by this sample day; and
- Lags of the overlapping rainfall events represented by this sample day.

The collection of the above data would not change the fact that inorganic particles represented in the TSS measurements is the major contributor to the turbidity reading and is the major constituent reduced when sediment BMPs are applied to nonpoint sources. The BMPs used on nonpoint sources for sediment also reduce the load of many of the unexplained contributors in the regression. The effort to have a perfect explanation of turbidity may not result in a better selection of BMPs. The regressions presented above between TSS and turbidity are adequate for the preparation of this TMDL. A stakeholder group of knowledgeable persons from the watershed may need additional information to set a plan of action for this TMDL.

The storm-flow correlation between turbidity and TSS for Poteau River was considered to be acceptable; the R^2 value for this regression (0.35) was within the range of R^2 values for turbidity and TSS from other approved TMDLs in Arkansas (FTN 2001, FTN 2003, FTN 2005). The base flow correlation between turbidity and TSS for Poteau River was considered poor because the R^2 value was low. For this reason, only the storm-flow regression was used for TMDL development (see Section 4.2).

The statistical significance of the regression was evaluated by computing the “P value” for the slope of the regression line. The P value is essentially the probability that the slope of the regression line is really zero. Thus, a low P value indicates that a non-zero slope calculated from the regression analysis is statistically significant. For both regressions, the P values were small and were considered good. The large number of data points caused the statistical significance of the regressions to be good even though the correlations were not strong.

4.0 TMDL DEVELOPMENT

4.1 Seasonality and Critical Conditions

EPA'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. The historical data analysis in Section 3 showed little or no correlation between turbidity levels and either season of the year or flow. Therefore, there is not a critical season or a single critical flow for this TMDL. The methodology used to develop this TMDL (load duration curve) addresses allowable loading for a wide range of flow conditions.

4.2 Water Quality Targets

Turbidity is an expression of the optical properties in a water sample that cause light to be scattered or absorbed and may be caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and plankton and other microscopic organisms (Standard Methods 1999). Turbidity cannot be expressed as a load as preferred for TMDLs. To achieve a load based value, turbidity is often correlated with a surrogate parameter such as TSS that may be expressed as a load. In general, activities that generate varying amounts of suspended sediment will proportionally change or affect turbidity (EPA 1991). Research by Relyea et. al. (2000) states, "increased turbidity by sediments can reduce stream primary production by reducing photosynthesis, physically abrading algae and other plants, and preventing attachment of autotrophs to substrate surfaces".

For the turbidity TMDL in this report, a relationship between turbidity and TSS presented in Table 3.2 was used to develop target TSS concentrations (i.e., numeric endpoints for the TMDLs). Since the base flow regression yielded such a poor correlation, the storm-flow regression was used to develop the target TSS concentrations for both base flow and storm-flow conditions. The target TSS concentration developed for base flow conditions was 17 mg/L (using the storm-flow regression and the primary turbidity criterion of 21 NTU). The base flow target

TSS would have been the same value (17 mg/L) if the base flow regression had been used instead of the storm-flow regression. The target TSS concentration developed for storm-flow conditions was 26 mg/L (using the storm-flow regression and the storm-flow turbidity criterion of 40 NTU). The discussion in Section 3.1 associating the primary turbidity criterion with the base flow portion of the duration curve is the basis for using the descriptor “base flow” in this document for the conditions when the primary turbidity criterion should apply.

4.3 Methodology for TMDL Calculations

The methodology used for the TMDL in this report is the load duration curve. Because loading capacity varies as a function of the flow present in the stream, this TMDL represents 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 2003). This method was used to illustrate allowable loading at a wide range of flows. The steps for how this methodology was applied for the TMDL 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. Plot observed loads with load duration curves (Section 4.6);
4. Calculate TMDL, MOS, WLA, and LA (Sections 4.7-4.9); and
5. Calculate percent reductions (Section 4.10).

4.4 Flow Duration Curve

A flow per unit area duration curve was developed for the study area (see Table F.1 in Appendix F for details). Daily stream flow measurements from the Poteau River near Panama, OK (USGS Gage No. 07249413) were sorted in increasing order and the percent exceedance of each flow was calculated. The flow was divided by the drainage area of the gage to get a flow per square mile. The flow duration curve is shown on Figure F.1 in Appendix F.

4.5 Load Duration Curves

Each flow per unit area from the flow duration curve was multiplied by the appropriate TSS target concentration to develop plots of allowable load versus flow exceedence (load duration curves). The water quality standards for Arkansas (APCEC 2004a) do not specify a range of flows or flow exceedences for which each of the turbidity criteria (primary and storm-flow) is applicable. As discussed in Section 3.1, it was assumed here that the lowest 40% of stream flow values represent flow conditions without significant influence from storm runoff and that stream flow values above the 40th percentile would have some influence from storm runoff. The TSS target corresponding to the primary turbidity criterion was applied to the lowest 40% of flows (from 100% exceedence of stream flow to 60% exceedence of stream flow). The TSS target corresponding to the storm-flow turbidity criterion was applied from 60% exceedence of stream flow to 0% exceedence of stream flow. The load duration curves for storm-flow conditions and base flow conditions are shown on Figures F.2 and F.3 (in Appendix F).

4.6 Observed Loads

The observed loads per unit of drainage area for Poteau River were calculated for each sampling day. Each observed load per unit of drainage area was calculated by simply multiplying the observed TSS concentration times the flow per unit of drainage area on the sampling day (with a conversion factor incorporated). The calculations for observed loads are shown in Table F.1 in Appendix F.

The load duration plots (Figures F.2 and F.3) provide visual comparisons between observed and allowable loads under different flow conditions. Observed loads that are plotted above the load duration curve represent conditions where observed water quality concentrations exceed the target concentrations. Observed loads below the load duration curve represent conditions where observed water quality concentrations were less than target concentrations (i.e., not violating water quality standards).

4.7 TMDL and MOS

The allowable load per unit area for storm-flow conditions was calculated as the TSS target for storm-flow conditions (26 mg/L) multiplied times the flow per unit area at the 30% flow exceedence. The 30% flow exceedence was used because it is considered to represent a typical flow value for storm-flow conditions (it is the midpoint along the flow duration curve between 0% and 60%). The allowable load per unit area for base flow conditions was calculated as the TSS target for base flow conditions (17 mg/L) multiplied times the flow per unit area at the 80% flow exceedence. The 80% flow exceedence was used because it is considered to represent a typical flow value for base flow conditions (it is the midpoint along the flow duration curve between 60% and 100%). The TMDL was calculated as the allowable load per unit area multiplied times the total drainage area at the downstream end of the reach. These calculations are shown at the bottom of Table F.1.

Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for uncertainty in available data or in the actual effect that controls will have on the loading reductions and receiving water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. For this TMDL, an implicit MOS was incorporated through the use of conservative assumptions. The primary conservative assumption was calculating the TMDL assuming that TSS is a conservative parameter and does not settle out of the water column.

4.8 Point Source Loads

The WLA for the TMDL was set to zero because no point source discharges to Poteau River were identified. This urban land area in the study area is 12.5%, which is small. The stormwater contribution to the point source will not be considered in the calculation of the TMDL.

4.9 Nonpoint Source Loads

The LA for nonpoint sources, including natural background, results in being equal to the TMDL because the WLA was zero and the MOS was implicit.

4.10 Percent Reductions

In addition to calculating allowable loads, estimates were made for percent reductions of nonpoint source loads that are needed. For each observed TSS load that exceeded the allowable load at that flow (i.e., each observed TSS load above the allowable load curve in Figures F.2 and F.3), a uniform percent reduction was applied until the number of TSS loads exceeding the allowable loads was less than or equal to an acceptable number. For storm-flow conditions, the acceptable number of exceedences was 20% of the number of storm-flow data. This percentage (20%) was based on the Arkansas water quality standards, which state that “the non-point source runoff shall not result in the exceedence of the in stream storm-flow values in more than 20% of the ADEQ ambient monitoring network samples taken in not less than 24 monthly samples.” (APCEC 2004a). For base flow conditions, the acceptable number of exceedences was 25% of the number of base flow data. This percentage (25%) was based on the ADEQ assessment criteria for turbidity (ADEQ 2002, ADEQ 2005a). For both storm-flow and base flow conditions, whenever the appropriate percentage multiplied by the number of observed values yielded a fractional number (e.g., $25\% \times 38 = 9.5$), the allowable number of exceedences was rounded up to the next whole number (e.g., 9.5 rounded up to 10) in accordance with the ADEQ assessment criteria (ADEQ 2002, ADEQ 2005a). The calculations for percent reductions are shown in Tables F.2 and F.3.

The percent reduction and the results of the TMDL calculations are summarized in Table 4.1 below. These calculations indicated that nonpoint source load reductions are necessary for the Poteau River.

Table 4.1. Summary of turbidity TMDL.

Reach ID	Stream Name	Flow Category	Loads (tons/day of TSS)				Percent Reduction Needed
			WLA	LA	MOS	TMDL	
11110105-001	Poteau River	Base flow	0	2.69	0	2.69	34%
		Storm-flow	0	193	0	193	57%

The percent reductions in Table 4.1 were calculated using methodology that is slightly different than the assessment criteria used by ADEQ to develop the 2004 303(d) list. The ADEQ assessment was performed using turbidity data that were categorized as either base flow or storm-flow values based on the month of the year in which the values were measured. The percent reductions in Table 4.1 were calculated using TSS data that were categorized as either base flow or storm-flow values based on stream flow data on each sampling day. Even with these differences, both the ADEQ assessment and the TMDL analysis indicated that this reach of the Poteau River is impaired. The 2004 draft 303(d) list is still being reviewed by EPA and has not been finalized yet.

4.11 Future Growth

For this turbidity TMDL, typical point source discharges that might occur in the future would not need a WLA because the surrogate being used for turbidity (TSS) is considered to represent inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension). The suspended solids discharged by most point sources are assumed to consist primarily of organic solids rather than inorganic solids. Discharges of organic suspended solids from point sources are already addressed by ADEQ and ODEQ through their permitting of point sources to maintain water quality standards for dissolved oxygen. Therefore, future growth for new point source discharges would not be restricted by this turbidity TMDL.

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 EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, this TMDL was prepared under contract to EPA. After development of the draft version of this TMDL, EPA prepared a notice seeking comments, information, and data from the general public and affected public. No comments, data, or information were submitted during the public comment period. EPA has transmitted the final TMDL to ADEQ for implementation and for incorporation into ADEQ's current water quality management plan.

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APPENDIX A

Maps

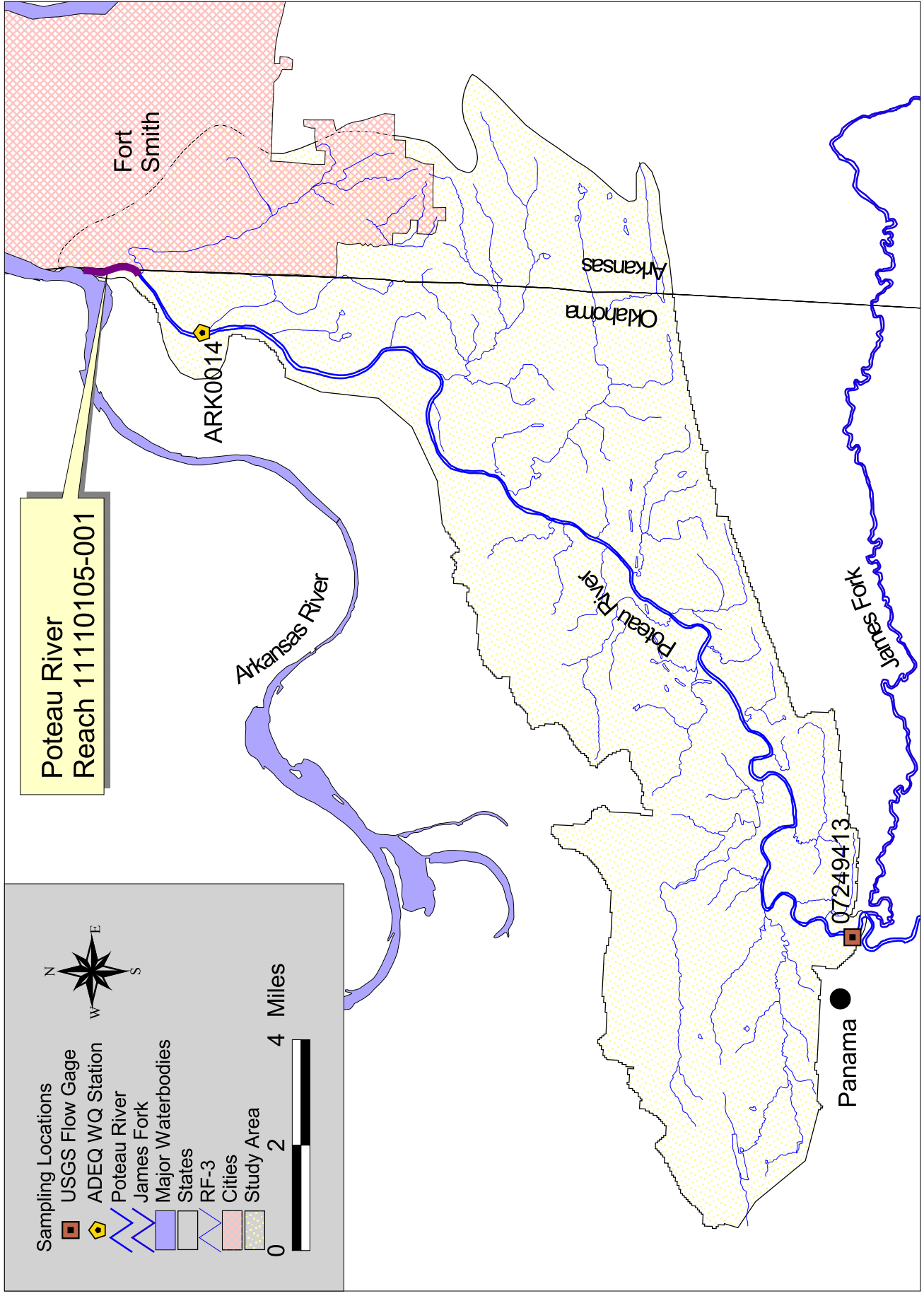


Figure A.1. Map of study area.

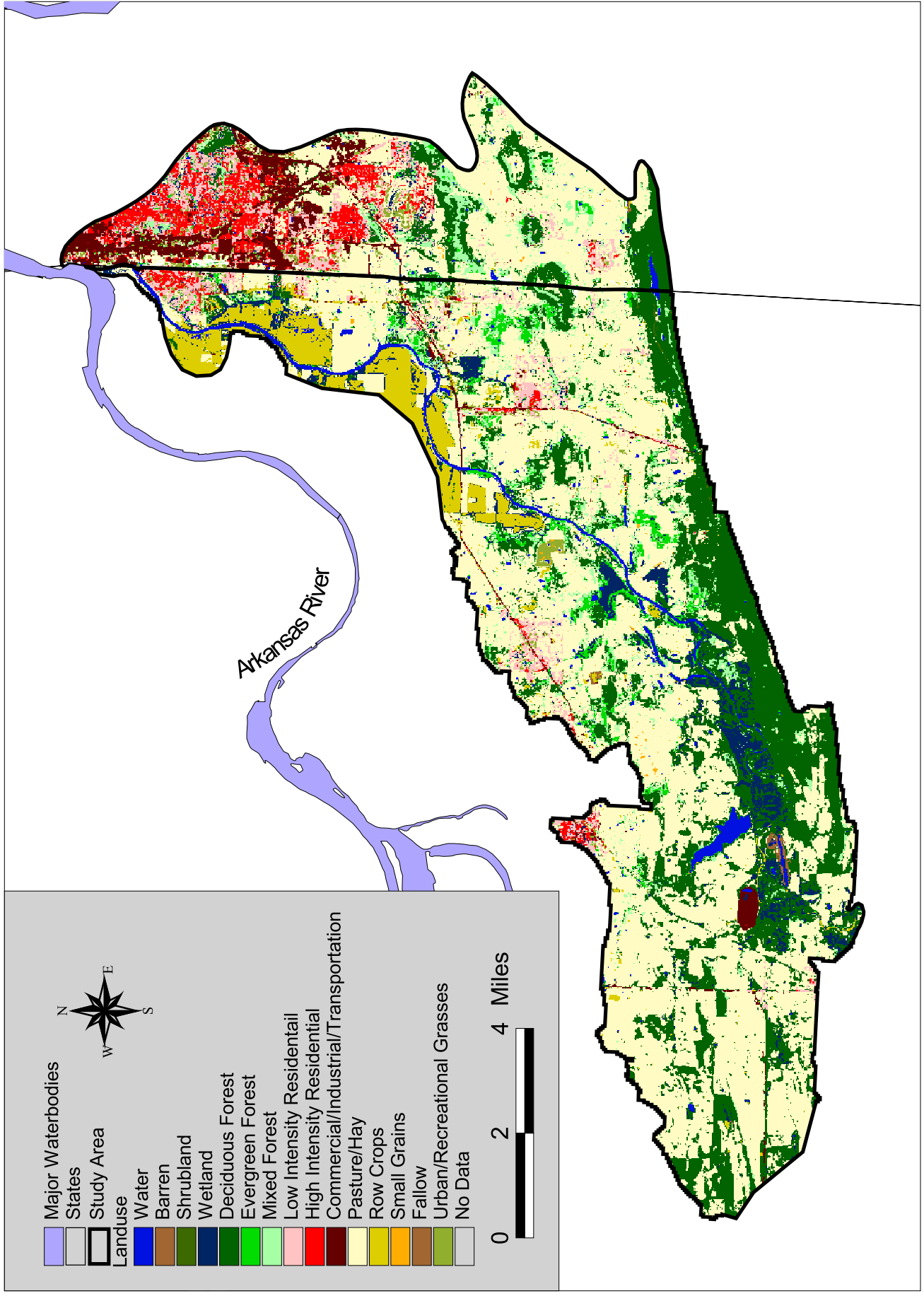


Figure A.3. Land use map.

APPENDIX B

Long Term Plots of Turbidity and TSS

Table B.1. Turbidity and TSS data measured at ARK0014.

Date	Observed Turbidity (NTU)	Observed TSS (mg/L)	Flow on sampling day (cfs)	Observed TSS load (tons/day)	Percent Exceedance	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow criterion?	Turbidity meeting storm-flow criterion?
7/29/2003	77.5	40.2	9	1.01	99.35%	Base flow	21	No	
9/2/1997	15	19.5	14	0.73	97.27%	Base flow	21	Yes	
8/18/1998	36	23.5	17	1.08	95.94%	Base flow	21	No	
9/20/1994	49	47.5	18	2.33	95.42%	Base flow	21	No	
10/5/1999	38	24.5	18	1.20	95.42%	Base flow	21	No	
9/4/2001	20	19.8	18	0.97	95.42%	Base flow	21	Yes	
11/16/1999	18	9	19	0.47	94.93%	Base flow	21	Yes	
11/7/1995	61	19.5	23	1.24	93.16%	Base flow	21	No	
10/19/1994	35	18.5	26	1.28	92.31%	Base flow	21	No	
8/27/2002	16.6	27	27	1.94	91.84%	Base flow	21	Yes	
9/11/1990	56	27	28	2.02	91.40%	Base flow	21	No	
7/29/1997	19	10.5	29	0.82	90.96%	Base flow	21	Yes	
7/21/1998	44	13	29	1.01	90.96%	Base flow	21	No	
8/14/2001	25	20	30	1.61	90.48%	Base flow	21	No	
7/10/2001	2	14.5	31	1.21	90.13%	Base flow	21	Yes	
11/9/1992	48	27	38	2.80	88.19%	Base flow	21	No	
10/22/2002	41.6	13.2	38	1.37	88.19%	Base flow	21	No	
9/12/2000	16	17.5	40	1.86	87.78%	Base flow	21	Yes	
7/30/2002	49	25	41	2.74	87.31%	Base flow	21	No	
11/19/2002	40	10.8	42	1.21	86.74%	Base flow	21	No	
10/9/2001	45	22.5	43	2.59	86.19%	Base flow	21	No	
10/20/1992	29	18	46	2.23	84.50%	Base flow	21	No	
8/17/1993	8	10	48	1.30	83.57%	Base flow	21	Yes	
9/13/1993	14	16	48	2.07	83.57%	Base flow	21	Yes	
9/30/1997	71	24	48	3.11	83.57%	Base flow	21	No	
7/9/1996	4.6	23.5	49	3.11	83.12%	Base flow	21	Yes	
8/8/2000	17	19	49	2.52	83.12%	Base flow	21	Yes	
11/13/2001	31	13	52	1.83	82.17%	Base flow	21	No	
3/18/1996	42	21	54	3.08	81.59%	Base flow	21	No	
10/10/2000	68	56.5	57	8.62	80.84%	Base flow	21	No	
12/5/1995	33	20.5	58	3.19	80.42%	Base flow	21	No	
9/17/2002	40	17.2	58	2.67	80.42%	Base flow	21	No	
10/31/2000	57	38	60	6.13	79.73%	Base flow	21	No	
7/8/2003	123	43.3	61	7.11	79.39%	Base flow	21	No	

Date	Observed Turbidity (NTU)	Observed TSS (mg/L)	Flow on sampling day (cfs)	Observed TSS load (tons/day)	Percent Exceedance	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow criterion?	Turbidity meeting storm-flow criterion?
8/3/1999	19	14.5	65	2.55	78.29%	Base flow	21	Yes	
12/7/1999	58	23.5	66	4.20	78.15%	Base flow	21	No	
6/3/1997	21		67	0.00	78.02%	Base flow	21	Yes	
12/10/2002	60.9	10.5	74	2.09	76.75%	Base flow	21	No	
9/11/1995	29	19.5	75	3.93	76.48%	Base flow	21	No	
8/2/1994	27	3	76	0.61	76.17%	Base flow	21	No	
7/5/1994	21	25.5	82	5.65	75.01%	Base flow	21	Yes	
9/9/1998			90	0.00	73.52%	Base flow	21		
10/9/1995	47	31.5	98	8.35	72.24%	Base flow	21	No	
11/4/1997	77	23	100	6.23	72.04%	Base flow	21	No	
9/3/1996	65	22	105	6.21	71.55%	Base flow	21	No	
5/8/2001	18	14	107	4.03	71.36%	Base flow	21	Yes	
4/15/2003	54	27	114	8.32	70.61%	Base flow	21	No	
6/25/2002	55		117	0.00	70.35%	Base flow	21	No	
6/23/1998	46	16	127	5.48	69.47%	Base flow	21	No	
2/11/2003	30.7	8.2	134	2.95	68.77%	Base flow	21	No	
9/2/2003	50.3	27.2	145	10.65	67.85%	Base flow	21	No	
7/20/1993	36	38	152	15.54	67.47%	Base flow	21	No	
2/8/2000	17	15	191	7.73	64.21%	Base flow	21	Yes	
9/7/1999	39	32.5	198	17.31	63.72%	Base flow	21	No	
10/19/1993	62	56	230	34.67	61.97%	Base flow	21	No	
2/13/1996	47	20.5	235	12.99	61.66%	Base flow	21	No	
8/25/1992	18	11	242	7.19	61.31%	Base flow	21	Yes	
1/9/1996	66	15	270	10.93	60.19%	Base flow	21	No	
7/8/1997	49	39	278	29.20	59.96%	Storm-flow	40		No
1/11/2000	66	20	278	14.97	59.96%	Storm-flow	40		No
8/8/1995	25	23.5	290	18.41	59.51%	Storm-flow	40		Yes
1/19/1999	28	12.5	360	12.13	57.09%	Storm-flow	40		Yes
8/13/1996	61	33.5	381	34.44	56.51%	Storm-flow	40		No
5/6/2003	203	41.2	410	45.56	55.94%	Storm-flow	40		No
4/11/2000	40	23.5	419	26.53	55.67%	Storm-flow	40		Yes
10/1/1996	85	30	426	34.47	55.47%	Storm-flow	40		No
5/31/1994	34	23.5	441	27.95	55.14%	Storm-flow	40		Yes
5/19/1998	59	42.5	475	54.46	54.41%	Storm-flow	40		No
3/14/2000	45	30.5	490	40.32	54.00%	Storm-flow	40		No
6/10/2003	94	56.4	537	81.70	52.90%	Storm-flow	40		No

Date	Observed Turbidity (NTU)	Observed TSS (mg/L)	Flow on sampling day (cfs)	Observed TSS load (tons/day)	Percent Exceedance	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow criterion?	Turbidity meeting storm-flow criterion?
12/4/2001	43	18.3	621	30.62	51.30%	Storm-flow	40		No
4/10/2001	22	27.5	622	46.09	51.25%	Storm-flow	40		Yes
4/4/1995	58	38	701	71.79	49.95%	Storm-flow	40		No
7/11/1995	20	19.5	713	37.51	49.68%	Storm-flow	40		Yes
12/2/1997	63	35.5	772	73.91	48.70%	Storm-flow	40		No
3/18/2003	50.7	17.8	985	47.26	45.58%	Storm-flow	40		No
11/6/1990	57	50	1033	139.24	45.05%	Storm-flow	40		No
1/7/1997	43	39.5	1047	111.48	44.90%	Storm-flow	40		No
1/14/2003	42.4	17.3	1079	50.32	44.43%	Storm-flow	40		No
4/28/1998	30	17.5	1100	51.91	44.13%	Storm-flow	40		Yes
5/6/1997	69	45	1175	142.55	43.32%	Storm-flow	40		No
6/11/1996	93	101	1185	322.86	43.14%	Storm-flow	40		No
4/9/1996	76	63.5	1581	270.64	39.40%	Storm-flow	40		No
6/22/1999	41	22	1687	100.10	38.76%	Storm-flow	40		No
7/6/1999	56	22	1730	102.64	38.46%	Storm-flow	40		No
5/26/1992	57	60	1773	286.83	38.11%	Storm-flow	40		No
5/16/2000	49	43	1805	209.28	37.88%	Storm-flow	40		No
1/3/1995	37	34	1816	166.45	37.84%	Storm-flow	40		Yes
1/4/1994	30	6.5	1976	34.63	36.84%	Storm-flow	40		Yes
10/9/1990	58	40	1997	215.41	36.70%	Storm-flow	40		No
3/23/1993	54	32	2051	176.94	36.36%	Storm-flow	40		No
11/15/1993	110	111	2083	623.33	36.11%	Storm-flow	40		No
11/17/1998	34	10.5	2104	59.57	35.96%	Storm-flow	40		Yes
2/8/1994	77	77	2189	454.58	35.27%	Storm-flow	40		No
6/6/2000	82	72	2264	439.57	34.76%	Storm-flow	40		No
12/4/1990	105	97	2382	622.93	33.91%	Storm-flow	40		No
9/15/1998	97	61.5	2574	426.83	32.27%	Storm-flow	40		No
7/28/1992	48	40	2670	287.98	31.53%	Storm-flow	40		No
2/3/1997	84	145	2937	1148.32	30.00%	Storm-flow	40		No
4/8/1997	84	69.5	2948	552.40	29.86%	Storm-flow	40		No
4/19/1994	33	10.5	2990	84.67	29.55%	Storm-flow	40		Yes
6/12/2001	52	59.8	3001	483.92	29.47%	Storm-flow	40		No
11/5/1996	66	41.5	3065	343.00	29.20%	Storm-flow	40		No
1/8/2002	37	17.5	3311	156.23	27.66%	Storm-flow	40		Yes
3/14/1995	51	52	3343	468.72	27.52%	Storm-flow	40		No
2/26/2002	38	21	3375	191.10	27.23%	Storm-flow	40		Yes

Date	Observed Turbidity (NTU)	Observed TSS (mg/L)	Flow on sampling day (cfs)	Observed TSS load (tons/day)	Percent Exceedance	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow criterion?	Turbidity meeting storm-flow criterion?
3/24/1998	37	14	3663	138.29	25.75%	Storm-flow	40		Yes
2/10/1998	33	15	3898	157.67	24.65%	Storm-flow	40		Yes
12/15/1998	38	12	3920	126.83	24.54%	Storm-flow	40		Yes
5/25/1993	35	14	4026	152.00	23.98%	Storm-flow	40		Yes
2/9/1999	72	36.5	4058	399.43	23.69%	Storm-flow	40		No
10/27/1998	47	24	4122	266.79	23.31%	Storm-flow	40		No
6/8/1993	6.93	18	4475	217.19	21.80%	Storm-flow	40		Yes
12/5/2000	7.7	32.3	4486	390.67	21.70%	Storm-flow	40		Yes
2/6/2001	45	31.3	4635	391.20	21.01%	Storm-flow	40		No
6/16/1992	82	71	4667	893.52	20.83%	Storm-flow	40		No
2/23/1993	42	24	4667	302.03	20.83%	Storm-flow	40		No
6/13/1995	54	30	4699	380.13	20.73%	Storm-flow	40		No
5/7/1996	65	43.5	4731	554.95	20.62%	Storm-flow	40		No
4/27/1993	83	74	5126	1022.91	19.15%	Storm-flow	40		No
4/13/1999	68	285	5223	4013.44	18.79%	Storm-flow	40		No
5/28/2002	120	134	5361	1937.19	18.46%	Storm-flow	40		No
3/16/1999	52	23.5	5511	349.21	18.00%	Storm-flow	40		No
12/3/1996	20	4	5543	59.78	17.84%	Storm-flow	40		Yes
1/8/2001	32	22.5	5607	340.18	17.62%	Storm-flow	40		Yes
7/5/2000	4.7	5.5	5885	87.27	16.65%	Storm-flow	40		Yes
9/29/1992	62	78	6002	1262.39	16.17%	Storm-flow	40		No
1/19/1993	52	36	6579	638.63	14.15%	Storm-flow	40		No
5/10/1994	53	23	7796	483.52	09.26%	Storm-flow	40		No
4/23/2002	45	42.8	7957	918.26	08.67%	Storm-flow	40		No
11/29/1994			8063	0.00	08.10%	Storm-flow	40		
1/31/1995	21	7	8373	158.04	06.84%	Storm-flow	40		Yes
3/13/2001	20	11	8704	258.17	05.44%	Storm-flow	40		Yes
3/1/1994	52	28.5	9260	711.59	04.41%	Storm-flow	40		No
12/14/1993	78	78	9676	2035.10	03.90%	Storm-flow	40		No
3/26/2002	76		10231	0.00	03.38%	Storm-flow	40		No
1/27/1998	44	20.5	11534	637.59	02.49%	Storm-flow	40		No
3/3/1997	120	80	13991	3018.04	01.51%	Storm-flow	40		No
5/18/1999	83	66	14952	2660.94	01.21%	Storm-flow	40		No
12/15/1992	73	50	17195	2318.24	0.96%	Storm-flow	40		No
11/15/1994	38	14.5	19758	772.51	0.71%	Storm-flow	40		Yes
5/9/1995	150		19972	0.00	0.67%	Storm-flow	40		No

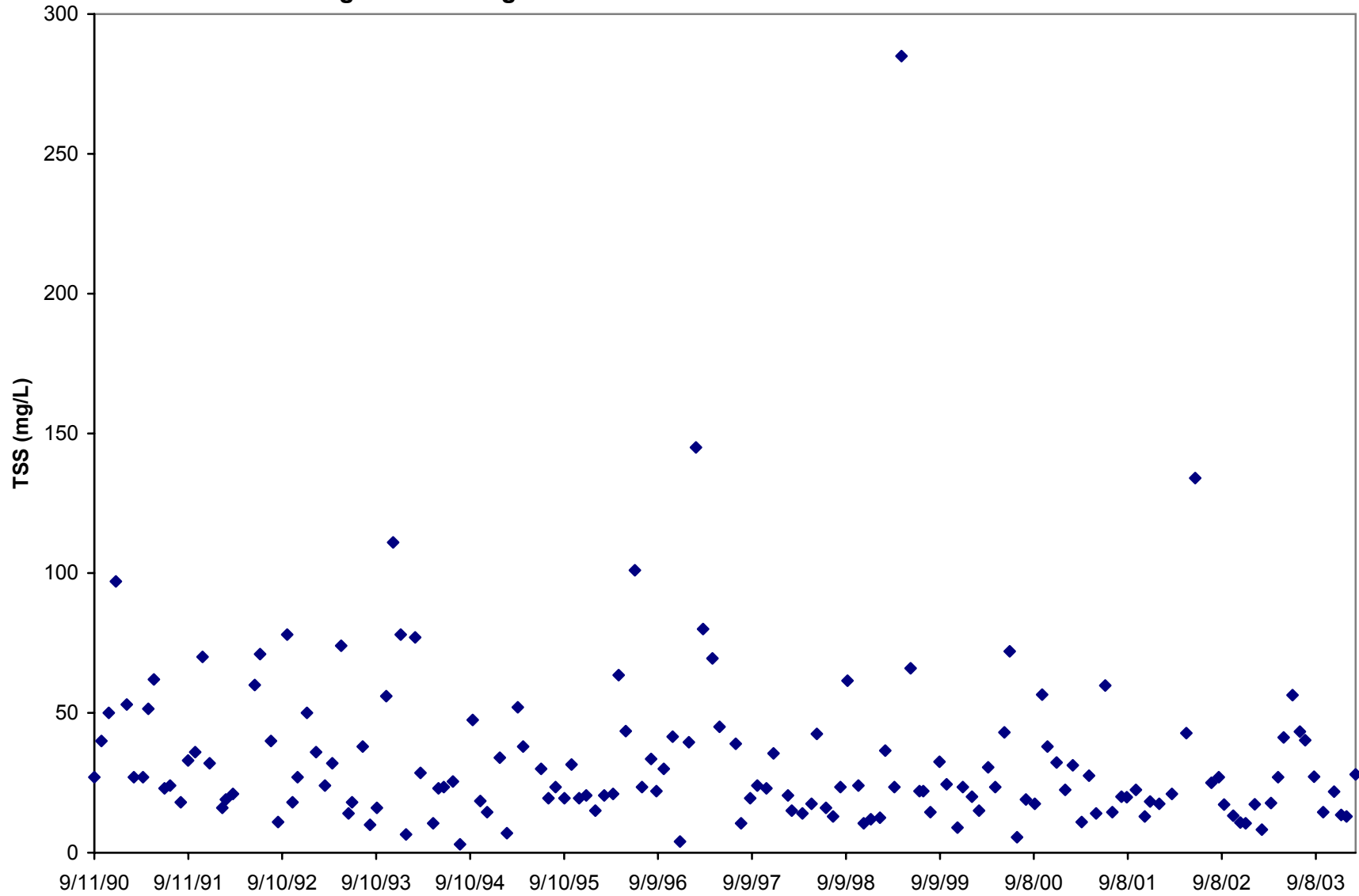
Date	Observed Turbidity (NTU)	Observed TSS (mg/L)	Flow on sampling day (cfs)	Observed TSS load (tons/day)	Percent Exceedance	Applicable category	Applicable water quality standard (NTU)	Turbidity meeting base flow criterion?	Turbidity meeting storm-flow criterion?
1/15/1991	77	53	#N/A	--	--	--	--	--	--
2/12/1991	40	27	#N/A	--	--	--	--	--	--
3/19/1991	36	27	#N/A	--	--	--	--	--	--
4/9/1991	77	51.5	#N/A	--	--	--	--	--	--
4/30/1991	46	62	#N/A	--	--	--	--	--	--
6/11/1991	44	23	#N/A	--	--	--	--	--	--
7/2/1991		24	#N/A	--	--	--	--	--	--
8/13/1991	28	18	#N/A	--	--	--	--	--	--
9/10/1991	36	33	#N/A	--	--	--	--	--	--
10/8/1991	8.4	36	#N/A	--	--	--	--	--	--
11/5/1991	60	70	#N/A	--	--	--	--	--	--
12/3/1991	45	32	#N/A	--	--	--	--	--	--
1/21/1992	2.8	16	#N/A	--	--	--	--	--	--
2/4/1992	32	19	#N/A	--	--	--	--	--	--
3/3/1992	23	21	#N/A	--	--	--	--	--	--
4/7/1992	34		#N/A	--	--	--	--	--	--
10/7/2003	37.4	14.5	#N/A	--	--	--	--	--	--
11/18/2003	88.5	21.8	#N/A	--	--	--	--	--	--
12/16/2003	82.4	13.5	#N/A	--	--	--	--	--	--
1/6/2004	58.9	13	#N/A	--	--	--	--	--	--
2/10/2004	75.5	28	#N/A	--	--	--	--	--	--

NOTE: For flows with "#NA", no flow was available.

Number exceeding applicable water quality standard for turbidity =	39	58
Total number of observations in each category =	56	83
Percent exceeding applicable water quality standard for turbidity =	70%	70%

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Figure B.1. Long Term Plot of TSS for Poteau River at ARK0014



APPENDIX C

Seasonal Plots of Turbidity and TSS

Figure C.1. Seasonal Plot of TSS for Poteau River at ARK0014

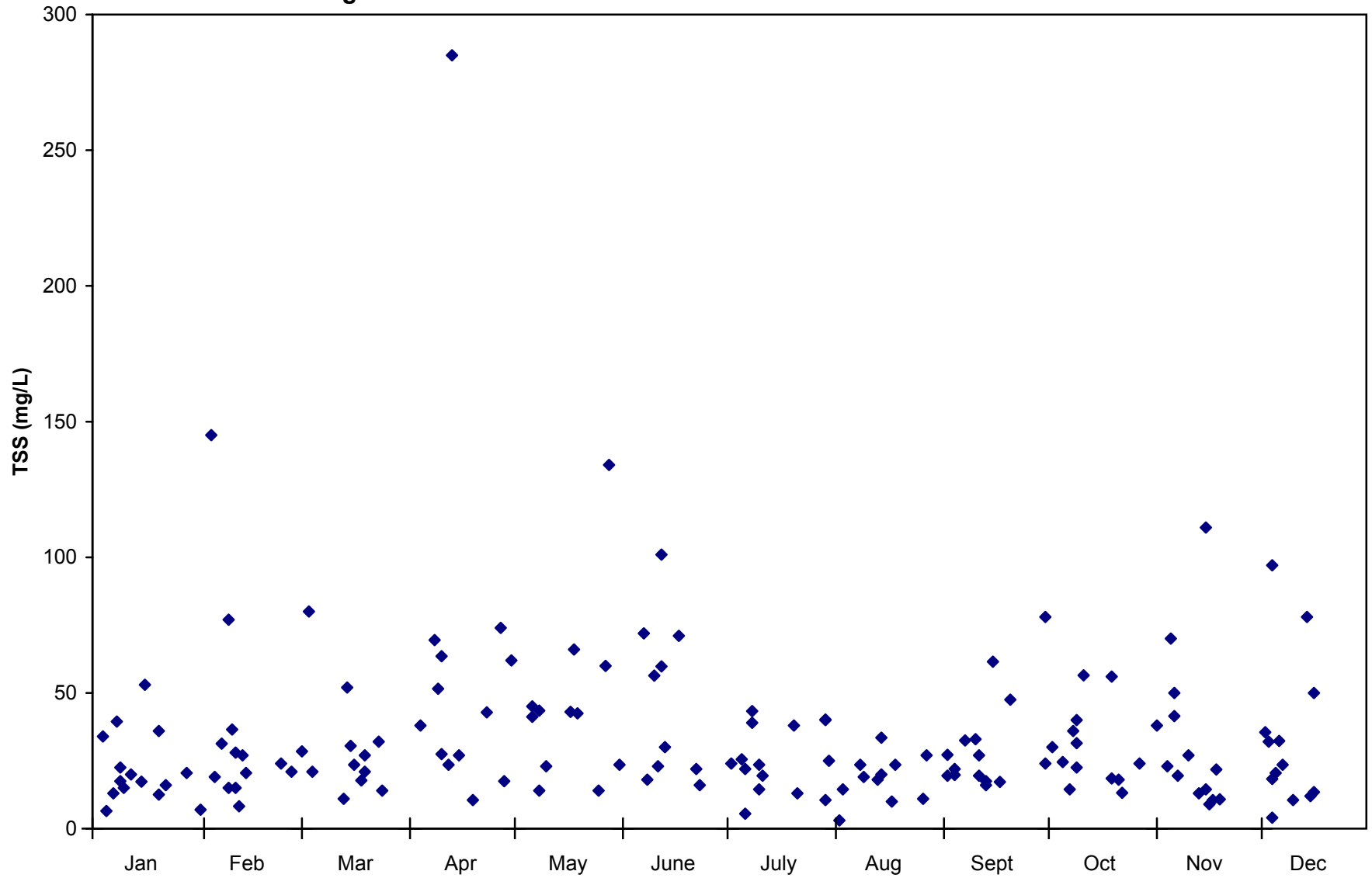
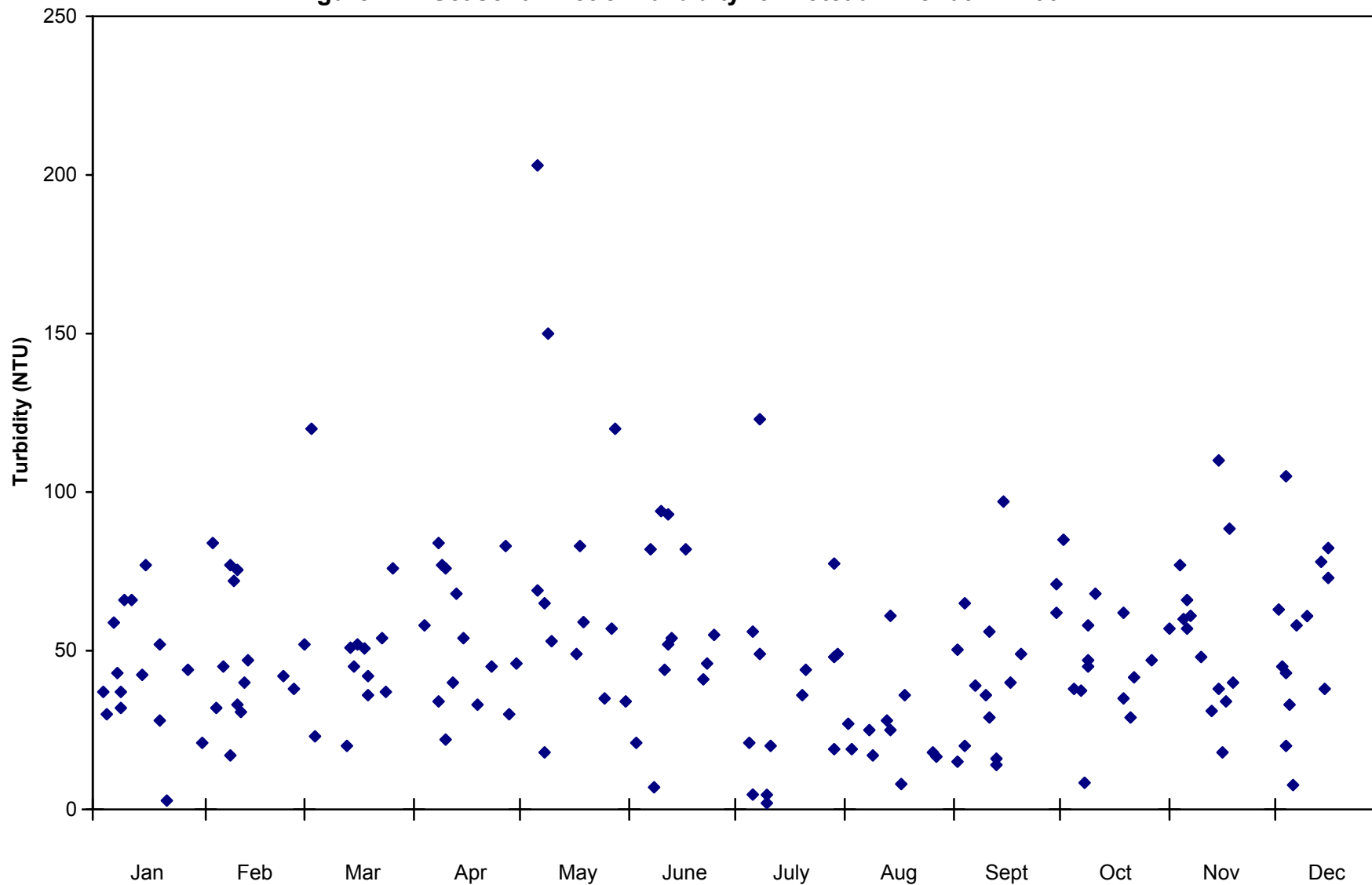


Figure C.2. Seasonal Plot of Turbidity for Poteau River at ARK0014



APPENDIX D

Plots of Turbidity and TSS vs Flow

Figure D.1. TSS vs Flow for Poteau River at ARK0014

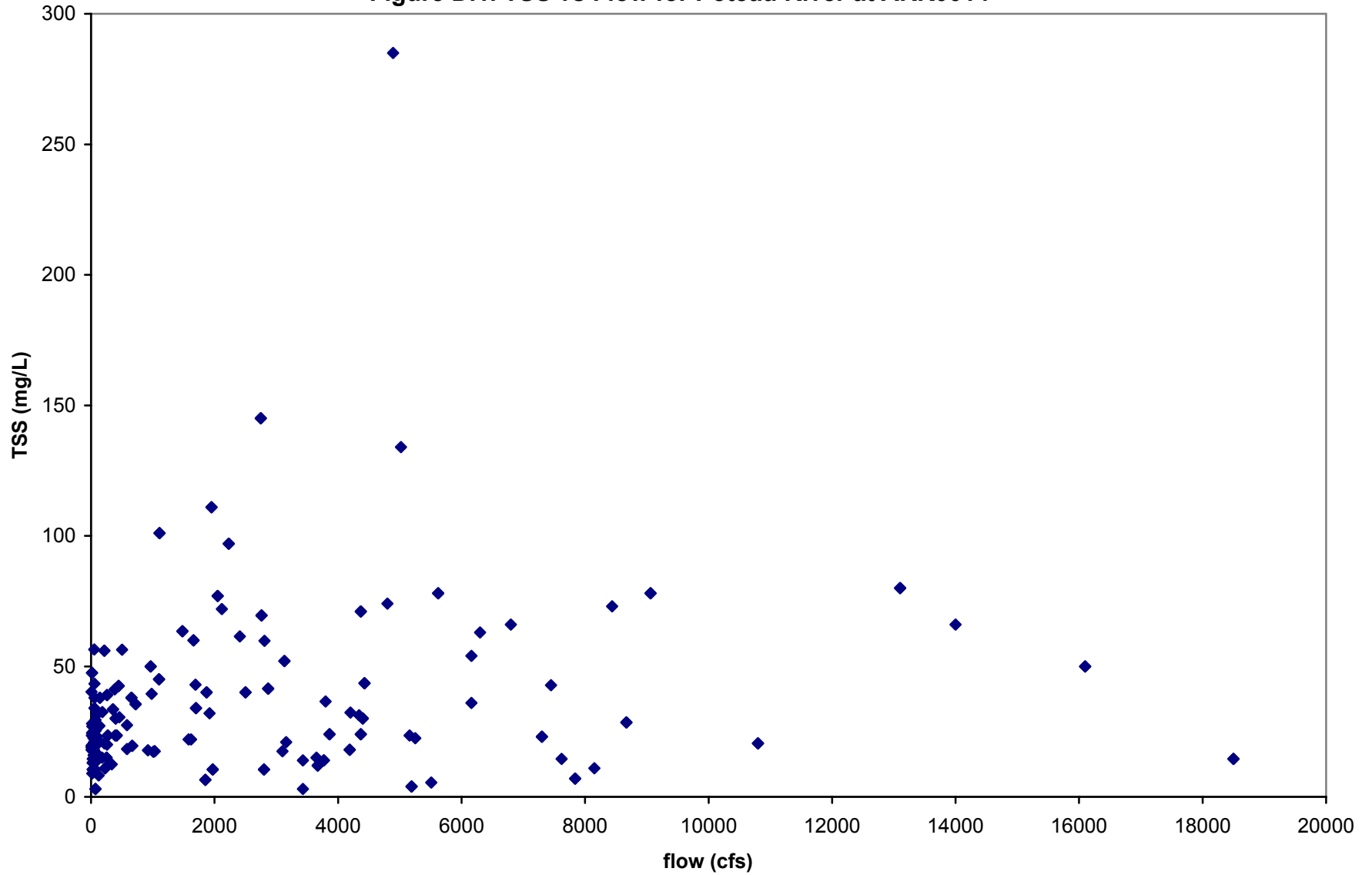
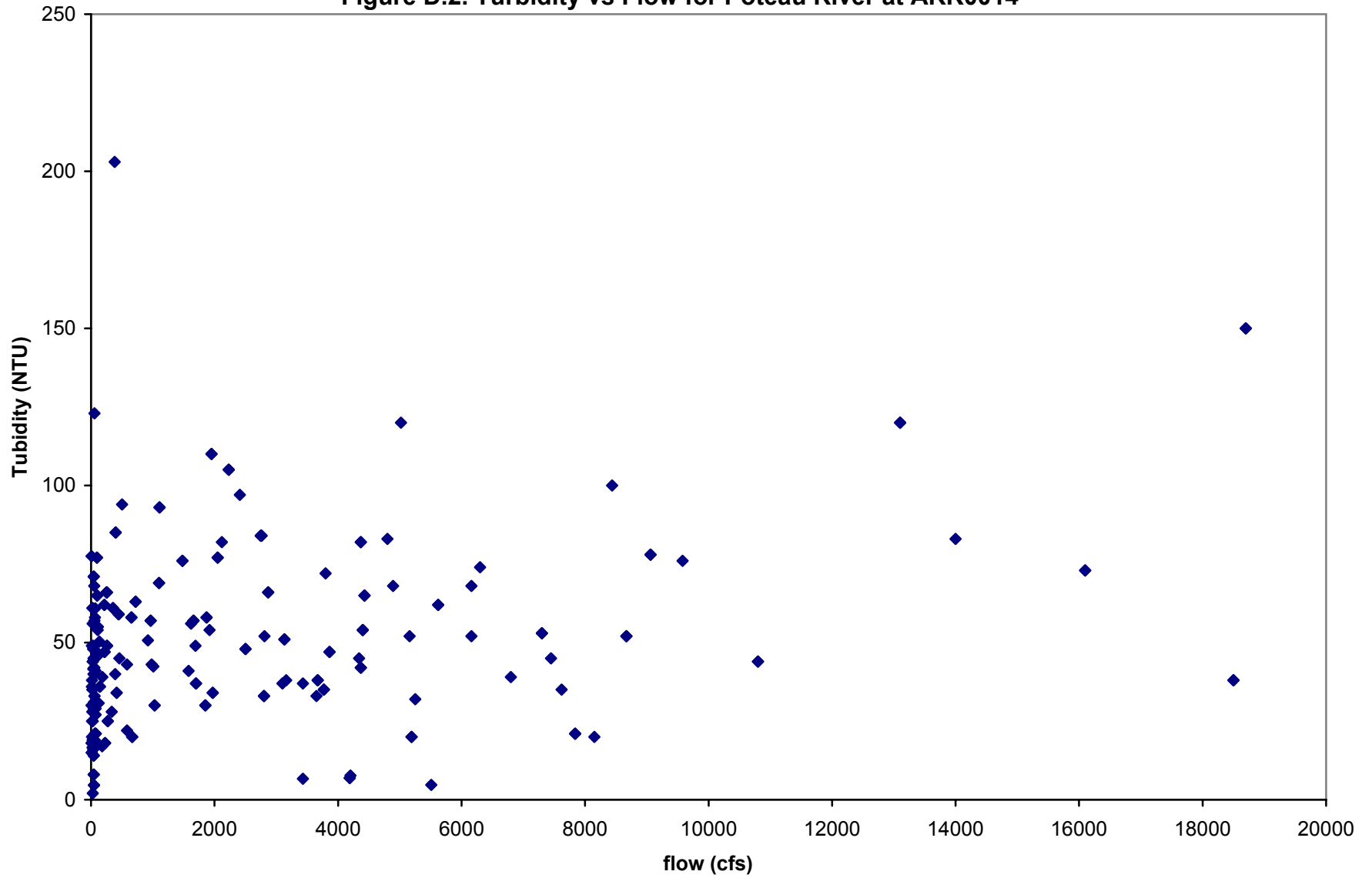


Figure D.2. Turbidity vs Flow for Poteau River at ARK0014



APPENDIX E

Plots of TSS vs Turbidity

Figure E.1. Base flow regression for TSS vs Turbidity for Station ARK0014

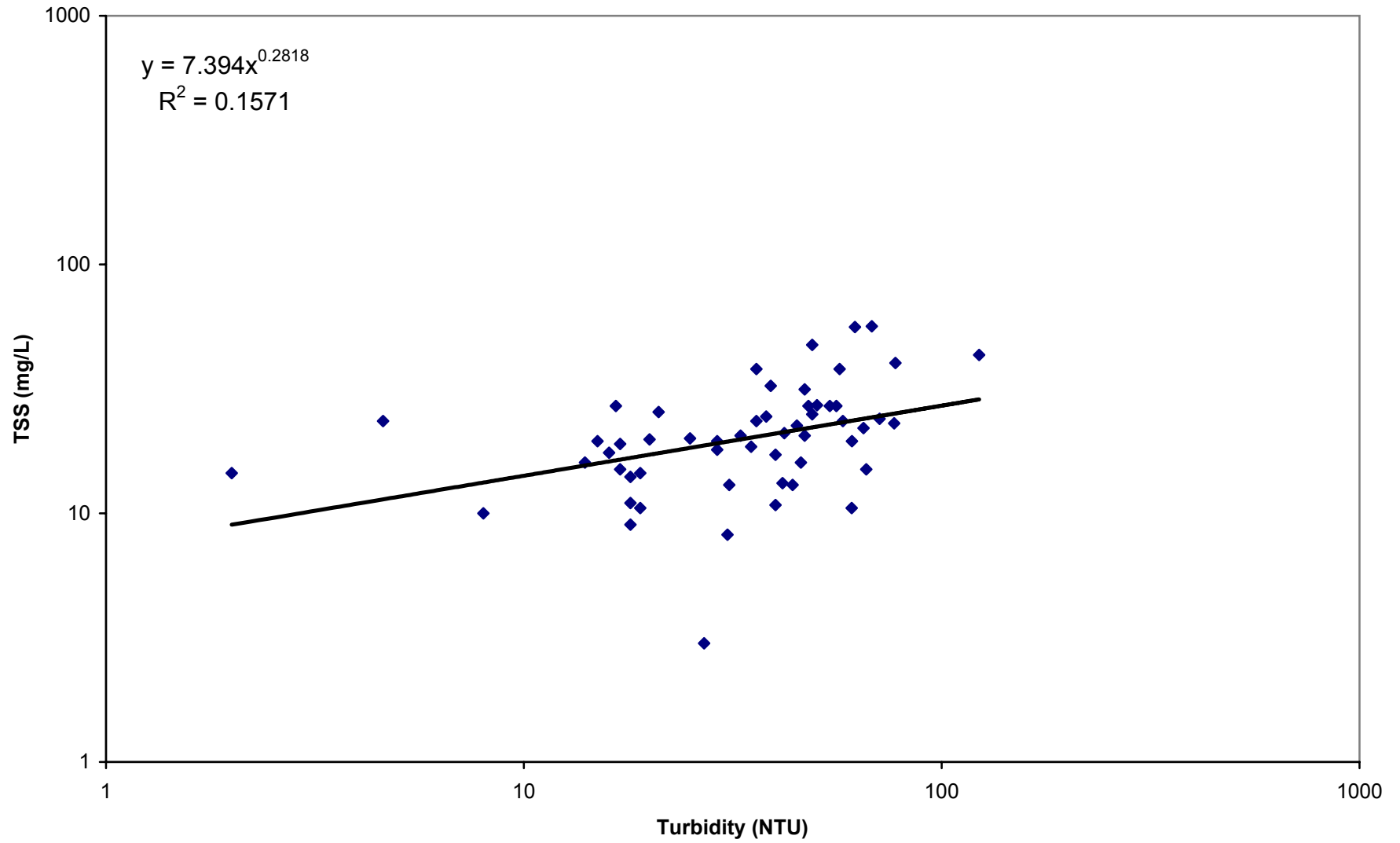
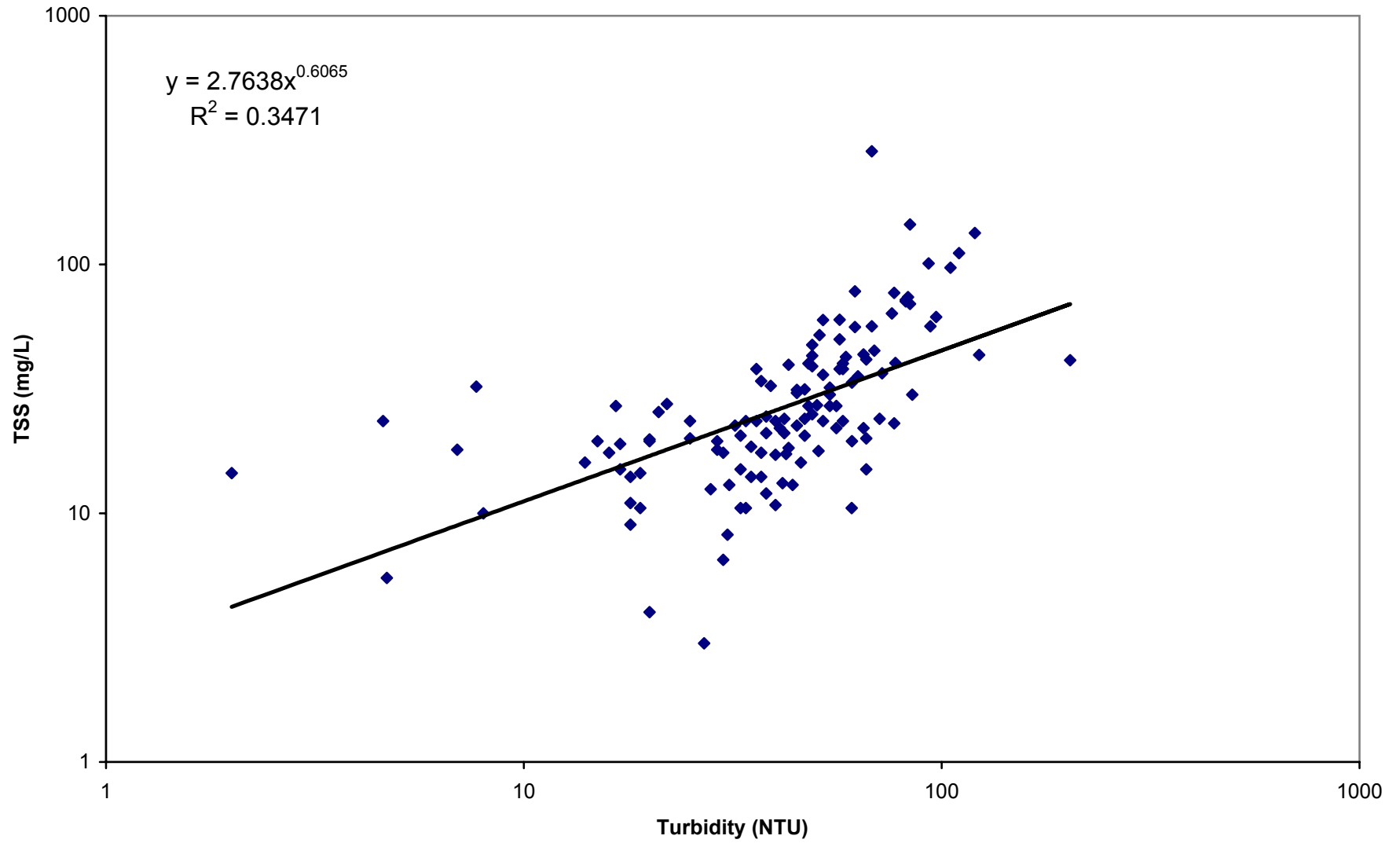


Figure E.2. Storm-flow regression for TSS vs Turbidity for Station ARK0014



APPENDIX F

Load Duration Curves and TMDL Calculations

Figure F.1. Flow Duration Curve for Poteau River at Poteau River near Panama OK

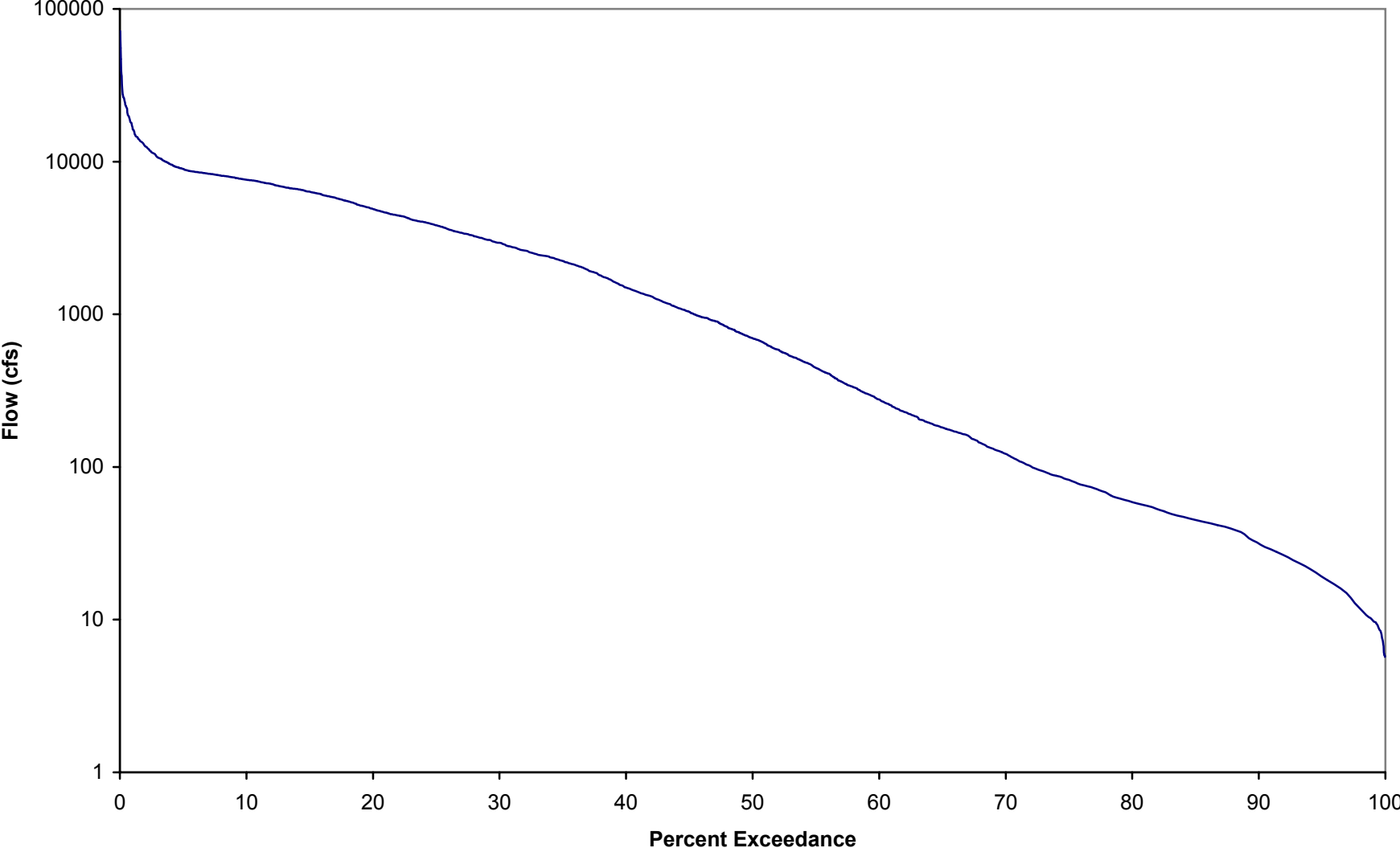


Figure F.2. Storm-flow TSS Load Duration Curve for Poteau River at ARK0014

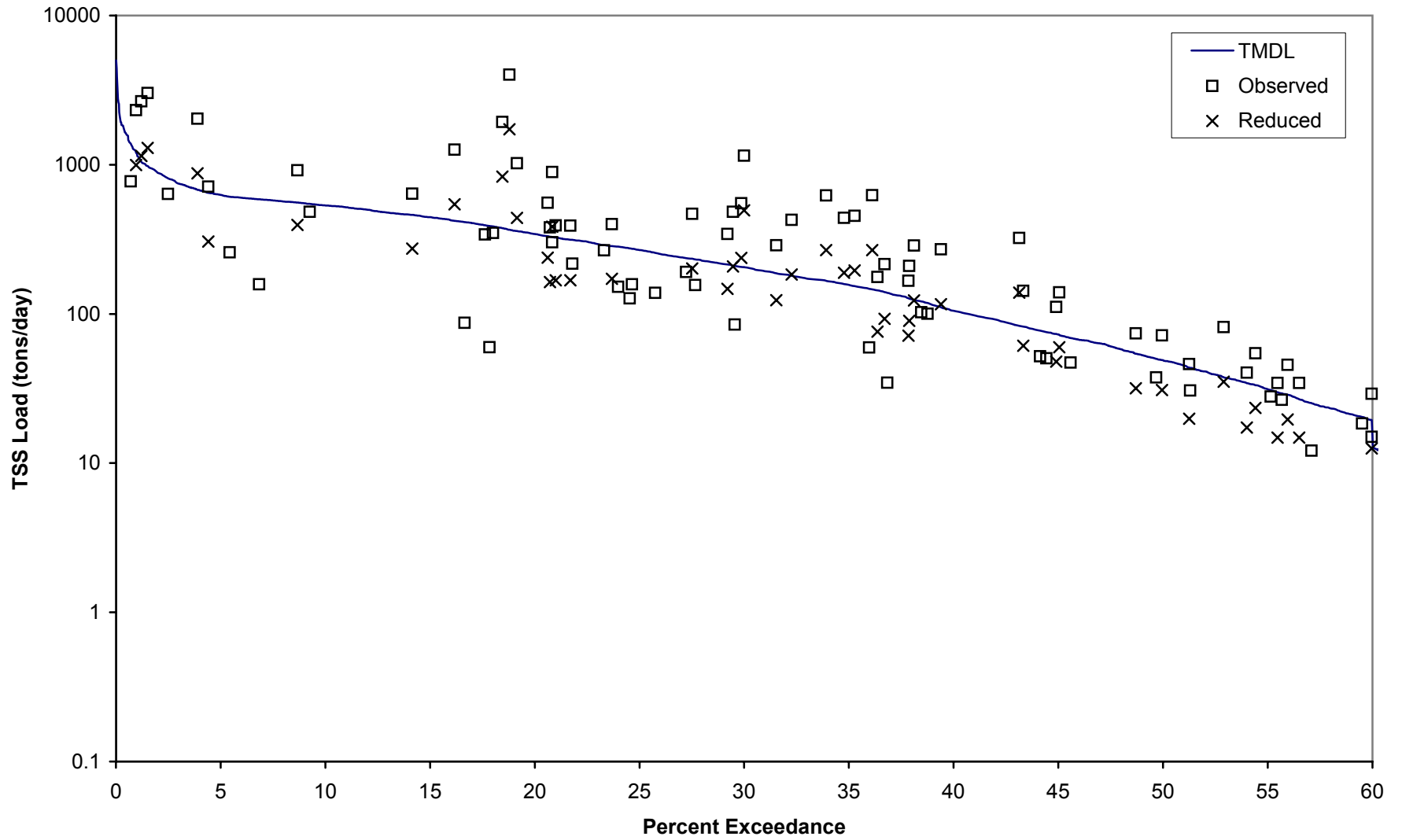


Figure F.3. Base flow TSS Load Duration Curve for Poteau River at ARK0014

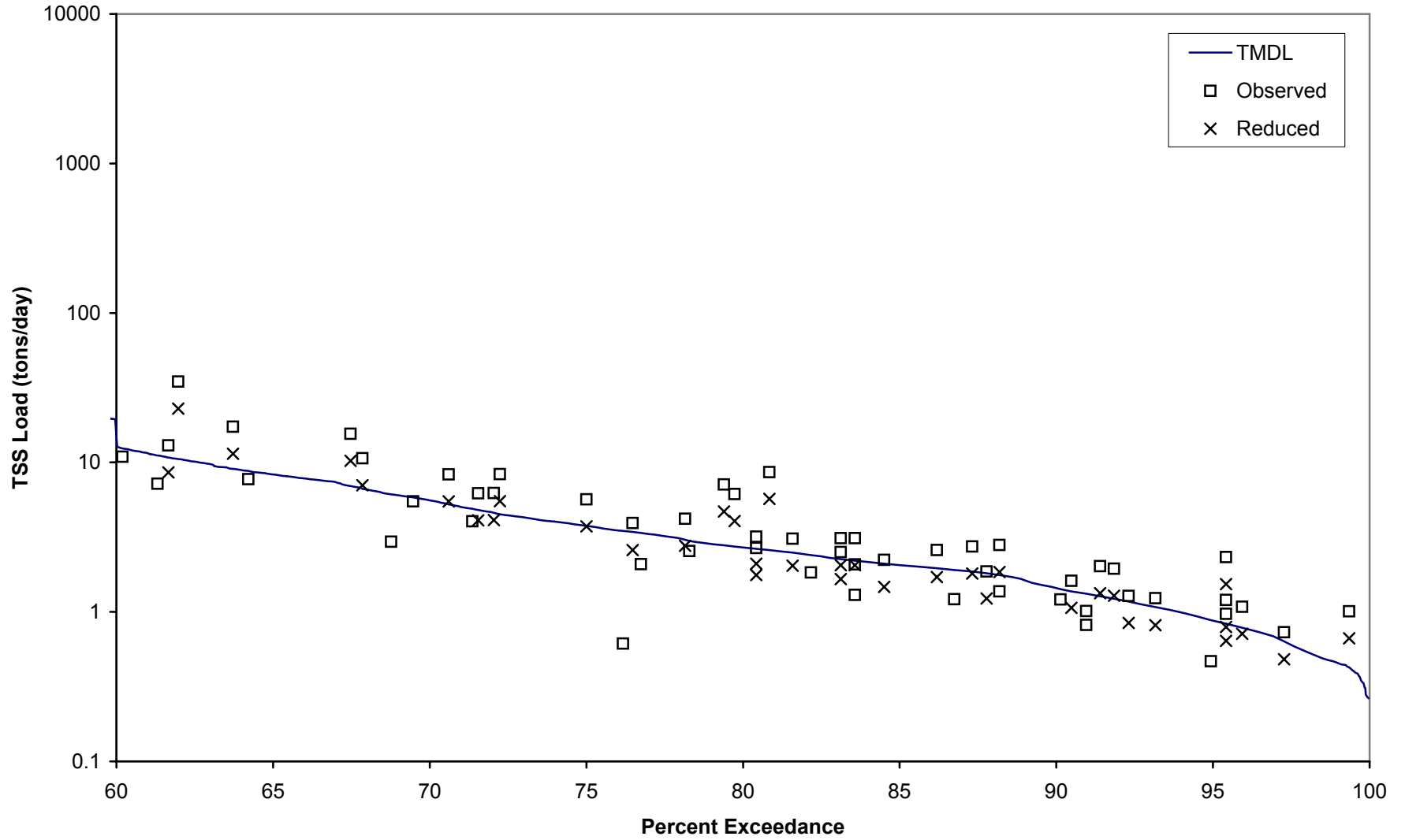


TABLE F.1. ALLOWABLE LOADS FOR POTEAU RIVER

drainage area of USGS gage	1767 square miles
drainage area of study area	121 square miles
TOTAL	1888 square miles

ratio = 1.068 total area to area of USGS gage

Date	Observed flow at Panama (cfs)	Adjusted flow at mouth (cfs)	Percent of days flow exceeded	WQ criterion type	WQ criterion (NTU)	Target TSS (mg/L)	Allowable TSS load to meet criterion (tons/day)
8/23/2003	5	6	99.97%	Base flow	21	17	2.64E-01
8/24/2003	5	6	99.97%	Base flow	21	17	2.64E-01
8/25/2003	5	6	99.97%	Base flow	21	17	2.64E-01

The rows between 99.97 and 80.03 percent flow exceedances are not shown for the sake of brevity.

8/17/2002	55	59	80.03%	Base flow	21	17	2.69E+00
9/16/2002	55	59	80.03%	Base flow	21	17	2.69E+00
7/9/2003	55	59	80.03%	Base flow	21	17	2.69E+00

The rows between 80.03 and 60.03 percent flow exceedances are not shown for the sake of brevity.

12/10/1990	259	277	60.03%	Base flow	21	17	1.27E+01
6/1/1998	259	277	60.03%	Base flow	21	17	1.27E+01
12/1/2001	259	277	60.03%	Base flow	21	17	1.27E+01
12/15/1990	260	278	59.96%	Storm-flow	40	26	1.95E+01
7/8/1997	260	278	59.96%	Storm-flow	40	26	1.95E+01
1/11/2000	260	278	59.96%	Storm-flow	40	26	1.95E+01

The rows between 59.96 and 30.00 percent flow exceedances are not shown for the sake of brevity.

6/20/1999	2750	2937	30.00%	Storm-flow	40	26	2.06E+02
6/21/1999	2750	2937	30.00%	Storm-flow	40	26	2.06E+02
10/12/2001	2750	2937	30.00%	Storm-flow	40	26	2.06E+02

The rows between 30.00 and 0.05 percent flow exceedances are not shown for the sake of brevity.

5/5/1990	52000	55536	0.05%	Storm-flow	40	26	3.89E+03
5/4/1990	59000	63012	0.03%	Storm-flow	40	26	4.42E+03
5/3/1990	67000	71556	0.01%	Storm-flow	40	26	5.02E+03

Flow at downstream end of reach 001 for base flow conditions (60 percent exce 58.7 cfs
 Target TSS for base flow conditions for reach 001 = 17 mg/L
 Allowable TSS load for base flow conditions for reach 001 = 2.69 tons/day

Flow at downstream end of reach 001 for storm-flow conditions (30 percent exc 2937 cfs
 Target TSS for storm-flow conditions for reach 001 = 26 mg/L
 Allowable TSS load for storm-flow conditions for reach 001 = 206 tons/day

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TABLE F.3. CALCULATIONS FOR PERCENT REDUCTION FOR BASE FLOW CONDITIONS
FOR POTEAU RIVER (STATION ARK0014)

Base flow target TSS conc. = 17 mg/L Error check for reduction is / is not needed: ok
 Percent reduction needed = 34% Error check for less or more reduction needed: ok

Category	Date	Observed TSS at ARK0014 (mg/L)	Flow on sampling day (cfs)	Percent exceedance for flow on sampling day	Current TSS load (tons/day)	Reduced TSS load (tons/day)	Allowable TSS load (tons/day)	Reduced load less than or equal to allow. load?
Base flow	7/29/2003	40.2	9.2916	99.35%	1.01	0.66	0.43	No
Base flow	9/2/1997	19.5	13.884	97.27%	0.73	0.48	0.64	Yes
Base flow	8/18/1998	23.5	17.088	95.94%	1.08	0.71	0.78	Yes
Base flow	9/20/1994	47.5	18.156	95.42%	2.33	1.53	0.83	No
Base flow	10/5/1999	24.5	18.156	95.42%	1.20	0.79	0.83	Yes
Base flow	9/4/2001	19.8	18.156	95.42%	0.97	0.64	0.83	Yes
Base flow	11/16/1999	9	19.224	94.93%	0.47	0.31	0.88	Yes
Base flow	11/7/1995	19.5	23.496	93.16%	1.24	0.82	1.08	Yes
Base flow	10/19/1994	18.5	25.632	92.31%	1.28	0.84	1.17	Yes
Base flow	8/27/2002	27	26.7	91.84%	1.94	1.28	1.22	No
Base flow	9/11/1990	27	27.768	91.40%	2.02	1.33	1.27	No
Base flow	7/29/1997	10.5	28.836	90.96%	0.82	0.54	1.32	Yes
Base flow	7/21/1998	13	28.836	90.96%	1.01	0.67	1.32	Yes
Base flow	8/14/2001	20	29.904	90.48%	1.61	1.06	1.37	Yes
Base flow	7/10/2001	14.5	30.972	90.13%	1.21	0.80	1.42	Yes
Base flow	11/9/1992	27	38.448	88.19%	2.80	1.85	1.76	No
Base flow	10/22/2002	13.2	38.448	88.19%	1.37	0.90	1.76	Yes
Base flow	9/12/2000	17.5	39.516	87.78%	1.86	1.23	1.81	Yes
Base flow	7/30/2002	25	40.584	87.31%	2.74	1.81	1.86	Yes
Base flow	11/19/2002	10.8	41.652	86.74%	1.21	0.80	1.91	Yes
Base flow	10/9/2001	22.5	42.72	86.19%	2.59	1.71	1.96	Yes
Base flow	10/20/1992	18	45.924	84.50%	2.23	1.47	2.11	Yes
Base flow	8/17/1993	10	48.06	83.57%	1.30	0.86	2.20	Yes
Base flow	9/13/1993	16	48.06	83.57%	2.07	1.37	2.20	Yes

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0014 <u>(mg/L)</u>	Flow on sampling day <u>(cfs)</u>	Percent exceedance for flow on <u>sampling day</u>	Current TSS load <u>(tons/day)</u>	Reduced TSS load <u>(tons/day)</u>	Allowable TSS load <u>(tons/day)</u>	Reduced load less than or equal to <u>allow. load?</u>
Base flow	9/30/1997	24	48.06	83.57%	3.11	2.05	2.20	Yes
Base flow	7/9/1996	23.5	49.128	83.12%	3.11	2.05	2.25	Yes
Base flow	8/8/2000	19	49.128	83.12%	2.52	1.66	2.25	Yes
Base flow	11/13/2001	13	52.332	82.17%	1.83	1.21	2.40	Yes
Base flow	3/18/1996	21	54.468	81.59%	3.08	2.04	2.50	Yes
Base flow	10/10/2000	56.5	56.604	80.84%	8.62	5.69	2.59	No
Base flow	12/5/1995	20.5	57.672	80.42%	3.19	2.10	2.64	Yes
Base flow	9/17/2002	17.2	57.672	80.42%	2.67	1.77	2.64	Yes
Base flow	10/31/2000	38	59.808	79.73%	6.13	4.04	2.74	No
Base flow	7/8/2003	43.3	60.876	79.39%	7.11	4.69	2.79	No
Base flow	8/3/1999	14.5	65.148	78.29%	2.55	1.68	2.99	Yes
Base flow	12/7/1999	23.5	66.216	78.15%	4.20	2.77	3.04	Yes
Base flow	12/10/2002	10.5	73.692	76.75%	2.09	1.38	3.38	Yes
Base flow	9/11/1995	19.5	74.76	76.48%	3.93	2.59	3.43	Yes
Base flow	8/2/1994	3	75.828	76.17%	0.61	0.40	3.48	Yes
Base flow	7/5/1994	25.5	82.236	75.01%	5.65	3.73	3.77	Yes
Base flow	10/9/1995	31.5	98.256	72.24%	8.35	5.51	4.50	No
Base flow	11/4/1997	23	100.392	72.04%	6.23	4.11	4.60	Yes
Base flow	9/3/1996	22	104.664	71.55%	6.21	4.10	4.80	Yes
Base flow	5/8/2001	14	106.8	71.36%	4.03	2.66	4.90	Yes
Base flow	4/15/2003	27	114.276	70.61%	8.32	5.49	5.24	No
Base flow	6/23/1998	16	127.092	69.47%	5.48	3.62	5.83	Yes
Base flow	2/11/2003	8.2	133.5	68.77%	2.95	1.95	6.12	Yes
Base flow	9/2/2003	27.2	145.248	67.85%	10.65	7.03	6.66	No
Base flow	7/20/1993	38	151.656	67.47%	15.54	10.26	6.95	No
Base flow	2/8/2000	15	191.172	64.21%	7.73	5.10	8.76	Yes
Base flow	9/7/1999	32.5	197.58	63.72%	17.31	11.43	9.06	No
Base flow	10/19/1993	56	229.62	61.97%	34.67	22.88	10.53	No
Base flow	2/13/1996	20.5	234.96	61.66%	12.99	8.57	10.77	Yes
Base flow	8/25/1992	11	242.436	61.31%	7.19	4.75	11.11	Yes

Table F.3. Base flow percent reductions
ARK0014

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0014 <u>(mg/L)</u>	Flow on sampling day <u>(cfs)</u>	Percent exceedance for flow on <u>sampling day</u>	Current TSS load <u>(tons/day)</u>	Reduced TSS load <u>(tons/day)</u>	Allowable TSS load <u>(tons/day)</u>	Reduced load less than or equal to <u>allow. load?</u>
Base flow	1/9/1996	15	270.204	60.19%	10.93	7.21	12.39	Yes

Total number of values = 55
 Allowable % of exceedances = 25%
 Allowable no. of exceedances = 14
 No. of exceedances before reductions = 37
 No. of exceedances after reductions = 14

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TABLE F.2. CALCULATIONS FOR PERCENT REDUCTION FOR STORM-FLOW CONDITIONS FOR POTEAU RIVER (STATION ARK0014)

Storm-flow target TSS conc. = 26 mg/L Error check for reduction is / is not needed: ok
 Percent reduction needed = 57% Error check for less or more reduction needed: ok

<u>Category</u>	<u>Date</u>	<u>Observed TSS at ARK0014 (mg/L)</u>	<u>Flow on sampling day (cfs)</u>	<u>Percent exceedance for flow on sampling day</u>	<u>Current TSS load (tons/day)</u>	<u>Reduced TSS load (tons/day)</u>	<u>Allowable TSS load (tons/day)</u>	<u>Reduced load less than or equal to allow. load?</u>
Storm-flow	7/8/1997	39	277.68	59.96%	29.20	12.56	19.47	Yes
Storm-flow	1/11/2000	20	277.68	59.96%	14.97	6.44	19.47	Yes
Storm-flow	8/8/1995	23.5	290.496	59.51%	18.41	7.92	20.37	Yes
Storm-flow	1/19/1999	12.5	359.916	57.09%	12.13	5.22	25.23	Yes
Storm-flow	8/13/1996	33.5	381.276	56.51%	34.44	14.81	26.73	Yes
Storm-flow	5/6/2003	41.2	410.112	55.94%	45.56	19.59	28.75	Yes
Storm-flow	4/11/2000	23.5	418.656	55.67%	26.53	11.41	29.35	Yes
Storm-flow	10/1/1996	30	426.132	55.47%	34.47	14.82	29.88	Yes
Storm-flow	5/31/1994	23.5	441.084	55.14%	27.95	12.02	30.92	Yes
Storm-flow	5/19/1998	42.5	475.26	54.41%	54.46	23.42	33.32	Yes
Storm-flow	3/14/2000	30.5	490.212	54.00%	40.32	17.34	34.37	Yes
Storm-flow	6/10/2003	56.4	537.204	52.90%	81.70	35.13	37.66	Yes
Storm-flow	12/4/2001	18.3	620.508	51.30%	30.62	13.17	43.50	Yes
Storm-flow	4/10/2001	27.5	621.576	51.25%	46.09	19.82	43.58	Yes
Storm-flow	4/4/1995	38	700.608	49.95%	71.79	30.87	49.12	Yes
Storm-flow	7/11/1995	19.5	713.424	49.68%	37.51	16.13	50.02	Yes
Storm-flow	12/2/1997	35.5	772.164	48.70%	73.91	31.78	54.13	Yes
Storm-flow	3/18/2003	17.8	984.696	45.58%	47.26	20.32	69.03	Yes
Storm-flow	11/6/1990	50	1032.756	45.05%	139.24	59.87	72.40	Yes
Storm-flow	1/7/1997	39.5	1046.64	44.90%	111.48	47.94	73.38	Yes
Storm-flow	1/14/2003	17.3	1078.68	44.43%	50.32	21.64	75.62	Yes
Storm-flow	4/28/1998	17.5	1100.04	44.13%	51.91	22.32	77.12	Yes
Storm-flow	5/6/1997	45	1174.8	43.32%	142.55	61.30	82.36	Yes
Storm-flow	6/11/1996	101	1185.48	43.14%	322.86	138.83	83.11	No

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0014 (mg/L)	Flow on sampling day (cfs)	Percent exceedance for flow on sampling day	Current TSS load (tons/day)	Reduced TSS load (tons/day)	Allowable TSS load (tons/day)	Reduced load less than or equal to allow. load?
Storm-flow	4/9/1996	63.5	1580.64	39.40%	270.64	116.38	110.81	No
Storm-flow	6/22/1999	22	1687.44	38.76%	100.10	43.04	118.30	Yes
Storm-flow	7/6/1999	22	1730.16	38.46%	102.64	44.13	121.30	Yes
Storm-flow	5/26/1992	60	1772.88	38.11%	286.83	123.34	124.29	Yes
Storm-flow	5/16/2000	43	1804.92	37.88%	209.28	89.99	126.54	Yes
Storm-flow	1/3/1995	34	1815.6	37.84%	166.45	71.57	127.29	Yes
Storm-flow	1/4/1994	6.5	1975.8	36.84%	34.63	14.89	138.52	Yes
Storm-flow	10/9/1990	40	1997.16	36.70%	215.41	92.63	140.02	Yes
Storm-flow	3/23/1993	32	2050.56	36.36%	176.94	76.08	143.76	Yes
Storm-flow	11/15/1993	111	2082.6	36.11%	623.33	268.03	146.01	No
Storm-flow	11/17/1998	10.5	2103.96	35.96%	59.57	25.61	147.50	Yes
Storm-flow	2/8/1994	77	2189.4	35.27%	454.58	195.47	153.49	No
Storm-flow	6/6/2000	72	2264.16	34.76%	439.57	189.02	158.73	No
Storm-flow	12/4/1990	97	2381.64	33.91%	622.93	267.86	166.97	No
Storm-flow	9/15/1998	61.5	2573.88	32.27%	426.83	183.54	180.45	No
Storm-flow	7/28/1992	40	2670	31.53%	287.98	123.83	187.19	Yes
Storm-flow	2/3/1997	145	2937	30.00%	1148.32	493.78	205.91	No
Storm-flow	4/8/1997	69.5	2947.68	29.86%	552.40	237.53	206.65	No
Storm-flow	4/19/1994	10.5	2990.4	29.55%	84.67	36.41	209.65	Yes
Storm-flow	6/12/2001	59.8	3001.08	29.47%	483.92	208.08	210.40	Yes
Storm-flow	11/5/1996	41.5	3065.16	29.20%	343.00	147.49	214.89	Yes
Storm-flow	1/8/2002	17.5	3310.8	27.66%	156.23	67.18	232.11	Yes
Storm-flow	3/14/1995	52	3342.84	27.52%	468.72	201.55	234.36	Yes
Storm-flow	2/26/2002	21	3374.88	27.23%	191.10	82.17	236.60	Yes
Storm-flow	3/24/1998	14	3663.24	25.75%	138.29	59.46	256.82	Yes
Storm-flow	2/10/1998	15	3898.2	24.65%	157.67	67.80	273.29	Yes
Storm-flow	12/15/1998	12	3919.56	24.54%	126.83	54.54	274.79	Yes
Storm-flow	5/25/1993	14	4026.36	23.98%	152.00	65.36	282.28	Yes
Storm-flow	2/9/1999	36.5	4058.4	23.69%	399.43	171.75	284.52	Yes
Storm-flow	10/27/1998	24	4122.48	23.31%	266.79	114.72	289.02	Yes

Table F.2. Storm-flow percent reductions
ARK0014

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0014 <u>(mg/L)</u>	Flow on sampling day <u>(cfs)</u>	Percent exceedance for flow on <u>sampling day</u>	Current TSS load <u>(tons/day)</u>	Reduced TSS load <u>(tons/day)</u>	Allowable TSS load <u>(tons/day)</u>	Reduced load less than or equal to <u>allow. load?</u>
Storm-flow	6/8/1993	18	4474.92	21.80%	217.19	93.39	313.73	Yes
Storm-flow	12/5/2000	32.3	4485.6	21.70%	390.67	167.99	314.47	Yes
Storm-flow	2/6/2001	31.3	4635.12	21.01%	391.20	168.22	324.96	Yes
Storm-flow	6/16/1992	71	4667.16	20.83%	893.52	384.21	327.20	No
Storm-flow	2/23/1993	24	4667.16	20.83%	302.03	129.87	327.20	Yes
Storm-flow	6/13/1995	30	4699.2	20.73%	380.13	163.46	329.45	Yes
Storm-flow	5/7/1996	43.5	4731.24	20.62%	554.95	238.63	331.70	Yes
Storm-flow	4/27/1993	74	5126.4	19.15%	1022.91	439.85	359.40	No
Storm-flow	4/13/1999	285	5222.52	18.79%	4013.44	1725.78	366.14	No
Storm-flow	5/28/2002	134	5361.36	18.46%	1937.19	832.99	375.87	No
Storm-flow	3/16/1999	23.5	5510.88	18.00%	349.21	150.16	386.35	Yes
Storm-flow	12/3/1996	4	5542.92	17.84%	59.78	25.71	388.60	Yes
Storm-flow	1/8/2001	22.5	5607	17.62%	340.18	146.28	393.09	Yes
Storm-flow	7/5/2000	5.5	5884.68	16.65%	87.27	37.53	412.56	Yes
Storm-flow	9/29/1992	78	6002.16	16.17%	1262.39	542.83	420.80	No
Storm-flow	1/19/1993	36	6578.88	14.15%	638.63	274.61	461.23	Yes
Storm-flow	5/10/1994	23	7796.4	9.26%	483.52	207.91	546.59	Yes
Storm-flow	4/23/2002	42.8	7956.6	8.67%	918.26	394.85	557.82	Yes
Storm-flow	1/31/1995	7	8373.12	6.84%	158.04	67.96	587.02	Yes
Storm-flow	3/13/2001	11	8704.2	5.44%	258.17	111.02	610.23	Yes
Storm-flow	3/1/1994	28.5	9259.56	4.41%	711.59	305.98	649.17	Yes
Storm-flow	12/14/1993	78	9676.08	3.90%	2035.10	875.09	678.37	No
Storm-flow	1/27/1998	20.5	11534.4	2.49%	637.59	274.16	808.65	Yes
Storm-flow	3/3/1997	80	13990.8	1.51%	3018.04	1297.76	980.86	No
Storm-flow	5/18/1999	66	14952	1.21%	2660.94	1144.20	1048.25	No
Storm-flow	12/15/1992	50	17194.8	0.96%	2318.24	996.84	1205.49	Yes
Storm-flow	11/15/1994	14.5	19758	0.71%	772.51	332.18	1385.19	Yes

Total number of values = 81
Allowable % of exceedances = 20%

<u>Category</u>	<u>Date</u>	Observed TSS at ARK0014 <u>(mg/L)</u>	Flow on sampling day <u>(cfs)</u>	Percent exceedance for flow on <u>sampling day</u>	Current TSS load <u>(tons/day)</u>	Reduced TSS load <u>(tons/day)</u>	Allowable TSS load <u>(tons/day)</u>	Reduced load less than or equal to <u>allow. load?</u>
					Allowable no. of exceedances =			17
					No. of exceedances before reductions =			48
					No. of exceedances after reductions =			17

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